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From Editor's desk

"Samo su dva izvora ljudskih poroka: lenjost i praznoverje,
i samo su dva dobročinitelja: rad i um" - Lav Tolstoj

Početkom novembra ove godine stupio je na snagu dugo očekivani **"novi" Zakon o bezbednosti i zdravlju na radu**. Kontinuirana briga, sprovođenje i unapređivanje bezbednosti i zdravlja na radu lica koja učestvuju u radnim procesima, kao i lica koja se zateknu u radnoj okolini, u sprečavanju povreda na radu, profesionalnih bolesti i bolesti u vezi sa radom i dalje su osnovna načela Zakona. Takođe su definisane: preventivne mere, obaveze i odgovornosti poslodavca, obaveze i odgovornosti zaposlenih, organizacija poslova bezbednosti i zdravlja na radu, evidencija, saradnja, izveštavanje, stručni ispiti za izdavanje licenci, a sve u cilju obezbeđenja onog najvažnijeg – zaštite zdravlja i života zaposlenih. Međutim, veliki broj naučno-istraživačkih institucija iz ove oblasti izrazio je nezadovoljstvo mnogim rešenjima i najavom da se ponovo čeka **"novi" Zakon**. Reči Meše Selimovića da "ništa ne treba čekati, svemu treba ići u susret" ukazuju na smer neophodnih aktivnosti.
Uređivački tim „Inženjerstva zaštite" poziva sve autore da i u narednoj godini objavljuju radove u ovom časopisu, jer je to jedini put da nauka i struka "pobedi" zakonsku regulativu.

"There are only two sources of human vices: laziness and superstition,
and only two benefactors: the work of the mind "- Leo Tolstoy

At the beginning of November this year came into effect the long-awaited "new" Law on Occupational Safety and Health. Continuous care, implementation and promotion of occupational safety and health measures aimed to protect persons involved in work operations, prevention of occupational injuries and occupational diseases, are still basic principles of the Law. It also defines preventative measures, duties and responsibilities of employers and employees, organizational aspects of occupational safety and health, keeping the records, collaboration principles, reporting, licensing procedures, etc. The most important goal is to protect health and lives of employees. However, a large number of research institutions in the field of occupational safety and health expressed dissatisfaction with many elements of the new legislation and with the announcement that soon there would be "new" changes in legislation again. The famous writer Mesa Selimovic once said that "nothing should be waited for, one should go to intercept the events", giving us the direction of the activities that should be taken.
The editorial team of "Safety Engineering" invites authors to continue publishing their research in this magazine in the next year, because it is the only way science and professional practice to achive "victory" over ever changing legislation.

On behalf of the editors
Dr Ivan Krstić

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STUDY OF OAK FORESTS AND SCRUBS OF HORNBEAM VEGETATION, METALS CONTENT OF TEUCRIUM CHAMEDRYS AND SOILS THE FIRST YEAR AFTER WILDFIRE ON VIDLIC MOUNTAIN

Abstract: *On the Vidlič Mountain in southeastern Serbia in the summer of 2007. the wildfire occured, in which burned beech and oak forests, scrubs of hornbeam, dry pastures and rocky ground vegetation. The influence of wildfire on oak forests and hornbeam the first year after fire was followed. Depending of the speed with wich the fire crossed the soil cover, there was a partial or total destruction of vegetation, plant species and their habitats. In the burned areas, soil was more alcaline in comparison to the non burned areas. Heavy metal content (Pb, Cd, Cu, Zn and Fe) was generaly increased both in the soil and plant species of Teucrium chamaedrys from the burned area, thought bellow the permired limits for each metal.*

Key words: fire, Vidlič, oak forests, scrubs of hornbeam, diversity, soil, heavy metals.

INTRODUCTION

The fire on the Vidlič Mountain was observed 20.07.2007. and lasted for ten days [1]. The cause of the fire is human factor by uncontrolled burning of stubble. In the vicinity of the fire starting point is rocky area, that favors the occurence of fire [2]. The vegetation of forests, rocks, shrubs and meadow formations was burned in the fire. A final consequence of fire was more than 2500 ha of burned low vegetation, scrubland and forests [3]. The fire caused changes in the composition and structure of the different communities and habitats of the species on the Vidlič Mountain.

Chemical characteristics of soil are potentially highly influenced by wild fires and they are of the essential importance for vegetation especially, pH and heavy metals content. Metals uptake by plants is strongly dependant on pH, while if plant has been used by humans disregarding the purpose, increased content of heavy metals may represent risk for human's health. That is the main reason why *Tecrium chamaedrys* was chosen- the plant has been widely used in traditional medicine for treatment of the stomach disorders.

MATERIAL AND METHODS

Field studies and deposition of collected plant material

Field research of the fire effects included thermophilous oak forests shrubbery hornbeam on the Vidlič Mountain in southeastern Serbia after one year. The result of field research was plant material, herbarized, labeled and deposited in the Herbarium of the Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš: Herbarium moesiacum (HMN).

Determination of plant material

Determination of the collected plant material was performed according to the Josifović et al. [4], Velcev [5] and Javorka [6]. The nomenclature is adjusted according to the Flora Europaea [7,8].

Phytocenological studies

Phytocenological studies of vegetation of oak forests and scrubs of hornbeam were carried out in accordance with the method of Braun-Blanquet [9]. The results of studies conducted on the areas affected by fire are presented in the form of phytocenological table.

Statistical analysis of the data

Analysis of floristic data was performed using classification and average clustering techniques (WPGMA) from the software package Statistica 8.0 [10]. The analyses employed the combined abundance-cover value of each species per plot. We transformed the combined values into numerical scale as proposed by Westhoff and van der Maarel [11].

Diversity

Alpha diversity of species in the community, within the minimum range, is performed in the software package "Flora" [12]. Species richnes (the total number of species) and Simpson's diversity index [13] that includes species evenness were calculated per quadrant for first season after fire.

Determination of pH of the soil

For measuring pH of the soil, 1 g of sample was weighted, and 5 cm^3 of deionized water was added. After 2 hours of mechanical shacking, the samples were centrifuged, and pH was measured in supernatants. The complete procedure was repeated, only instead of deionized water, KCl solution (1 mol/dm^3) was used.Measurement of pH was performed by pH-meter (Hanna instruments, pH 211, Microprocesor pH meter).

Determination of metals content in soil

Soil samples were collected in 2008. year, from area of oak forst with hornbeam shrubs near locality Vučje and from burned area in the immediate vicinity.The soil samples ewre firstly dryed on the air, until constant mass was achieved, then they were sieved through the polyethylene sieve, in order to obtain well grained and homogenized samples for analysis. Metals content was determined in bio-available, extractible and total fraction of the soil, after three steps sequential extraction. Soil samples treatment was preformed according to the procedure proposed by Tipping et al. with aim to obtain bioavailable metal fraction [14]. The extractible metal fraction was obtained according to the procedure AAS proposed by Manual [15]. Total metal fraction was obtained using the procedure proposed by Radojević & Bashin [16].

Analysis of the metal content was performed using atomic absorbance spectrophotometer (AAS) Perkin-Elmer M-1100.

Determinaton of metal content in plant material

After grinding, samples of 1 g of plant material was weighted in the glass beakers, portions of 10 cm^3 of concentrated HNO_3 were mizzled and left to stand over nigh. By heating over the wather bath, the volumes were reduced, until red fumes of NO_2 didn't disappear. Samples were cooled, and portions of 4 cm^3 70 % $HClO_4$ were added to each solution. The heating process was repeated, reducing volumes up to a small quantity, and filtered over the filter paper (blue mark) into the volumetric flasks of 25 cm^3 and filled with deonized water up to the mark. In these solutions contecentrations of Cu, Pb, Cd, Fe and Zn were detrmined using AAS Perkin-Elmer M-1100 [15].

RESULTS AND DISCUSION

Burned vegetation of oak forests and scrubs on the Vidlič Mountain

The forests on calcareous terrains are more sensitive to the occurrence of heath caused by fire, because it's carbonate basis (which is mostly presented on the Vidlič Mountain) contributes to faster and greater warming and drying up of ground vegetation [17].

In the first year after fire (2008), six phytocenological plots of the burned oak forests and shrubs were made (Table 1), on the skeletal brown soil of the localities Vučje and Visočki Odorovci, at altitudes of 643-885m, on the southern exposure (S), cover at an inclination 5-40, with the number of species 21-55 and values of Simpson diversity index in the range of 0.951-0.98 (Table 2). In all phytocenological plots, was recorded a total of 142 species and subspecies, of which 7 species within trees and 24 species and subspecies in the shrub layer. Only in one plot are recorded 72 species and subspecies. On the locality of Vučje (plot c) where is preserved layer of trees, and oak forests is only partially burned, is recorded the lowest number of species (23) and on the locality Visočki Odorovci (plot g) the largest number of species (55) was recorded. The average number of species is 38.5. Herbaceous species with the higest presence are: *Orlaya grandiflora, Teucrium chamaedrys, Eryngium campestre, Geranium dissectum, Poa pratensis, Brachypodium pinnatum* and *Sideritis montana.*

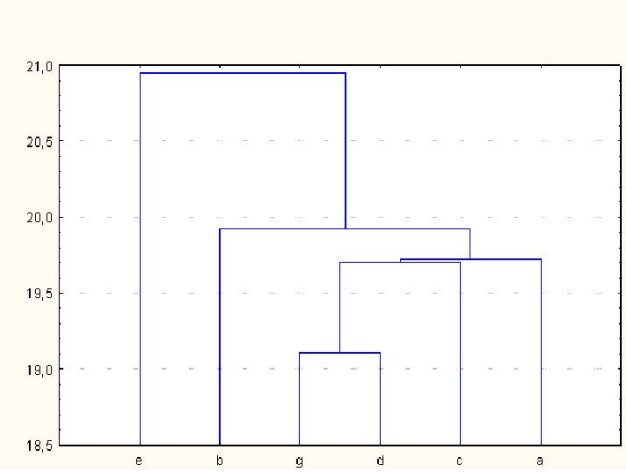

Figure 1. *Cluster analysis of the burned areas of oak forests and shrubs first year after fire*

In figure 1, on a dendrogram grouping of shared plots **d** and **g** can be noticed**.** These two plots are from different and distant localities, but they are both positioned in burned areas of oak forests with approximate sizes of slope and altitude (table 1), which makes them similar in species composition. Plot **e** in the dendrogram clearly stands out from the rest of plots, indicating it's specific species composition, dominated by shrubby species *Prunus tenella*, which is a natural rarity, and it is not recorded in other plots.

Table 1. *Oak forests and shrubs hornbeam the first year after fire (2008)*

Locality	V u č j e					Visočki Odorovci	level of presence.
Altitude (m)	643	650	660	910	907	885	
Exposure	S						
Slope°	5	20	15	30	20	40	
Geological substrate	l i m e s t o n e						
Type of soil	s k e l e t a l b r o w n s o I l						
Surface of plot (m)	100				50	100	
General coverage of vegetation (%)	80		90	60	100	85	
Height of vegetation (m)	2	1,5	5	5	1,5	0,5	
Diameter of the tree (cm)			8				
Date	20.7.	13.7.	13.7.	20.7.	20.7.	6.7.	
Label of plot	**a**	**b**	**c**	**d**	**e**	**g**	
Floristic composition:							
Layer of trees:							
Quercus cerris	.	.	1.1	.	.	+.1	II
Carpinus orientalis	.	.	1.2	.	.	.	I
Quercus petraea	.	.	1.1	.	.	.	I
Fraxinus ornus	.	.	1.1	.	.	.	I
Acer hyrcanum	.	.	1.1	.	.	.	I
Pyrus pyraster	.	.	.	+.1	.	.	I
Quercus pubescens	.	.	.	.	.	2.2	I
Shrub layer:							
Rosa canina	+.1	.	.	+.1	+.1	+.1	IV
Acer hyrcanum	+.1	.	+.2	.	.	.	II
Crataegus monogyna	+.1	.	.	1.1	.	.	II
Ononis pusilla	.	+.1	.	+.1	.	.	II
Quercus cerris	.	.	+.1	.	.	2.2	II
Rosa agrestis	.	.	.	+.1	.	+.1	II
Crataegus laevigata	.	.	.	.	+.1	1.1	II
Ulmus mino	+.1	.	.	.	.	.	I
Carpinus orientalis	.	.	1.2	.	.	.	I
Sorbus torminalis	.	.	+.1	.	.	.	I
Quercus petraea	.	.	+.1	.	.	.	I
Fraxinus ornus	.	.	+.2	.	.	.	I
Evonymus latifolius	.	.	.	+.1	.	.	I
Chamaecytisus austriacus	.	.	.	+.1	.	.	I
Rhamnus cathartica	.	.	.	+.1	.	.	I

Prunus tenella	.	.	.	.	3.3	.	I
Malus pumila	.	.	.	.	2.2	.	I
Ononis spinosa	.	.	.	.	1.2	.	I
Prunus spinosa	.	.	.	.	1.1	.	I
Viburnum lantana	.	.	.	.	+.1	.	I
Syringa vulgaris	.	.	.	.	+.1	.	I
Clematis vitalba	.	.	.	.	.	1.1	I
Prunus domestica subsp.*insititia*	.	.	.	.	.	+.1	I
Cornus mas	.	.	.	.	.	+.1	I
Layer of herbaceous plants:							
Orlaya grandiflora	1.1	+.1	.	2.2	+.1	1.2	V
Teucrium chamaedrys	1.1	1.2	.	+.1	+.1	+.1	V
Eryngium campestre	+.1	+.1	.	+.1	+.1	+.1	V
Geranium dissectum	+.1	.	.	1.1	1.1	+.1	IV
Poa pratensis	+.1	.	.	+.1	2.2	+.1	IV
Brachypodium pinnatum	.	+.1	.	3.3	1.1	2.2	IV
Sideritis montana	.	2.2	.	+.1	+.1	+.1	IV
Medicago sativa subsp. *falcata*	.	+.2	.	2.2	1.1	+.1	IV
Althaea hirsuta	.	+.1	.	1.1	1.1	+.1	IV
Bupleurum praealtum	.	.	+.1	+.1	+.1	1.2	IV
Fragaria vesca	2.2	.	.	1.1	.	+.1	III
Crepis setosa	+.1	.	.	+.1	.	+.1	III
Euphorbia cyparissias	.	1.1	.	+.1	+.1	.	III
Allium flavum	.	1.1	.	+.1	+.1	.	III
Carduus candicans	.	+.1	.	+.1	.	+.1	III
Asperula purpurea	.	1.2	.	.	1.1	1.1	III
Helleborus odorus	.	.	1.1	+.1	+.1	.	III
Dactylis glomerata	.	.	1.2	+.1	.	+.1	III
Ononis pusilla	+.1	.	.	+.1	.	.	II
Centaurea calcitrapa	4.4	.	.	.	.	+.1	II
Festuca pratensis	2.2	.	.	.	.	+.1	II
Agrimonia eupatoria	+.1	.	.	.	.	+.1	II
Carex humilis	.	2.2	.	1.1	.	.	II
Convolvulus cantabrica	.	2.2	.	1.1	.	.	II
Helianthemum nummularium	.	+.1	.	1.1	.	.	II
Satureja kitaibelii	.	1.2	.	.	+.1	.	II
Arabis recta	.	+.1	.	.	+.1	.	II
Melica ciliata	.	1.2	.	.	.	+.1	II
Festuca valesiaca	.	+.2	.	.	.	+.1	II
Teucrium montanum	.	+.2	.	.	.	+.1	II
Allium scorodoprasum subsp.*rotundum*	.	+.1	.	.	.	+.1	II
Thlaspi perfoliatum	.	+.1	.	.	.	+.1	II
Coronilla varia	.	+.1	.	.	.	+.1	II
Viola odorata	.	.	+.1	+.1	.	.	II
Vincetoxicum hirundinaria	.	.	+.1	.	.	+.1	II
Acanthus balcanicus	.	.	+.1	.	.	+.1	II
Linaria vulgaris	.	.	.	+.1	+.1	.	II
Verbascum lychnitis	.	.	.	+.1	+.1	.	II
Cuscuta europaea	.	.	.	2.2	.	+.1	II
Galium aparine	.	.	.	2.2	.	+.1	II
Bromus erectus	.	.	.	1.1	.	+.1	II
Lactuca serriola	.	.	.	+.1	.	+.1	II
Crepis foetida subsp. *rhoeadifolia*	.	.	.	+.1	.	+.1	II
Campanula bononiensis	.	.	.	.	+.1	1.1	II

Carduus acanthoides	2.2	.	.	.	.	.	I
Achillea millefolium	1.1	.	.	.	.	.	I
Euphorbia seguierana subsp. *niciciana*	1.1	.	.	.	.	.	I
Chrysopogon gryllus	.	2.2	.	.	.	.	I
Leontodon hispidus	.	1.1	.	.	.	.	I
Carex caryophyllea	.	+.2	.	.	.	.	I
Cruciata glabra	.	.	1.2	.	.	.	I
Festuca heterophylla	.	.	+.2	.	.	.	I
Melica uniflora	.	.	+.2	.	.	.	I
Fallopia convolvulus	.	.	.	1.1	.	.	I
Thalictrum aquilegiifolium	.	.	.	.	1.2	.	I
Vicia lathyroides	.	.	.	.	1.2	.	I
Trifolium pratense	.	.	.	.	1.2	.	I
Viola jordanii	.	.	.	.	1.1	.	I
Torilis japonica	.	.	.	.	.	1.1	I
Lepidium campestre	.	.	.	.	.	1.1	I

In only one plot with the value +.1 were found following plant species :
Plot a: *Trifolium scabrum*, *Achillea pannonica*, *Verbascum speciosum*, *Cirsium arvense*, *Marrubium peregrinum*, *Galium verum*, *Thymus glabrescens* , *Torilis arvensis*;
Plot b: *Asperula cynanchica*, *Linaria genistifolia* subsp. *sofiana*, *Muscari neglectum*, *Coronilla scorpioides*, *Euphorbia falcata*, *Crucianella angustifolia*, *Cerastium brachypetalum*, *Campanula trichocalycina*, *Ajuga chamaepitys*, *Bromus commutatus*, *Dichanthium ischaemum*, *Agropyron cristatum*, *Thesium arvense*;
Plot c: *Glechoma hirsuta*, *Lathyrus venetus*, *Festuca ovina*;
Plot d: *Crupina vulgaris*, *Digitalis lanata*, *Tamus communis*, *Daucus carota*, *Viola tricolor*, *Lapsana communis*;
Plot e: *Nigella arvensis*, *Cuscuta approximata*, *Trifolium alpestre*, *Camelina rumelica*, *Vicia sativa*, *Trifolium badium* Schreber, *Thymus pannonicus*, *Stellaria media*, *Vicia tetrasperma*, *Petrorhagia prolifera*, *Allium sphaerocephalon*., *Potentilla recta*, *Hypericum perforatum* L., *Artemisia alba*;
Plot g: *Myosotis arvensis*, *Himantoglossum hircinum*, *Calystegia sepium*, *Clinopodium vulgare*, *Viola alba*, *Centaurium erythraea*, *Geum urbanum*, *Veronica austriaca* subsp. *austriaca*, *Ornithogalum pyrenaicum*, *Stachys germanica*, *Sonchus asper*, *Poa angustifolia.*

Table 2 shows mathematical values of alpha diversity of burned areas first year after the fire (2008). It can be seen that the diversity is lowest in plot **c**, which was taken at the place where the oak forest was partially burned and the layer of trees preserved and restored quickly. More open or less concluded community, in which the floor of trees and shrubs was conserved in a small extent, preserved higest index of diversity (plot **g**), from the locality Visočki Odorovci, which is made at the place where the oak forest was completely burned. All other plots have medium values and were made in places where scrub of hornbeam was burned (plots **a, b, d, e**).

Considering the correlation between the burned areas of oak forests and shrubs hornbeam, it may be observed that plots made at high altitudes and higher slopes, have larger total number of species and diversity, and vice versa (Table 2).

Table 2. *Orographic data, species richness and alpha diversity by Whitaker (1972) of burned areas, first year after fire (2008)*

Plot	Altitude (m)	Slope(°)	Species richness	Diversity
a	643	5	26	0.951
b	650	20	38	0.970
c	660	15	23	0.955
d	910	30	44	0.973
e	907	20	45	0.974
g	885	40	55	0.980

pH of Soil

At the site of the plant species *Teucrium chamaedrys*, occuring with the highest level of presence (V) in the floor of herbaceous plants, pH value of the soil was determined and compared with the nearest soil pH from the non burned area (Table 3.).
Obtained soil pH from non burned area, after treatment with deionized water are lower than pH of soil from burned area. After the wild fire, acidic compounds from the organic fraction of soil were destroyed and it has contributed to the increase of pH of fire-affected soils.
A relatively simple method to determine whether the soil particles neutral, positively or negatively charged is a measurement of the soil pH in 1 M KCl solution and in deionized water. The difference obtained in this way is referred as ΔpH and is calculated by the following formula:

$$\Delta pH = pH_{H2O} - pH_{KCl}$$

Table 3. *pH values of soil at site of plant species Teucrium chamaedrys: (NB)-non burned and (B)-burned, after treatment with deonized water and 1M KCl solution*

	pH (H_2O)		pH (KCl)	
	NB	B	NB	B
Teucrium chamaedrys	7.24	7.38	6,78	6,83
ΔpH	0.14		0.05	

Changes in pH (ΔpH) for soils from both burned and non burned areas have positive (0.55 and 0.46, respectively), indicating presence of negatively charged colloidal soil particles. It is noticeable increase of soil pH at the burned in comparison with non burned areas.

Content of heavy metals in soil and plant species *Teucrium chamaedrys*

The content of heavy metals Cu, Pb, Cd, Zn and Fe in underground and above-ground parts of plants collected from the burned and non burned areas of oak forests with hornbeam shrubs was determined by AAS method after mineralization, and then calculated the average content of each metal in the whole plant.

Table 4 shows the contents of heavy metals in underground and above-ground organs of plant *Teucrium chamaedrys* and in soil from burned and non burned areas.

In the soil affected by wild fire in the habitat of plant species *Teucrium chamaedrys*, Cu content is slightly lower than in soil from non burned area, while in the plant, from burned area Cu content was almost three times higher in comparison to non burned area.

The bioavailability of metals from soil to plants is determined by soil characteristics, forms in which metal is present in soil, and especially by the interaction between the soil and plants. Bioaccumulation factor can be defined as ratio of the amount of heavy metals in airal and underground part of the observed plant species [18]. Bioaccumulation factor represents the ratio of transfer soil-plant, and can be calculated as ratio of metal concentration in the plant and the total concentration of metal in the soil.

Table 4. *Content of heavy metals in underground and above-ground parts of plant species Teucrium chamaedrys and in soil from non burned (NB) and burned (B) area (mean ± standard deviation)*

Teucrium chamaedrys	Cu	Pb	Cd	Zn	Fe
Soil (NB)	26.73±0.23	40.61±0.31	0*	68.75±0.28	21661.09±5.24
Above-ground (NB)	1.76±0.09	1.97±0.07	1.04±0.21	32.85±0.21	157.36±1.15
Underground (NB)	0*	0*	1.14±0.16	19.40±0.25	249.00±2.14
Whole plant (NB)	**0.88±0.05**	**0.99±0.42**	**1.09±0.18**	**26.13**±0.19	**203.18±1.65**
Soil (B)	24.70±0.08	114.93±0.17	5.64±0.14	76.01±0.32	11086.43±4.32
Above-ground (B)	2.24±0.11	1.90±0.08	1.80±0.14	48.40±0.48	177.16±1.63
Under-ground (B)	2.75±0.23	3.85±0.17	1.40±0.17	35.25±0.38	519.12±1.28
Whole plant (B)	**2.50±0.17**	**2.88±0.13**	**1.60±0.15**	**41.83±0.26**	**348.14±1.46**

*concentration (in ppm) bellow detection limit of AAS

Coefficient of transport of heavy metals from underground to above-ground part of the plant can be calculated from the ratio of the total amount of metals in the plant and the total amount of metal from the corresponding soil where the plant grows, to determine the mobility and bioavailability observed metals from the soil [19].

Table 5. *Values of bioaccumulation factors of heavy metals for plant species Teucrium chamaedrys from non burned (NB) and burned (B) area of oak forest with hornbeam schrubs*

	NB	B
Cu	0.033	0.101
Pb	0.024	0.025
Cd	1.091	0.284
Zn	0.380	0.550
Fe	0.009	0.031

Bioaccumulation factors and koeficient of transfer soil-plant for plant species *Teucrium chamaedrys* are presented in Table 5.

Plant species *Teucrium chamaedrys* from the burned area has the bioaccumulation factor for zinc greater than 0.5, which indicates its tolerance to increasing concentrations of zinc.

The interaction of plants with heavy metals can be viewed through the transfer coefficient of the heavy metal between the underground and above-ground parts of the plant. It is calculated as the ratio of the concentration of heavy metals in aboveground and underground part of the observed plant species [18].

Calculated values for Cu, Pb, Cd, Zn, Fe of plant species *Teucrium chamaedrys* from non burned (NB) and burned (B) area are presented in Table 6.

Table 6. *Coeficients of transfer (CT) for Cu, Pb, Cd, Zn, Fe in plant Teucrium chamaedrys, from non burned (NB) and burned (B) area*

	Cu	Pb	Cd	Zn	Fe
Above-ground (NB)	1.76±0.09	1.97±0.07	1.04±0.21	32.85±0.21	157.36±1.15
Underground (NB)	0*	0*	1.14±0.16	19.40±0.25	249.00±2.14
CT (NB)	**0**	**0**	**0.91**	**0.59**	**1.69**
Above-ground (NB)	2.24±0.11	1.90±0.08	1.80±0.14	48.40±0.48	177.16±1.63
Underground (NB)	2.75±0.23	3.85±0.17	1.40±0.17	35.25±0.38	519.12±1.28
CT (NB)	**0.82**	**0.49**	**1.28**	**1.39**	**0.34**

*concentration (in ppm) bellow detection limit of AAS

In soil from the burned habitat of the examined plant, as well as in the plant itself, Pb content was higher than in soil and plant from non burned habitats. In plant species from burned area, Pb was determined in the aboveground part, while in the underground part it was present in concentrations below detection limit. In plant material form burned area a higher content of Pb was determined in the underground than in above ground part. In soil from burned area Cd was found in conecentration of 6 ppm, while in the soil from non burned areas it was bellow detection limit of the method. Plants from burned area contained somewhat more Cd from plants from non burned area. In soil from burned area higher amounts of Zn were registreted. The above ground part of the plant contained greater amount of Zn, than underground part, and total content of Zn was higher in case on burned area.

The content of Fe is higher both in soil and plant from burned area, in comparison to non burned area. In under ground parts of tested plant from both areas, the Fe content was higher.

CONCLUSIONS

Recovering of vegetation of oak forests and shrubs hornbeam the first year after fire depends on degree to which the number of species has been destroyed, or whether it is burned partially or completely.

The smallest diversity is at the place where the oak forest was partially burned, so it is maintained layer of three and fast restored. On the other side, the highest diversity index was recorded in the place where the oak forest was completely burned.

In general, soil from all burned sites, showed increased values, i.e. it become more alcaline. The similar findings are also in cas eof the tested metals- their concentrations were higher in the soil from burned areas, indicating potential risk that fire can provoke. In our case, both burned and non burned localities are in area with low pollution and non of the metal's concentration exceeds average value of each metal in the Earth crust. Content of each metal in analyzed plant may vary, which is caused by tendency of the plant to accumulate metal species in underground and above ground part.

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BIOGRAPHY

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ISTRAŽIVANjE VEGETACIJE HRASTOVIH ŠUMA I ŠIBLjAKA GRABIĆA, SADRŽAJ TEŠKIH METALA U BILjCI PODUBICI I U ZEMLjIŠTU PRVE GODINE NAKON POŽARA NA PLANINI VIDLIČ

Marković Marija, Stankov Jovanović Vesna, Mitić Violeta, Stamenković Slaviša, Ilić Marija, Pešić Dušica

Apstrakt: *Na planini Vidlič u jugoistočnoj Srbiji u leto 2007. godine došlo je do požara u kome je gorela vegetacija bukovih i hrastovih šuma, šibljaka grabića, suvih pašnjaka i kamenjara. U ovom radu sagledan je uticaj požara na vegetaciju hrastovih šuma i šibljaka grabića prve godine nakon požara. U zavisnosti od toga kojom je brzinom požar prešao preko zemljišnog pokrivača, došlo je do delimičnog ili potpunog uništenja vegetacije, odnosno biljnih vrsta i njihovih staništa. Na opožarenom staništu se pokazalo da je zemljište alkalnije u poređenju sa neopžarenim zemljištem. Sadržaj teških metala (Pb, Cd, Cu, Zn i Fe) je uglavnom povećan u zemljištu i biljnoj vrsti podubici - Teucrium chamaedrys na požarištu, ali ne prelazi dozvoljene granice koncentracije u zemljinoj kori za svaki metal posebno.*

Ključne reči: požar, Vidlič, hrastove šume, šibljak grabića, diverzitet, zemljište, teški metali.

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AN EXPERIMENTAL VERIFICATION OF INFLUENCING FACTORS ON THE MECHANISM OF HEAT TRANSFER IN THE CAVITY ROOF VENTILATION

Abstract: *The roof, as a part of the building envelope with the thermal performance that's a major requirement for guaranteeing a comfortable and hygienic interior climate, provides protection from thermal damage incurred by the sun. To improve this protection ability, the use of a ventilated roof can be considered, which has a ventilation layer known as a cavity, beneath the roof cover panel. Based on the proposed mechanism of heat transfer and the influence of such factors as cavity ventilation, the slope of the roof, intensity of solar radiation, the size and shape of the cavity, and panel profiles, airflow and temperature distribution are analyzed in the cavity, in an effort to improve the cooling effect of ventilation in the cavity of the roof. In this study, the influence of these elements on airflow is studied.*

Key words: temperature distribution, cooling effect, air flow, thermal comfort, ventilation channel.

INTRODUCTION

There is a growing awareness regarding the need to reduce energy consumption and to improve indoor environment quality, and accordingly, the energy performance of a building envelope is becoming more and more important. Building envelopes play a major role in solar heat gain, because they are in direct contact with outdoor air. In a conventional construction, the surface temperatures of a building envelope can easily reach 75–80 °C, depending on the orientation, tilt and the time of year [1]. It is also important to minimize the cooling loads from solar heat gain.

In summer, because of the significant increase in solar heat gain via the roof, heat transfer from the outside to the inside through the roof occupies a great portion of the cooling load. This heat can be discharged by adding another layer - a ventilation layer - in the roof. Thus, the absorbed solar energy from the roof will be transferred to the airflow induced by convection and the ventilated roof can decrease the cooling load by preventing heat accumulation in the roof.

MECHANISM OF HEAT TRANSFER IN A VENTILATED ROOF

Roofs can generally be divided into two types: warm roofs and cool roofs.Warm roof designs are configured with each component of the roof assembly placed in contact with the preceding component as in Fig. 1(a). Cool roof designs are configured with the insulation located below the deck, allowing for a ventilation space. In a cool roof, the cavity for ventilation is generally located in the space above an insulated ceiling assembly and below the deck, as in Fig. 1(b). Sometimes, the cavity of a cool roof is closed, to be protected from weather exposure. Fig. 1(c) shows a cool roof with a non-ventilated cavity.

This paper provides results of experiments performed on roofs that include cavities: a ventilated roof and a non-ventilated roof, under summer conditions. The reason for ventilation is based on the assumption that outdoor air passing through a roof will, in average, cool the structure over time.

The balance of heat transfer in a ventilated roof, as shown in Fig. 2, includes conductive heat transfer from the outside to the inside due to temperature difference across the roof, radiation heat gain from the outer surface, together with convective heat transfer, when outdoor air passes through the ventilated cavity [2]. We analyzed the thermal performance of the ventilated roof by estimating the amount of exhausted heat by the following Equation (1):

$$Q_{SO}=Q_{out}+Q_V \quad (1)$$

where

Q_{SO} is the heat gain from solar radiation (W),

Q_{out} is the heat flow back to the outside (W),

Q_{in} is the heat flow to the interior (W),

Q_V is the exhausted heat via the cavity (W) and is given by

$$Q_v = \dot{m} c_p (T_{out} - T_{in}), \quad (2)$$

where

$\dot{m}$ is the mass flow rate (kg/s),

c_p is the air specific heat at constant pressure (J/kgK),

T_{out} is the outside air temperature in the shade (K),

T_{in} is the indoor air temperature (K).

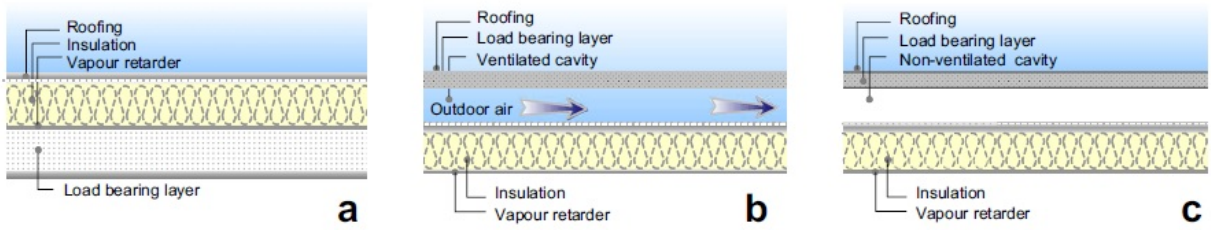

Figure 1. *Roof types according to configuration of roof components. (a) Warm roof. (b) Cool roof with ventilated cavity. (c) Cool roof with non-ventilated cavity.*

ROOF-SIMULATOR

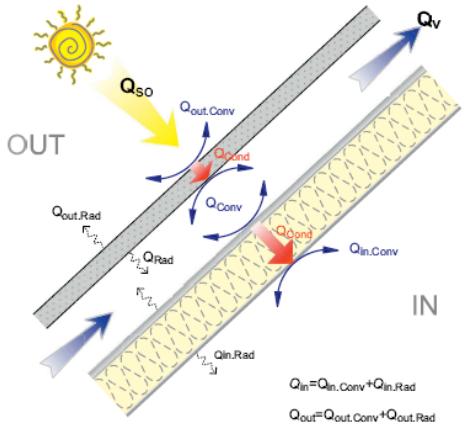

Figure 2. *Mechanism of heat transfer in a ventilated roof*

The temperature distribution in the cavity was measured to check the temperature difference between the inlet and the outlet. The airflow velocity was measured at the outlet to evaluate mass flow rate. Through the temperature distribution and airflow velocity measurements, we estimated the exhausted heat flux from the cavity as the thermal performance of the ventilated roofs. If the heat flux from the cavity to the outside [Q_v] is increased, heat flow from the cavity to the interior [Q_{in}] would be decreased [3].

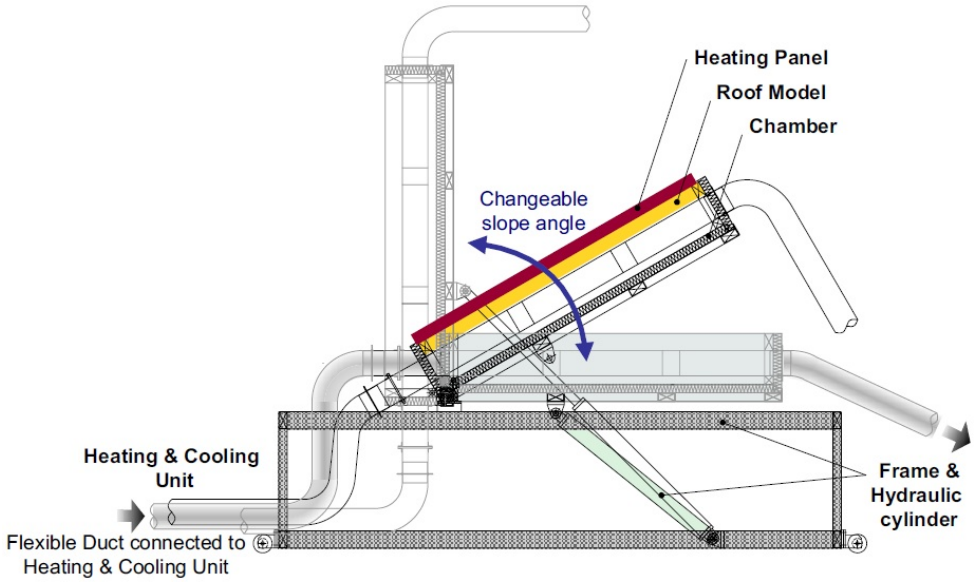

Figure 3. *Schematic view of the Roof-simulator*

A series of tests were carried out using the Roof-simulator [4]. To compare the performance of various roofs which have different types of cavities under the same conditions, the Roof-simulatorwas designed. The Roof-simulator consists of:

- Heating Panel (which simulates the solar heat gain)
- Roof Panel (the object of evaluation)
- Chamber (which simulates a room under the roof)
- Heating and Cooling Unit (which keeps the temperature of the chamber constant)

The heating panel which simulates the solar heat gain is composed of a metal lid, glass wool, a gypsum board, a heating foil, and an aluminum plate. The aluminum plate (thickness: 2 mm) beneath the heating foil disperses heat evenly to make the heat flux to the roof panel uniform, and the glass wool (thickness: 50 mm) above the heating foil blocks the heat flux directed upward. The heating panel controls the surface temperature of the roof model.

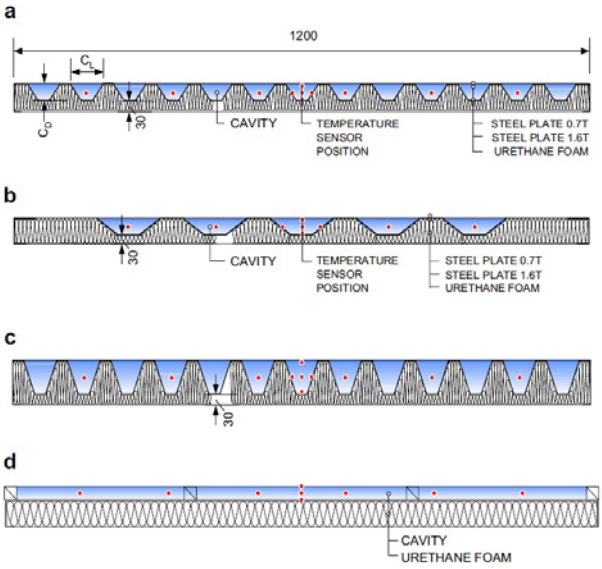

Figure 4. *Horizontal sections of the roof models. (a) The roof model with ribbed panel having a cavity size of 90 mm [C_L] x 30 mm [C_D]. (b) The roof model with ribbed panel having a cavity size of 180 mm x 30 mm. (c) The roof model with ribbed panel having a cavity size of 90 mm x 60 mm. (d) The roof model with flat panel having a cavity size of (null) mm x 30 mm*

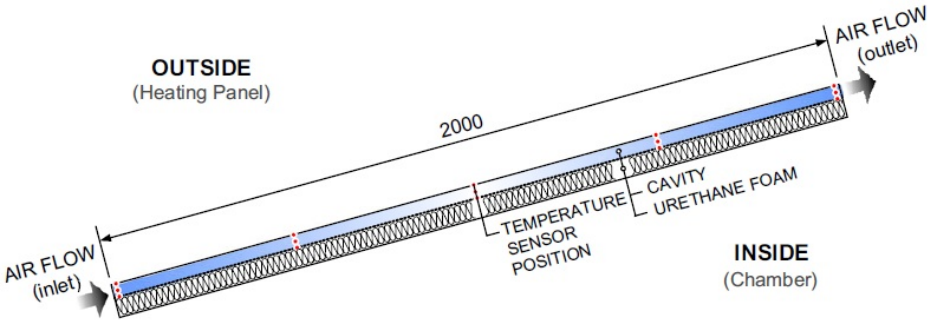

Figure 5. *Vertical section of the roof model*

The testing facility was air-conditioned during the experiments by an HVAC system, so that the temperature of influent air to the cavity was constant. There is no air stream caused by the HVAC system, so the airflow in the cavity is caused only by the buoyancy force.

Measurements were taken of temperatures and air velocity for the roof models in the Roof-simulator. Temperatures were measured with T-type thermocouples, which have a temperature range of -65 °C -130 °C and an error range of ±0.5 °C. The points of temperature measurement were placed at five positions from the inlet to the outlet of the cavity, to obtain temperature variation along the airflow path. To measure temperature distribution at the surfaces of a cavity, thermocouples were inserted in the middle cavity. The red spots in Figs. 4 and 5 indicate the positions of the temperature sensors.

Air velocity was measured using which is a high-precision multifunctional instrument. Because the cavitywas enclosed by metal, it could be assumed that therewas no airflow into the chamber. In a cavity having a uniform section area, if all of the airflow entering the cavity is made to flow out through the outlet of the cavity, air velocity will be same everywhere in the cavity. Therefore, only the air velocity at the outlet of the cavity was monitored.

The temperature difference between the inlet and the outlet and the air velocity at the outlet were used to estimate the heat flux along the cavity, and the temperatures of each surface of the cavity were monitored to investigate heat flux to the indoors. A preparatory test was performed to stabilize the

temperature of the roof panel and the chamber. When the heating panel started to work, the temperature of the heating panel slowly increased. After air-conditioning by heating and cooling unit, the temperature in the chamber was maintained at a constant level.

RESULTS AND DISCUSSION

Slope of the roof

As shown in Fig. 6(c), the cavity temperature of 65 °C was almost the same as the temperature of the heating panel when the slope of the roof was at an angle of 0°. However, when the slope of the roof was steeper, an airflow was developed. The temperature at the middle cavity dropped to 40,3 °C, when the slope of the roof had an angle of 55°, as shown in Fig. 6(a). The airflow velocity and temperature difference were increased, the more the roof angle was increased, and the amount of exhausted heat became relatively higher due to the effect of the buoyancy force. The exhausted heat at each angle is shown in Fig. 6(b). The exhausted heat increased from 178W to 286W. Thus, a minimum angle is required when the ventilated roof is applied to produce a buoyancy force. This experiment did not, however, consider the effect of cavity length. In real situations, it must be considered that the total path and resistance of the cavity may be increased.

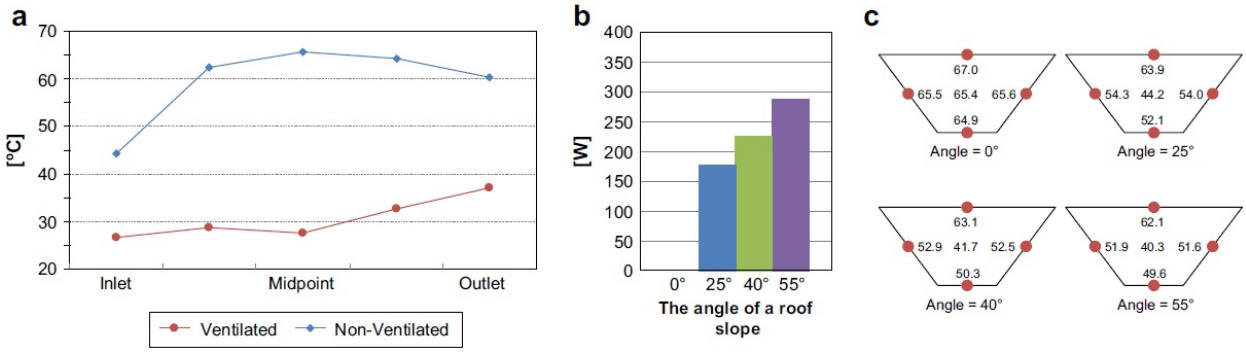

Figure 6. *Experimental results for the slope difference of roofs. (a) Temperature variation in cavity. (b) Exhausted heat from a cavity. (c) Temperature distribution in the middle cavity [°C]*

Intensity of solar radiation

In the case where the heating temperature was 55 °C, the cavity temperature was shown to be about 37,1 °C, as shown in Fig. 7(c). The temperature at the middle cavity was 40,0 °C when the heating temperature was 75 °C. When the heating temperature was increased, the temperature difference and the amount of heat exhausted were also increased. The exhausted heat was increased from 188W to 367W in Fig. 7(b). The temperature of the roof surface rises in proportion to the solar heat gain, and thus the ventilated roof can be useful where the solar heat gain is relatively high.

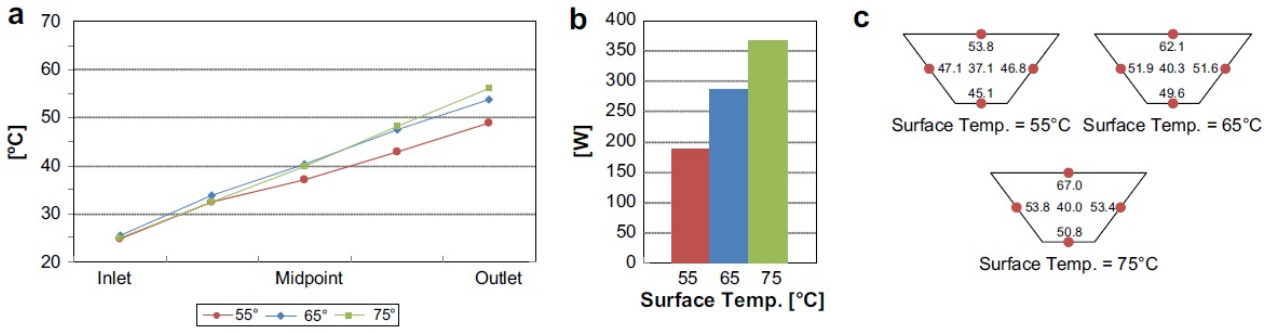

Figure 7. *Experimental results for the surface temperature difference of heating panels. (a) Temperature variation in cavity. (b) Exhausted heat from a cavity. (c) Temperature distribution at the outlet of cavity [°C]*

Cavity width

To analyze the effect of cavity width on thermal performance, the 90 mm x 30 mm cavity was compared with the 180 mm x 30 mm cavity, where the width of the cavity was doubled. The temperatures in the cavities increased similarly from the inlet to the outlet. The temperature difference between the inlet and the outlet was 28,2 °C for the 90 mm x 30 mm cavity and 22,7 °C for the 180 mm x 30 mm cavity, as shown in Fig. 8(a). The air velocity at the outlet of the 90 mm x 30 mm cavity was 0,47 m/s, while it was 0,5 m/s for the 180 mm x 30 mm cavity. Therefore, the exhausted heat of the 90 mm x 30 mm cavity was more than that of the 180 mm x 30 mm cavity; the exhausted heat being 286W for the 90 mm x 30 mm cavity and 172W for the 180 x 30 mm cavity, as shown in Fig. 8(b).

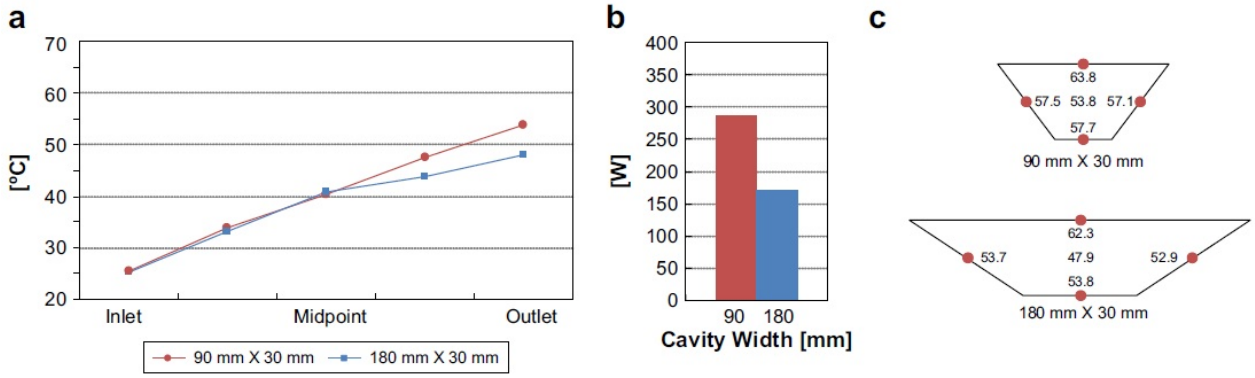

Figure 8. *Experimental results for the width difference of cavities. (a) Temperature variation in cavity. (b) Exhausted heat from a cavity. (c) Temperature distribution in the middle cavity [°C]*

While the surface temperatures of the cavities were similar to each other, the surface temperatures at the outlet of cavity for the 90 mm x 30 mm cavity were higher than those for the 180 mm x 30 mm cavity. The reason why the surface temperatures of the 90 mm x 30 cavity were higher, as in Fig. 8(c), is estimated to be because the shorter length of the perimeter promoted heat conduction and the closer surfaces transferred more radiant heat to one another. High surface temperatures speed up the airflow in cavity, so that the exhausted heat is increased. Therefore, to exhaust heat from cavity, effectively.

Cavity depth

Fig. 9 shows temperature distribution and the tendency of the exhausted heat for different depths of the ribbed panel. The temperature difference between the inlet and the outletwas greater for the 90 mm x 30 mm cavity than for the 90 mm x 60 mm cavity, as shown in Fig. 9(a). The temperature difference for the 90 mm x 60 mm cavity was 10,4 °C. Also, the air velocity at the outlet was 0.47 m/s for the 90 mm x 30 mmcavity and 0.61 m/s for the 90 mm x 60 mm cavity.

It can be considered that lower temperature in the 90 mm x 60 mm cavity was due to low surface temperatures and high air velocity. The low surface temperatures of the 90 mm x 60 mm cavity in Fig. 9(c) were because the heat transfer by conduction and radiation between each of the surfaces was less than those for the 90 mm x 30 mm cavity, because of cavity size. Also, the larger the cavity section area, the less the effect of friction resistance for airflow in the cavity. Therefore, it can be estimated that larger section area of the 90 mm x 60 mm cavity increased air velocity in the cavity.

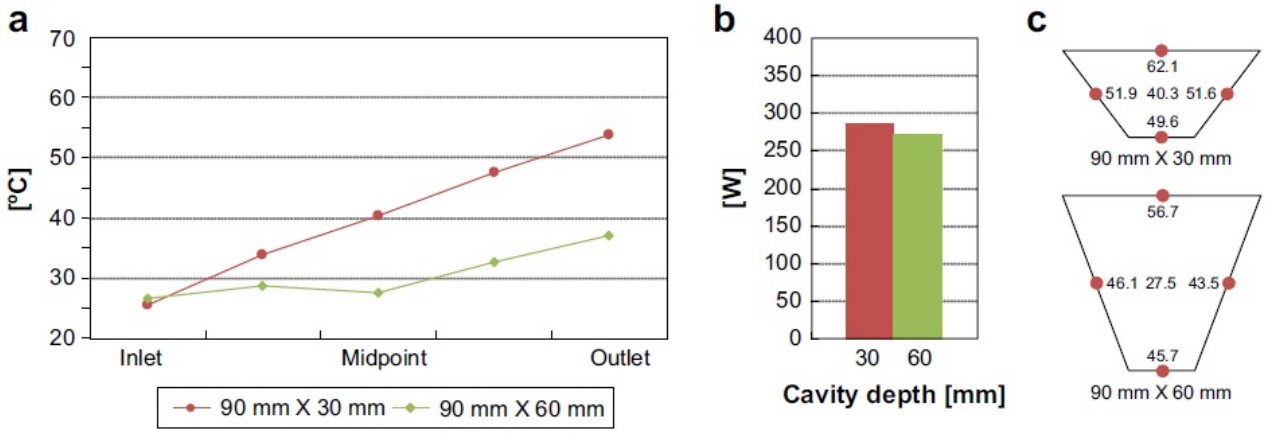

Figure 9. *Experimental results for the depth difference of cavities. (a) Temperature variation in cavity. (b) Exhausted heat from a cavity. (c) Temperature distribution in the middle cavity [°C]*

As shown in Fig. 9(b), the two cases are similar with regards the exhausted heat from a cavity. The amount of exhausted heat was 286W for the 90 mm x 30 mm cavity and 274W for the 90 mm x 60 mm cavity. The similarity in exhausted heat can be because the 90 mm x 30 mm cavity had a large temperature difference, while the 90 mm x 30 mm cavity indicated a higher air velocity.

Shape of a cavity

As shown in Fig. 10(a), the temperature difference between the inlet and the outlet of a roof having a ribbed panel was 10,4 °C and that of a roof having a flat panel was 5,7 °C. The air velocity for the case of the ribbed panel was also much higher than for the flat panel; 0.61 m/s for the ribbed panel and 0.22 m/s for the flat panel. The ribbed panel is thus revealed to have superiority in thermal performance compared to a flat panel having the same effective ventilated area. The ribbed panel showed higher surface temperatures in a cavity compared to the flat panel, as shown in Fig. 10(c), because of the conduction through the ribbed panel forming the cavity. It seems the higher surface temperatures promote airflow in the cavity. In consequence, the amount of exhausted heat from a cavity in the ribbed panel was much larger than that in the flat panel, as shown in Fig. 10(b).

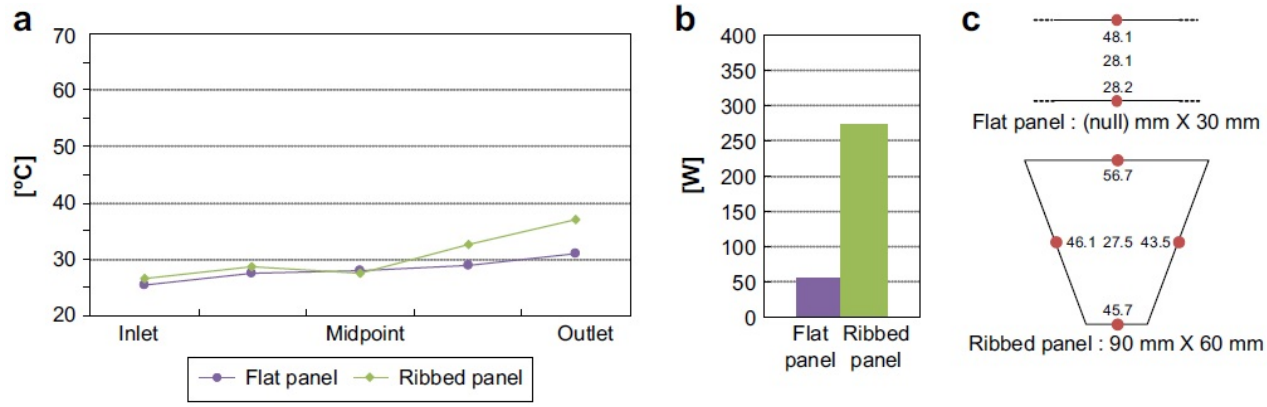

Figure 10. *Experimental results for the figure of a cavity. (a) Temperature variation in cavity. (b) Exhausted heat from a cavity. (c) Temperature distribution in the middle cavity [°C]*

CONCLUSION

By employing a ventilated layer in the roof, thermal accumulation in the roof can be prevented, and cooling load can be decreased. When the roof angle and the shape of a cavity are the same, increasing the surface temperature of the roof can improve the insulation performance of the ventilated roof. This means that the ventilated roof is useful where the solar heat gain is high. It has been proven that the steeper the slope of the roof, the lower the cavity temperature, when other parameters are the same. The additional work of finding a proper angle should be performed only after comparing it with other factors such as the direction of the roof and the region of the building. It is necessary

to obtain a sufficient cavity depth and width to develop airflow velocity. In the case of the ribbed panel, the temperature of the lower surface of a cavity is high, because of conduction through the ribbed metal panel. Thus, a device serving as a thermal breaker has to be installed to prevent conduction.

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BIOGRAPHY

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EKSPERIMENTALNA VERIFIKACIJA UTICAJNIH FAKTORA NA MEHANIZAM PRENOSA TOPLOTE U ŠUPLJINI VENTILACIONOG KROVA

Dragana Temeljkovski

Apstrakt: *Krov, kao deo omotača zgrade sa svim svojim termalnim karakteristikama koje utiču na termalni komfor unutrašnjosti zgrade, omogućava zaštitu od termalnih oštećenja, uzrokovanih uticajem sunca. U obzir uzimamo upotrebu ventilacionih krovova, sa ventilacionim slojem poznatim kao kanalom koji je pozicioniran direktno ispod krovnog pokrivača, kako bi poboljšali mogućnost zaštite od temalnih oštećenja. Na osnovu predloženog mehanizma prenosa toplote i uzimajući u obzir faktore kao što su, ventilacioni kanal, nagib krova, intezitet solarne radijacije, veličina i oblik kanala, i vrste panela, analiziran je proces protoka vazduha i distribucije temperature u kanalu sa ciljem poboljšanja efekta hlađenja i ventilacije u kanalu krova. U ovom radu je razmatran uticaj ovih elemenata na strujanje vazduha.*

Ključne reči: distribucija temperature, efekat hlađenja, protok vazduha, termalni komfor, ventilacioni kanal.

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ENVIRONMENTAL ASPECTS OF CONTINUOUS BIODIESEL PRODUCTION AT PILOT LEVEL BY HETEROGENEOUSLY CATALYZED OIL METHANOLYSIS

Abstract: *The environmental aspects of a continuous biodiesel production pilot process based on the sunflower oil methanolysis employing the quicklime as a solid catalyst were analyzed. The environmental impacts of important factors present in all phases of the proposed pilot process were evaluated. The aim of the work was to indentify the potential harmful effects of the proposed process for biodiesel production on the environment and to propose the preventive and protective measures.*

Key words: biodiesel, ecological and environmental aspects, heterogeneous catalysis, methanolysis, safety.

INTRODUCTION

In past ten years demand for biofuels across the world has grown. Among the biofuels, the biodiesel draws attention to both researchers and producers because it represents an eco-friendly alternative to conventional diesel fuel due to its biodegradability, low toxicity and less harmful emmisions during the combustion (reduced particulate matter, carbon monoxide and dioxide, sulphur dioxide). By definition, it is a mixture of fatty acids and short chain alcohol that meets biodiesel quality standards.

Biodiesel has a significant position on the fuel market because of its properties that are very similiar to those of conventional diesel fuel. For instance, its application does not requare significant modification of existing diesel engine. In order to meet the world demands for biodiesel, the higher production capacities must be provided and therefore the interest in the installation of continuous production plants is growing. Generally, industrial production of biodiesel in the world at present is mostly based on the homogeneously catalyzed oil alcoholysis. Recently, much effort has been made aiming at developing the technologies based on the use of heterogeneous catalysts because of many advantages over homogeneous ones. By employing solid catalysts, the neutalization step of by-product (glycerol) is eliminated, so the process becomes cheaper and safer [1]. The best-known commercial process for biodiesel production based on the heterogeneously catalyzed vegetable oil methanolysis is the Esterfip process [2]. High quality biodiesel and glycerol are obtained in two successive fixed bed reactors at higher temperature and pressure. The mixed oxide of zinc and aluminium is used as a catalyst. This process is more environmentally friendly bacause the glycerol neutralization and methyl esters washing steps are not included. The envoronmental benefit of biodiesel is already well-known; however, the eco-environmental aspects of the overall biodiesel production are very important as well. Instalation of large capacity plant for biodiesel production not only increases the equipment size but also generates higher quantities of hazardous and flammable materials that need to be handled in a proper way to prevent potential pollution of the environment. Therefore, existing regulations for the eco-environmental impact assessment of industrial biodiesel production are very important. The regulations of the Republic of Serbia lay down the rules and the standards that any industrial production must meet. Environmental impact assessment considers the satus of the environment, the eco-environmental impact of implemented technology for biodiesel production, definition of measures for prevention and environmental monitoring program.

In this work the environmental aspects of a biodiesel pilot production process based on the vegetable oil methanolysis over quicklime as a cheap catalyst were analyzed. The aim of the work was to identify the potential eco-environmental impacts of the proposed biodiesel production process, to perform the hazard analysis of each production step and to define the protective measures in order to minimize, prevent or manage the potentional hazardous impacts according to the existing law regulations.

CONTINUOUS BIODIESEL PILOT PRODUCTION PROCESS BASED ON VEGETABLE OIL METHANOLYSIS OVER QUICKLIME

The sunflower oil methanolysis over quicklime bits in a flow packed-bed reactor [3] was assessed with respect to the environmental impact. The global scheme of the proposed process is presented in Figure 1.The pilot process includes the biodiesel production and purification. According to the proposed process, the sunflower oil methanolysis is performed at the atmospheric pressure and the reaction temperature of 60 °C, is kept constant by circulating hot water (at 60±2 °C) through the reactor jacket. Methanol is mixed with the vegetable oil prior to entering the reactor and then the mixture is heated up to 60 °C flowing through a heater by exchanging heat with hot water (60±2°C. Centrifugal pumps are used for transporting the reactants from the reservoirs to the reactor. Calcined quicklime bits (2-3.15 mm) are used as a catalyst in the form of packed bed. The catalyst bits are calcined in a furnace at 550 °C within 4 h.

The biodiesel plant is consisted of two identical packed-bed reactors whereas one of them is used as a spare reactor. The laboratory research showed that after 30 h of running the flow through the catalyst bed was blocked due to the catalyst bits agglomeration [4]. Therefore, the process is running continuously in 24 h, when the feedstream is redirected to the spare reactor. While running the second reactor, the first one is prepared for the next use bydischarching the spent catalyst and filling with a fresh batch of the catalyst bits. The effluent (reaction mixture consisted mainly of methyl esters, glycerol and the excess of methanol) is pumped to a flesh evaporator in order to remove the excess of methanol which facilitates the methyl esters separation in a gravitational separator. After separating from glycerol (containing an amount of methanol), the methyl esters are purified by a two step process followed by filtration. The final separation of methanol and glycerol is done by vacuum evaporaton. Methanol from the two separation steps is reused with fresh methanol.

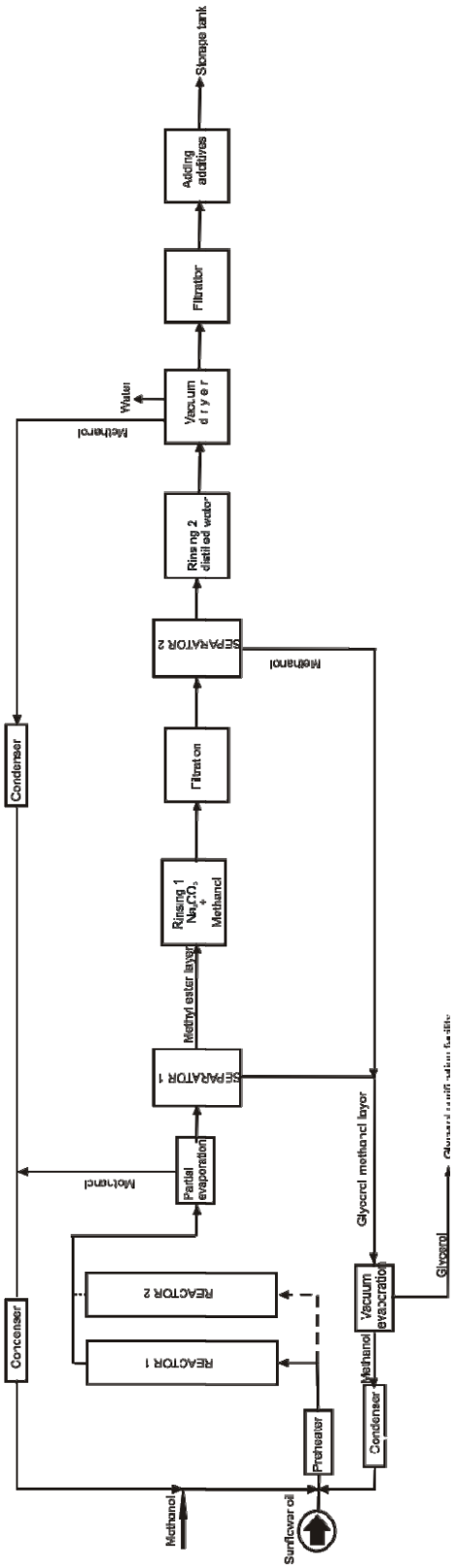

Figure 1 Global scheme for continuous sunflower oil methanolysis catalyzed by quicklime bits (dashed line - redirection of feedstream from reactor 1 to reactor 2)

ENVIRONMENTAL ASPECTS THE VEGETABLE OIL METHANOLYSIS OVER QUICKLIME

The environmental aspects of the biodiesel production pilot process were analyzed through following steps:

- Catalyst preparation,
- Feedstocks preparation and handling,
- Methanolysis of sunflower oil,
- Separation and purification of crude methyl esters,
- Addition of additives to methyl esters,
- Glycerol purification and
- Storage of the final products.

Catalyst preparation

Quicklime (basically, calcium oxide) is a low cost material and it will be employed as a heterogeneous catalyst in the process of oil methanolysis. It is purchased from a quicklime plant in the form of bits (1-5 mm), which are sieved to separate the bits of the specified size. Since dust can be generated during the sieving, the working room must properly be ventilated. It is recommended to collect dust settled down by means of wet clothes, which are then water washed in a bucket. Quicklime belongs to the group of non flammable solid materials (melting point 2572 °C and boiling point 2850 °C) that vigorously react with water realasing a large amount of heat. Since this can cause the ignition of combustible materials with a harmful impact on the environment, quicklime should be stored properly. Qucklime must not be stored near hydrogen halides, halogen compounds, acids, light metals and water. It should be stored in well closed containers made of proper materials in a cool and dry place. Quicklime is classified as Fx IV J by the Regulation on technical and other requirements for materials and goods according to their behavior in a fire [5]. Also, since quicklime contact with eyes and skin can cause irritation or burning, the employees that work with it should wear safety goggles, gloves and clothing that fully cover arms and legs. Quicklime does not show any bioaccumulation effect and can be used for soil stabilization and remediation. If it is transported, handled and stored properly, it does not have any hazardious effect on the environment.

Feedstocks preparation and handling

The main feedstocks for biodiesel production are sunflower oil and methanol. They do not require any special pretreatment and will be used in the form as they are purchased. Methanol is mixed with sunflower oil in the required molar ratio (6:1); the mixture is heated to 60 °C flowing through the preheater and then introduced into the reactor at its bottom. The centrifugal pumps are used for the sunflower oil and methanol transportantion from the external overground reservoirs to the reactor. Sunflower oil from a tanker truck is discharged by means of a pipeline (or hose) into the external storage tank. It is very important for sunflower oil to be stored in a dry atmosphere. It belongs to non-hazardous materials as its auto-ignition temperature is over 300 °C; therefore, it does not have any negative effect on the environment. Methanol is colorless, clear, toxic, volatile, highly flammable liquid with dinstinctive odor and soluble in water. It boils at 64,5 °C and solidifies at -98 °C. Its ignition and auto-ignition temperature are 11°C i 455 °C, respectively. It can combust in the presence of oxygen and carbon dioxide with a pale blue flame that changes colour with time. Methanol vapours form an exsplosive mixture with air in the concentration of 6.7–36 % [6] that is flammable in the presence of static electricity. Also, methanol reacts with oxidizing materials. Considering the high toxicity of methanol and its vapours as well as its solubility in water, any accident with metanol causes the pollution of the water, soil and air and is harmful for public health. If methanol is handled and stored properly according to the standards and regulations, then the accidents and pollution of environment will be prevented.

Generally, the liquid feedstocks must be handled following the standards and regulations in order to avoid incidents and accidents during transportation, operation and storage [1, 7]. For the purpose of their storage, the external vertical tanks equipped with all required technical devices for the parameters (temperature, pressure and quantity) control and monitoring will be used. A particular requirement for the methanol storage tanks is to maintain the overpressure at a constant level in the inert atmosphere in order to minimize the risk of fire and methanol emission in the air. The storage tanks must be constructed according to the corresponding safety standards and regulations and must be placed in protective, waterproof bund. In this way, the pollution of soil and underground water will be prevented.

During certain production steps, mostly related to the manipulation and maintaince such as handling of feedstocks and final products or leakage from pipelines, the wastes can be generated. This type of wastes could be also harmful to the environment because of its toxicity, explosivity and flammability. Also, the certain amount of waste can be generated during the lab testing of feedstocks and products quality. In the case of spilled liquid wastes, an adequate absorbent should be used, which should, after the use, be disposed properly in a PE HD bag in the waste disposal storage. It is also necessary to provide the spill boxes for collecting spills at the connection points of transport hoses. The collected waste should immediately be disposed in the container specified for the corresponding waste located in the waste disposal storage.

Methanolysis of sunflower oil

The production of biodiesel by methanolysis of sunflower oil over quicklime is conducted continuously, as a closed process with full automatization of the reactor system. As the spillage of raw materials, intermediate or final products into waterway or soil that can endanger the working and

living environment, it is essential that the process takes place in a closed production hall. The facility should be made in the form of an impermeable bund connected by a pipeline with the lowest reservoir for incidental spills that prevents any further spillage.

The sunflower oil methanolysis will be performed in the flow packed-bed reactor running 24 h at atmospheric pressure. Since the catalyst bed is blocked after 24 h operation, the flow of the reactants mixture is redirected to the second reactor. During the in the operation of the second reactor, the first reactor is emptied and then filled with the fresh catalyst bits. The spent catalyst can cause an environmental pollution problem if disposed improperly as a waste. In the case of spillage of the spent catalyst, it is necessary to collect it in the proper container which is the same as that used for quicklime dust. Since the spent catalyst contains Ca diglyceroxide on the catalyst surface [8], it is necessary to conduct a further investigation in order to define the appropriate procedure of its treatment.

In order to achieve a high oil conversion degree, the methyl ester synthesis should be realized with the methanol excess. After completing the reaction, the unreacted methanol will stay in the final reaction mixture that complicated the separation of the two layers that is methyl ester and glycerol, due to the solubility of glycerol in methanol [9]. Therefore, in order to achieve a faster separation in the gravitational separator, it is necessary to perform flash evaporation of methanol. A certain amount of methanol retaining in the glycerol layer can be removed by distillation. The methanol vapors are condensed in a condenser using cooling water from the cooling unit, and then the liquid methanol goes back to the process through the circular flow.

All tanks are equipped with independent sensors for the control of maximum liquid level that will regulated the operation of transport pumps. Also, the parts of the production facility where methanol vapors may occur must be equipped with sound and light signal devices, which will register its presence at the concentration above the maximum allowed concentration. For this reason, the production facility must be equipped with a proper ventilation system with the independent power generator.

The potential ecological problems could occur during the methanolysis process if the anticipated fluid pressures are exceeded during the transportation using pumps. For the protection, the entire floor in the facility must be built in the form of "impermeable bund" for accidental spills. During pumping the raw materials and the final products from tanker trucks to the reservoirs or vice versa, flexible fittings and special tubes resistant to the transported fluids should be used. Since being insensitive to biodiesel, teflon, viton, nylon, aluminum, stainless steel or fiberglass can be used as materilas for all equipments in the contact with biodiesel [10].

Also, it may happen that a part of the fluid drains from the pipeline when cleaned with compressed air. Therefore, the containers for collection of accidentaly generated wastes should be placed at appropriate places. These wastes will then be disposed (without delay) in a collective container, marked for the corresponding waste material and located in the storage of hazardous waste. In the case of the accidental spilliage of large quantities of hazardous wastes are spilled, it is necessary to use an appropriate absorbent for collecting the waste, which will then be disposed in the storage of hazardous wastes. The quality of water discharged into the sewerage during the process must be in accordance with the Law on Waters [12], the Regulation on hazardous substances in water [13] and the Regulation on the methods and the minimum number of wastewater quality testing [14]. Generally, the pollution of water and the environment during the biodiesel production cannot be expected if the prescribed protective measures are applied.

Product separation and purification

In order to separate the crude methyl ester product from the glycerol-methanol layer, the final reaction mixture is led directly to the gravitational separator (Fig. 1). The crude methyl esters should further be purified in order to fulfill the prescribed standard specification. The main problem is caused by the leaching of calcium from the catalyst bits into the reaction mixture. The use of the method developed by Alba Rubio et al. [15] is recommended, which includes the methyl ester washing by the suspension of Na_2CO_3 in methanol (5% of the ester mass) under reflux, vacuum drying and polishing.

The methyl esters product contains volatile components, such as methanol and water that evaporate during the drying process in the vacuum evaporator. Therefore, the resulted gas phase leavin the evaporator is introduced into a condenser, where the vapour is cooled and condensed.

To achieve the required quality of the final product according to the EN 14214 standard, the methyl esters must be filtered to remove possibly presented fine mechanical impurities. The value must not exceed 24 mg/kg [16]. The filtration process is conducted using the 2.5 μm filter, which is placed on pump discharge line.

Addition of additives to methyl esters

Fatty acid methyl esters (biodiesel) obtained from sunflower oil show better flow properties at lower temperatures compared to those which are obtained from the oily (e.g. palm oil) and faty feedstocks with a high content of saturated fatty acids [17]. However, independently of the origin feedstock, the biodiesel has higher values of cloud and pour point, compared to the conventional diesel fuel [18]. Therefore, the properties of the biodiesel derived from sunflower oil must be improved by adding appropriate additives (e.g. Wintron®). With these additives, biodiesel could be

transported to storage tanks, even in winter conditions. Also, the addition of antioxidant additives can improve the stability of biodiesel to oxidation and prevent/ clean corrosive deposits in the engine with internal combustion.

The addition of additives to the biodiesel is usually carried out in the helicoial static mixer. The amount of additives is defined according to the measured mass flow of the final biodiesel. Delivering of additives is done in containers, which will be sent back to the supplier after emptying, in order to eliminate the possibility of environmental pollution.

Purification of glycerol layer

The glycerol layer, separated from the crude biodiesel, has an amount of methanol, which should be separated by destilation and reused in the process. If necessary, glycerol is further purifiied, depending of its application. The vertical storage tank for glycerol is located out of the production plant. After refining in a separate facility, glycerol is further used as a raw material in the chemical and cosmetic industry.

From an ecological point of view, glycerol is extremely stable in typical storage conditions (cool and dry place without the presence of heat and ignition sources), compatible with many other chemicals, odorless, practically non-toxic and has no known negative impact on the environment. When glycerol is accidentally spilled on the floor, it is necessary to use the appropriate absorbent, which is, after using, disposed in a proper manner [19].

Storage of the final products

In order to maintain the quality of the final biodiesel product as long as possible at the level defined by the standard EN 14214 (max allowed water content 500 ppm), it is essential to ensure a dry atmosphere in the storage tank. To prevent hydrolysis, oxidation and increase of water content, biodiesel must not come in the contact with the ambient air. Such conditions may be achieved with an inert atmosphere under a pressure of the inert gas (nitrogen) in the storage tank. Transport of the both final products from the storage to the market is carried out with tanker trucks. Loading/unloading installations must be equipped with all necessary technical devices for measuring the amount, temperature and pressure, as well as elements for connecting storage tanks and tanker trucks.

MONITORING PROGRAM FOR ENVIRONMENTAL QUALITY MEASUREMENTS IN THE PRODUCTION OF BIODIESEL

For determining the environmental measures during the continuous biodiesel production process in the presence of quicklime, it is needed to identify the emissions of possible pollutants in air, water and soil, as well as noise emissions and generation of hazardous wastes.

Air quality monitoring is performed on the basis of the act of the competent authority for environmental protection (Law on Air Protection [20]) if it is necessary to determine the level of air pollution in a particular area that is not covered by the official.

According to the Regulation on limit values for emissions of **air** pollutants [21], the measurement of pollutants emissions is conducted by using the corresponding measuring instruments at the measuring points and the prescribed method of measurement. The emergence of unorganized emissions is possible during the technological process, storage of hazardous waste, as well as in possible accidental situations.

Monitoring of **groundwater** quality is carried out by an authorized organization under the Regulation on limit values of pollutants in surface and ground waters and sediments, and deadlines for their achieving [22]. In order to prevent pollution of groundwater and soil, a regular control of parameters is needed. Therefore, the the generated amount of wastes is temporarily stored on cement surfaces. Also, in order to ensure the preservation of the recipient quality within the technological process, it is necessary to install the oil and grease separator for purification of wastewater that can be generated during washing the working area and surface runoffs. The storage of hazardous wastes originated from the production process must be an independent covered and fenced place. The floor must be protected by a special coating that is resistant and impervious to chemicals. An ideal floor protection is concrete coated with an AISI 316 Ti stainless sheet (1 mm thick). For the collection an eventually accidental spill of hazardous waste, it is necessary to build a small pit (5x5x5 dm) in the corner of the floor i.e. "impermeable bund".

The programme of systematic monitoring of **soil** quality is prescribed by the Regulation on systematic soil quality monitoring programme, indicators for risk assessment of soil degradation, and methodology for the development of remediation programmes [23]. Monitoring of soil quality is not carried out at the estate level. The individual soil monitoring at specific locations is implemented in accordance with the decision of the authorized inspection bodies related to the environmental protection. It is implemented by accredited institutions. Spillage or leakage of waste, especially hazardous, can occur during the biodiesel production, when it is necessary to take all envisaged measures, which will minimize their impact on the soil. Depending on the amount of spillage material, it is necessary to test the soil and takes the measures for recovery and remediation.

A legal or physical person who is the owner or user of **noise sources** must provide a single measurement of noise in the prescribed manner, make a report about the noise measurement and pay the cost of noise intensity measuring in the impact zone in accordance with the Law on the Protection of Environmental Noise [24]. During regular operation of the complex, it is necessary

to control and maintain the equipments and devices in order to prevent an increase in noise level and to implement engineering control aimed at the staff compliance to operating instructions, as well as at the damping and isolation of noise sources. In the biodiesel production, the noise sources may be pumps, fans for air transport to the rooms and in the external environment, as well as the resonance of brass channels.

According to the current legislation, each type of **hazardous waste** must be stored in a special container that is clearly marked with an identification sheet in accordance with the Law on Waste Management [25]. As a rule, wastes should not be mixed with each other, and each type of waste must be stored separately in a steel vessel intended and marked for the specific waste. The producer must keep a record of the type, quantity, utilization and liquidation of hazardous waste and packaging. The transportation of hazardous waste is provided through an authorized organization for handling of certain types of wastes. The total annual amount of waste must be registered and an annual report must be submited to the appropriate authority for the protection of the environment within the prescribed period.

CONSLUSIONS

In this paper, the continuous biodiesel pilot production via the methanolysis of sunflower oil using quicklime as a low-cost catalyst was analyzed in order to assess its possible impact on the environment. The main goal was to determine the possibility of negative impacts of certain factors and process conditions on the occupational and living environments. The production process is performed in two alternative packed-bed reactors at moderate operating conditions. Regarding to the catalyst, properly manipulation, transportation and storage willt prevent its harmful environmental impact. A possible critical point in the biodiesel production from the environmental point of view is the quicklime storage. However, the application of the prescribed storage conditions excludes the possibility of any accident. In addition, it is necessary to pay special attention to the storage areas of raw materials and products that must be built according to the safety regulations. Sunflower oil and glycerol do not have any harmful impact on the environment. However, methanol represents a potential danger during the process. To exclude the risk of fire and its emission into the air, the storage tank of methanol should additionally be equipped with the devices for maintaining constant overpressure of the nitrogen atmosphere.

The performed analyze of all parameters that may affect the environment quality, led to the conclusion that there will be no negative effects on the ecosystem if all legal measures of protection during the process are respected and applied.

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BIOGRAPHY

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EKOLOŠKI ASPEKT KONTINUALNE PROIZVODNJE BIODIZELA PRIMENOM HETEROGENO-KATALIZOVANE METANOLIZE ULJA

Ninoslava Popović-Nikolić, Marija Miladinović, Ivana Banković-Ilić, Olivera Stamenković, Vlada Veljković

Apstrakt: *U radu je analiziran ekološki aspekt poluindustrijskog kontinualnog postupka za dobijanje biodizela heterogeno-katalizovanom metanolizom suncokretovog ulja primenom negašenog kreča kao katalizatora. Analizom su obuhvaćene sve faze predloženog postupka, a data je i procenu uticaja pojedinih faktora opasnih po okolinu. Cilj rada je bio da se identifikuju potencijalni negativni uticaji proizvodnje biodizela na životnu sredinu i predvide mere zaštite.*

Ključne reči: biodizel, ekološki aspekt, heterogena kataliza, bezbednost.

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A NEW APPROACH FOR DETERMINING THE SYSTEM TIME WITHOUT FAILURES USING PETRI NETS

Abstract: *A new method for determining the time without failures using Petri nets will be presented in this paper. Petri nets are very appropriate for modelling and analysis of different systems. Due to its simplicity, this method can be applicable in practice, for example, for reliability analysis and for the time without failures calculation. The results are illustrated using the example of electric power system.*

Key words: Petri nets, time without failures, fault tree

INTRODUCTION

The scientific and technical progress of systems resulted in appearance and development of reliability theory. Complex systems should have high reliability considering the consequences of their failures influencing on further work and people security. Reliability $R(t)$ is usually defined as the probability of system work without failures in certain period of time and given environmental conditions. Reliability is defined by the following relation:

$$R(t) = \int_{t_1}^{\infty} p(t)dt \tag{1}$$

where $p(t)$ is probability density distribution.

Since, the moments of failures and time without failures are random variables, reliability theory is based on the application of probability theory and mathematics statistic.

During the exploitation, system is under influence of different, exterior and interior, factors, i.e., wear, corrosion, aging etc. These factors can change the system characteristics and have strong influence on its work. Also, they can change the values of system parameters and its reliability and in the limit case can bring system to the instability or failure. Since, failures are random variables, system state is random, also.

One method for the reliability analysis is the application of Petri nets. Petri Nets are a graphical and mathematical modeling tool applicable to many systems, [1-7]. They are used for describing and studying information processing systems that are characterized as being concurrent, asynchronous, distributed, parallel, nondeterministic, and/or stochastic. As a graphical tool, Petri Nets can be used for a visual-communication similar to block diagrams. Tokens are used in these nets to simulate the dynamic of systems. As a mathematical tool, it is possible to set up the state equations, algebraic equations, and other mathematical models which describe behaviour of dynamical system.

Petri nets are very appropriate for reliability modelling and analysis of different systems. Petri nets can be applied in the field of systems safety, logistic, industry, computer science, etc. They are simple, easy to expand and analysed using simulation. Petri nets are the only class of graphs allowing complete analysis of reliability, [8-12].

If some of the system state coordinates are random variables, Stochastic Petri nets can be used for analysis of such systems.

Fault tree method is very applicable for reliability analysis and system safety. Using this method is easy to determine which combination of system elements can lead system to the failure. Based on fault tree is easy to obtain Petri net.

1. THE BASIC ELEMENTS OF PETRI NETS

Petri net is a special case of directed graph with initial state called initial marking, M_0. Also, Petri net represents bipartite, weighted graph consisting of two kinds of nodes called places and transitions. Nodes are connected by arcs. Arcs are directed either from place to transition or from transition to place. Places are denoted by circles and transitions by bars or boxes. Arcs are labeled with their weights (positive integers), so the k – weighted arc can be interpreted as a set of k parallel arcs. Unity weight is usually omitted. A place is an input place to a transition if there exists a directed arc connecting this place to the transition. A place is an output place of a transition if there exists a directed arc connecting the transition to the place.

For instance, input (output) places may represent preconditions (postconditions), and transition an event. Input places may represent the availability of resources, transition their utilization and output places the release of the resources.

Each place p is marked with nonnegative integer k. It is said that the place is marked with k tokens. Marking is denoted by m - vector M, where m is a total number of places. The pth element of vector M, denoted as $M(p)$, represents the numbers of tokens in place p.

The presence or absence of a token in a place can indicate whether a condition associated with this place is true or false, for instance. For a place representing the availability of resources, the number of tokens in this place indicates the number of available resources. At any given time instance, the distribution of tokens on places, called Petri Net marking, defines the current state of the modeled system.

In its simplest form, a Petri Net may be represented by a transition together with its input and output places. This elementary net may be used to represent various aspects of the modelled systems.

Petri Net can be defined as *PN=(P, T, I, O, Mo)*, where

1. $P = \{p_1, p_2, \ldots, p_m\}$ is a finite set of places,
2. $T = \{t_1, t_2, \ldots, t_n\}$ is a finite set of transitions, $P \cup T \neq \varnothing$, and $P \cap T = \varnothing$,
3. $I : (P \times T) \mapsto N$ is an input function defining directed arcs from places to transitions, where N is a set of nonnegative integers,
4. $O : (P \times T) \mapsto N$ is an output function defining directed arcs from transitions to places, and
5. $M_0 : P \mapsto N$ is the initial marking.

The following rules are used to govern the flow of tokens.

Enabling Rule: A transition *t* is said to be enabled if each input place *p* of *t* contains at least the number of tokens equal to the weight of the directed arc connecting *p* to *t*.

Firing Rule:

(a) An enabled transition *t* may or may not fire, and

(b) A firing of an enabled transition *t* removes from each input place *p* the number of tokens equal to the weight of the directed arc connecting *p* to *t*. It also adds in each output place *p* the number of tokens equal to the weight of the directed arc connecting *t* to *p*.

Classical Petri nets can be used only for the analysis of qualitative system characteristics because they do not contain the time concept. It is possible to describe only logical structure of the modelled system.

Introducing the time into Petri nets the Timed Petri nets are obtained. They can be used for the quantitative analysis of the system too. If time is random variable it is about Stochastic Petri nets (SPN).

In most Time Petri nets, time delay is given to the transitions. Only in some types of Petri nets, time delay is given to the places and/or arcs. Tokens of place p become unreachable to all input transitions for a certain time period. Petri nets like this is called *Timed Places Petri nets* (TPPNs).However, it is convinient to give delays to the transitions because they represents activities which perform in time. When transition becomes enabled it will fire after certain time. Petri nets like this is called *Timed Transitions Petri nets* (TTPNs).

2. SYSTEM MODELLING USING PETRI NETS

System with series connected elements represents the simpliest model for the analysis. In this system, the failure of one element causes the failure of the entire system.

The probability of the system work without failures can be increased decreasing the number of series connected elements or increasing the reliability of each element. It is obvious that the increase of the number of elements reduces the system reliability, [13, 14].

System with series connected elements can be modelled using Petri nets. In the next figure transitions are time transitions. However, it is possible to model this system using classical transitions, too.

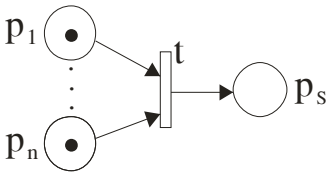

Figure 1. *Petri net of the system with series connected elements*

The presence of token in place p_i means that the appropriate element of the system, *i*, $i = 1, \ldots, n$, is reliable. Classical Petri nets is only possible to ascertain if the system is reliable or not (the presence or absence of token in the place p_S, respectively). Usually is necessary to determine with which probability the system is reliable. If time is assigned to the tokens, then the reliability of element depends on time for which token stays in a place. The system time without a failures, *T*, can be obtained on the next way:

$$T = \min\{t_{p1}, t_{p2}, \ldots, t_{pn}\} \qquad (2)$$

where t_{pi}, $i = 1, \ldots, n$ represents the time for which token stays in a place, i.e., the time interval in which the appropriate element works correctly. The time for which token stays in a place can be a random variable represented by some probability distribution. Each place has its own probability distribution of time for which token stays in a place.

System with parallel connected elements gives the possibility of the reliability increase in relation to the elements reliability. Parallel elements can be used as spare elements and when some element fails the system still works because the function of the failed element undertake other elements. The appropriate Stochastic Petri net for system with parallel connected elements is given in the next figure.

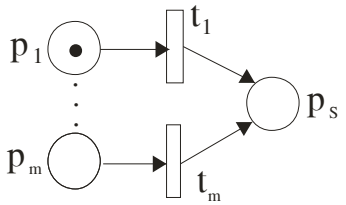

Figure 2. *Petri net of the system with parallel connected elements*

The system time without a failures, *T*, can be obtained on next way:

$$T = \max\{\tau_1, \ldots, \tau_m\} \quad (3)$$

where $\tau_1, \ldots, \tau_m$ represents the time for which token stays in a place or time of transition firing.

In next figures composite systems are presented.

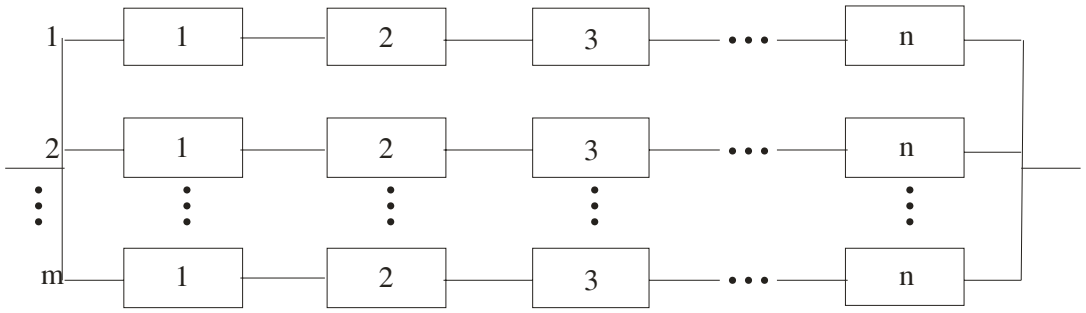

Figure 3. *Composite system*

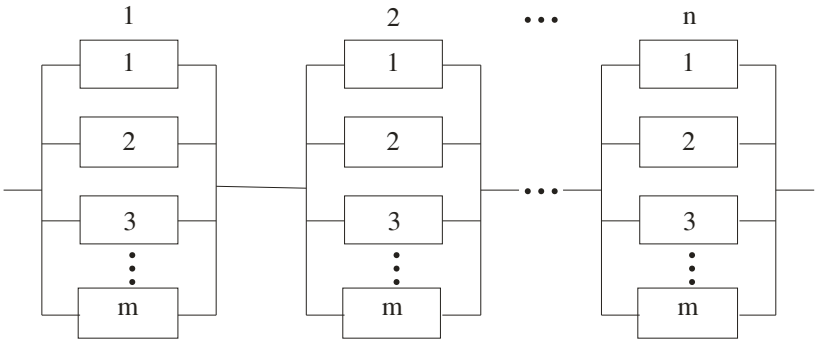

Figure 4. *Composite system*

In the next figures the appropriate Stochastic Petri nets are given.

The time without a failures, *T*, of the system can be obtained in the next way:

$$T = \max_i \min\{\tau_{i1}, \ldots, \tau_{in}\},\ i = 1, \ldots, m \quad (4)$$

$$T = \min_i \max\{\tau_{i1}, \ldots, \tau_{im}\},\ i = 1, \ldots, n \quad (5)$$

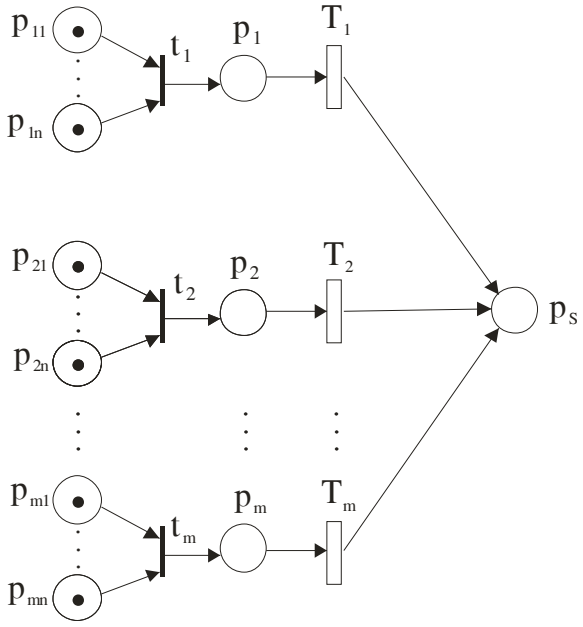

Figure 5. *Stochastic Petri net of Figure 3*

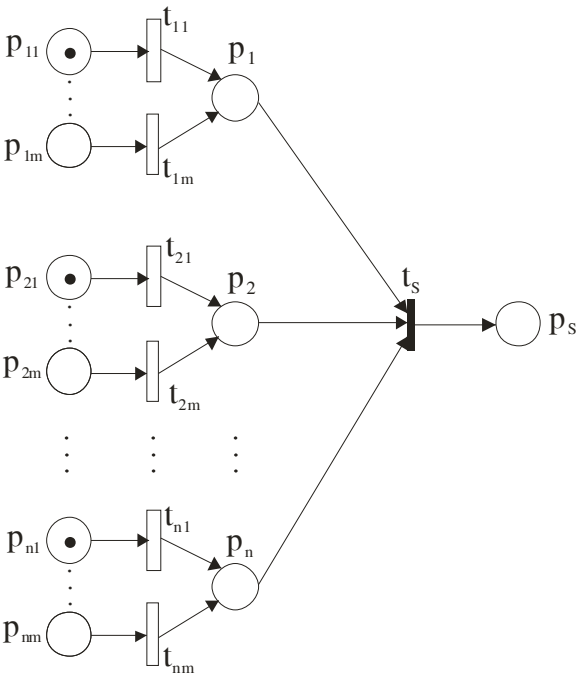

Figure 6. *Stochastic Petri net of Figure 4*

3. THE EXAMPLE OF TIME WITHOUT A FAILURES CALCULATION USING PETRI NETS

In this chapter a simple electric power system is used, [15-18]. From power plant *E* through the power lines L_1 and L_2 consumer *C* is powered. Consumer C is connected to the buses *S*. Buses *S* are supplied from the local source *G* which is connected over switch *B*.

For the reliability analysis of supplying consumer *C*, the next fault tree is used.

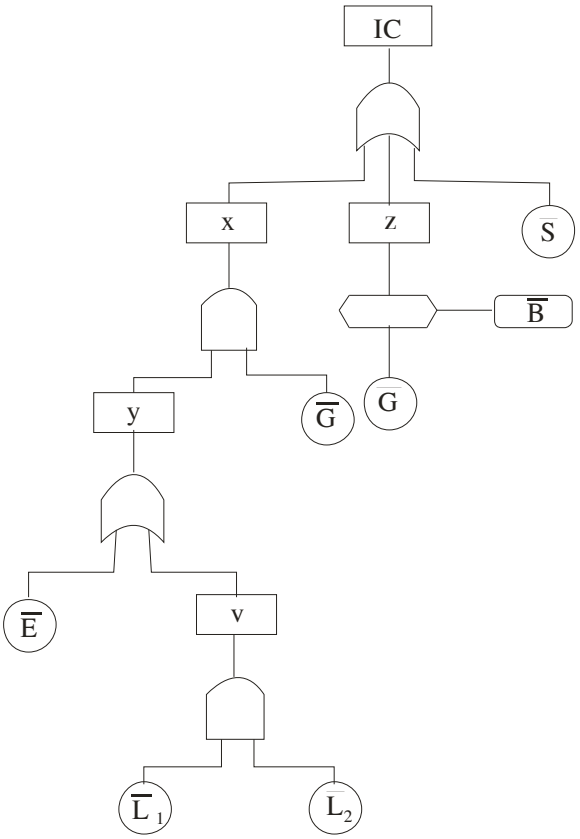

Figure 7. *The faul tree of electric power system*

Symbols in figure denote next events:

- *IC* - supply interruption of consumer *C*,
- *x* - malfunction at the same time of generator G and system for buses supply,
- *z* - malfunction of generator *G* and failure of switch *B*,
- *y* - malfunction at the same time of both wiring or malfunction of power plant *E*,
- *v* - malfunction at the same time of both wiring,
- $\overline{S}$ - malfunction of buses *S*,
- $\overline{E}$ - malfunction of power plant,
- $\overline{G}$ - malfunction of generator,
- $\overline{B}$ - failure of switch,
- $\overline{L}_1, \overline{L}_2$ - malfunction of both wirings L_1 and L_2.

Final event - failure of consumer *C* supply will appear when event *x* or *z* or $\overline{S}$ happen. Event *z* will happen when generator *G* is damaged and switch *B* can not turn off the generator because of the damage of switch itself or because of the failure of the protection that activates the switch. In that case, buses power must be stopped by turning off wirings L_1 and L_2. Event *x* will happened when both events *y* and $\overline{G}$ happen. Event *y* will appear when either $\overline{E}$ or *v* happen, and event *v* will appear when both wirings are in malfunction.

The appropriate Petri net is given in the next figure.

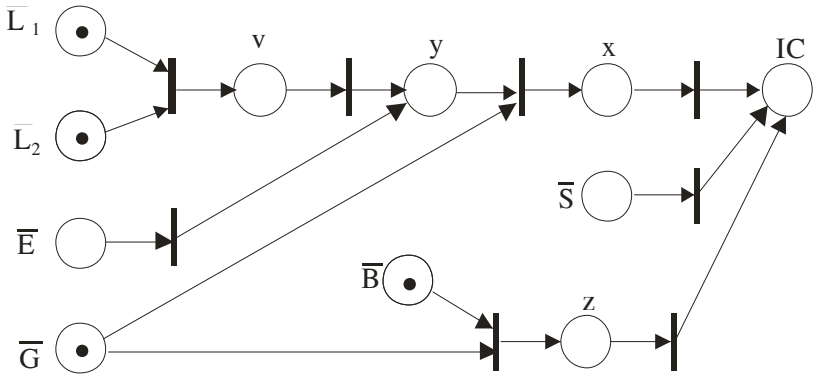

Figure 8. *Petri net of the electric power system*

The presence of tokens in a place denotes that certain event happened. Using classical Petri net it can be determined if the failure of consumer *C* appeared or not. Stochastic Petri nets can be used if we want to determine the probability of failure.

The system reliability is obtained using relation $R(t) = P\{T > t\}$, where T is the time without failures calculated in the fallowing way:

$$T = \max\{\tau_1, \tau_2, \tau_3\} \quad (6)$$

where:

τ_1 - is the time without failures of generator *G* and the system supplying buses,

τ_2 - is the time without failures of buses *S*,

τ_3 - is the time without failures of generator *G* and switch *B*,

$$\tau_1 = \min\{\tau_4, \tau_5\}$$

τ_4 - is the time without failures of both wirings or power plant *E*,

τ_5 - is the time without failures of generator *G*,

$$\tau_4 = \max\{\tau_6, \tau_7\}$$

τ_6 - is the time without failures of both wirings,

τ_7 - is the time without failures of power plant *E*,

$$\tau_6 = \min\{\tau_8, \tau_9\}$$

τ_8 - is the time without failures of wiring L_1,

τ_9 - is the time without failures of wiring L_2,

$$\tau_3 = \min\{\tau_5, \tau_{10}\}$$

τ_{10} - is the time without failures of switch *B*.

All of this time intevals refer to the time that token is in place or to the time necessary for transition to fire.

CONCLUSION

The appearance and development of reliability theory is a consequence of scientific and technical progress of the systems. For the reliability analysis Petri nets can be used successfully. Petri nets are a graphical and mathematical modeling tool applicable to many systems. Petri nets can be applied in the field of systems safety, logistic, industry, computer science, etc. They are simple, easy to expand and analysed using simulation. Petri nets are the only class of graphs allowing complete analysis of reliability. Fault tree method is very applicable for reliability analysis and system safety. Using this method is easy to determine which combination of system elements can lead system to the failure. Based on fault tree is easy to obtain Petri net.

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BIOGRAPHY

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NOVI PRISTUP ZA DOBIJANJE VREMENA BEZ OTKAZA SISTEMA KORIŠĆENJEM PETRI MREŽA

Bojana Zlatković, Biljana Samardzić

Apstrakt: *Novi način za određivanje vremena bez otkaza sistema korišćenjem Petri mreža je prikazan u ovom radu. Petri mreže su veoma pogodne za modeliranje i analizu različitih tipova sistema. Zbog svoje jednostavnosti, ovaj metod se može primeniti u praksi, na primer, za analizu pouzdanosti i izračunavanje vremena bez otkaza sistema. Rezultati su ilustrovani na primeru jednog elektroenergetskog sistema.*

Ključne reči: Petri mreže, vreme bez otkaza, stablo otkaza.

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GENERAL PRINCIPLES AND CHARACTERISTICS OF FORMATION AND OUTBREAK OF SANITARY LANDFILL FIRES

Abstract: *This paper discusses fires that occur in sanitary landfills as a result of oxidation processes in the landfill body. The paper provides an overview of the causes and incidence of landfill fires, as well as their classification. Finally, it analyzes fire occurrence indicators.*

Key words: landfill, fire, waste, landfill gas, indicators of fires.

INTRODUCTION

Waste disposal in landfills may lead to unpleasant odours, accumulation of landfill gases, fires and explosions, greenhouse effect, surface and ground water pollution, soil pollution, increased vehicle noise, workers' health risk of various typical and atypical infectious diseases as well as diseases caused by air pollution, uncontrolled scattering of lightweight waste, etc. Figure 1 shows the reported percentage of the most common landfill processes and occurrences that degrade the environment.

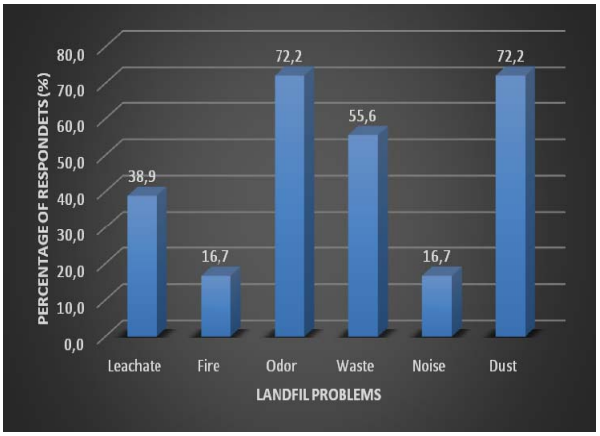

Figure 1. *Percentage of the most common landfill processes and occurrences that degrade the environment* [1]

Regardless of the low reported percentage of the occurrence of fires and explosions in relation to other phenomena, they still entail the highest risk and the most serious consequences to the environment, which requires a special approach and analysis of all their relevant parameters and causes. The serious nature of this issue is reflected in the data reported by the Sector for Emergency Management of the Republic of Serbia, according to which there were 877 landfill fires in Serbia in 2015.

1. LANDFILL FIRE CAUSES

It is difficult to determine with precision what causes landfill fires since there are numerous different factors contributing to their formation and outbreak. The factors influencing landfill gas ignition are complex both for their physicochemical properties and for their incidence and duration. Out of the total percentage of landfill ignition factors, the origin of about 40% cannot be determined. It is known that ca. 20% of fires occur due to smouldering waste, which consists of materials with different ignition points (e.g. cigarettes, matches, paper, fabrics, etc.) [2]. It is also known that about 5% of landfill fires are caused by spontaneous combustion, about 7% by reignition of a previously suppressed fire, and about 8% are due to insufficient control of open fires.

2. FIRE OUTBREAK PERIODS

According to statistical data, the most common fire outbreak period is between March and August, which is when 60% of the total annual landfill fires occur (Figure 2). The registered percentage of landfill fires is 11.2% in July, 10.6% in April, and 9.9% in May, which, combined, constitutes one third of the total annual fires. Such monthly incidence is explained by the presence of dominant fire factors, such as increased air temperature and decreased air humidity.

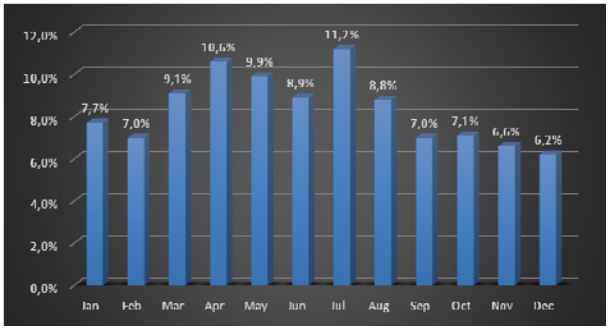

Figure 2. *Monthly incidence of landfill fires* [3]

Landfill fires caused by spontaneous combustion (Figure 3) gradually increase in frequency with the decrease in air temperature and changes in other meteorological conditions. These fires occur most frequently during October (10.6%) and November (10.6%).

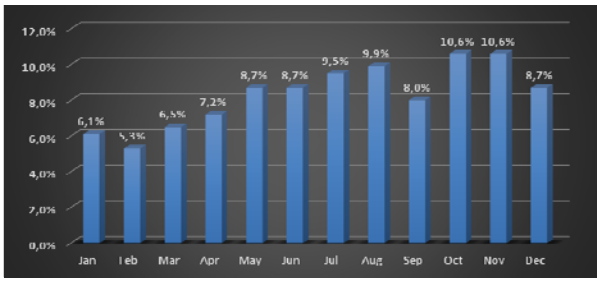

Figure 3. *Monthly incidence of landfill fires caused by spontaneous combustion* [3]

Insufficiently compacted inert material can allow the oxygen from the air to penetrate into the landfill, accelerate oxidation, or contribute to complete oxidation of a partially oxidized gas. Oxidation is accompanied by the release of heat in the landfill body, and even a slightly higher degree of oxidation poses a fire risk. Penetration of ambient air into the landfill body can also be increased due to the difference in barometric pressure between the landfill body and ambient air. These processes, which are particularly prominent in the spring or late autumn, are caused by strong winds and atmospheric changes that heat and cool the landfill surface.

3. FIRE-RELATED EVENTS

Landfill fires entail a series of dominant events, such as flames (34%), unpleasant odours (28%), smoke (10%), landfill surface depressions (21%), etc. Other events (7%) include emissions of incomplete products of combustion and leachate outflow from fire suppression activities.

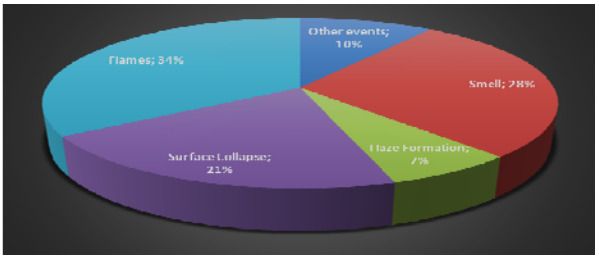

Figure 4. *Fire-related events* [4]

The duration period of landfill fires and their accompanying events can last from a few days to a few months and even a year (Figure 5).

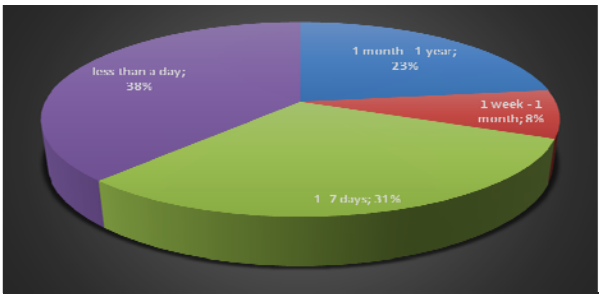

Figure 5. *Landfill fire duration* [4]

4. LANDFILL FIRE CLASSIFICATION

According to the amount of inflammable material – waste – caught on fire, landfill fires can be classified into four categories [5] :

- Category 1 – easily extinguished fires; include fires on vehicles, equipment, or buildings at the landfill;
- Category 2 – fires on flat surfaces or slopes for waste disposal, which covers less than 200 m³ of inflammable waste;
- Category 3 – fires that cover 200-5,000 m³ of inflammable waste and require up to a week to be extinguished;
- Category 4 – fires that cover more than 10,000 m³ of inflammable waste and require more than two weeks to be extinguished.

According to the point of origin at the landfill, fires can be classified into [3]:

- fires in the active landfill sections, which are the most common (77%);
- vehicle fires, including dustcarts, presses, compactors, and other vehicles (4%);
- wood, thicket, and grass fires from landfill fire propagation (12%);
- fires in landfill buildings – administrative offices and auxiliary facilities (e.g. guardhouse, weighing scales) (7%).

According to the manner of combustion, landfill fires can be classified into:

- flaming fires (open-flame combustion) and
- smouldering fires (smouldering combustion without flames).

Flaming fires are typically surface fires, whereas smouldering fires are usually underground fires.
Accordingly, landfill fires can also be classified into [6]:

- surface fires and
- underground fires.

4.1. Surface fires

Surface fires originate in the active sections of the landfill where waste is deposited daily. The inflammable material comprises incompact waste, a few days to a few weeks old, usually at the depth of 0.31 m to 1.22 m, in the aerobic decomposition phase. These fires can become more intensive due to landfill gas (methane), which can spread them across the entire

landfill. Surface fire usually burn at relatively low temperatures and emit thick white smoke and products of incomplete combustion. Their causes include: disposal of unnoticed smouldering materials in the landfill; excessive accumulation of landfill gas in the landfill body; damage of the degassing system; inadequate landfill waste management; landfill accidents and damage; etc.

4.2. Underground fires

Underground landfill fires originate deep beneath the landfill surface, in the deposited waste that is months or years old. They usually occur due to overload of the landfill gas collection system or due to spontaneous combustion. Waste often oxidizes in the immediate vicinity of gas wells or near the landfill surface, which allows the oxygen to penetrate into the landfill body, which in turn leads to fast oxidation of organic waste. The most common cause of underground landfill fires is the increased concentration of oxygen in the landfill body, which increases bacterial activity and raises temperature (aerobic decomposition). These so-called 'hot spots' can come into contact with methane and cause a fire. Such fires tend to smoulder continuously for weeks and even months, without any visible flames or large volumes of smoke. The fire spreads imperceptibly within the landfill body until the surface layer collapses, until there is a hole in the surface, or until smoke becomes visible. Underground fires are detected in the gas collection systems due to increased temperature at the top of the gas well or due to appearance of soot. These fires produce inflammable and toxic gases (e.g. carbon monoxide), which can damage the systems for landfill filtrate and gas collection. They are usually more difficult to extinguish than surface fires.

According to their point of origin in the landfill body, underground fires can be classified into (Figure 6):

1) fires in gas wells near the landfill surface;
2) fires in gas wells within the landfill body;
3) fires inside the landfill body;
4) fires near the landfill surface.

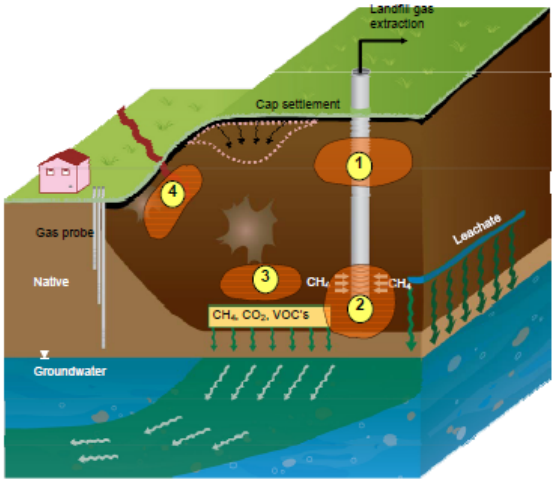

Figure 6. *Underground fire points of origin* [7]

5. INDICATORS FOR DETECTING HOT SPOTS IN THE LANDFILL BODY

There are four main indicators of underground landfill fires:

- smoke and odours from the landfill;
- increased temperature in gas collection systems and measuring points;
- occurrence of cracks, subsidence, or depressions;
- changed concentrations of landfill gas components.

The presence of hot spots, which determine the point of origin of underground fires, can be detected based on depressions and the smoke and odours coming from the landfill surface. They only indicate the part of the landfill where the fire originated, but not the depth. More precise locations of 'hot spots' are determined through the examination of the concentrations of CO and other landfill gas components by means of a quantitative laboratory analysis. Landfill gas monitoring during a fire reveals a change in the concentrations [8] (Table 1).

Table 1. *Changes in concentrations of landfill gas components during a fire*

Gas	Indication of potential development	Background concentrations ($\%_{vol}$)	Hot spot area concentrations ($\%_{vol}$)
Methane	Decrease	55 - 56	10
Carbon dioxide	Decrease	43 - 44	16
Oxygen	Increase	0.05	8
Carbon monoxide	Increase	0.0006 - 0.0019	0.0052
Hydrogen	Increase	0.06 - 0.07	1.6

These data suggest that CO has the highest volume percentage and that it is justifiably used as an underground fire indicator. Table 2 shows CO concentration ranges, which are taken as the qualitative probability factor for the occurrence of a fire in the landfill body.

Table 2. *Empirical scale for the assessment of fire occurrence in the landfill body*

CO ($\%_{vol}$)	Possibility of a fire in the landfill body
0 - 0.0025	No fire
0.0025 - 0.01	Possible fire in the landfill body
0.01 - 0.05	Possible smouldering fire in the landfill body
0.05 - 0.1	Probable fire in the landfill body
>0.1	Fire in the landfill body

Since the landfill temperature in the aerobic phase, which lasts from several days to several weeks, ranges from 80 to 90°C and, after the transition to the anaerobic phase, which lasts for years, the temperature ranges from 30 to 50°C, any temperature increase indicates the appearance of hot spots during fires. If gas temperature in a gas well increases without visible smoke or depression, it is difficult to determine the exact point of origin of the underground fire. Fire temperature in the landfill body can be measured with thermocouples [8] (Table 3).

Table 3. *Temperature ranges of hot spots in the landfill body*

Depth (m)	Temperature in hot spot area (°C)	Background waste temperature (°C)
3-4	40-60	7-22
5	40-60	22-35
10	550	39-65
15	105	45-55
25-30	70	30-40

The temperature in the landfill body depends on the amount and composition of inflammable waste. Table 4 shows the amounts of heat released during the combustion of different types of waste.

Table 4. *Calorific values of municipal solid waste components* [9]

Component	Caloric values (kJ/kg)		
	As received	Dry	Moisture/ash free
Paper	15 750	17 530	18 650
Corrugated boxes	16 380	17 280	18 260
Plastic coated paper	17 070	17 910	18 470
Waxed milk carton	26 350	27 290	27 660
Lawn grass	4 760	19 250	20 610
Leaves	18 490	20 540	21 460
Green logs	4 870	9 740	9 840
Flowering plants	8 560	18 580	19 590
Wood and bark	19 570	19 940	20 140
Rubber	25 930	26 230	29 180
Upholstery	16 120	17 320	17 800
Polystyrene	38 020	38 090	38 230
PVC	22 590	22 640	23 160

CONCLUSION

Even though the incidence of fires is smaller than the incidence of other processes and events in landfills, fires entail the highest environmental risk and damage. It cannot be determined with a 100% certainty when and where a landfill fire will occur, but it is possible to analyse the causes and the most common periods of occurrence, and to classify fires. If a fire occurs, its duration period can vary and entail a series of dominant events. The point of origin is determined through monitoring of fire indicators. As it is easier to determine the point of origin for surface fires, the most reliable method for pinpointing underground hot spots is to monitor the changes in the concentrations of landfill gas components and temperature changes within the landfill body.

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BIOGRAPHY

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OPŠTI PRINCIPI I KARAKTERISTIKE FORMIRANJA I NASTANKA POŽARI NA SANITARNIM DEPONIJAMA

Lidija Milošević, Emina Mihajlović, Amelija Đorđević, Jasmina Radosavljević

Apstrakt: *U radu su prikazani požari koji se nastaju na sanitarnim deponijama kao posledica formiranja procesa oksidacije u telu deponije. Dat je pregled uzroka formiranja i učestalost procesa nastajanja požara kao i njihova kategorizacija. Posebno je dat prikaz izbora indikatora koji su u funkciji nastanka požara.*

Ključne reči: deponija, požar, otpad, deponijski gas, indikatori požara.

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COMPARATIVE CONCENTRATION MEASUREMENTS OF DUST PRODUCED BY WOOD PROCESSING MACHINES

Abstract: *Industrrial activities have to comply with protective measures. For this reason, it is essential to know the maximum allowable concentration of chemical hazards (gas, steam and dust) which can occur in the workplace. In wood industry, a large amount of wood dust is produced during the mechanical wood processing. Unless adequate measures for its removal are undertaken, there may be potential hazards for the workers' health. The research has been carried out for purpose of determining the level of dust emission in different machines in wood processing workshops with no dedusting system included, by measuring concentrations of wood dust produced during the processing of wooden material.*

Key words: wood processing, wood dust, concentration measuring.

INTRODUCTION

During the technological process of mechanical treatment and wood processing, a large amount of wood waste is produced. The amount of waste, as well as its dimensions and shape, depend on the type of machine, procession degree, as well as the type of wood being processed. In certain wood processing operations, such as cutting and grinding, a large amount of fine wood dust is processed. This dust can be particularly hazardous for the health of workers, and there is also a risk from fires and explosions occurring, which can additionally threaten the workers and material goods [1].

As mentioned before, exposure to dust at workplace presents a potential hazard for the workers' health. Inhaling wood dust can cause allergic reactions of respiratory mucosa, that is, the respiratory system. If great amount of wood dust is present, it will have an irritating effect on eyes, nose and throat. Significant accumulation of fine dust particles may damage lung function, initiate asthma attack, and have carcinogenic effect as well [2].

In terms of occupational safety and health, dust can be classified by size into three categories, which are: respirable dust, inhalable dust, and total dust. Respirable dust is the type of dust which is small enough to get deep inside the lungs, therefore passing through the nose, throat and upper parts of the respiratory tract. The size of respirable dust particles is $\leq$ 5 μm (about 1/12 the width of an average human hair). Inhalable dust is the dust which usually can't get further from the nose, throat and upper respiratory tract, and whose average size is about 10 μm. Total dust includes all the particles, regardless of size and structure [3].

Testing of chemical hazards (gas, steam and dust) is performed at workplace, in the work environment, where chemical hazards occur in technological and working processes. The testing of chemical hazards is performed by taking at least one sample at workplace, closest to the hazard source [4].

There are many factors which can affect the noxiousness of substances in the work environment, the most important of which is the concentration of hazardous substances (in our case the wood dust concentration). Concentration, of course, refers to the amount of toxic matter, in a working environment, where the worker is exposed and where the measuring unit is usually mg/m^3 [5].

In order to protect the workers' health and safety, countries prescribe the limit values for concentration of chemical hazards.

Each country has its norms on maximum allowable concentrations (MAC), that is, on limit values, of chemical hazards at the workplace. The Serbian standard is SRPS Z.B0.001:1991 – maximum allowable concentrations of toxic gases vapours and aerosols in working premises atmosphere, and it includes over a 1000 different toxic matters. Testing of working atmosphere is performed according to the prescribed norms given in the standard. The SRPS Z.B0.001/1:2007 standard presents the alteration of the SRPS Z.B0.001:1991 Serbian standard and it is its integral part. The standards have been reviewed and confirmed in March 2012. According to it, the MAC for wood dust is 10 mg/m^3 [6].

For inhaling particles of hard wood types, the 1999/38/EC Directive of European Union prescribes the TWA limit value of 5 mg/m^3. TWA (Time Weighted Average) is measured or calculated as an average measured value for the period of eight hours [7].

OSHA (Occupational Safety and Health Administration) is the main federal agency in the USA, whose task is the enforcement of legislation in the area of occupational safety and health, and it prescribes the PELs (Permissible exposure limits) [8]:

- TWA 15 mg/m^3 for the total wood dust (soft and hard wood), and
- TWA 5 mg/m^3 for respirable wood dust (soft and hard wood).

According to the document published by HSE (Health and Safety Executive – a UK government body that deals with the management of health and safety at work) which contains a list of allowed exposure limits at workplace for soft and hard wood dust, the TWA for a working period of eight hours is 5 mg/m^3 [9].

Contemporary wood processing facilities use the systems for gathering wood waste, that is, wood dust. Special equipment, that is, system for dedusting is applied to the wood processing machines [10].

Due to the lack of funds, or more often due to the negligence or lack of awareness of dust wood, it may occur that some wood processing facilities may not have the equipment applied, and that the working conditions are therefore unfavorable.

This paper contains the analysis of wood dust concentration levels, measured in a wood processing facility where a dedusting system is not included, with the aim of determining the level of emission in different machines and defining the necessities of system installation.

WORKING METHOD AND MATERIALS

The research has been carried out in the workshops of factories producing furniture, mainly made of beech wood. In these workshops, various machines are used for wood cutting and processing. The machines used for processing, as well as types of wood processing during the measuring of wood dust concentration are given in the table below.

Table 1. *The font size and appearance for the styles*

Wood processing machine	Types of wood processing for a particular machine
Hand-held circular saw	Cutting
Table circular saw	Cutting
Dual circular saw	Cutting
Jointer (surface planer)	Shaping of wood elements
Wood shaper (spindle moulder)	Shaping of elements
Belt grinder	Grinding of elements
Spindle grinder	Grinding of elements
Drum grinder	Grinding of elements

Figure 1 shows the processing of beech tree elements in one of the processing machines listed.

Figure 1. *Processing of beech wood elements on belt grinder*

All of the listed machines for wood cutting and processing were not connected to a dedusting system.

For purpose of determining the pollution and air purity of the work atmosphere, special analytical methods have been developed. In the working atmosphere, it is important to constantly control concentrations of toxic gases, steams and particles, in order to determine whether they are within the allowed limits of MAC. For this reason, methods need to be adequate, sensitive enough, reliable and specific. Thereby, one of the most important factors upon determining the pollution of work atmosphere is the adequate way of sampling, with the aim of getting a precise result. Depending on the purpose of air sampling, there can be three sampling sites [11]:

1. Sampling is performed nearby the source of air pollution, with the aim of gaining information on the amount of pollutants released into the working environment. These samples are important for planning technical measures for suppressing air pollution.
2. Samples are taken from different parts of the work room, with the aim of getting spatial distribution of air pollution concentration.
3. Sampling is performed in workers' environment, with the aim of determining the level of exposure to pollutants. These samples should be taken in the workers' inhaling zone, and if they are changing their positions while working, the representative samples should be taken in all of their working positions. These samples are the most important in estimating the level of harm on health; therefore, sampling during the research is performed this way.

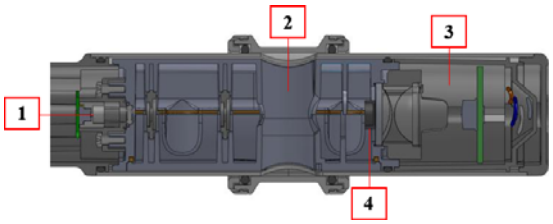
Using the CEL – 712 Microdust Pro instrument from Casella (figure 2), measuring is carried out in the period of three minutes per machine, by the Laboratory for air quality control at the Faculty of Occupational Safety in Niš, University of Niš.

CEL - 712 Microdust Pro is a portable instrument for measuring particle concentration (dust, smoke, fumes, pollen and other aerosols) in real time [12].

Figure 2. *CEL - 712 Microdust Pro*

Microdust Pro does not belong to instruments with traditional gravimetrical methods of dust measuring (which demand a certain sampling period and are not adequate for estimating the change of concentration degree in real time). It is an ideal instrument for estimating dust concentration in real time in mg/m³ in controlled areas. This instrument is portable and it has a separate probe which enables working in relatively inaccessible areas.

Microdust Pro uses a variable laser light source, which goes through the measurement chamber, that is, the measuring technique is light scattering with the help of visible, red laser light (wavelength of 635 nm <5 mW). The intersection of sampling probe is shown in figure 3.



1. Laser source
2. Measurement chamber (Sample volume)
3. Optical detector
4. Light stop

Figure 3. *Sampling probe*

In clean air conditions, no light gets to the receiver. When dust particles enter the chamber, a beam of laser light scatters at a narrow angle and one of its parts can be registered by the receiver.

So, Microdust Pro performs precise measures of dust concentration based on the principle of rectilinear light scattering. This instrument enables a graphical display of concentration changes, has internal data recording (which can later be displayed on computer), a simple user interface and the ability of measuring a wide range of concentrations. The measuring range of Microdust Pro instrument may be from 0.001mg/m^3 to 250 g/m^3 , covering six different measuring ranges: 0 - 2.5 mg/m^3, 0 - 25 mg/m^3, 0 - 250 mg/m^3, 0 - 2500 mg/m^3, 0 - 25 g/m^3 and 0 - 250 g/m^3.

The data generated by the CEL – 712 Microdust Pro instrument can be copied to a computer via USB cable. After copying, this data can be processed and analyzed using the Casella Insight Data Management software (figure 4). Casella Insight software enables instrument configuration, data downloading, data management and analysis, and has different reporting functions.

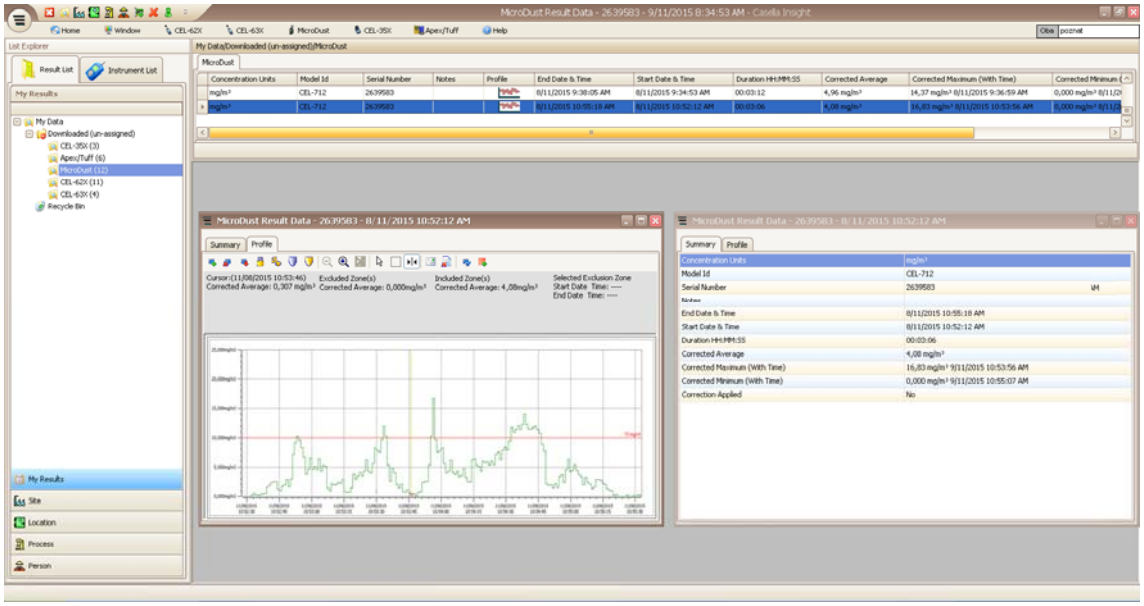


Figure 4. *Casella Insight Data Management software*

RESULTS AND DISCUSSION

The measured results of wood dust concentrations in air can be read directly from the screen of Microdust Pro instrument (figure 5), but the detailed information is received only after gaining data with the help of previously mentioned Insight Data Management software.

The results of wood dust concentrations in air, measured in Insight Data Management software can be displayed in the form of table (figure 6.) and graphs (figure 7.)

Measuring results (Table 2) show that there may be different wood dust concentrations, depending on the type of wood processing.

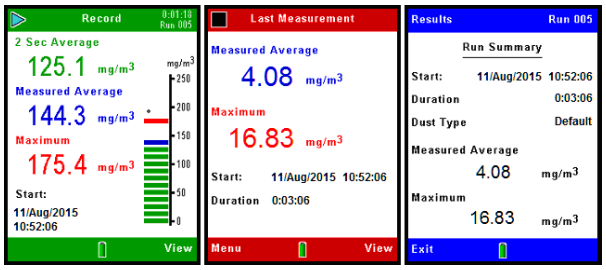


Figure 5. *Display of concentrations during (green) and after measuring (red and blue) [12]*

Sample Time	Corrected Concentration	Notes
8/11/2015 10:53:47 AM	0,547 mg/m³	
8/11/2015 10:53:48 AM	0,089 mg/m³	
8/11/2015 10:53:49 AM	0,742 mg/m³	
8/11/2015 10:53:50 AM	0,831 mg/m³	
8/11/2015 10:53:51 AM	2,367 mg/m³	
8/11/2015 10:53:52 AM	2,500 mg/m³	
8/11/2015 10:53:53 AM	2,500 mg/m³	
8/11/2015 10:53:54 AM	5,34 mg/m³	
8/11/2015 10:53:55 AM	10,28 mg/m³	
8/11/2015 10:53:56 AM	16,83 mg/m³	
8/11/2015 10:53:57 AM	9,68 mg/m³	

Figure 6. *Display of concentrations during (green) and after measuring (red and blue) [12]*

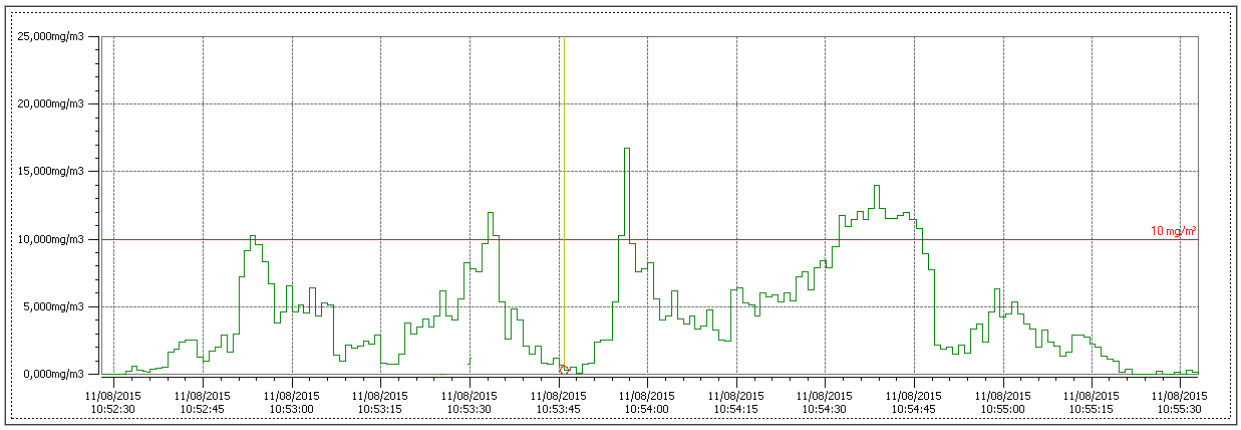


Figure 7. *Display of concentrations during (green) and after measuring (red and blue) [12]*

Table 2. *Average and maximum wood dust concentrations depending on types of wood processing machines and limit values of the standards and directives mentioned.*

Type of wood processing machine	**Average concentration [mg/m³]**	**Maximum concentration [mg/m³]**	**MAC** SRPS Z.B0.001:1991	**TWA** 1999/38/EC, 1910.1000 - T. Z1, EH 40/2005	**STEL** EH 40/2005
Hand-held circular saw	9,19	18,24	10 mg/m³	5 mg/m³	20 mg/m³
Table circular saw	8,59	15,52			
Dual circular saw	12,67	27,12			
Jointer (surface planer)	12,09	23,86			
Wood shaper (spindle moulder)	4,96	14,37			
Belt grinder	6,49	17,12			
Spindle grinder	4,08	16,83			
Drum grinder	3,91	12,75			

In working with hand-held circular saw and table circular saw, average wood dust concentrations have been recorded (9,19 mg/m^3 and 8,59 mg/m^3), which are similar to the MAC values of 10 mg/m^3 from the SRPS Z.B0.001:1991 standard.

The measurements recorded during the wood processing on dual circular saw and jointer, show high concentrations of up to 12,09 mg/m^3 and 12,67 mg/m^3, exceed the MAC of 10 mg/m^3 for wood dust, which is prescribed by the SRPS Z.B0.001:1991 Standard.

The average concentrations measured in other machines were lower, and did not exceed the MAC by the SRPS Z.B0.001:1991 Standard. However, they too exceed the allowed TWA values for respirable dust (5 mg/m^3) by the OSHA PEL, as well as the measures for maximum concentration given by the directives of EU and the British HSE.

Judging by the before stated, it can be noted that the value of 10,00 mg/m^3 for the MAC is double the size for dust wood, compared to other standards listed.

Contrary to the Serbian SRPS Z.B0.001:1991 Standard, the British EH 400/2005 also states STEL (Short-Term Exposure Limit) and represents the concentration of the hazardous chemical substance which the employee may be exposed to for a short time with no real health danger. The exposure to such hazardous chemical substance may last up to 15 minutes and may not be repeated more than four times during work time. The shortest time between the two periods of exposure needs to be at least 60 minutes. Maximum concentrations recorded during the wood processing on dual circular saw and jointer (27,12 mg/m^3 and 23,86 mg/m^3) exceed the STEL for cellulose inhalable dust which, according to the EH 40/2005 is 20 mg/m^3. The Serbian standard does not state the short-term exposure limits.

CONCLUSION

This paper is based on the research carried out in the carpenter workshops, in factories for producing furniture made of beech wood, with the aim of analyzing how the work conditions affect the very work process and the environment, that is, the workers' health.

Based on the conducted measurements and the analyzed data, it has been determined that during the wood processing with no protective measures, a large amount of wood dust may be generated, depending on the processing, that is, on the type of machine used.

It has also been determined that during the wood processing the amount of wood dust processed in this machine may be harmful for the safety of workplace, as well as the workers' health. Large concentrations have been measured during the processing by hand-held circular saw, table circular saw, dual circular saw, and jointer. The average dust wood concentrations, measured during the wood processing in these machines, were very close to or over the MAC prescribed by the standard SRPS Z.B0.001:1991 (10 mg/m^3), while in other machines, lower values have been recorded. However, all of the measured wood dust concentrations produced during tree processing in all of the machines tested, were above the allowed TWA values for respirable dust, which according to the OSHA is 5 mg/m^3, and above the TWA value which also amounts 5 mg/m^3, according to the directives of EU and British limits of work place exposure *EH 40/2005*. This data shows that the Serbian standard is not according to the global directives, that is, standards. Also, the Serbian standard does not state the short-term exposure limits of STEL, which is one of the disadvantages, as the workers' short-term exposure to concentrations larger than MAC, which may also harm the workers' health, is not taken into account.

Since the maximum allowable concentration for wood dust given in the Serbian standard is double the limit values given in the previously mentioned standards and directives, and since the standard does not take into account a short-term limit value of exposure, it is advised that they are reviewed and coordinated.

Considering the fact that large concentrations of dust wood are produced due to the lack of dedusting systems in the furniture producing factory, we can conclude that the work conditions in the workshops are unfavorable. In order to keep people healthy and the workplace safe, maintaining the workplace hygiene and cleaning off and removing wood dust is essential. Taking all of this into account, the conclusion is that a deducting system installation is necessary in all of the analyzed machines for wood processing.

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BIOGRAPHY

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UPOREDNA MERENJA KONCENTRACIJE PRAŠINE KOJA NASTAJE NA MAŠINAMA ZA OBRADU DRVETA

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Apstrakt: *Industrijske aktivnosti je neophodno uskladiti sa merama zaštite. Zbog toga je potrebno poznavanje maksimalno dozvoljenih koncentracija hemijskih štetnosti (gasova, para i prašina) koje mogu da se jave na radnom mestu. U drvnoj industriji se prilikom mehaničke obrade drveta stvara velika količina drvene prašine. Ukoliko se ne preduzmu adekvatne mere za njeno uklanjanje stvara se potencijalna opasnost po zdravlje radnika. Istraživanje je sprovedeno u cilju određivanja stepena emisije prašine na različitim mašinama u radionicama za obradu drveta u kojima nije prisutan sistem za otprašivanje, merenjem koncentracija drvene prašine nastale prilikom obrade drvenog materijala.*

Ključne reči: Obrada drveta, drvena prašina, merenje koncentracije.

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ENVIRONMENTAL CAPACITY: NEOTERIC APPROACH IN SUSTAINABLE ENVIRONMENTAL MANAGEMENT

Abstract: *Forecasting changes in the environment, creating preventive actions and defining the corresponding measures are in the focus of contemporary scientific researches in the area of sustainable environmental management. An essential part of preventive thinking is consideration of the concept of environmental capacity. The aim of this study is to examine determinants of environmental capacity, vulnerability and resilience based on the principles of sustainable development. The study is based on observing relevant components and structure of the environmental capacity, vulnerability and resilience concept. In that sense, this paperwork represents an assay to highlight the basic attributes of the abovementioned concept, and to identify the specific linkages between them.*

Key words: environmental capacity, determinants, management.

INTRODUCTION

The scientific use of the concepts of environmental capacity is central to many areas of environmental protection and environmental quality management processes, and is a basic tool for the analysis of adverse effects of environmental problems both regarding state of the environment (eco-centric point of view) and potential of environmental services to humans (eco-anthropogenic point of view).

There is no doubt that the development of environmental capacity concept was contributed by the activities of the Rome's club and a Conference on the environment held in Stockholm in 1972. year (United Nations Conference on the Human Environment) where The Declaration of the United Nations Conference on the Human Environment, or Stockholm Declaration, was adopted on 16th June.

In parallel with the strengthening of environmental awareness in the world, within that time present European Economic Community was published the first wave of the directives pertaining to the issue of environmental quality management. For the first time, these directives are talking about environmental quality standards, which are divided into two groups (regarding water quality): the emission and the emission standards. In terms of respecting the capacity of the environment the imission standards respects the environmental component when defining the maximum allowable input of pollutants in a particular recipient. These documents can be recognized as first studies regarding the environmental component of the environment capacity concept.

However, after more than 30 years, only with catastrophic events such as the Indian Ocean earthquake and tsunami began the researches that relates to the active role of humanity in the process of environmental capacity management, and consideration of economic and social components of environmental capacity, which is shown on Figure 1.

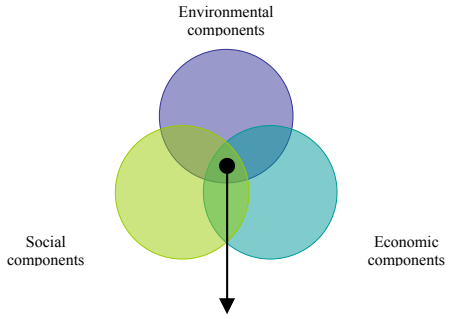

Figure 1. *Environmental capacity components*

In formal sense, the term of environmental capacity is for the first time defined by group of authors working within unique Research framework as "a property of the environment and its ability to accommodate a particular activity or rate of an activity ... without unacceptable impact" (GESAMP, 1986). The environmental capacity concept is therefore central to the promotion of sustainable development. Importantly, it requires us to address the cumulative impacts of whole sectors of activity, and ideally all economic activity, on the ecosystem within a specified area.This definition clearly states the environmental or biophysical component of environmental capacity, but following chapters will explain that environmental capacity concept goes far beyond only this dimension.

UNDERSTANDING ENVIRONMENTAL CAPACITY

Scientific and historical records the data and the results of statistical analysis shows and point to a steady, but

ever-present, increase in risk, the number, type and intensity of hazards, either man-made or environmental and the increasingly complex and severe consequences that threaten not only humanity but the total biosphere of the Earth (Blaikie, 1994). Conducted researches, analysis and forecasts indicate the possibility of the occurrence of large-scale droughts and sudden floods, even where it has been never occurred. These new climate changes are highly conducive to the development of new epidemics, affecting the growth of hunger, poverty and massive migration of citizens. Harmful processes to people and property, environmental degradation, and especially their consequences, do not recognize national boundaries, but increasingly have trans-regional dimensions, with a tendency to diffuse in sense of global expansion (Cardona, 2004).

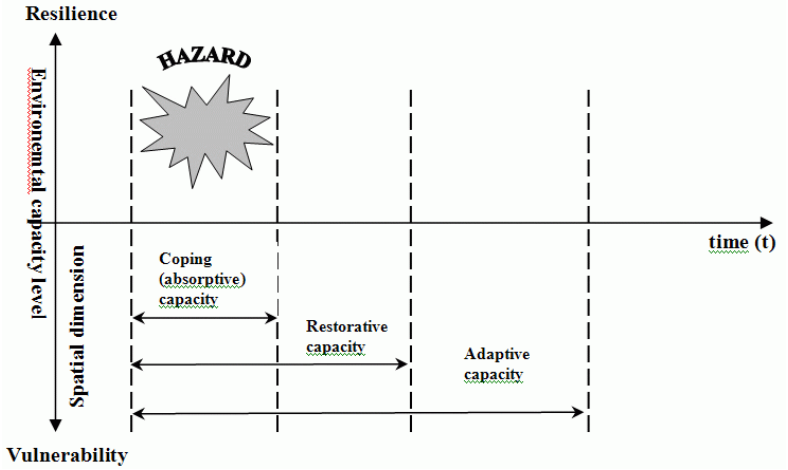

Figure 2. *Time and spatial dimension of environmental capacity*

Science and practice today focus on further development of the complex actions of timely recognition and forecast of the threats. Evaluation of new challenges, risks and threats, must be based on complex analysis and in particular the prediction of new hazards and it's consequences, with emphasis on the planning and undertaking of preventive measures of monitoring and supervision of implementation of the measures that directly or indirectly affect the reduction of the risks and consequences (Cardona, 2005). Previous findings obtained by the science as evidenced by the positive experiences from practice show that the risk factors and the risk can not be totally identified, monitored, evaluated and predicted (Cardona, 2006). For such reasons, humanity and environment will remain vulnerable to hazards, but it is necessary to identify level of vulnerability to different hazards and capacity to manage them.

When talking about environmental capacity, it is necessary to bear in mind that there are different levels of environmental capacity in general, either on vertical or horizontal scale, i.e. taking into account time or spatial dimension, which is shown in Figure 2.

In terms of terminology, contemporary literature provides a considerable number of definitions that refers to the terms introduced in the Figure 2. UN/ISDR - UN Office for DRR (Disaster Risk Reduction) sets next definitions:

Capacity *- the combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals,*

Coping capacity *- management activities that address and seek to correct or reduce disaster risks which are already present,*

Adaptive capacity *- generally alludes to a longer time frame that coping capacity and implies that some learning either before or after an extreme event or change in conditions has occurred. The IPCC (*2007*) defines adaptive capacity in relation to climate change as "the ability of a system to adjust to climate change (including climate variability and extremes),*

Restorative capacity *- the ability of a system (ecosystem) to be restored in previous state, either before occurrence of a short-time hazard or after continual pollution load,*

Hazard *- a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage,*

Resilience *- the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions,*

Vulnerability *- the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard*

Observed in time, environmental capacity has its:

- short time component - coping (absorptive) capacity,
- medium time component - restorative capacity and
- long time component - adaptive capacity.

Table 1. shows the development of coping and adaptive capacity definitions (Thomalla, 2006).

Table 1. *Development of coping capacity and adaptive capacity definitions*

Reference	Coping capacity or coping strategies	Adaptive capacity or adaptation
Davies (1993)	Short-term response to an immediate and in habitual decline in access to food	Permanent change in the ways in which food is acquired
Kelly and Adger (2000)	Ability to respond to an occurrence of harm and to avoid its potential impacts	Ability to transform structure, functioning or organisation to survive under hazards' threatening existence
Yohe and Tol (2002)	Range of actions available to respond to the perceived climate change risks in a given policy context	Ability to change the set of available inputs that determine the level of coping capacity
Eriksen et al. (2005)	The responses that people employ to maintain wellbeing in the face of environmental stress within the existing structures	Changing the framework within which coping takes place
IPCC (2007, 2001)	'Coping Range' (2001 TAR) The variation in climatic stimuli that a system can absorb without producing significant impacts	Adaptation: adjustment in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits benefits. Adaptive capacity: the ability of a system to adjust to climate change to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.
Birkmann et al. (2009)	Immediate responses to hazards such as a specific flood event	Medium - and long term strategies for changes in institutional frameworks
Lemos and Tompkins (2008)	Design and implementation of risk management institutions - such as disaster preparedness plans - that can mitigate the most immediate climate impacts	Socioeconomic and political reforms that addresses the inequalities at the root of differential vulnerabilities
Pelling (2011)	The strategies used by those living with rapid onset disasters such as flash floods, and chronic disasters, including drought and food insecurity	Change in those practices and underlying institutions that generate the root and proximate causes of risk, frame capacity to cope and further rounds of adaptation to climate change

With no less importance is the definition provided by The Law on Environmental Protection of the Republic of Serbia which defines a level of environmental capacity as "*the ability of the environment to accept a certain amount of pollutants per unit of time and space without irreparable damage to the environment*".

Whether the environmental capacity is observed in the time or spatial dimension, there is a general rule (author's note) that at every instance there are substantial interlinkages between economic, social state of those who are users of environmental services and bio-physical state of environment. There are integrative frameworks focused on interaction between properties of ecological-social-economic systems (Janaćković, 2013; Malenović Nikolić, 2015). At the other hand, there are researchers that distinguish biophysical (or natural, environmental) component of environmental capacity as external factor from social and economic (or socioeconomic) component of environmental capacity as an independent, internal factor, when observing human society (Adger, 2000; 2005).

What about environmental vulnerability?

The concept of vulnerability often has been used to describe the susceptibility of physical, biotic, and social systems to harm or hazard, either accidental or hazard that are continual in it's nature due to different human activities. United Nations/International Strategy for Disaster Reduction (UN/ISDR), for example, defines vulnerability as the ''*conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of a community to the impact of hazards*''. Numerous authors outline concept of vulnerability more generally as susceptibility of observed system to damage, due to the sensitivity or exposure of a system, people, or places to impacts, stresses, or perturbations. Apart from the concept of general vulnerability or biophysical vulnerability, there is also social component of vulnerability, which is related to the characteristics and experiences of communities and people who must respond to and recover from the environmental hazards or stressors to which they are exposed, either accidentaly or in continual sense. Nowadays, the concept of vulnerability has been continuously widened and broadened towards a more comprehensive approach encompassing susceptibility, exposure, coping capacity and adaptive capacity, as well as different thematic areas, such as physical, social, economic, environmental and institutional vulnerability (Adger, 2000; 2005) .

CONCLUSION

The concepts of environmental capacity (coping, restorative, adaptive), vulnerability, resilience, exposure and sensitivity are interrelated and have wide application to global change science. The subject of this paperwork was aimed towards examination of environmental capacity concept as a novel approach in the field of environmental quality management. This aims towards clearly and unequivocally proving the causal relationships between attributes and determinants of environmental vulnerability, resilience, and capacity. This is only a first step in further research that should be focused on demonstrating the necessity of assessing environmental vulnerability, resilience, and capacity determinants.

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BIOGRAPHY

Dejan Vasović was born in Prokuplje, Serbia, in 1982.
He received the diploma in environmental protection engineering and the Magister of technical sciences degree in same field from the University of Nis, Faculty of Occupational Safety in Niš.
His main areas of research include environmental protection, environmental capacity management, water quality, environmental security, etc.
He is currently working as an teaching assistant at the Faculty of Occupational Safety in Nis, University of Nis.

KAPACITET ŽIVOTNE SREDINE: SAVREMENI PRISTUP U ODRŽIVOM UPRAVLJANJU ŽIVOTNOM SREDINOM

Dejan Vasović, Ljiljana Takić, Goran Ristić

Rezime: *U oblasti održivog menadžmenta životnom sredinom, savremena istraživanja su uglavnom usmerena ka kreiranju preventivnih aktivnosti i korektivnih mera, kao i prema predikciji promena u životnoj sredini. U tom smislu, razmatranje koncepta kapaciteta životne sredine predstavlja neizostavnu komponentu preventivnog delovanja. Uvažavajući principe održivog razvoja, cilj ovog rada je usmeren ka pregledu determinanti kapaciteta životne sredine, kao i ranjivosti i otpornosti iste. Tematika istraživanja je usmerena ka relevantnim komponentama i strukturi koncepta kapaciteta životne sredine, ranjivosti i otpornosti. U tom smislu, ovim radom se ističu osnovne karakteristike pomenutih koncepata, kao i specifične veze izmedju njih.*

Ključne reči: kapacitet životne sredine, determinante, upravljanje.

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ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

Abstract: *The adoption of the code of ethics of engineering in the 21st century should involve putting public interest above all others. However, in market economy collective interest is not in the foreground. In the foreground are placed particular interests of employers, i.e. multinational companies. The degradation of the environment and endangering life on Earth, brought about a new philosophy in form of sustainable development, which should include the adoption of the Code of Ethics that puts the public interest above individual, especially when it comes to economic activities. The economy and the environment are equaly important for sustainable development in terms of ethics. Engineers have an ethical dilemma that arises from the conflict of ecological and economic conditions of their work. In this article, scientific approach of professor Sharon Beder on this issue is presented.*

Key words: engineers, ethics, engineering ethics, sustainable development.

INTRODUCTION

This paper presents the scientific view of professor Sharon Beder. She is a visiting professor in the School of Social Sciences, Media and Communication at the University of Wollongong in New South Wales, Australia. Sharon's research has focussed on how power relationships are maintained and challenged, particularly by corporations and professions. She is interested in environmental politics; the rhetoric of sustainable development; the philosophies behind environmental economics; and trends in environmentalism and corporate activism/public relations. She specifically studied the engineering ethics, she points out on the relationship between individual and public interests. The author connects engineering ethics and sustainable development, she considers that them fundamental ethical values are identical.

As pointed out by the author, most engineering codes of ethics worldwide exhort engineers to consciously put the public interest above all others. This seems to run counter to the market philosophy that the public interest will be achieved by individuals pursuing their own self-interest. It is this latter philosophy that is at the heart of sustainable development with its emphasis on economic valuation and economic instruments to achieve environmental protection. Sustainable development policies generally embody an economic determinism with respect to technological change. It avoids the issue of ethics and assumes environmental and economic goals are compatible. Yet engineers today are grappling with the ethical dilemmas posed by everyday conflicts between the economic and environmental requirements of their work.

In the past conflict between self-interest and public interest was seldom a problem for engineers, since engineering works were almost synonymous with human progress. Today environmental issues have created a divergence between self-interest, employer interest, professional interest and public interest. But how realistic is it to expect engineers to display higher ethical standards than those normally expected of the wider community? And can individual ethics play a significant role in influencing technologies that are collectively shaped by professional paradigms and philosophies?

Modern engineering codes of ethics require engineers to put the public interest before professional interests and business interests. In the first part of this paper we will show how the author creates a link between the professional interests and business interests. In the second part of the paper we will consider the ethical requirement for engineers to serve the public interest comparing this with the prevailing ethic of the market which stresses self-interest as the norm, from the perspective of professor Sharon Beder. Finally we will show how the author Beder understands the relationship between the sustainable development and the engineering ethic.

PROFESSIONAL INTERESTS - BUSSINES INTERESTS

The first engineering society to adopt a code of ethics was the Institution of Civil Engineers in England in 1910. The American Institute of Consulting Engineers used the British Code to derive their own which they formally adopted the following year. Other engineering societies quickly followed. Such codes were, and still are, a mixture of moral values and rules of business etiquette governing how engineers should relate to each other in their business dealings, a code of gentlemanly

conduct rather than a code of ethics to protect the public welfare.

Codes of ethics serve several purposes. Firstly they are the hallmark of the professions. Engineers "lay claim to professional standing" to distinguish themselves from workers in general and to share in the prestige of the older more respected professions of medicine and law.[1] Edwin Layton[2] claimed that the emergence of a professional identity was also a reaction to the large authoritarian bureaucratic structures which engineers were increasingly finding themselves working in. The ideal of professionalism was based on esoteric knowledge and social service and Layton identifies three themes to the new ideology. Firstly, the engineer was identified as the agent of technological change and so essential to human progress. Secondly, the engineer was considered a "logical thinker free-of bias" and therefore able to lead and arbitrate between classes. Thirdly, the engineer was thought to be socially responsible for ensuring progress and the benevolence of technological change.[3]

The claim to professionalism and social responsibility also enabled engineers to assert their independence from business,[4] at least rhetorically if not in practice. Engineers had readily aligned themselves with business and capitalist values because it was business people and their capital which enabled them to build their great works.[5] Layton points out "Engineers accepted without question the structure, power, and basic ideological principles of business."[6] David Noble suggests that the modern engineer came into being to serve the purposes of the capitalist.

From the outset, therefore, the engineer was at the service of capital and, not surprisingly, its laws were to him as natural as the laws of science. If some political economists drew a distinction between technology and capitalism, that distinction collapsed in the person of the engineer and in his work, engineering.[7]

Engineers, at least in the West, have therefore incorporated business values into their engineering activities. Zussman argues that "cost is itself a criterion of technical efficiency" which must be considered along with the physical properties of the materials. The purpose of technology, in a capitalist society, is determined by the market and engineering is seen as a means, not an end.[8] Ritti's study of an American systems design company also found that engineers placed great importance on having the opportunity to help their employing company increase its profits.[9] Whalley suggests that engineering employees "are socialised and selected" from the beginning to accept the legitimacy of both bureaucratic authority and the dominance of business values. These are secured by a career structure which rewards the trustworthy.[10]

Business interests and engineering interests have always been aligned and in the past there has been little conflict between engineering interests and the public interest since engineering works were perceived to be almost synonymous with human progress. However, as the community began to question whether new technology was always in their interest so engineering interests have been seen to occassionally conflict with the public interest and in recent years engineering codes of ethics have stressed the importance of prioritising the public interest. This element of the code of ethics can best be understood in terms of a social contact between the engineering profession and the community in which the engineering profession promises public service in return for professional status.

PUBLIC INTEREST – SELF INTEREST

About modern engineering codes in Australia, author writes as follows: most modern engineering codes of ethics state that engineers should hold paramount the health and safety of the public or, in the words of the Australian Code of Ethics, engineers: shall at all times place their responsibility for the welfare, health and safety of the community before their responsibility to sectional or private interests...[11]

In a recently released discussion paper on "Dealing with Risk" the Institution of Engineers, Australia, argued that its code of ethics is part of a longstanding agreement the engineering profession has with the community; "its terms are that engineers will put the health, welfare and safety of the community before all other considerations; and the quid pro quo is, and should continue to be, that the community allows us to regulate the profession ourselves."

In the words of professor Beder, Traditionally morality has been defined by religion, laws and cultural conventions. In today's society many people are not religious and religious morality seems to be confined to issues of life, death and sexuality; not reaching far into people's everyday working lives. Laws also, necessarily only have limited jurisdiction. They can cover blatant fraud and deception but are not able to force engineers to make "good" judgements.

Furthermore, in his study the author explains the relationship between a work ethic and the category of ethical egoism or self interest. She claims that increasingly in a market economy, the morality of working life (apart from a work ethic that stems from Protestantism[12]) is based on cultural conventions which often fall within the category of ethical egoism or self interest. Ethical egoism is a minimalist form of moral reasoning which some would argue has nothing to do with morality. It reasons that each individual should look after themselves. Some argue that this form of reasoning involves considering other people's interests as well because in the long-term it serves one's own self-interest to do so. Adam Smith, demonstrated ethical egoism in his argument that social welfare is best served by individuals pursuing their own interests and companies pursuing maximum profits in a free market.

As the author says, engineering ethics normally go beyond ethical egoism, at least in principle. The ethical

principle that engineers put the public interest before other interests seemingly works against their self-interest. However some philosphers, such as Hobbes and Rousseau, discuss ethics and morality in terms of a social contract that serves self-interest in the long-term. The terms of this contract are that if everyone follows the rules of morality rather than acting on personal self-interest, then everyone will be better off, society will be a better place to live in.

Morality consists in the set of rules, governing how people are to treat one another, that rational people will agree to accept, of their mutual benefit, on the condition that others will follow these rules as well.[13]

However, as Rachels points out, there is a natural limit to the social contract. If people obey these rules so that they will be better off then, in cases where obeying the rules means they will be worse off, they won't do it. "We may not exact a sacrifice so profound that it negates the very point of the contract." [14]

This is particularly relevant to the engineering code of ethics because if it is a form of social contract which provides social status to engineers then it is not reasonable to expect engineers to obey any rules in the code of ethics which requires them to forfeit their status as engineers. If putting the public interest first requires them to risk their jobs and career then this will be seen as too great a sacrifice by most engineers. And because the individual status of engineers is so dependent on their employers, this social contract has little power for engineers.

The author claims that the various studies have confirmed that codes of ethic and conduct have little power.[15] Engineers are essentially subordinate and their status derives from organisational mobility rather than technical expertise. As the Australian Institution of Engineers' Professional Practices Officer, Derek Baldwin, readily admits, "it takes a man or women of considerable strength and courage" to obey the code of ethics rather than his or her employer. And Michael Dack, a Director of the Institution, admits that the code of ethics has a "very weak moral power" compared to the employer who has the "power of economic life and death over an employee".[16]

THE ETHIC OF SUSTAINABLE DEVELOPMENT

The central ethical principle behind sustainable development is *intergenerational equity*. The Brundtland Commission defined sustainable development as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[17]

According to the author's opinion the intergenerational equity can be defended in both consequentialist and deontological terms. Firstly it can be considered in terms of ensuring long term consequences of today's actions. This utilitarian viewpoint fits the pragmatic concerns of some business interests. The environmental crisis threatens the sustainability of economic activity. Many activities such as agriculture, forestry, fishing, tourism and recreation are dependent on a healthy environment. Others are indirectly affected as it becomes more expensive to obtain resources and because pollution decreases the health of the work-force. Looking ahead to the future ensures the sustainability of business activities.

Also the author believes that the intergenerational equity can also be considered a duty that current generations have to future generations or a right of future generations. However, if we examine the way that sustainable development is operationalised we see that it is done in a way that protects the market system and perpetuates individualism and self-interest above any ethic of equity.

David Pearce argues that if we are to ensure intergenerational equity then future generations need to be compensated for any environmental damage done by current generations and that this is best done by ensuring that damage is made up for by increased wealth and human-made assets. In other words natural capital (the environment) can be run down if human-made capital (money, equipment, infrastructure, knowledge etc) are increased.[18] In order to compensate future generations we need to value of the environment in the same way as we value human-made assets; that is we need to give it a monetary price.[19]

Environmental economists, such as Pearce, also claim that environmental degradation has resulted from the failure of the market system to put any value on the environment. They argue that because environmental `assets' are free or underpriced they tend to be overused or abused, resulting in environmental damage. Because they are not owned and do not have price tags then there is no incentive to protect them. This is a view shared by business people. The Business Council of Australia claims that the environmental problem is that important environmental assets tend not to be priced in a market like other assets. These assets are common property - they belong to everybody, and to nobody. Without ownership rights there is not the incentive for any person or group to look after them properly... if the environment has a zero price to users it will eventually be used up.[20]

These views, which have been incorporated into sustainable development rhetoric and sustainable development policies, call for putting a price on the environment. However the whole process of pricing the environment to ensure that decisions take account of environmental degradation works against intergenerational equity and instead extends market logic and market morality into a wider sphere of operation.

There are two main ways of operationalising the idea of putting a price on the environment. The first is through cost-benefit analyses. The second is through the use of economic instruments.

Cost-benefit analyses has traditionally been used by governments as part of their decision-making processes but in the past environmental costs and benefits have usually not been quantified and incorporated into the analyses but listed separately in a qualitative form for consideration. The sustainable development approach is to incorporate these environmental costs and benefits by pricing them and incorporating them into the calculations.

In a way CBA is the ultimate embodiment of consequentialist ethics in that it seeks to ensure that good consequences outweigh bad consequences and consequences are measures in money terms. In reality however CBA works against the ethic of equity and the measuring of consequences in financial terms fails to capture the consequences fully.

As the author says, using the market, whether an actual market or a contrived one, to value the environment tends to produce values that reflect and therefore maintain the prevailing distribution of income. Wealthier people are willing to and able to pay more for what they want so their preferences will have more weight in any survey. Moreover according to a CBA siting a dirty industry in an already dirty area will be less costly than siting it in a clean area where wealthier people can afford to live. This is because the decline in property values will be less as a result of the resulting pollution.

The valuation of the environment in terms of the total of what each individual is willing to pay denies a separate concept of public interest. As Lenihan and Fletcher state "The welfare of society has meaning only as the summation of the welfare of its individual members"[21] Daly and Cobb also point out that the economic view of value is based on a reduction of human values to individualism and reduces the world to one in which "individuals all seek their own good and are indifferent to the success or failure or other individuals' is fundamental to economics..."[22] Therefore valuation of the environment through CBA is a concept that embraces the values of ethical egoism and is in fact antithetical to an ethic of

The author claims that another increasingly popular way of incorporating environmental values into decision-making is through the use of economic instruments. The idea is that prices of resources should reflect the true cost, including environmental costs involved in their extraction and manufacture. If this were the case then, the economists argue, people would use environmental resources more wisely.

Of course putting a monetary value on these costs suffers the same problems involved in cost-benefit analysis. However in practice, economic instruments seldom involve calculating the real value of environmental damage. Rather, in the case of price-based measures such as pollution charges, an extra amount is charged, chosen somewhat arbitrarily by the government, that is supposed to provide an incentive to change environmentally damaging behaviour. In the case of tradeable pollution rights, a level of emissions is chosen and rights to emit up to that level are traded between companies or auctioned off by the government. In both cases the idea is that by making economic adjustments, individuals and firms can continue to pursue their self interest and the environment will be protected at the same time.

Professor Beder says that advocates claiming that economic instruments provide a way that the power of the market can be harnessed to environmental goals[23]. They also serve a political purpose in that they reinforce the role of the `free market' at a time when environmentalism most threatens it. Chant et al argue that "contrary to the popular view that a market system leads to the abuse of the environment" it is in fact the absence of a market which leads to environmental degradation.[24] Economic instruments attempt to make a virtue out of the profit motive and ethical egoism.

CONCLUSIONS

The emergence of ecological crisis, the conflict between the personal and the public interest for the engineers was very rare, as are the inventions of engineers were synonymous with human progress. However, the problem of environmental causes disagreements between the interests of employers, engineers and the public interest. In 21th century modern engineering code of ethics to require the engineer to put the public interest before the professional and business interests. Sustainable development with its philosophy should be the basis of a new code of ethics, which will protect the environment by putting the public interest above the professional, economic (business) and personal interests.

When considering the relationship between personal and public interests, it is necessary to examine the question of morality of engineers. As a kind of a social norm, morality is one flexible category that can be examined from the aspect of an individual or society as a whole. Therefore, every engineer has their own moral principles which should be incorporated in the values which society promotes as desirable. This applies, among other things, on the issue of sustainable development.

When a society recognizes a moral norm as particularly important, it obtains the character of a legal norm prescribed by a legal act. Only in this way it can be secured with reasonable certainty that a moral principle is respected as mandatory in society. Otherwise, the disrespect of the principle is followed by a prescribed sanction, where it is known in advance which entity carries out the sanction and what the sanction is. Legal norms are obeyed for two reasons – one's own beliefs about the validity of conduct which is required or the fear of sanctions which will follow in the event of non-compliance with the code of conduct. Therefore, every individual, including engineers, should observe legal

standards from their own beliefs about their validity, which is very desirable. But it is sufficient to comply with the legal standards for fear of prescribed sanctions. For this reason, it is especially important that every legislator recognizes the importance of the principle of sustainable development, which is to be standardized by legal acts and specified by the rights and obligations of environmental protection systems. In this way, the society can ensure the respect of this principle in practice.

The authors conclude that a revolution in ethics is needed to displace the powerful ethical egoism that rationalises the market as the predominant decision-making tool in our society. It is unrealistic to expect engineers to manifest higher ethical conduct than is the norm throughout the community in which they live. Sustainable development, with its rhetoric of intergenerational equity, is in reality a way of endorsing market morality and is inadequate to the solution of modern environmental problems.

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BIOGRAPHY

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INŽENJERSKA ETIKA I ODRŽIVI RAZVOJ

Ivana Ilić Krstić, Aleksandra Ilić Petković

Apstrakt: *Etički kodeks inženjera u 21. veku, treba da obuhvati etičke norme koje svesno stavljaju javni ili opšti interes iznad svih ostalih interesa. Međutim, sa razvojem tržišne ekonomije opšti (kolektivni) interes nije u prvom planu. U prvi plan se stavljaju posebni i individualni interesi poslodavaca, odnosno multinacionalnih kompanija. Degradacija životne sredine i ugrožavanje života na Zemlji, dovodi do nove filozofije u vidu održivog razvoja, koji bi trebalo da uključuje usvajanje Etičkog kodeksa koji stavlja javni interes iznad pojedinca, posebno kada je reč o ekonomskim aktivnostima. Privreda i životna sredina u etičkom smislu su podjednako važne za održivi razvoj. Međutim, inženjeri imaju etičke dileme koje proizilaze iz sukoba ekoloških i ekonomskih uslova njihovog rada. U ovom radu se razmatra refleksivno razmišljanje i naučni aspekt profesorke Sharon Beder o prevazilaženju sukoba između opštih i individualnih interesa inženjera u proizvodnom procesu.*

Ključne reči: inženjeri, etika, etika inženjera, održivi razvoj.

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IMPROVING THE ENVIRONMENTAL PROTECTION SYSTEM OF MINING AND ENERGY COMPLEX BASED ON PREPARATION FOR EMERGENCY RESPONSE

Abstract: *Response in case of emergencies is one of the very responsible work activities in mining and energy complex. The guidelines of ISO 14001 related to preparedness for emergency responses are the basis for the functioning of environmental management system. Management representatives in mining and energy complex have an obligation to establish, implement and maintain procedures to identify potential emergency situations and ways of reacting, as prescribed by the ISO 14001 standard. The main goal of applying planned actions is to reduce the consequences for the quality of the environment and to preserve human health and safety.*

Key words: environmental, mining and energy complex.

INTRODUCTION

Preparation of documents related to the preparedness of emergency response at the open pit mines and thermal power plants starts with the phase of development of existing procedures related to preserving the quality of working and living environment and health and safety of the employees. Drafting of preparedness procedures for emergency response should include procedures for identification of the elements for early detection of incidents, proposed protective measures in case of emergency and corrective actions.

Procedure proposal should be the result of a team work of experts in fields of mining, energy, mechanical engineering, environmental protection, occupational safety and fire protection. Common defining of procedures for emergency response provides an opportunity for a comprehensive preparation for the cases of landslides, spontaneous combustion of coal, burning of explosives, fire in the storage of liquid fuel, explosions, emissions of pollutants, bursting of ash dams, pyralene spills of oil or natural disasters. Defined response procedures should be fully understood by performers of work activities, with a detailed plan of work tasks and the evacuation plan. Employees, based on studied procedures, should be able to report the accident, perform alerting, notification, and internal communication. Leader in the department for emergency response situations should alert the workers responsible for implementation of the monitoring system on the possible need for continuous monitoring of the environmental quality parameters. The aim is to prepare and adopt procedures for preparedness of emergency responses.

PROCEDURE FOR EMERGENCY RESPONSE

Drafting of procedures for preparedness of emergency responses implies a clear idea of reaction and sequence of activities, which are the responsibility of all employees. It is based on methods for identifying potential emergencies and accidents [1], emergency procedures defining the necessary protective measures and actions of procedure analysis and acting in real situations. Table T. 1 presents display of guidelines of ISO 14001, which can be applied in an integrated management system of mining and energy complex. Applying the realization approach within the process of environmental management system, developed on the basis of ISO 14001 guidelines, is presented in table T.2 and T.3. Management representative for environmental protection and head of environmental protection have a task to: consider the significant environmental aspects, legal requirements and other regulations, analyze previous incidents, respond to the incident situations and effects on the environment [2,3]. The sequence of planned work activities, within the framework of preparedness for emergency response is presented in Figure 1. Management representative for environmental protection prepares and periodically checks the plan of emergency response [4], based on the identification of elements [5] for early detection of the incident, the proposal of preventive measures and defined reaction procedures, which are showed in Figure 1.

Table T.1 *Guidelines of ISO 14001 standards in the system of environmental management and energy transformations in mining and energy complex*

Policy
-Environmental Protection Policy
Planning of mining and energy management system
-The exercise of work activities -Identification of environmental aspects -Identification of mining and energy complex impacts
General and specific objectives of environmental protection and mining and energy complex programs
-Environmental management system programs -Internal audits of application of prescribed measures for environmental protection -Training of workers for environmental protection
Mining and energy complex documentation in the area of systems management
-Control of environmental protection systems -Procedures for emergency situations response -Documents related to the application of protective measures in mining and energy complexes -Document management
Reviewing management system improvements
-Reviewing of environmental management system in mining and energy complex -Identifying areas for improving the functioning of the management system -Taking measures to improve the environmental management system

Table T.2 *Requirements for the environmental management system in the mining and energy complex, general requirements, environmental policy and planning phases in accordance with the requirements of ISO 14001*

ISO 14001: 2004	Designation
Requirements for the environmental management system in the mining and energy complex	**4**
General requirements	4.1
Environmental policy in the mining and energy complex	4.2
Planning	4.3
Implementation and operation	4.4
Checking	4.5
Review	4.6

Table T.3 *Realization - the second phase of planning and ISO 14001 requirements*

ISO 14001: 2004	**Designation**
D (Do) - Realization - Implementation and operation Application of adopted communication procedures, documenting, document management, operational control and emergency response by the workers and representatives of the environmental protection department in the mining and energy complex	**4.4**
Resources, roles, responsibility and authority of the representatives of environmental protection department in the mining and energy complex	4.4.1
Competence, training and awareness of workers in the environmental protection department of the mining and energy complex	4.4.2
Communication of environmental protection department representatives with the management and employees of mining and energy complex	4.4.3
Documentation relating to the application of protective measures in mining and energy complexes	4.4.4
Control of documents	4.4.5
Control of operations (Operational control) for implementation of environmental protection measures in mining and energy complexes	4.4.6
Emergency preparedness and response	4.4.7

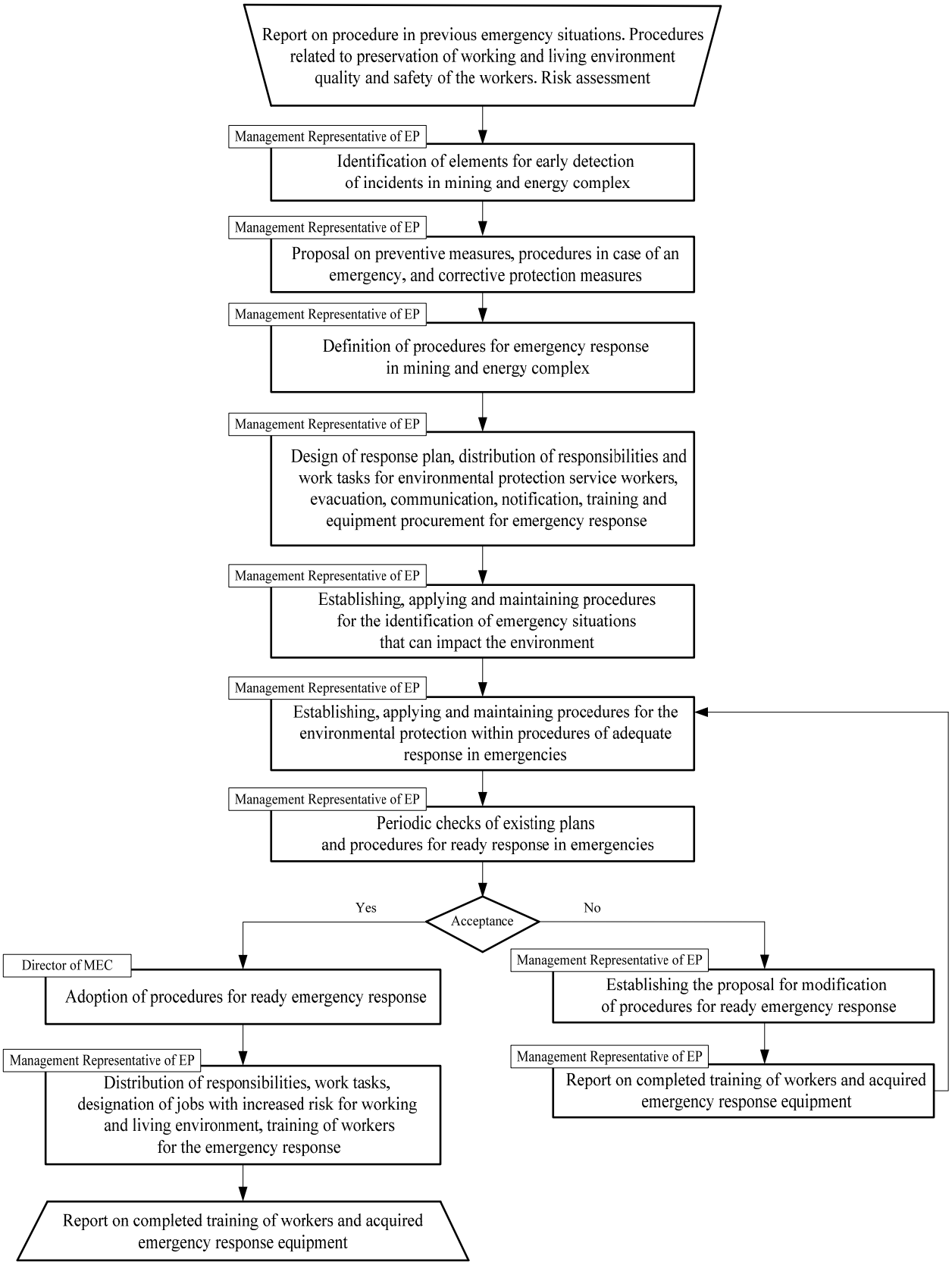

Figure 1 *Flowchart of drafting and implementing the program of preparedness for emergency response*

The director of mining and energy complex adopts the procedure for preparedness of emergency response. Identification of procedures to react and defining the necessary documentation, from the report on responding to the response plan, is presented in Figure2.

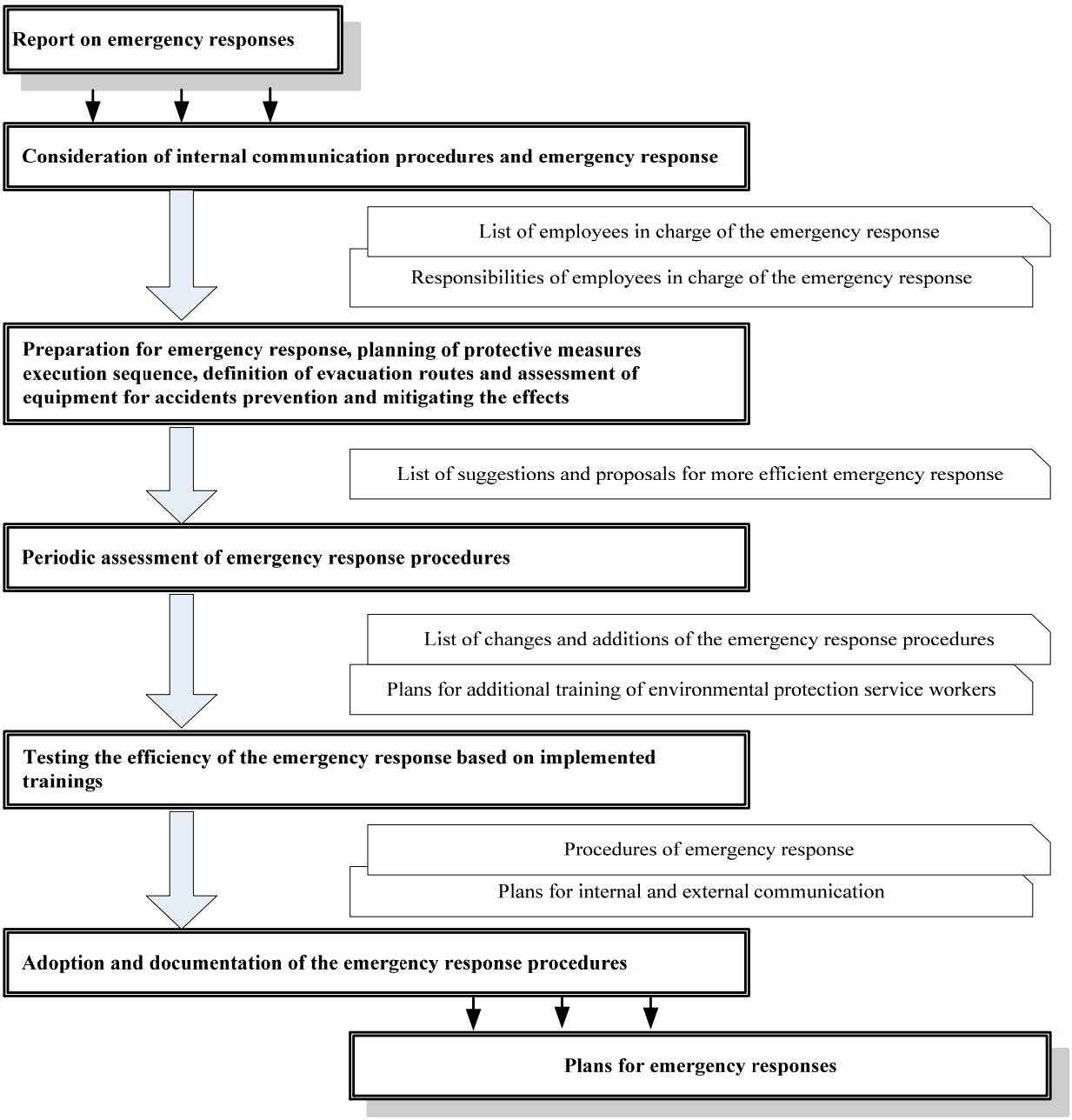

Figure 2 *Diagram of environmental management system requirements for identifying and documenting procedures for preparedness of emergency response, in accordance with ISO14001*

Figure 2 represents the requirements of the ISO14001 relating to the identification and documentation of procedures for the preparedness of emergency response. The result of considering work activities carried out in the previous period and method of implementation of internal communication is reflected in the amended lists of employees in charge of emergency response and employees' responsibilities. The list of suggestions and proposals for a more effective response in case of emergency situations should be established on the basis of considerations of equipment availability, the order of execution of work activities and evacuation routes.

Periodical review of the adopted procedures and efficiency of the response enables amendments and changes to the list of response procedures and plans for additional training for workers, plans of internal and external communication and emergency response plans.

Communication of workers responsible and trained for emergency situations with the head of the environmental protection service, management representative for environmental protection and management representative for the functioning of environmental management system, police service, fire services, emergency medical services and services for emergency situations should be planned and organized in detail. External services and organizations react in case of emergencies or participate in rehabilitation of the consequences of emergency situations.

In the analysis of the procedures applied during the pilot exercises, one should pay attention to: the availability and accuracy of equipment for emergency response, accuracy of the information and alert system.

Checking of preparedness procedures for the emergency response can be performed on the basis of the proposed checklist in table T.3.

Table T.3 *Verification checklist for procedures of preparedness and emergency response in mining and energy complex within the environmental management system*

Questions related to auditing procedures of preparedness and emergency response in mining and energy complex within the environmental management system	**Reply**	
Did the management of the mining and energy complex establish procedures for the identification of possible emergencies that may threaten the quality of the environment?	Yes	No
Did the management of mining and energy complex consider the link of emergency response to the adopted general and specific environmental goals?	Yes	No
Did leadership of mining and energy complex implement and maintain procedures for the identification of possible emergencies that may have an impact on the environment?	Yes	No
Is there any documentation on notifying workers of mining and energy complex on the responsibilities, duties and procedures that should apply in case of emergencies?	Yes	No
Have workers in mining and energy complex successfully mastered the training on response in case of emergencies?	Yes	No
Are workers responsible for the emergency response in mining and energy complex competent enough for the application of urgent protective measures?	Yes	No
Do workers in the emergency response service have the necessary equipment to respond when needed?	Yes	No
Are the conclusions drawn after completion of the exercise discussed and adopted in the new proposal of procedures for emergency response?	Yes	No

Efficiency evaluation of plans and procedures should be performed through periodical test exercises and by simulating emergency situations, and test results should be used for the improvement and periodic changes to procedures and plans.

CONCLUSION

A key issue relates to the existence of cooperation between representatives of management in mining and energy complex and manager of the department of environmental protection with the operators, because the exchange of useful information can play a significant role in the prevention of unimaginable consequences.

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BIOGRAPHY

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UNAPREĐENJE SISTEMA ZAŠTITE ŽIVOTNE SREDINE RUDARSKO-ENE-RGETSKOG KOMPLEKSA BAZIRANO NA PRIPREMI ZA REAGOVANJE U VANREDNIM SITUACIJAMA

Jelena Malenović Nikolić, Goran Janaćković, Ivica Ristović

Apstrakt: *Reagovanje u slučaju vanrednih situacija spada u veoma odgovorne radne aktivnosti rudarsko-energetskog kompleksa. Smernice standarda ISO 14001 vezane za pripravnost reagovanja u vanrednim situacijama predstavljaju osnovu za funkcionisanje sistema upravljanja zaštitom životne sredine. Predstavnici rukovodstva rudarsko-energetskih kompleksa imaju obavezu da uspostave, primenjuju i održavaju postupke za identifikaciju mogućih vanrednih situacija i načina reagovanja, kao što je i propisano standsardom ISO 14001. Cilj primene planiranih postupaka je da se smanje posledice po kvalitet životne sredine i očuva zdravlje i bezbednost ljudi.*

Ključne reči: životna sredina, rudarsko-energetski kompleks.

BOOK REVIEW / PRIKAZ KNJIGE

RAČUNARSKA TEHNIKA - OSNOVI ORGANIZACIJE I PRIMENE PERSONALNIH RAČUNARA

Dejan Krstić, Milan Blagojević, Goran Janaćković

Računarska tehnika - Osnovi organizacije i primene personalnih računara - prilagođena je programu predmeta Računarska tehnika, koji se izučava tokom prvog semestra u prvoj godini osnovnih akademskih studija na Fakultetu zaštite na radu u Nišu. Knjiga se sastoji od tri glavna dela.

U prvom delu, Matematičko-logičke osnove računara, opisan je: način formiranja brojnih sistema, kodiranje realizacija aritmetičkih operacija u računarskom sistemu, logičke funkcije i načini realizacije logičkih funkcija korišćenjem osnovnih postupaka minimizacije logičkih funkcija po kreterijumu minimalnog broja logičkih kola.

U drugom delu, Arhitektura personalnih računara, opisana je arhitektura računara i osnovne komponente računara, kao i njihove karakteristike.

U trećem delu, Aplikativni softver, opisane su različite vrste programskih paketa i aplikacija, a detaljno su objašnjena dva programa iz programskog paketa

Microsoft Office - Microsoft Word (program za obradu teksta) i Microsoft Excel (program za unakrsna tabelarna izračunavanja).

Pored toga, knjiga sadrži još dva poglavlja u kojima se nalaze i pitanja za proveru znanja za svaki od delova i rečnik pojmova iz oblasti informatike koji se navode u knjizi.

Autori

BOOK REVIEW / PRIKAZ KNJIGE

ZBIRKA ZADATAKA IZ RAČUNARSKE TEHNIKE SA PRAKTIKUMOM

Goran Janaćković, Dejan Krstić, Bojana Zlatković

Zbirka zadataka iz Računarske tehnike sa praktikumom - prilagođena je programu predmeta Računarska tehnika, koji se izučava tokom prvog semestra u prvoj godini osnovnih akademskih studija na Fakultetu zaštite na radu u Nišu. Ova publikacija se sastoji od dva dela:

- Zbirke zadataka i
- Praktikuma računarskih vežbi.

U prvom delu, pod nazivom Zbirka zadataka, prikazani su izvodi sa predavanja, primeri i rešeni zadaci iz brojnih sistema, kodiranja, izvršavanja aritmetičkih operacija, logičkih funkcija i minimizacije logičkih funkcija.

U drugom delu, pod nazivom Praktikum, prikazana su kratka metodička uputstva za korišćenje Operativnog sistema Windows XP/7 i korišćenje pojedinih aplikativnih programa: Microsoft WORD 2007, Microsoft Excel 2007 i programa za simulacija logičkih kola CEDAR. Za svaki od ovih delova su dati primeri i vežbe z a r ad n a p ersonalnim r ačunarima u o kviru računarskih vežbi na ovom predmetu.

Ovaj materijal može da posluži studentima Fakulteta zaštite na radu za savladavanje nastvnog plana i programa iz predmeta Računarska tehnika, i ujedno je praktikum za laboratorijske vežbe u Računarskom centru.

Autori

KVALITET

Nacionalno sertifikaciono telo
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Imenovano telo (Notified Body) za ocenjivanje usaglašenosti proizvoda prema:

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- Pravilniku o električnoj opremi namenjenoj za upotrebu u okviru određenih granica napona
- Pravilniku o bezbednosti mašina

Akreditovana organizacija za:

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- Sertifikaciju proizvoda
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- Etaloniranje merila elektromagnetskih veličina
- Sertifikaciju sistema menadžmenta (9001)

Ocenjivanje i sertifikacija sistema upravljanja:

- 9001 Sistem menadžmenta kvalitetom
- HACCP/22000 Sistem menadžmenta bezbednošću hrane
- 14001 Sistem upravljanja zaštitom životne sredine
- 18001 Sistem upravljanja zaštitom zdravlja i bezbednosti na radu
- **13485 MEDICINSKI UREĐAJI - Sistemi menadžmenta kvalitetom**

Ispitivanje IMUNOSTI elektrotehničkih proizvoda

SRPS ISO 61000-3-2	SRPS ISO 61000-4-4
SRPS ISO 61000-3-3	SRPS ISO 61000-4-5
SRPS ISO 61000-6-1	SRPS ISO 61000-4-6
SRPS ISO 61000-6-2	SRPS ISO 61000-4-8
SRPS ISO 61000-6-3	SRPS ISO 61000-4-9
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ЧАСОПИС ЗА ЗАШТИТУ НА РАДУ, ПРАВНУ, ЗДРАВСТВЕНУ, ЕКОЛОШКУ И ЗАШТИТУ ОД ПОЖАРА

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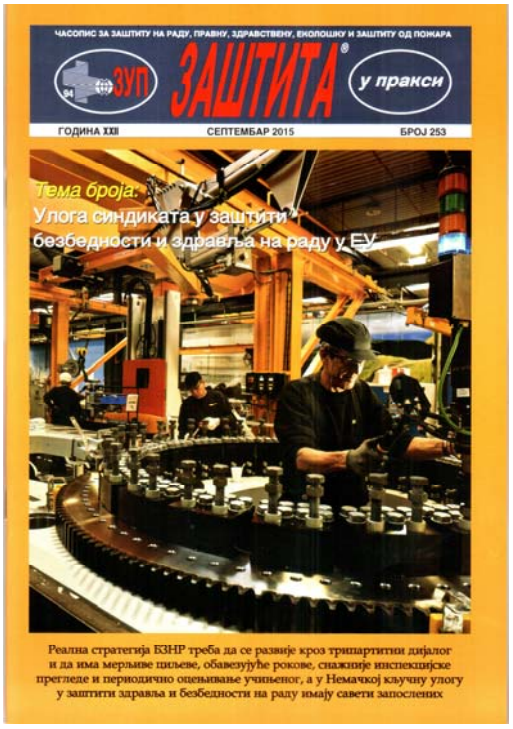
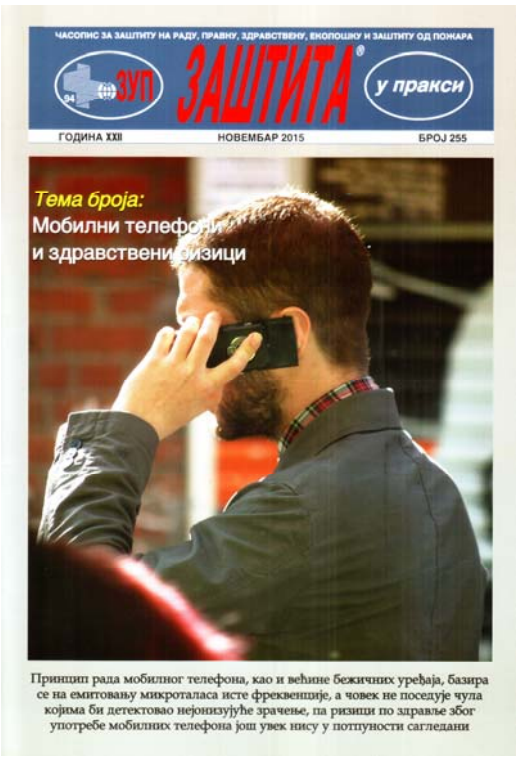




SEIBL TRADE

Odabir renomiranih svetskih proizvođača izdvaja Seibl Trade od drugih kompanija i čini osnovu za bolju produktivnost i zaštitu na radnom mestu

PULSAFE

Pulsafe obezbeđuje moderan i ergonomski dizajn za svaku vrstu primene koja zahteva zaštitu očiju i lica.

CENTURION

Zahtevi zaštite na radu u industrijama mogu biti različiti i individualni koliko i same industrije. Iz tog razloga Centurion je i dizajnirao fleksibilnu liniju specijalizovanih zaštitnih šlemova.

Bilsom HOWARD LEIGHT

Bilsom antifoni i Howard Leight čepovi za uši su sinonim za tehnološke inovacije, fleksibilnost i nenadmašnu udobnost uz maksimalnu zaštitu.

BACOU

Bacou, vodeća kompanija u razvoju jedinstvenih i inovativnih koncepata, nudi širok izbor ultra udobne obuće prilagođene delatnostima i inspirisane poslednjim modnim trendovima uz kombinaciju bezbednosti, udobnosti i stila.

optrel

Sa 20 godina iskustva i inovacija Optrel predstavlja vodećeg proizvođača optoelektronskih ćelija. Optrel maske za zavarivanje, proizvedene u Švajcarskoj, su najbolja garancija za efikasnost, kvalitet i udobnost.

FERNEZ WILLSON

Willson i Fernez obezbeđuju rešenje za sva radna okruženja kompletnom gamom panorama-gas maski, polumaski, respiratora sadovodom vazduha, filtera i opreme za jednokratnu upotrebu.

Perfect Fit

Perfect Fit ima najopsežniju ponudu zaštite za ruke: sečene i prošivene rukavice od kože ili tehničkog tekstila, pletene i premazane rukavice.

MUTEXIL TWW

Mutexil i TWW odeća je dizajnirana da pruži radnicima moderan izgled koji odgovara današnjim standardima udobnosti i lakoće korišćenja i predstavlja savršen spoj stila, higijene i zaštite.

MILLER

Miller kao sinonim za bezbednost

Kao globalni lider na polju opreme za zaštitu od pada, Bacou-Dalloz već više od pedeset godina razvija rešenja kako bi učinio bezbednijim rad na visini.
Miller, kao najinovativnije priznato svetsko ime u zaštiti od pada, nudi širok izbor proizvoda koji poboljšavaju zaštitu, udobnost i performanse korisnika, i ohrabruju ga da koristi opremu 100% vremena u toku rada.

Seibl Trade d.o.o. – ovlašćeni distributer Bacou-Dalloz zaštitne opreme
Bulevar Mihajla Pupina 10g/s1 - YU Business Center – 11070 Novi Beograd – Srbija
Tel/Fax +381 11 311 9661, 301 5514, 301 5516 – Web: **www.seibl-trade.com**

ALEKSANDAR INŽENJERING D.O.O.
Novi Sad, Srbija
Prodaja i servis mernih instrumenata
http://www.merniinstrumenti.com

TERMOVIZIJSKE KAMERE
Instrumenti za termovizijsku dijagnostiku

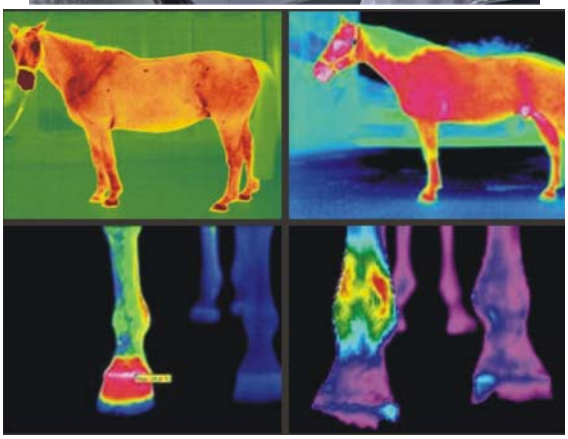
Termovizijska dijagnostika se koristi u tehničke i medicinske svrhe, a posebno je našla primenu u zaštiti i bezbednosnim sistemima. Termovizijske kamere omogućavaju da ljudsko oko sagleda ono što ne može da vidi. Svako telo emituje određenu količinu energije koja može da se registruje kamerom za termoviziju.
Na osnovu rezultata snimanja ili posmatranja kroz objektiv kamere, registruje se infracrveno ili toplotno zračenje i najnižeg stepena, a omogućava se izuzetno precizno merenje temperature bez ikakvog kontakta sa objektom čije se fizičke karakteristike mere. Na osnovu rezultata dobijenih testiranjem moguće je napraviti preciznu evaluaciju mehaničkih, termičkih, električnih i bioloških procesa. Informacije o struji, voltaži, otporu i energiji su dragoceni za adekvatno postavljanje električnih instalacija i njihovo puštanje u rad.
Kineska kompanija Wuhan Guide Infrared, koju na našem tržištu zastupa "Aleksandar Inženjering", godinama unapređuje tehnologiju registrovanja termalne, odnosno infracrvene energije. Termovizijske kamere "Wuhan Guide Infrared" su tehnološki superiorni proizvodi, visokih performansi i za životnu sredinu neškodljivi.

Za industriju
TP8 serija

EasIR Serija i EasIR-9

EasIR Serija je nova infracrvena kamera proizvođača Guide, koja pomera granice infracrvenog snimanja svojim odličnim karakteristikama i niskom cenom. Dizajnirana je za rad pod teškim radnim uslovima i za korisnike, koji ne moraju biti visoko obučeni, EasiR Serija je otporna na udarce i robus tna i pod najtežim radnim uslovima.

Za medicinu
Termovizijske kamere vrlo lako i precizno detektuju detektuju temperatune razlike pojedinih delova površine tela čoveka i životinja i mogu se koristiti u mnogim medicinskih granama kao u epidemiologiji, virusologiji, reumatologiji, hirurgiji, dijagnostici kancera, metaboličkih bolesti, vaskularnih promena, stomatologiji, kao i za otkrivanje različitih bolesti i pre nego što su doživeli punu kliničku sliku pa je značajna njena uloga u ranom otkrivanju i prevenciji.



Za zaštitu od požara, zaštitu radne i životne sredine
Protivpožarna ručna termička kamera IR1190 je opremljena sa detektorom ultravisoke rezolucije, što joj omogućuje prikazivanje slike besprekorne jasnoće, a time se pomaže vatrogascima da vide kroz oblake dima i da identifikuju moguće žrtve pre nego što do dođe do povrede, ili smrti

Napredna tehnologija infracrvenog merenja temperature vam pomaže da odredite tačan izvor vatre, a time da donesete tačnu i blagovremenu odluku, koja neće biti ugrožena od strane nepreciznosti merenja detektora. Na raspolaganju je i bežični prenos video informacija, kojim se može ostvariti slanje žive slike iz prve ruke u komandni centar, gde se onda mogu doneti brze i precizne odluke.

INSTRUCTIONS FOR AUTHORS

SAFETY ENGINEERING Journal publishes original scientific and professional contributions in the field of occupational safety engineering, environmental safety and fire safety.

Scientific articles:

- original scientific paper (a paper which presents previously unpublished results of authors' research using scientific method)
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- scientific discussion and topic review (debate on a specific scientific topic based on scientific arguments)

Professional papers:

- professional paper (paper which provides useful experiences for advancement of professional practice, not necessarily based on scientific method)
- informative contribution (editorial, comment, etc.)
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Papers are printed in Serbian and English, and published in both hard copy and electronic format on the website of the Faculty of Occupational Safety, University of Niš.

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Manuscripts should be submitted in written and electronic form.

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Template for papers can be found on the journal website:

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- informativni prilog (uvodnik, komentar i sl.);
- prikaz (knjige, računarskog programa, slučaja, naučnog događaja, i sl.).

Radovi se štampaju na srpskom i engleskom jeziku, a objavljuju se u pisanom i elektronskom formatu na sajtu Fakulteta zaštite na radu Univerziteta u Nišu.

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Obim rukopisa je ograničen na osam dvokolonskih stranica formata A4.

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Čarnojevića 10 a, 18000 Niš
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ISSN 2217-7124 = Safety Engineering (Niš)
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