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CONTENTS

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CONSIDERATION OF THE IMPACT OF AIR PURITY AND ATMOSPHERIC CONDITIONS ON THE EFFICIENCY OF PHOTOVOLTAIC PANELS

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Various factors influence the efficiency of photovoltaic panels during their exploitation, such as type of material they are constructed, the size of the load, the possibility of rotation, weather conditions, air purity, etc. The aim of this paper is to consider the results of research showing that the air purity and atmospheric conditions affect the efficiency of the photovoltaic panels. Testing of above factors on the efficiency of the photovoltaic panels was carried out in real conditions.

Key words:solar power, photovoltaic panels, operating efficiency, air purity, atmospheric conditions

1. INTRODUCTION

The intensive use of fossil fuels (coal, oil and natural gas), particularly during the 20th century has resulted in a reduction of its reserves. Estimates say that it will be enough coal for the next 70 years, and oil reserves for the next 50 years. In addition that there is no possibility of their renewal, fossil fuels are the major polluters of the environment. Namely, with the combustion of these fuels significant amounts of CO2 are released from one of gases that negatively affect climate change. Also, the increase of population from 2.5 billion in the year 1950 to nearly 7 billion today, or the estimated 10 billion by the year 2050, as well as the continuous improvement of living comfort, leads to increased energy consumption. All of the above imposes the need to find new energy sources, preferably from renewable sources. In addition to wind energy, biomass energy, hydropower, geothermal energy, tidal energy, etc., special attention should be paid to the energy of the Sun, because it is available in all parts of the world.

Solar energy is a renewable source of energy, it is the energy of solar radiation that is noticeable in the form of light and heat which we receive from the largest source of energy on the Earth, the Sun. The solar radiation is responsible for the constant renewal of wind energy, currents, waves, water flows and thermal gradients in the oceans. For decades, the solar energy has been used to produce heat energy used for water heating and space heating. The use of solar energy has many advantages; it is quiet, clean and reliable energy source. Due to the rising cost of fossil fuels, as well as the increasing public awareness of the need to preserve the environment, there is also a growing interest in using solar energy. Despite its huge potential, the use of solar energy currently covers a very small percentage of energy requirements of mankind. Party, this is due to the slow development of current technologies for the use of solar energy, but the biggest problem is the current price of system for the solar energy utilization.

There are several technologies for the use of solar energy, such as:

- electricity production by direct conversion of solar energy into electrical energy using photovoltaic cells;
- electricity production, by indirect conversion of solar energy into electricity, firstly the solar energy is converted into the heat, and then the heat into the electrical energy (the so-called concentrated solar thermal power plant);
- thermal energy production used for space heating, preparation of sanitary hot water, for various purposes in the industry, the agriculture and so on. This is the simplest and cheapest way of using solar energy;

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- thermal energy production used in solar absorption cooling systems and so on.

Photovoltaic cells can be used as the sole sources of energy or as supplementary energy sources. As the sole sources of energy, they are used for: the power supply of space satellites and ships, for providing electricity in buildings where there is no distribution network, for supply of various signaling and telecommunications apparatus. The power of solar radiation is much greater in the universe, because the Earth's atmosphere absorbs a large part of the radiation, and the obtained energy is greater. As additional sources of energy, photovoltaic cells can be connected to the distribution network, but it is necessary to install the appropriate converter (inverter), which takes into account the required voltage, frequency and phase position in order to achieve successful transfer of power in the distribution network. The main elements of a photovoltaic system are: the photovoltaic panel, battery charge controller, battery, inverter voltage [1].

The production of electricity using photovoltaic cells has many advantages. One of the main advantages is that the conversion is performed directly, without the need for mechanical parts (which in practice means that they have extremely low maintenance, there is no environment warming and have a longer working life), the benefits are also: the ever-present free fuel, do not pollute the environment, fit in with the "peak daily load" when consumption rises during the day and so on. The biggest disadvantage of electricity generation using photovoltaic cells is that the electricity is produced only during the day, when the sun is shining; the disadvantage is also because the effects of work is reduced in cloudy and rainy weather and in the winter when the solar radiation intensity is 4-5 times lower than in the summer. [1].

The aim of this paper is that based on the exploitation tests results examine the impact of air purity as well as atmospheric conditions on the efficiency of the photovoltaic panels in real conditions.

Factors influencing the efficiency of the photovoltaic cells

Photovoltaic cells work on the principle of the photovoltaic effect, whereby under the influence of solar radiation in photovoltaic cells, which are usually made of silicon, the direct voltage is generated. The photovoltaic cell produces a voltage of about 0.5 [V] with the current density of several tens [mA/cm^2], depending on the intensity of solar radiation, but also on the radiation.

The efficiency of photovoltaic cells is defined as the ratio of the electrical power provided by the photovoltaic cell and solar radiation power [1]:

$$\eta = \frac{P_{el}}{P_{sol}} = \frac{U \cdot I}{E \cdot A} \tag{1}$$

where:

P_{el} [W] - is output electrical power of photovoltaic cells
P_{sol} [W] - power of solar radiation
U [V] - effective value of the output voltage
I [A] - effective value of the output current
E [W/m^2] - solar radiation intensity
A [m^2] - cell surface T

For better understanding of the basic characteristics of photovoltaic cells, the ideal photovoltaic cell can be modeled (presented) with the parallel connection of an ideal current source and the diode, because by their nature the illuminated photovoltaic cell acts as a constant current source. In order to obtain a realistic photovoltaic cell, the parallel and series resistance Rs and Rp should be added to this model, thereby taking into account the power losses in the cell, Fig. 1. The model is applicable to any type of the photovoltaic cell.

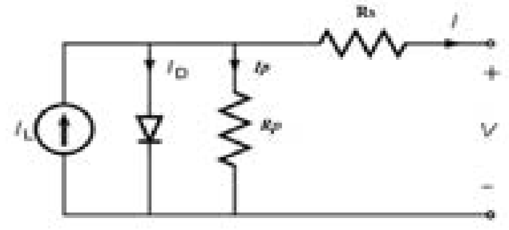

Figure 1. One diode model of photovoltaic cells [1]

Current-voltage characteristics of photovoltaic cells are given by the relation [1]:

$$I = I_L - I_o\left[e^{\frac{e(V+R_S)}{nkT}} - 1\right] - \frac{V+R_S}{R_P} \tag{2}$$

Where:

I - the current through the connectors of photovoltaic cells

V - the voltage at the connectors of photovoltaic cells

I_L - photo generated current of the photovoltaic cells, which depends on the intensity of the solar radiation

I_o - the reverse (dark) saturation current of the photovoltaic cell

R_S - series resistance of the photovoltaic cell

R_P - parallel resistance of the photovoltaic cell

e - elementary (electronic) charge

n - ideality factor of the photovoltaic cells

k - Boltzmann constant

T - the absolute temperature

The parameters I_o, R_s, R_p for each photovoltaic cell are different and depend on its physical size. The typical values for R_s and R_p, of silicon photovoltaic cells are $R_s < 0{,}5$ [Ω] and $R_p > 500$ [Ω].

Fig. 2 shows I-V (current-voltage) and P-V (power- voltage) characteristics of photovoltaic cells [1].

Figure 2. I-V and P-V characteristics of the photovoltaic cell [1]

I-V and P-V characteristics of the photovoltaic cell are nonlinear and are greatly affected by external factors such as temperature and intensity of solar radiation which is shining on it, also these characteristics depend on R_s serial and R_p parallel resistance which every cell has. Fig. 2 shows that, under certain operating conditions (voltage V and cell current I), there is a maximum power P that photovoltaic cell can give. To achieve maximum utilization of energy it is necessary to work always in the point of maximum power - MPP (Eng. Maximum Power Point) [2].

Fig. 3 shows P-V characteristics of panels in six different intensities of solar radiation [2].

Series resistance R_s depends on the material and in the photovoltaic cells production it is preferred to be as small as possible. The series resistance R_S cell is ohmic resistance that meets the current flowing through the cell then through the cell surface to the ohmic contacts to the junction with a connection to an external circuit. It is caused by the resistance of materials, contacts and so on. The product of series resistance and the surface of the cell is in the order of 0.0025 [Ω / m^2] for the typical photovoltaic cells. If the series resistance increases, the voltage at the connectors of the solar cell is reduced, resulting in a decline in electricity, or the reduction of the current - voltage characteristics slope, and for big R_S the photovoltaic cell acts as a the resistor [1].

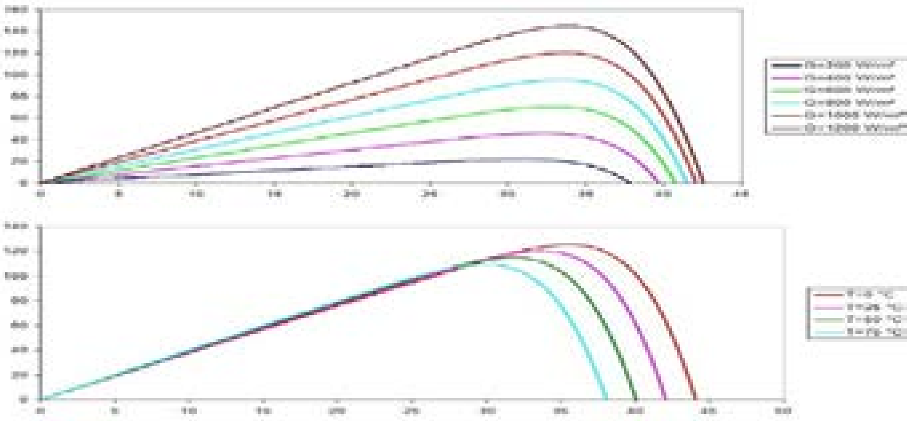

Figure 3. P-V panel characteristics in six different intensities of solar radiaton [2]

The parallel resistance (shunt) Rp depends on the properties of the cell and mainly is large enough that it can be ignored. It derives from micro defects and impurities within the solar cell. The parallel resistance Rp of the cell is caused by local defects in the p-n junction. For an ideal cell, it would be infinite, but in every real cell of current losses are proportional to the cell voltage. In the equivalent scheme cells of current losses are shown with parallel resistance Rp. If the parallel resistance decreases, more current flows through it, so there is lower current for the same voltage connections of the solar cell. If the parallel resistance further decreases, it will significantly reduce the voltage of the photovoltaic cell, so it will behave similar to the resistor [1].

In order to obtain a suitable voltage, i.e. the current, the cells may be connected in parallel or series depending on the need. Larger number of connected photovoltaic cells makes up a photovoltaic panel (module), in which the cells are fixed and protected from atmospheric impact. Using more connected one-diode models in series connection, the model of photovoltaic panels is implemented.

The silicon is the main semiconductor element in the production of the photovoltaic cells. The silicon belongs to group IV of the periodic table of elements. The silicon can be easily obtained and processed; it is non-toxic and does not build compounds that are harmful to the environment. With oxygen the silicon builds SiO and SiO2, which belong to the dielectric materials. In terms of the structure the silicon may be an amorphous, poly-crystalline and mono-crystalline and, therefore, there are three types of silicon photovoltaic cells, as follows [1]:

- the photovoltaic cell of monocrystalline silicon
- the photovoltaic cell of polycrystalline silicon
- the photovoltaic cell of amorphous silicon

In addition to the photovoltaic cells from silicon, there are also cells from gallium arsenide GaAs, and germanium Ge. The cells of these materials are characterized by a high degree of utilization. These cells are mainly used for special purposes, such as satellites and space exploration. The most widely used are photovoltaic panels with monocrystalline or polycrystalline silicon cells.

The of photovoltaic solar cells efficiency ranges from only a few percent to 40%, and most often in the range from 10% for a cheaper design with amorphous silicon, and 25% for the more expensive units. The monocrystalline silicon cells have the utility factor of approximately 24%, the polycrystalline silicon cells have the utility factor of approximately 15% and the amorphous silicon cells have the utility factor of approximately 10%. In recent years, it has been experimenting with so-called cascade or multi-layer cells composed from various semiconductors, which have a greater efficacy. The residue that is not converted into electrical energy is generally converted into heat, and thereby heats the cell. In general, an increase in temperature of photovoltaic solar cells affects the reduction of its efficiency. [3-4].

2. THE PARAMETERS THAT SHOULD BE CONSIDERED WHEN DESIGNING PHOTOVOLTAIC SYSTEMS

One square meter of photovoltaic panels can provide power to 150 [W] lasting up to thirty years without maintenance. The panels will even work in diffuse light in cloudy days, but with a lower power output. The voltage produced by a photovoltaic panel remains approximately the same regardless of the weather, but the power will vary. The most important parameter that needs to be considered when designing photovoltaic solar system is output power, which largely depends on four factors [5-8]:

- the maximum power of the solar panel (expressed in peak watts or [Wp]),
- solar radiation intensity,
- angle of sun exposure and
- the number of sunshine hours.

2.1. Maximum power of the solar panel

The maximum power of solar panels Pmax is expressed in [Wp] and means how much of the solar energy per time unit the panel will convert in optimal conditions, ie. at noon with direct sunlight in cold weather. The maximum intensity of solar radiation is 1.000 [W / m^2].

2.2. Solar radiation intensity

Factors influencing the intensity of solar radiation, and thus the photovoltaic panels' efficiency are:

- weather conditions (clouds, fogs, etc.),
- the height of the sun in the sky and so on.

Weather conditions are somewhat lightly understood, the panel 50 [W] should produce 50 [W] for each hour of solar radiation intensity of 1.000 [W/m^2]. The panel will produce half of this amount (25 [W] per hour) when exposed to 1/2 of above mentioned solar radiation intensity (500 [W/m^2]). The diffused light that passes through thin clouds can provide about 300 [W/m^2]. In very bad weather with thick, dark clouds, the intensity of solar radiation could fall to 100 [W/m^2] and produce only 5 [W] per hour. The sun's rays are scattered and become more diffuse when passing through the fog or pollution [1].

The next factor, the height of the sun above the horizon varies with the seasons. When the sun is very high in the sky (summer), its rays travel through the atmosphere for a shorter period of time over a shorter distance than when it is low in the sky (winter). A place that gets a lot of sun in September could be in the shadow from November to February due to obstacles (trees, chimneys, roofs, etc.) [5].

2.3. The angle of sun exposure

The factor that creates the biggest problem is optimal position of the panel towards the Sun. It is always best to direct the panels to the south with the ideal angle of inclination independently of the geographical location and time of year. The sun's rays should fall on the panel at a right angle. In Europe the ideal situation is the roof facing south with elevations between 40 and 60 degrees, or even better, a flat roof or surface on which the position of the panel can be adjusted as desired. One can deviate from these values if there are structural or aesthetic limitations to fit into existing architectural structures [1].

The future of photovoltaic systems will depend largely on the possibilities of integrating the panels into the building structure. The largest number of photovoltaic systems in the world was realized with fixed panels. Movable panels that follow the path of the sun in azimuth and elevation are also used. These systems are more efficient but much more expensive.

Among other parameters, which need to be considered when designing photovoltaic systems, and which have not yet mentioned from the energetic point of view, it is important to mention the time of returning the invested energy. Like any device, photovoltaic cells also, in order to produce, require some investment of energy. The time of return of invested energy is the time during which photovoltaic cells must work in order to produce electricity that was needed for its production. This time ranges from one to several years, while the lifespan is from 10 to 30 years, depending on the technology.

3. RESEARCH RESULTS AND ITS ANALYSIS

Due to the long exposure to external influences on the panel, dirt accumulation due to external influences is occurring. To determine what impact external factors have on the panel itself in real conditions of exploitation we carried out:

- measurements in cloudy and foggy weather with clear and deliberately dirty panel,
- measurements in sunny weather with clear and deliberate dirty panels etc.

The measurements were taken in October in Novi Sad. When testing we used two exactly the same photovoltaic panels of type HYP 230, one of which was completely clean, and the other was intentionally dirty. The panels have the following characteristics: power 230 [W], load voltage of VOC = 37 [V], short-circuit current ICS = 8.33 [A], the nominal voltage Vn = 32 [V], the nominal current In = 7.78 [A], Fig. 4.

Figure 4. Amorphous silicon photovoltaic panels

To measure the intensity of solar radiation [W/m^2], we used the device Voltcraft PL-110SM, technical data: measuring range: 0-1.999 [W/m^2], interruption: 0, 1 [W/m^2], accuracy: ± 10 [W/m^2] or 5%. To measure the output electrical power from the panel we used the instrument for measuring power wattmeter.

3.1. Research results in sunny weather

To determine what is the efficiency of the panels in sunny weather, with a high intensity of solar radiation, measurements were carried out under such conditions, the results of which are shown in Table 1.

Table 1. The results of measurements obtained in sunny weather

Time	Intensity of solar radiation E [W/m^2]	Output power of the panel P_{el} [W]	
		Clean panel	Dirty panel
6:00	140	55	30
7:00	150	71	35
8:00	210	140	72
9:00	820	210	180
10:00	910	215	185
11:00	990	220	200
12:00	1110	233	201
13:00	1150	240	203
14:00	1120	235	202
15:00	1110	233	198
16:00	890	210	183
17:00	205	99	85
18:00	70	80	72

Fig. 5 shows how the intensity of sunlight has changed during tests in sunny weather.

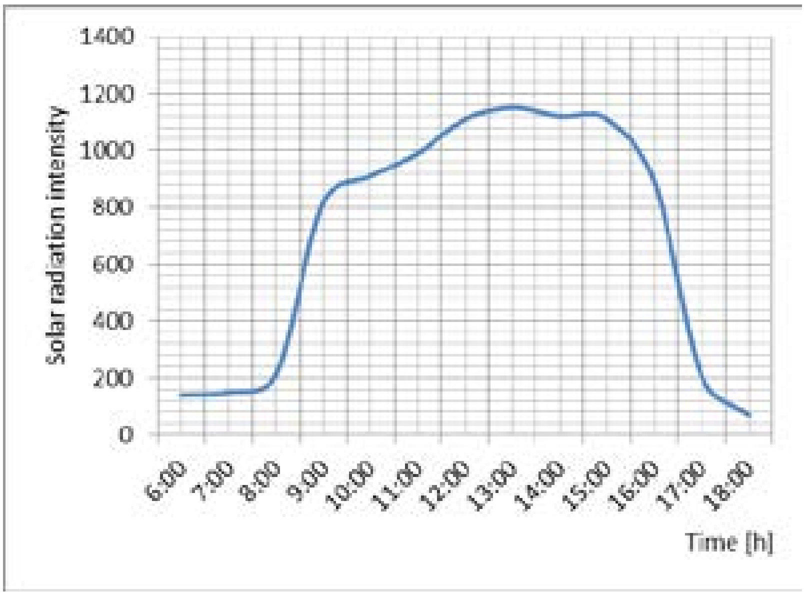

Figure 5. The change of solar radiation intensity in sunny weather

Fig. 6 shows how the power changed depending on the intensity of solar radiation with clean and dirty panels in sunny weather.

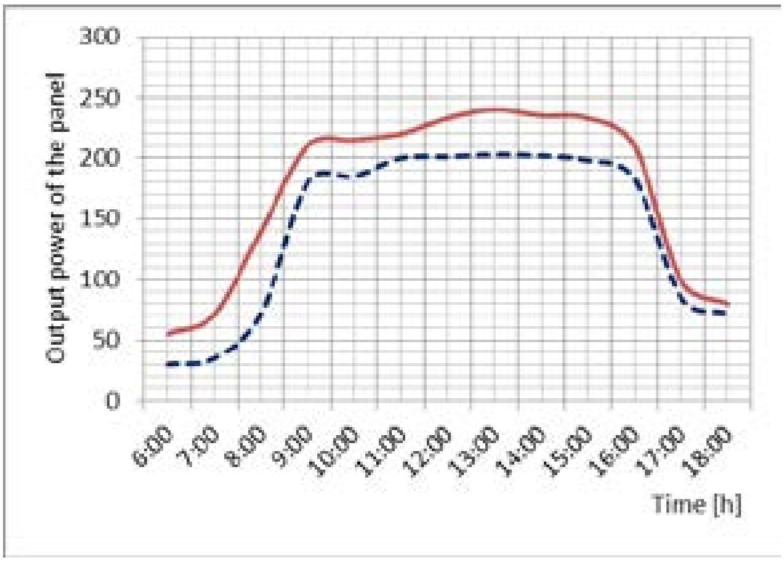

Figure 6. The dependence of the power from the solar radiation intensity with clean (solid line) and dirty panels (dotted line) in sunny weather

Analyzing the data from Table 1 and Fig. 6 it can be seen that the photovoltaic panel during the most intense solar radiation (from 11 to 14 [h]) gives more power than it is indicated in the technical specification.

3.2 Research results in cloudy and foggy weather

In order to determine the efficiency of the photovoltaic panels in low-intensity solar radiation, tests were carried out in cloudy weather, the results of which are shown in Table 2. Measurements were taken every hour, when the measurement started the weather was moderately cloudy, and as day progressed, there was a complete cloudiness and occasional rainfall, so the highest intensity of solar radiation was recorded in the morning. As in the previous case, here also the attention is focused on the output power of the panel.

Fig. 7 shows the change in the intensity of solar radiation during tests in cloudy weather.

Fig. 8 shows how the power at the output of the panel was changed depending on the intensity of solar radiation with clean and dirty panels in cloudy weather.

Table 2. The results of measurements obtained in cloudy weather

Time	Intensity of solar radiation E [W/m^2]	Output power of the panel P_{el} [W]	
		Clean panel	Dirty panel
6:00	175	45	30
7:00	180	46	31
8:00	400	201	78
9:00	800	199	188
10:00	700	185	172
11:00	700	185	172

12:00	680	168	158
13:00	650	149	140
14:00	647	150	141
15:00	630	168	150
16:00	520	157	145
17:00	200	78	71
18:00	110	60	50

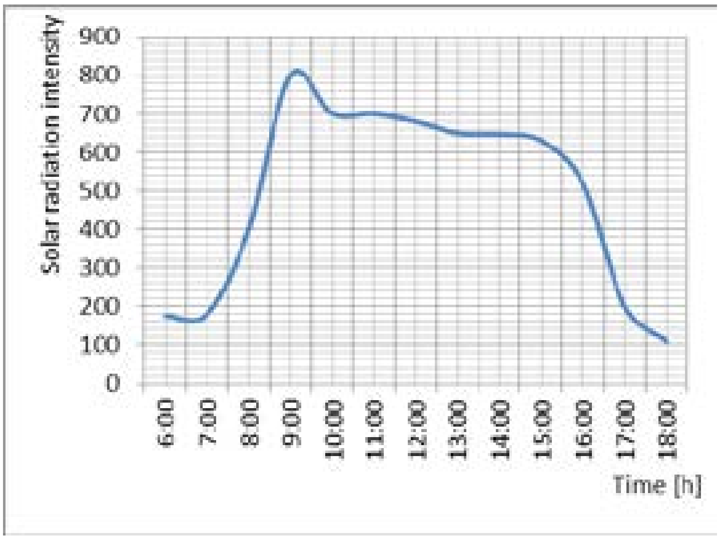

Figure 7. The change of solar radiation intensity in cloudy weather

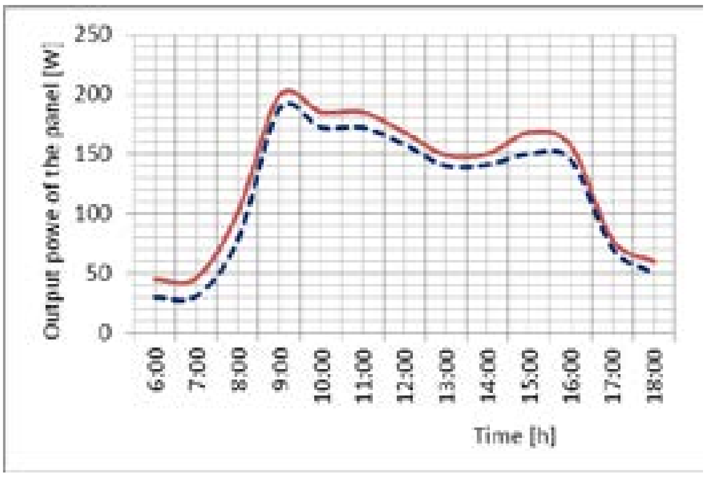

Figure 8. The dependence of the power from the solar radiation intensity with clean (solid line) and dirty panels (dotted line) in cloudy weather

Analyzing the data from Table 2 and Fig. 8. it can be seen that even with a low-intensity of light the panel provides the power that is slightly smaller than power which is indicated in the technical specification by the manufacturer.

Furthermore, analyzing the data from both Table 1 and Table 2, and Fig. 6 and Fig. 8 it can be seen that, at the maximum intensity of solar radiation, dirty panel provides approximately 20% less power than clean panel.

Fig. 9 shows how the power at the output of the panel was changed depending on the intensity of solar radiation with clean panel, in sunny and cloudy weather. It can be seen that in cloudy weather output power of the panel is considerably smaller even up to 70%, than in sunny weather.

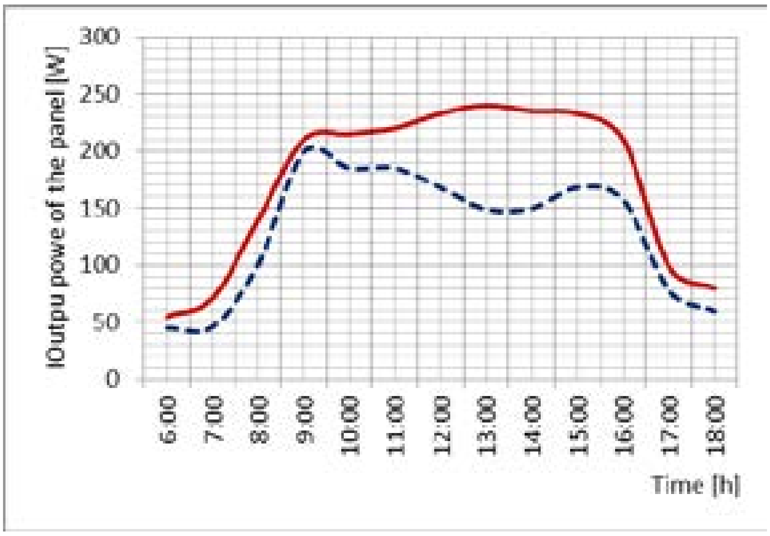

Figure 9. The dependence of the power from the solar radiation intensity with clean panel in sunny (solid line) and in cloudy weather (dotted line)

Furthermore, the measurements were carried out in sunny weather with two completely clean panels, one of which is moveable (takes optimal position towards the Sun) and the other is fixed (in the optimal position relative to the Sun in 13 [h]). Fig. 10 shows the diagram from which it can be seen that the movable panel is significantly more efficient than the fixed one, especially in the morning and in the early evening.

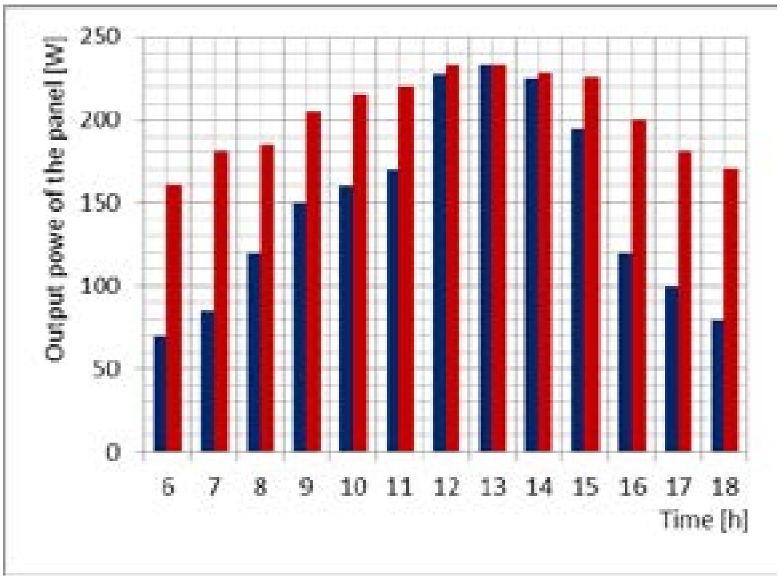

Figure 10. Illustration of the efficiency of the fixed (blue) and moving (red) photovoltaic panels during the day

4. CONCLUSION

Based on conducted research results it can be concluded that with low intensity of solar radiation (in cloudy weather) solid output power is obtained. On the other hand, in terms of greater intensity of solar radiation for which panel is designed (in a sunny day) the panel shows the full potential. It can be concluded that the impurities that accumulate on the surface of the panel during operation reduce its efficiency by approximately 10 to 20%. Therefore, it is necessary to maintain the panels regularly, or occasionally clean outer surface of the panel. Also, it can be concluded that the output power of the panel influences the position of the panel in relation to the Sun, or that the panel that occupies optimal position relative to the Sun is significantly more efficient than the fixed panel.

The obtained results lead to the conclusion that in our region that is not foggy, photovoltaic panels can be used effectively, especially mobile panels (occupying the optimum position to the Sun), and their efficiency can be increased by regular cleaning. The electricity production, using the photovoltaic panels, decreases the consumption of fossil fuels and emission of harmful gases into the atmosphere, which contributes to environmental protection and sustainable development of the society.

5. REFERENCES

[1]Ilić, B., Adamović, Ž., Kenjić, Z., Blaženović, R., Renewable Energy and Energy Efficiency: automated diagnostic systems of renewable energy, increasing energy efficiency and reliability of technical systems, by automated diagnosis(Obnovljivi izvori energije i energetska efikasnost: automatizovana dijagnostika postrojenja obnovljivih izvora energije, povećanje energetske efikasnosti i pouzdanosti tehničkih sistema automatizovanom dijagnostikom), Srpski akademski centar, Novi Sad, 2013

[2]Forcan, M., The effect of partial solar insulation series and the proposed method of its elimination (Efekat djelimičnog osunčanja solarnog niza i predložena metoda njegove eliminacije), Infoteh-Jahorina, Vol. 12, March 2013.

[3]Mikulović, J., Đurišić, Ž., The statistical method for the assessment of electricity production from photovoltaic systems (Statistička metoda za procenu proizvodnje električne energije iz fotonaponskog sistema), Infoteh-Jahorina, Vol. 11, March 2012.

[4]Pešović, U., Milanković, I., Jagodić, D., Ranđić, S., The model of the intensity of global solar radiation on a horizontal surface (Model intenziteta globalnog sunčevog zračenja na horizontalnu površinu, Infoteh-Jahorina), Vol. 11, March 2012.

[5]Adamović, Ž., Ilić, B., Jovanov, G., Vulović, S., Cvetković, S., Energy efficiency: Green Energy, Higher Technical School of Professional Studies, Belgrade (Energetska efikasnost: Zelena energija, Visoka tehnička škola strukovnih studija), Belgrade 2013

[6]Ilić, B., Adamović, Ž., Savić, B., The impact of automated diagnostics to energy efficiency and reliability of the buildings technical systems, (Uticaj automatizovane dijagnostike na energetsku efikasnost i pouzdanost tehničkih sistema zgrada) Scientific Journal Technical Diagnostics, no. 2, Belgrade, 2013 For better understanding of the basic characteristics of photovoltaic cells, the ideal photovoltaic cell can be modeled (presented) with the parallel connection of an ideal current source and the diode, because by their nature the illuminated photovoltaic cell acts as a constant current source. In order to obtain a realistic photovoltaic cell, the parallel and series resistance *Rs* and *Rp* should be added to this model, thereby taking into account the power losses in the cell, Fig. 1. The model is applicable to any type of the photovoltaic cell.

UDC: 614.841.45:692.23

CHARACTERISTICS OF FAÇADE FIRE SPREADING

Dubravka BJEGOVIĆ[1], Miodrag DRAKULIĆ[2], Milan CAREVIĆ[3], Bojan MILOVANOVIĆ[1]

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Paper deals with characteristics of façade fire spreading in buildings, which is very important danger for the firemen during the intervention, as well as for the successful evacuation of occupants. Needs for the comprehensive researching of façade fires become more important because of ambitious programme of façade renovation as the part of energy efficiency measures carrying out. The aim of this paper is to get attention on importance of fully consideration of the façade renovation taking into account both thermal insulation characteristics of the used materials and their reactions on fire in very specific conditions too. The technical legislation of this field will be also critically analyzed in this paper. Finally, preliminary results of the full scale façade fire testing of three different types of façades will be presented.

Key words: *building, façade, fire, energy efficiency, testing*

1. INTRODUCTION

1.1 Work motivation and importance of the façade fire

The need for a comprehensive study of a fire that is rapidly spreading across the façade of the building to neighboring floors which initially were not endangered by the fire becomes increasingly important for many reasons. One of them is certainly increasingly rigorous domestic technical regulations [1] compliant with European directives that ranks safety in case of fire very highly and declares it as another basic requirement that buildings must comply during its existence, immediately after the mechanical resistance and stability. In doing so within the fire safety special attention is paid to safe and efficient evacuation of the occupants, as well as achieving satisfactory conditions for the operation of emergency (rescue) services. Façade fire, because of its dynamic expansion and the potential formation of toxic fumes, directly threaten the safety of these segments of both users and rescue services.

Another reason for a detailed study of the façade fire is ambitious program of façade reconstruction anticipated as part of the implementation of energy efficiency of buildings. The above mentioned programs, in many EU countries, have significantly advanced in realization or are at an early stage, as is the case with the Republic of Croatia [2] and the countries of the region. Although the technical regulations in the field of energy efficiency primarily concerned with the façade of the building coating, prescribing the maximum permitted values of the coefficients of thermal transmittance, consequently, significantly increases the mass of embedded insulating materials, which are very diverse in terms of quality fire protection properties, i.e. declaring a different reaction to fire. In this regard, it is necessary to draw attention to a comprehensive view of the façade renovation taking into account the thermal insulation properties of the materials used, as well as their response to the fire in terms that are very specific and cannot be characterized as so far accepted classification of building materials.

2. THERMODYNAMICS BASIS

The study of fire in buildings usually involves the analysis of fire development and smoke expansion in the building, or its individual parts. The basic postulate of the fire concept of the building is that areas with different functional requirements and different risks of occurrence and fire spreading are separated by barriers / walls of adequate fire resistance classes. Besides this passive fire protection measures, it is anticipated to install of a number of active fire protection systems (e.g. Stable systems for fire extinguishing with water, gas or foam, systems of natural and mechanical smoke removal, positive-pressure ventilation systems, etc.).

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Combining described passive and active fire protection measures in the observed area aims to prevent the occurrence or spread of fire. However, if a fire occurs and its uncontrolled development to the point of "flashover", this as a rule results in rupture of glass walls or the collapse of the façade elements. On this occasion, the so-called "window" flame-smoke model is formed, the description of which follows below. Flames are coming from outside the premises of the initial fire, and because of intensive thermal buoyancy it is dynamically formed above place of the façade penetration. Characteristics of the window model is that the flame comes into a position parallel to the façade surface, and therefore combines two simultaneous transfer of heat from the flame pillar on the façade in close vicinity.

It is a convective heat transfer due to buoyancy flow of hot air and fiery pillar radiation, i.e. hot flue gases to the surface of the façade above the place of façade penetration. Established thermal radiation is very intense, with relatively little loss of heat to the surrounding atmosphere. It also preheats façade surface directly above the portion of the façade, which has been affected by the fire and prepares for further combustion. This combined effect is responsible for a rapidly fire spreading on façades made of flammable materials.

3. CRITICAL REVIEW ON TECHNICAL REGULATIONS

3.1 Curent Croatian legislation and flammability classes of façade elements

According to the new Croatian provision [3], which is in line with EU regulations, flammability class of façade materials, and other construction elements are related to the types of buildings and their position in these buildings (on the façade, the interior of the building, the evacuation route, etc.). The buildings are divided according to the cited regulation in subgroup 5 (ZPS1 from to ZPS5), and the category of high-rise buildings. The above classification relies on the German and Austrian regulations, and that has expanded with the category of possession of the building for people and their status (e.g. mobile - immobile, sick people, children, etc.)

Listed building division includes:

Buildings of the subgroup 1 (ZPS 1) are free-standing buildings with at least three sides available to firefighters for fire extinguishing from the terrain level, containing up to three floors from the elevation of the top floor for people to 7.00 meters measured from the level of the external terrain from which is firefighters intervention possible, i.e. evacuation of threatened people, and containing an apartment or single business unit , of floor plan (gross) area to 400,00 m² and a total up to 50 occupants;

Building of the subgroup 2 (ZPS 2) are free-standing buildings and buildings in a row, containing up to three floors with the floor elevation of the top floor for people to 7.00 meters measured from the level of the external terrain from which the firefighters intervention is possible, i.e. evacuation of threatened people, and containing no more than three apartments and a maximum of three business units of individual ground plan (gross) area to 400,00 m² and in total up to 100 occupants;

Building of the subgroup 3 (ZPS 3) are buildings containing up to three floors with the floor elevation of the top floor for people to 7.00 meters measured from the level of the external terrain from which the firefighters intervention is possible, i.e. evacuation of threatened people, where less than 300 people are gathered, but are not in the subgroups of buildings ZPS1 or ZPS 2;

Building of the subgroup 4 (ZPS 4) are buildings containing up to four floors with the floor elevation of the top floor for people to 11.00 meters measured from the level of the external terrain from which the firefighters intervention is possible, i.e. evacuation of threatened people, and which contain one apartment or a single business unit, without limitation of ground plan of (gross) area or more business units of individual ground plan (gross) area up to 400.000 m² and in total up to 300 occupants;

Building of the subgroup 5 (ZPS 5) are buildings with the floor elevation of the top floor for people to 22.00 meters measured from the level of the external terrain from which the firefighters intervention is possible, i.e. evacuation of threatened people, which are not classified into subgroups ZPS 1, ZPS 2, ZPS 3, and ZPS 4, as well as buildings that are mainly composed of underground floors, the building in which immobile and persons with reduced mobility reside, and people who cannot independently evacuate (hospitals, homes for the aged, psychiatric institution, nursery , kindergartens and the like), and the buildings in which people live where movement is limited for safety reasons and / or have specific areas in which more than 300 people may be gathered;

high buildings outside of the aforementioned subgroups, and they are classified as buildings with the floor elevation of the floor levels for people over 22.00 meters measured from the level of the external terrain from which the firefighters intervention is possible, i.e. evacuation of threatened people, using the auto-mechanical ladders or auto-telescopic basket or articulated boom lifts.

3.2 Classes of materials combustibility in accordance with Croatian regulations

In terms of combustibility class of materials in Croatia valid EN standards are taken over, but until 2019, as well as previously taken DIN standards. European standards (EN 13 501-1) in terms of reaction to fire, divide the material into 7 classes of combustibility (A1, A2, B, C, D, E and F), three additional classes considering the production of smoke (s1, s2, and s3) and three additional classes with respect to the fuel dropping (d0, d1 and d2). By combining mentioned characteristics a total of 40 different classes of materials is obtained that define the response of materials in the fire (Table 1).

Table 1 - Classes of materials combustibility according to EN standard 13501-1

A1		
A2-s1,d0	A2-s1,d1	A2-s1,d2
A2-s2,d0	A2-s2,d1	A2-s2,d2
A2-s3,d0	A2-s3,d1	A2-s3,d2
B-s1,d0	B-s1,d1	B-s1,d2
B-s2,d0	B-s2,d1	B-s2,d2
B-s3,d0	B-s3,d1	B-s3,d2
C-s1,d0	C-s1,d1	C-s1,d2
C-s2,d0	C-s2,d1	C-s2,d2
C-s3,d0	C-s3,d1	C-s3,d2
D-s1,d0	D-s1,d1	D-s1,d2
D-s2,d0	D-s2,d1	D-s2,d2
D-s3,d0	D-s3,d1	D-s3,d2
E		
E-d2		
F		

3.2.1 Provisions of Croatian regulations governing the transfer of fire to the front

Pursuant to the above mentioned Croatian regulation, the application of aforementioned combustibility classes of front elements is regulated, depending on the subgroup in which the building is classified (Table 2).

Table 2 - Combustibility classes of façade elements materials in relation to the building subroups

Građevni dijelovi	Zgrada podskupine (ZPS)									
	ZPS 1	ZPS 2	ZPS 3							Visoke zgrade
Ovješeni ventilirani elementi pročelje										
Klasificirani sustav	D	D-d1	D-d1	C -d1			B -d1			A2-d1
ili										
Izvedba sa slijedećim klasificiranim komponentama										
Vanjski sloj	D	D	D	A2-d1		B-d1	A2-d1		B-d1	A2-d1
Podkonstrukcija										
– štapasta	D	D	D	D	ili	D	C	ili	C	A2
– točkasta	A2	A2	A2	A2		A2	A2		A2	A2
Izolacija	D	D	D	B		A2	B		A2	A2
Toplinski kontaktni sustav pročelja										
Klasificirani sustav	D	D	D	C -d1			C -d1			A2-d1
ili										
Sastav slojeva sa slijedećim klasificiranim komponentama										
– pokrovni sloj	B-d1	B-d1	B-d1	B-d1			B-d1			A2-d1
– izolacijski sloj	E	E	D	B			A2			A2

In terms of prevention of vertical transmission of fire at the front (façade) of the building due to a fire that broke through the openings (windows), quoted Croatian legislation provides making of intermittent distances in the height of 1.2 meters. This intermittent distance, apart of fire resistance has to be made from materials which in terms of reaction to fire are at least equal to the combustibility class of materials from which the structure is built. This would mean that regardless of the type of insulation façade, intermittent distances should normally be made from a non-combustible material (Class A1 or A2), because the structures are most commonly derived from such material (except for the wooden structures). Ultimately, such a solution would be asking for belts of non-combustible insulation with a width of 1, 2 meters around the façade of the building which is not done in practice.

Generally above regulation is not fully clear, because it speaks only of intermittent distance above the opening at the front and does not define the lateral intermittent (safety) distances around the opening that would prevent the spread of fire in the horizontal direction. Such spread of fire could lead to the transmission of fire on the front and in the vertical direction, although above the opening through which the fire broke out the transfer would not occur. In this sense, the regulation seeks correction considering the poverty of design experience in these types of details.

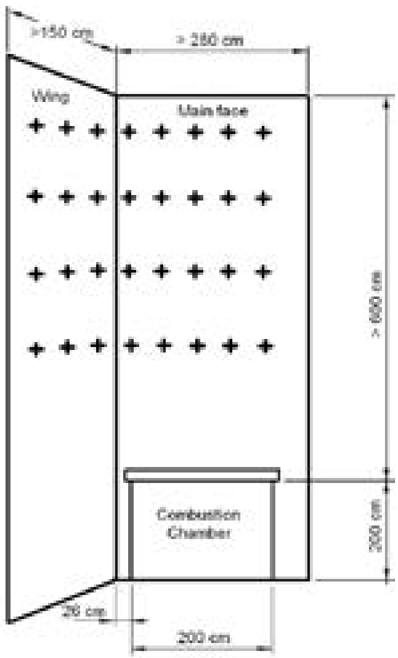
TEST RESULTS OF DIFFERENT TYPES OF FAÇADES

This section presents the preliminary test results of three different types of façades, conducted on 05/28/2014 in the Laboratory for thermal measurements (LTM) organized by the Civil Engineering Faculty, University of Zagreb and the Croatian Association for the Fire Protection , with the participation of the Swedish Institute SP and Slovenian ZAG, as research partners.

The test was conducted as a "full scale" test of three samples of façades, each individual height of 8 m, which allows the simulation of the development of the façade fire in the two-story building. All samples were derived from the classified façade systems ETICS as follows:

- the first sample of the fuel isolation of expanded polystyrene, the class B s2 d0 (EPS):
- the second sample of the fuel isolation of expanded polystyrene, the class B s2 d0 + horizontal fire barriers of stone wool (EPS + MW);
- third sample with non-combustible insulation of stone wool A2 s1 d0 (MW).

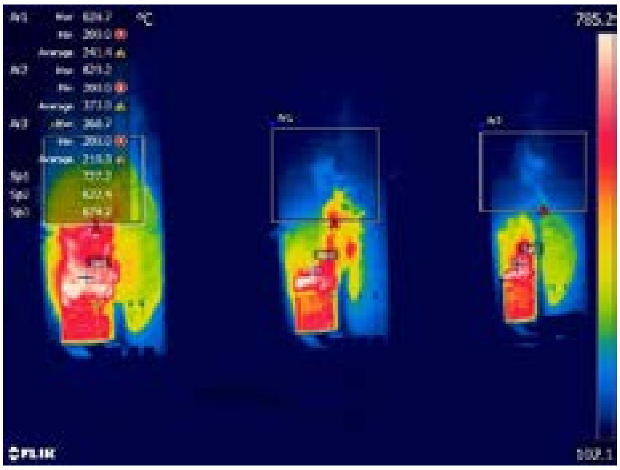
Testing is performed in its entirety according to British Standard [4], which includes natural combustion of wood material in the furnace, with the developed strength of the fire of approximately 2,5 MW.



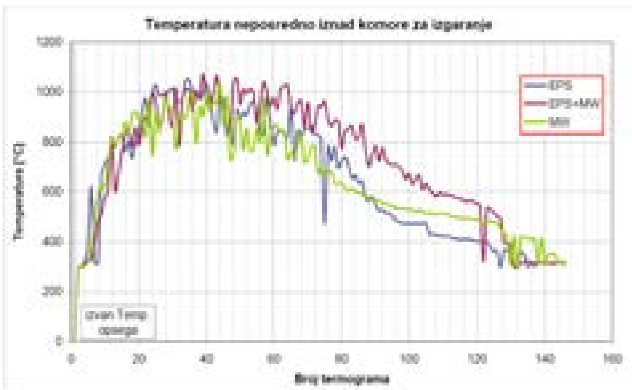
Picture 1 – Configuration of the to façade test sample according to BS 8414-1

Picture 2 – Layout of façade samples, during the fire test

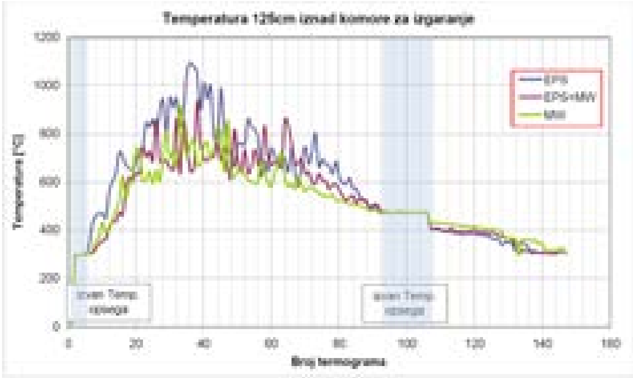
(from left to right: EPS, EPS+MW, MW)



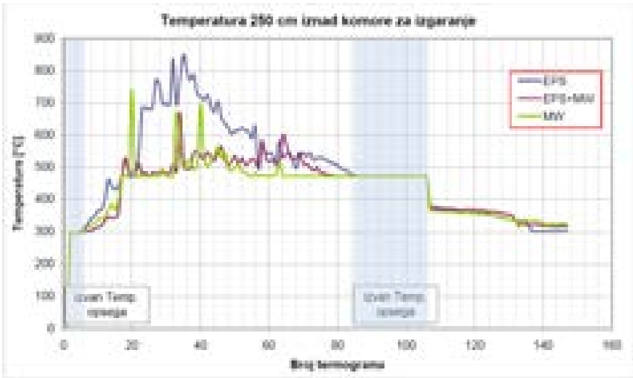
Picture 3 –The thermogram taken 13 minutes after the ignition of fuel in the furnace



Temperature 125 cm above the combustion chamber



Number of thermograms



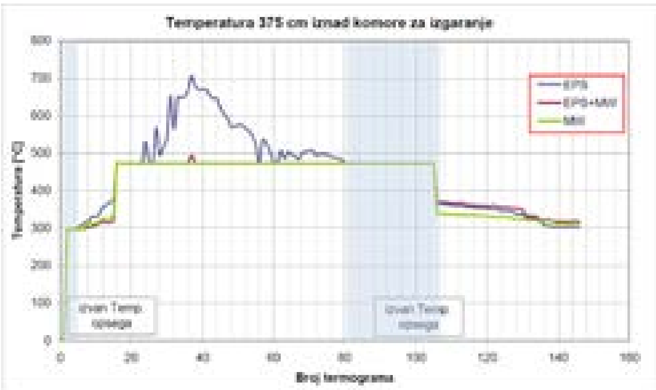


Figure 1 - Distribution of temperature at different heights of samples façade

(directly above the combustion chamber, at 125 cm, to 250 cm and 375 cm above the chamber)

CONCLUSION

Preliminary results façade testing in nature suggest that there are significant differences in the behavior of façade systems and their components in the fire, although all generally meet the prescribed requirements in terms of heat-insulating properties that they possess. Additionally the classified system insulated with expanded polystyrene (EPS) showed the worst results since the measured values of the temperature of the correspondent heights of measurements, as well as the largest area affected by fire that can be seen on the attached thermogram. By installing the horizontal fire barrier just above the opening that represents the window pane, even with a height which is substantially less than the prescribed intermittent distances (1,2 m), the results of such façade system behavior (EPS + MW) in the fire are much better than the system built entirely of EPS combustible insulation. However, for the long delay in the spread of fire through combustible façade, it would be necessary to perform fire barrier according to proven technical rules. Façade system with non-combustible stone wool insulation (MW) showed the best behavior during the fire test, keeping its integrity till the end of testing, with no vertical propagation of temperature in the façade.

It is important to note that façade system with non-combustible insulation did not generate toxic and irritating smoke gases, unlike combustible EPS insulation that is very smoky and combustible dripping fuel. The flow and composition of smoke gases are not measured during the present testing and is the subject of future research in this area.

REFERENCES

[1]Construction Law (Official Gazette of the Republic of Croatia Number 153/13)

[2]Technical regulation of the rational use of energy and thermal protection of buildings (Official Gazette of the Republic of Croatia Number 97/14)

[3]Regulation of fire resistance and other requirements that buildings must meet in case of fire (Official Gazette of the Republic of Croatia Number 29/13)

[4]BS 8414-1: Fire Performance of external cladding systems, Part 1: Test method for non-loadbearing external cladding systems applied to the face of the building

Table 2 - Combustibility classes of façade elements materials in relation to the building subroups

Building Components	Building subgroups (ZPS)
	High buildings
	ZPS 1 ZPS2 ZPS3
	Suspended ventilated façade elements
Classified system	D D-d1 D-d1 C -d1 B-d1 A1-d1
or	
	Performance with the following classified components
Outer layer substructure	D D D A1-d1 B1-1 A2-d1 B-d1 A1-d1
-dowel type	D D D D or D C or C A2
-dotted type	A2 A2 A2 A2 A2 A2 A2 A2
Insulation	D D D B A2 B A2 A2
	Façade thermal contact system
Classified system	D D D C-d1 C-d1 A2-d1
Or	
Layers composition with the following classified components	
-covering layer	B-d1 B-d1 B-d1 B-d1 B-d1 A2-d1
-insulation layer	E E D B A2 A2

METHOD OF EXPLORATION OF SOIL BIOCENOSE OIL POLLUTION ON THE GROUNDS OF STUDY OF THE AMOUNT AND COMPOSITION OF OIL PRODUCTS

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A method of estimating the extent of ill-being of the territories to detect emergency zones and zones of environmental disaster on the grounds of study of the amount and composition of oil pollution in soil biocenoses has been offered. Analytical information has been processed by the method of zonal coding of infrared and luminescence spectrums of soil deposit and plant biomass extracts. Identification of oil pollution has been performed on the basis of polynomial method of visualization of spectral data and comparison of visual images by means of graphic superimposition and use of regression analysis.

Key words: *soil, phytotoxicity, oil pollution, infrared spectroscopy and molecular luminescence.*

It is extremely difficult to estimate the extent of negative influence of oil pollution on the soil. For that purpose nature of interaction of oil products with all the elements of soil biocenose has to be determined. The issues of study of the mutual transition processes of foreign oil products between soil and soil organisms, able to ensure negative influence on biological objects, as well as present a direct or indirect threat for human health in food chains have not been completely studied till the moment.

Parameters estimating the influence of oil products on biological objects are among criteria of territory estimate in order to detect emergency zones. But in some regulatory documents it is recommended to use only indirect criteria of this group – depression of plants growth and determination of soil phytotoxicity [1]. At the same time direct study of the number and composition of organic pollutants in biological objects would enable determining pollution of natural systems. It is aimed to ensure safe conditions of human living, what is a final purpose of environmental monitoring at emergency forecasting.

In any case changed correlation of concentration of certain groups of organic pollutants is witnessed in living organisms anyway. The bigger is concentration of organic pollutants in the water, the lower are their indices of accumulation by hydrobionts, what is caused by organism saturation with toxicant. At that the greatest content is seen in predatory fish, to organism thereof organic pollutants usually enter with food, as well as bottom-living fish, eating maggots, water insects, molluscs and offal (catfish, bream etc.). Levels of content of organic pollutants in fish enable determining pollution of water area with such pollutants. In particular, differences of pollution have been considered on example of Baikal oil-fish in the northern and southern parts of Baikal [2]. Higher content of pesticides (2-3 times more) and polychlorobiphenols (2-5 times more) have been detected in fish from the southern part of Baikal. Whereas quite contrast concentrations (much lower) have been established for Siberian roach and river perch in Upper Angara, which, probably, correspond to such level of toxicants, which should be in Baikal at absence of human economic activity. Relatively high concentrations of polychlorobiphenols (PCB) in fatty tissue of seals in the Gulf of Riga have enabled to conclude that a source of gulf ecosystem pollution with PCB is available in this area [3]. Practically all fresh-water organisms in one way or another find themselves under exposure of organic pollutants polluting the environment and become the source of pollution of other representatives of fish fauna, related with food chains with them.

The specific features of composition of organic pollutants and level of their content in cow milk enable having a conclusion on the source of atmospheric emissions of the compounds being considered. Thus, on the grounds of data about PCB content in cow milk it has been established that a source of emission is available in the area of Angarsk [3]

Human bio-tissues also accumulate and keep many organic pollutants for a long time, what is explained by their resistance to bio-degradation. That is why monitoring of organic pollutants in human bio-tissues, in particular in blood, enables determining level of pollution of environment and population in general by these compounds [4].

A method used to estimate the extent of ill-being of the territories to detect emergency zones and zones of environmental disaster on the grounds of study of the amount and composition of oil pollution in soil biocenoses has been developed in this work.

In terms of phase composition the soil comprises three phases: solid, liquid and gaseous. Foreign oil components, entering to the soil, interact with all these phases and via metabolic processes enter organisms living in the soil and having direct relation with the soil.

Foreign oil products contained in the soil could be classified into three categories:

- background oil pollution available in soils on the territory of location and close to residential settlements, oil fields, pipelines, companies of oil industry etc. in conditions of their normal operation;
- oil products, which enter the soil as a result of violation of technological regulations, accidents, burns, i.e. different emergencies;
- oil products coming from migration from subsoils, formed as a result of thermal transformation processes of Earth crust organic substance, abiogenic synthesis in depth horizons and “breathing” of hydrocarbon accumulations.

Organic substance of the soil acts as a subsystem with regard to the soil and at the same time it is a complex system. Organic substance exists in all the solid phases and in all mechanical and morphological differences, whereas it is not subject to physical articulation, staying in dynamic balance between solid, liquid and gaseous phases. Entry of foreign oil products to the solid could lead to occurrence of an emergency (ER), but criteria used to classify ER are quite divergent. Soil phytotoxicity, expressed in reduced number of germinated plants compared to background areas is an important criterion. ER rate by this criterion is a reduction of the germ number for 1.4÷2 times. It has been established that such reduction occurs at concentration of oil products in the solid on the level of 250 ml/kg in average [1].

In practice oil pollution content level is estimated on the grounds of study of the amount of oil products in environments adjacent to the soil. It means that relations of the object (soil) with other elements of ecosystem, rather than itself is being studied. Pollution of plants in this system is estimated not by means of direct measurements and comparison of obtained results with rated values, but by means of determination of a share of polluted plants in % of total volume of studied volume. Such an approach does not enable determining quantitative characteristics of oil products content in plants bio-mass, and moreover its does not established their qualitative composition.

Thus, it is hard to escape a conclusion that it is necessary to develop a method of direct research of the amount and composition of oil products contained in plants bio-mass and compare such characteristics against existing aspects for soil cover.

In order to get plants bio-mass in terms of its growing on soil polluted with oil products and further direct determination of the amount and composition of oil products experiments on determination of phytotoxicity have been performed within framework of this work. Dependencies of the number of germs and days of examination have been approximated with a linear function with a quite high confidence. Average growth rate of germs could be characterized with slope ration of regression equation.

The greatest growth rate of germs is witnessed on a clean soil. A relatively high growth rate of plants on samples of soil polluted with diesel fuel should be noted. Germs on the soil with this type of oil pollution appeared even at ER pollution level.

Direct analysis of oil products by methods of IR-Fourier spectroscopy and molecular luminescence from extract of grass bio-mass and soil samples have been performed in obtained bio-mass, as well as potting soil. Total content of oil products in plants bio-mass according to data of molecular luminescence is about 3-6 times less, than that in soil layer, and according to data of IR spectroscopy – in some cases it was 10 times less. In samples polluted with gasoline exceeded content of oil products in plants bio-mass compared to soil was even higher than the one at pollution with crude oil.

A way of coding, widely used in expert-forensic processing at processing of 2D graphic objects, e.g. fingerprints, elements of handwriting etc., has been used for spectrum analysis. One of the tasks of this research was to select logically defined segments in luminescence and IR spectrums, which expressed a real physical concept. Narrow intervals of wave length 10 nm, covering a specific “cross-section”, within which shifts of luminescence maximum wave lengths of the five groups of elements are allowed, have been chosen as segments for luminescence spectrum coding. Luminescence spectrum after coding looks, as shown in figure 1. Infrared spectrums have been coded on wave numbers of absorption bands of hydrocarbon molecule valence vibrations.

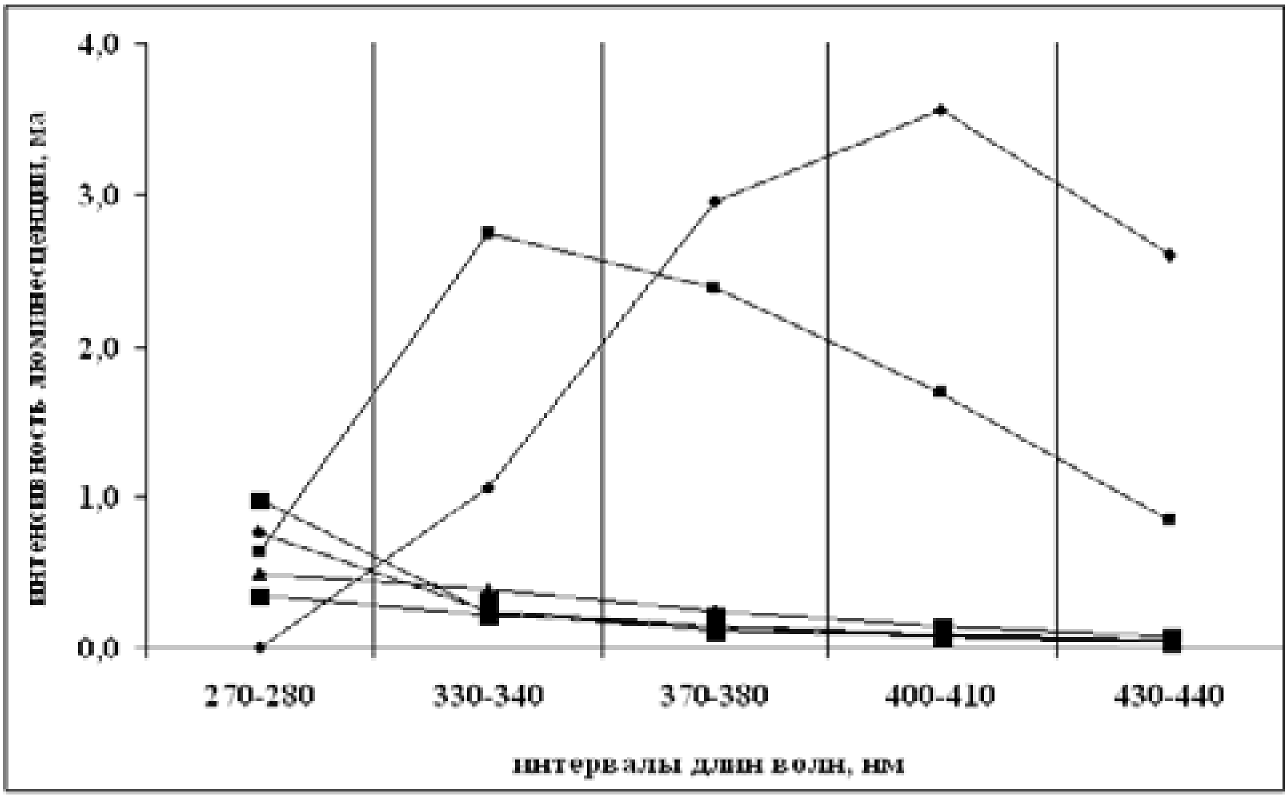

Figure 1. – Coding of rated luminescence spectrums of grassy bio-mass extracts, grown on the soil with different types of oil pollution.

After receipt of the primary data “package” they are assigned with common structure, which enables performing direct quality comparison. For that purpose spectrums are rated with regard to any selected aspect. A method of rating with regard to integral intensity has been chosen in our work. Rated spectrums have been coded on the same segments, as coding of original (not rated) spectrums. Spectrum codes have been analyzed by method of regression analysis by means of establishing graphic images (fingerprints) and respective functional dependencies (regression equations).

Correlation of fingerprints has been performed by means of their superimposition, as well as comparison of regression equation indices by methods of mathematical statistics. If any coincidence is detected, objects are deemed to be identical. In case of any difference – not identical. Any aspects, which help to detect any differences between the objects, are accepted as identification parameters.

Approximating functions of group composition of grassy bio-mass extracts, built by codes of rated luminescence spectrums, show significant difference between data packages being studied even at visual comparison (figure 2).

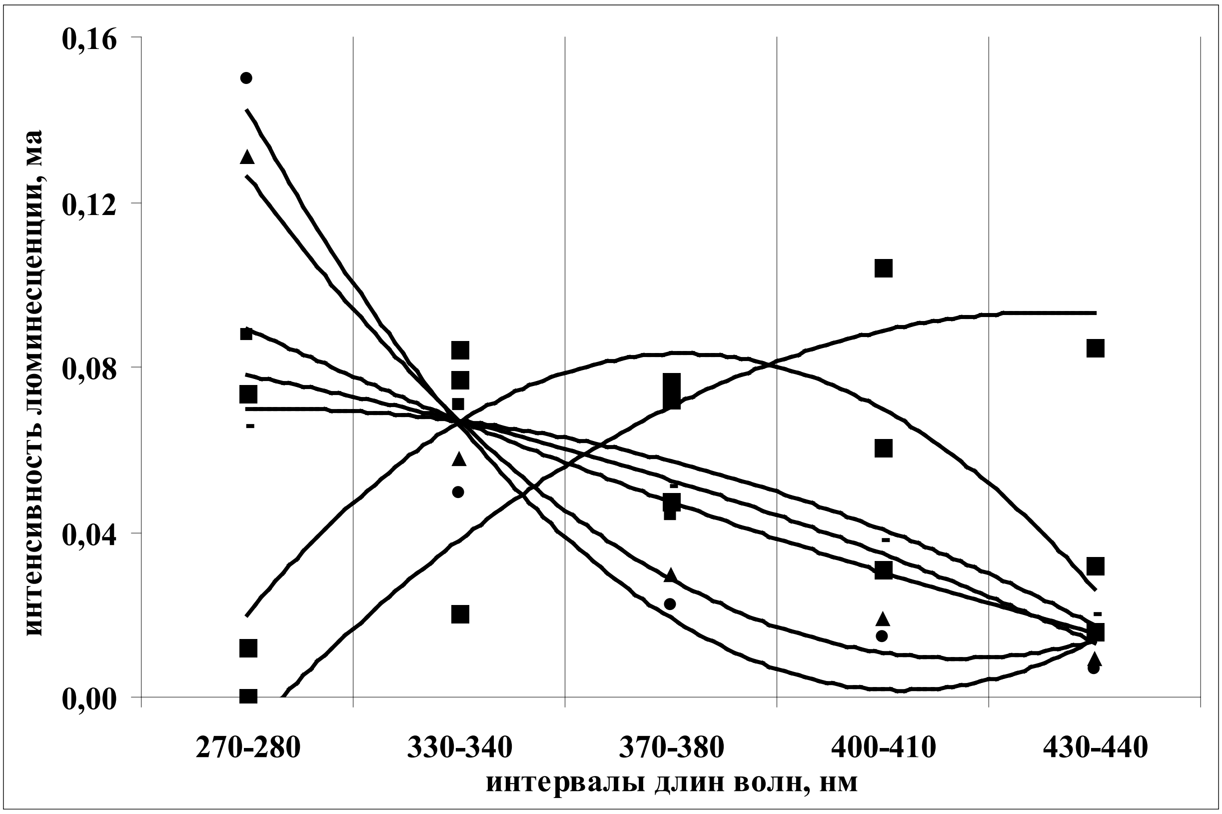

Figure 2.- Approximating functions of group composition of grassy bio-mass extracts according to rated luminescence spectrums.

The first thing, which should be noted. Codes of all received luminescence spectrums have been approximated by square polynom with accuracy not less than 0.9. Second, approximating functions of luminescence spectrum of grass extract, grown on clean soil, passes in the middle of indexer. Above it are functions of grass spectrums grown on the soil polluted with oil, below – spectrums of the grass grown on the soil polluted with gasoline. Approximating functions of luminescence spectrum of grass extract, grown on the soil polluted with diesel fuel are located close to clean soil line. This result is well agreed with the result obtained at study of phytotoxicity, according to which soil pollution with diesel fuel had the least negative influence on plants growth.

Approximating functions of group composition of grass extracts differ from functions of extracts of grassy bio-mass. Here lines referring to soils polluted with diesel fuel, pass in the same area of indexer, as lines of extracts of soil polluted with gasoline.

Approximating functions of molecular hydrocarbon composition of grassy bio-mass extract, built by rated IR spectrums are almost amalgamated. It certifies their low diagnostic capacities. IR-spectroscopy method could not be used for identification of oil pollution type. Its application is required for quantitative estimate of pollution level pursuant to adopted standards [5].

Conclusions made on the grounds of visual correlation of approximating functions, are verified with results of statistical processing of functional dependencies. In particular index values in regression equations built by results of luminescence analysis, for samples, grown on soils polluted with oil and gasoline go beyond borders of confidential intervals at probability of 0.95. It means that obtained regression equations may serve as means of identification of oil pollution.

A good positive linear correlation is shown by data packages related to similar types of oil pollution in grassy bio-mass and potting soil. It enables performing diagnostics of soil cover with oil pollution on the grounds of results of study of extracts of organic elements of plants bio-mass.

System of zonal coding of infrared and luminescence spectrums of soil deposits and plants bio-mass extracts enables performing mathematical processing of analytical information. Identification of oil pollution could be performed on the grounds of polynomial method of visualization of spectral data and comparison of visual images by means of graphic superimposition and with the use of methods of mathematical statistics.

REFERENCES

[1] Haustov A.P., Redina M.M. Ohrana okruzhajushhej sredy pri dobyche nefti. M.: Delo, 2006. 552 s.
[2] Mamontov A.A., Mamontova E.A., Tarasova K.N. Dioksiny. Su-pertoksikakgy XXI veka. Ozero Bajkal. Regiony Rossii. Vypusk № 6. M.: VINITI, 2001. S. 54-164.
[3] Zagrjaznenie dioksinami i rodstvennymi soedinenijami okruzhajushhej sredy Irkutskoj oblasti (gigienicheskie aspekgy problemy). Metodicheskoe posobie / Pod red. Galazij G.I. Irkutsk: 2000. 46 s.], chto podtverzhdeno vposledstvii rezul'tatami snegovoj s#emki.
[4] Amirova Z.K. Tehnogennoe zagrjaznenie jekosistem promyshlennogo regiona polihlorirovannymi dibenzodioksinami i dibenzofuranami. Avtoref. diss. Ufa, 1999. 48 s.
[5] Metodika vypolnenija izmerenij massovoj doli nefteproduktov v mineral'nyh, organogennyh, organo-mineral'nyh pochvah i donnyh otlozhenijah metodom IK-spektrometrii. PND F 16.1:2.2.22-98. (Izdanie 2005 g.).

CONFORMITY ASSESSMENT OF NEW MODELS OF SUBWAY TRAINS REQUIREMENTS OF FIRE SAFETY

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Currently most of the rolling stock is outdated samples that generally do not meet modern fire safety requirements. The basic document defining the fire safety requirements for rolling stock subway is NPB 109-96 "Subway cars. Fire safety requirements", which specifies the requirements for materials and construction of interior finishes, heating devices, electric equipment and its installation, means the fire alarm, fire extinguishing equipment, fire barrier designs, ensuring the safe evacuation of passengers in case of fire.

Studies have shown that the electric train underground "Neva" models 81-556, 81-557 and 81-558 compliant NPB 109-96 "Subway cars. Fire safety requirements.

Key words: *NPB 109-96, Subway cars, Fire safety requirements*

One important social facilities of the modern metropolis is the passenger transport system, the main element of which is underground. Many years of experience in operating subways as well as numerous studies have shown that the most dangerous scenario of a fire is a fire in the subway rolling stock at the station or in tunnel. In this case, it is crucial to establish the fact of fire and the location of the fire, to limit the spread of fire, evacuate people and organize firefighting.

Currently most of the rolling stock is outdated samples that generally do not meet modern fire safety requirements. The basic document defining the fire safety requirements for rolling stock subway is NPB 109-96 "Subway cars. Fire safety requirements", which specifies the requirements for materials and construction of interior finishes, heating devices, electric equipment and its installation, means the fire alarm, fire extinguishing equipment, fire barrier designs, ensuring the safe evacuation of passengers in case of fire.

Specialists of St-Petersburg venture "Vagonmash" and the Czech company "Skoda transportation" with the active participation of specialists from St-Petersburg subway and the "Kirov Plant" there was elaborated a subway train with asynchronous traction drive "NeVa". The train consists of six cars - two head, two intermediate and two trailer cars of the following modifications:

- A motorized cab control (G) (Model 81-556);
- Intermediate motor without control cabin (M) (model 81-557);
- Intermediate unpowered trailer (P) without cab control (model 81-558).

The basic scheme of the formation of the train: G + M + P + P + M + T. The design allows the train to change the basic scheme of formation up to 8 cars. Main technical characteristics of cars are given in Table 1.

Table 1 - Basic technical characteristics of cars

Model of car	81-556	81-557	81-558
Dimensions according to GOST 23961	"M"	"M"	"M"
Wagon tare weight, ie, not more than	29.5	28.5	21.5
The length of the car along coupler head, mm	19850	19210	19210
The height of the floor above the rail head, mm	1150	1150	1150
The height of the car from the rail head, mm	3655	3655	3655
The width of the door opening when the sliding door open, mm	1208	1208	1208
Number of seats, pcs.	42	48	48
Nominal capacity of passengers	174	188	188

In order to confirm compliance with the requirements of fire safety, specialists of VNIIPO (now called SRIPRITLS of St-Peterburg University of State Fire Service of EMERCOM) carried out in full the required testing and research in accordance with the requirements and procedures provided by NPB 109-96.

In particular, there were conducted fire tests of fire resistance of fire barrier design, including glazed end walls of the car, the partition between the cabin and the control and undercar space and the passenger compartment.

All tested structures withstood the test. Photos 1 and 2 show the layout of partitions after the fire test. In the course of the research there was also carried out test of operation of automatic fire alarm system, automatic fire extinguishing system verification using self-activated powder fire extinguishers, as well as check other requirements NPB 109-96 (in particular, tons REQUIREMENTS to ensure safe conditions for the evacuation of passengers, photo 3 - 8)). The tests carried out confirmed the existence and operability of required fire protection systems.

Photo 1 - Model of the end glazed partition after the fire tests on NPB 109-96 (photo V.O.Bulatov).

Photo 2 - Model of the partition between the cabin and the control after the fire tests on NPB 109-96 (photo V.O.Bulatov).

a) Monitor (A200) on the remote control, cabin control cars model 81-556. At the time of testing the system fire alarm (message on screen display "*** Fire *** on 2nd car 29.6.2012 10.17.43"

b) Information on the remote ASPS when testing the system fire alarm

Photo 3 - messages on the monitor (A200) on the remote control and the remote ASPS when testing the system fire alarm NeVa trains. (Photo V.O.Bulatov).

Photo 4 – Self-activated powder extinguisher OSP-1 and the “Fire detector” (IP101-V, located to the right of OSP-1) in the device compartment cab, cover is opened (photo V.O.Bulatov).

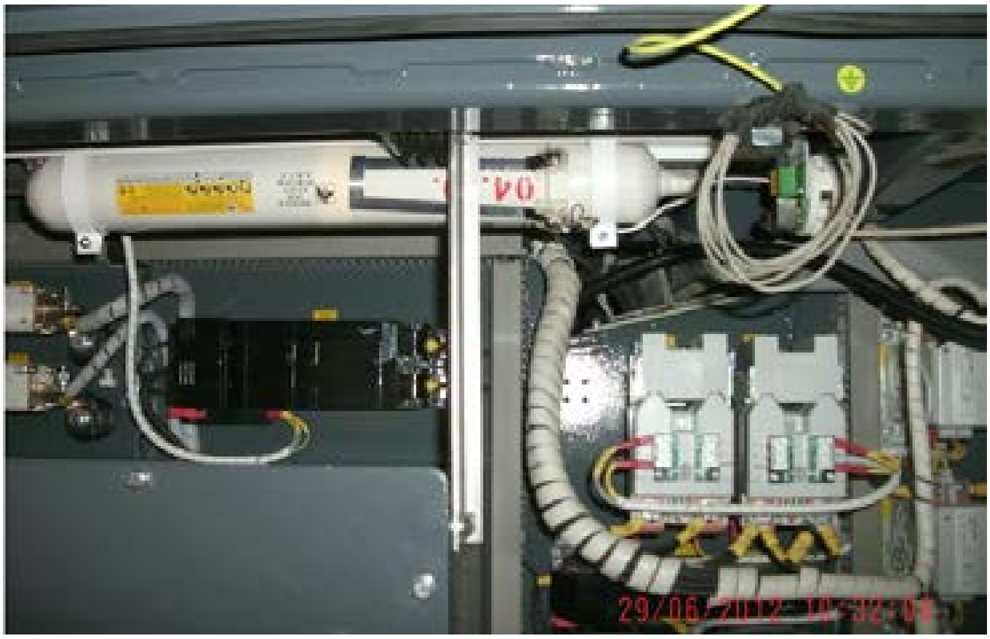

Photo 5 – Self-activated powder extinguisher OSP-1 and the «Fire detector» (IP101-V, located to the right of OSP-1) in the undercar space, cover is opened. (photo V.O.Bulatov).

Photo 6 – Passage through the train "NeVa" cars (photo V.O.Bulatov).

Photo 7 - Exit on concrete track through the door located in the cab of the train “Neva” (photo V.O.Bulatov).

Further calculations were carried of fire load on train cars. During the research it was determined that calculation weight for cars of model 81-556 is m_p = 26.48 kg / m ^{2}, and for the models 81-557 and 81-558 - m_p = 28.17 kg / m ^{2}, which does not exceed m $_p$ = 35 kg / m ^{2}, established by requirements NPB 109-96.

Additionally, over and above the requirements NPB 109-96 train “NeVa” is equipped with modern video surveillance system, both inside and outside the train. The system allows the operator to quickly get visual information about any car (passenger compartment and the cab), and also has the ability of video-recording to allow in emergency situations to reconstruct the course of events in detail.

Photo 8 - Video surveillance system of the train “NeVa”. (Photo V.O.Bulatov).

a) view of the control cab at the opposite end of the train

b) view of the passenger compartment

a) outer view

Studies have shown that the electric train underground "Neva" models 81-556, 81-557 and 81-558 compliant NPB 109-96 "Subway cars. Fire safety requirements. "

It should be noted that in the history of the subway this is the first unique experience pf conducting a comprehensive study of all systems of metro cars for compliance with fire safety requirements.

Literature

1. NPB 109-96 "Subway cars. Fire safety requirements. "

SOME ACTUAL PROBLEMS OF STUDYING THE EXPERIENCE OF ELIMINATION OF LARGE-SCALE EMERGENCIES IN NETWORKING COOPERATION BETWEEN HIGHER EDUCATIONAL INSTITUTIONS OF EMERCOM OF RUSSIA

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Some aspects of networking cooperation using by the study of experience of elimination the consequences of large-scale emergencies in the educational process are considered шn this article.

Key words: *large-scale emergencies, networking cooperation, natural disaster*

Now an important aspect of improving the training of professionals is network cooperation in education. According to E.N. Glubokova it is a horizontal cooperation between educational institutions to extend the functionality and resources [1]. In this case, network communication is becoming a highly innovative technology that allows educational institutions to develop dynamically.

It is important that networking cooperation is happening not only because of the spread of innovations, but also due to the dialogue between educational institutions and experience exchanging, the reflexion of processes that take place in the education system as a whole [2]. In the E.N. Glubokova opinion, the primary element of networking cooperation is the precedent of interaction, network event (project, seminar, meeting, information exchange, etc.) [1].

Our analysis shows that for the staff training of the EMERCOM of Russia adequate to modern requirements, is important to organize the networking cooperation between the higher education institutions EMERCOM of Russia. At the same time that important information, that being the content of such cooperation, is proposed to be the experience of elimination of large-scale emergencies.

The necessity of scientific comprehension and practical usage of the elimination of large-scale emergencies in the network cooperation between higher educational institutions of EMERCOM of Russia is due to measures taken by the state and the Ministry to improve the response to such emergencies.

In 2013, the Far East regions of Russia have suffered from the flood, the strongest in the last 115 years. Considerable part of population was in the zone of serious flooding in the Far Eastern Federal District. Flood affected more than 183 thousand people.

It was necessary to mobilize in a short time forces and resources of EMERCOM, the Defense Ministry, the Interior Ministry, several other departments to eliminate this large-scale emergency. Several tens of thousands of EMERCOM employees were rescuing people from the disaster. Rescuers has shown the high professional skills, active civic position, performing their duties honestly.

The analysis of the staff training of EMERCOM of Russia shows that the participating experience in the elimination of large-scale emergencies is not fully used in the educational process in higher education institutions EMERCOM of Russia. The analysis of media publications and practices of educational institutions shows that in the educational process in higher education institutions presents the underestimation of the importance of network cooperation between higher education institutions for studying and exchanging of experience of emergencies elimination.

The use of the experience of emergencies elimination of emergency emergencies by staff training of EMERCOM of Russia relies heavily on empirical observations and personal opinions and is not able to provide the required level for the staff training in higher education institutions EMERCOM of Russia.

The professional experience, the process of its formation and its usage are studied in books by E.Y. Artynov, A.K.Markov, V.F. Petrenko, K.K. Platonov, V.F. Serkin, S.D. Smirnov, J.K. Strelkov, G.V. Sukhodolskiy, N.A. Holodnaya, A.G. Shmelyoff.

However, the problem of studying the experience of eliminating the consequences of large-scale emergencies through the implementation of opportunities for networking cooperation between higher education institutions of EMERCOM of Russia in pedagogy has not been investigated. There are no specific recommendations for the usage of such cooperation in the educational process.
Taking into consideration such circumstances it is possible to conclude about the need for active and purposeful usage of opportunities for networking cooperation between higher educational institutions and other institutions and organizations of EMERCOM of Russia to study the experience of unit commanders, university trainers and other participants of elimination of emergency situations.

Thus, there is the necessity of pedagogical science and practice in the study of issues of networking cooperation between higher education institutions of EMERCOM of Russia as a pedagogical conditions of perfection of studying the experience of elimination of emergency situations in training employees EMERCOM of Russia.

Here we propose to consider the experience of elimination of emergency situations as a complex psychological formation, that has a significant influence on the development of professionalism of employees of EMERCOM of Russia during their training process.

The experience of elimination of emergency situations is a special form, a kind of professional experience of specialists and is expressed in the aggregate of special knowledge, skills, abilities in action by emergency situations presented in three areas of personality: motivational, cognitive, behavioral.

Representations about the cognitive structure of individual experience, in which occur the processes of fixing and rebuilding the image of outside activities can serve as the basis of using the experience of elimination of large-scale emergencies in the training and education of employees EMERCOM of Russia.

The establishing of networking cooperation between higher educational institutions of EMERCOM of Russia corresponds to "calls" of information society, determining trends in the development of the education system. In the course of such interaction by studying the experience of elimination of emergency situations professional competence of students forming, improving professional skills of employees, experience of teachers, commanders, officers, employees and departments, becomes property of students in educational institutions and professional community, raises quality of training of staff of EMERCOM of Russia.

On networking cooperation in the system of higher educational institutions of EMERCOM of Russia in the study of experience of elimination of emergency situations should include a resource center and unified database. As such center may act the St. Petersburg University of the State Fire Service Emercom of Russia, given the fact that in this university are serving and learn direct participants of the elimination of large-scale emergencies.

It should also be noted that the study of the experience of liquidation of large-scale emergency situations at network cooperation between higher educational institutions contributes to the process of adaptation of university graduates to the dynamics of changes in the professional field, and for the participants of emergency elimination promotes professional fulfillment.

Accordingly, the usage of the experience of liquidation of large-scale emergencies in the networking cooperation between higher educational institutions EMERCOM of Russia can be represented as a pedagogical process of infocommunicational exchange by psychological courses of action in emergencies, ensuring sustainable and successful reproduction of professional activity in large-scale emergencies.

Networking cooperation between educational institutions, departments and organizations of EMERCOM of Russia should be considered as an important pedagogical conditions of training, education, psychological training, performance of duty, personal and professional development of direct participation by the EMERCOM employees.

The accumulation of experience in the training and duty can be viewed as the process of developing semantic components of professional consciousness employee of EMERCOM of Russia, ensuring the creation of a kind of "archetypes" of professional activity and their subsequent filling of the experience of qualified specialists from the immediate environment.

Thus, our analysis suggests to allocate that studying the experience of liquidation of consequences of large-scale emergency situations in the networking cooperation between higher educational institutions of EMERCOM of Russia as an important pedagogical condition of formation of professional competence of of university graduates EMERCOM of Russia.

REFERENCES

[1] Glubokova E.N. Setevoe vzaimodeystvie v sfere obrazovaniya kak razvivayuschiysya protsess v teorii i praktike // http://kafedra-forum.narod.ru/index/0-39
[2] Setevoe vzaimodeystvie innovatsionnyih obrazovatelnyih uchrezhdeniy // http://wiki.saripkro.ru/index.php

MUTUAL MANDATORY INSURANCE IN RUSSIAN HISTORY

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This article considers law aspects of mutual mandatory insurance in Russian history.

Key words: *rmutual land insurance, mandatory insurance, fire insurance, mutual insurance, mutual insurance companies*

Creation of mutual insurance companies was a significant step in the formation of the All-Russian insurance market in the second half of the XIX century. It was a serious competition to stock insurers, who established a monopoly dictate of prices for insurance services in order to profit from insurance operations, which was their main activity.

Mutual societies did not bear the cost for staff and multiple agents maintaining, that means they were able to significantly lower the insurance rates or to use a part of the raised funds for preventing insurance claims under the same payments to victims. These benefits especially increased with the introduction of mandatory insurance. The decree of Alexander II of 10 October 1861 on the establishment of urban mutual insurance companies initiated the mutual fire insurance. The emperor said in the decree: "After explaining the favor of mutual fire insurance of property and various systems of the insurance to homeowners of the cities, suburbs and towns then offer them, if they do not wish to establish a mutual insurance companies." Some mutual companies reproduce this phrase of the emperor at its policies.

The St. Petersburg mutual fire insurance company began to operate in 1862, and about a year later – the Moscow one [1]. During the period from 1863 to 1918 there were established more than 220 urban mutual fire insurance companies. The feature of these insurance institutions was not only the principle of reciprocity, but also the insurance area limitations in certain city. Due to the fact that the city mutual fire insurance companies were established on a voluntary basis, many companies started out with great difficulty, and the volume of insurance operations were minor for many of them. However, the companies, which managed to attract a large number of insurers had the opportunity not only reduce the amount of insurance premium, but even issue free, so-called, gifts policies at the adequacy of insurance capital accumulation....

The district councils laid foundation of a more solid basis and broad dissemination of mutual companies.

Royally approved on April 7, 1864 "The regulations on district council mutual insurance" was the beginning of mandatory fire insurance in the Russian Empire for all rural buildings, both private and public, which were within the boundaries of the peasant settlements.

District council mutual fire insurance was carried provincial council, which were not insurance institutions. Rural buildings were the subject to the accountant mandatory insurance in an amount not exceeding 75% of the structure cost. In addition to the accountant, there was an additional insurance, allowing farmers to insure their home ownerships in the total cost. District council was allowed to insure structures on a voluntary basis. District council insurance also was limited by the territory, district council had the insurance right only in its province.

Mutual insurance was very common in pre-revolutionary Russia and had a significant part of more than 1/3 of the domestic fire insurance market. Mutual-share private insurance companies existed in Russia besides mutual suburban and urban fire insurance. Mutual societies were created by the manufacturers for insurance of industry, factory and agricultural risks, which reluctantly accepted by insurance joint-stock companies. The impetus for the creation of these companies was the factor of the high cost of insurance in the joint-stock companies.

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The main difference between the mutual form of insurance against the shareholder is a non-profit principle of company creation, there was no need for dividend payments and it has the minimum cost for staff and business management. Mutual insurance companies directed income from insurance operations to the formation of reserve capital and fire prevention measures [2].

The vast majority of policyholders were homeowners. Then the industrial risk insurance began to develop. The activity of mutual insurance companies covered almost the whole of Russia to the end of the XIX century. However, the main problem for it was insignificant insurance field, which causes instability of operations. In this case, joint companies refused to enter into reinsurance relationship with mutual companies. This fact prompted the companies to create their own unions to stabilize the fire insurance operations with secondary risk redistribution among its participants.

Penza union of mutual fire insurance companies began operating on 1 July 1890, which was transformed into the Russian union of mutual fire insurance companies in 1909. The work of joint insurance companies in the Russian Empire before the 1890s was based on the Provision of the joint commercial and industrial companies, adopted by the State Council[3].

The state supervision over the insurance business was created in 1894 in Russia due to the significant increase of the number of private insurance companies, in accordance with the Regulation on the supervision of insurance institutions and companies. In the economic department of Ministry of Internal Affairs was created the Insurance Committee for the supervision of insurance institutions and companies in accordance with the Regulation on the supervision of insurance institutions and companies. The duties of this committee were to oversee the provincial mutual insurance, mutual insurance companies in cities, as well as for Russian or foreign joint insurance company or mutual insurance companies. Insurance Committee considered the draft statutes and polis insurance conditions, monitored the financial activities of insurance companies, considered the reports, balance sheets and statistical records that insurance companies were required to report annually to the Committee. 1 Rural insurance automatically came under the supervision. All these measures have strengthened the insurance system of the country, gave impetus to its further development.

By the end of the XIX century in the Russian Empire there was a system of insurance in the Russian and foreign joint insurance companies, city and county mutual insurance companies and government insurance (pension funds) for the miners, railway men and agriculture in provinces. Insurance business was developing. For example, in 1913 the property for the amount of 21 billion rubles was insured in all insurance institutions in Russia[4].

The provisions of statutes and rules on the various types of insurance, insurers developed at that time still have not lost relevance and it is still fundamental in similar documents of modern insurance business. In other words, the basis of external and internal business workflow of insurance organizations was formed in the XIX century. It is surprising that tradition of voluntary published annual reports in the media implicit by insurance companies in the XIX century now it is the responsibility of today's insurers in accordance with the requirements of the law "On the organization of insurance business in the Russian Federation." Insurance issues were widely reported in the press: headings or application for insurance business existed in business publications, there were produced a number of specialized magazines such as "Strakhovye vedomosti", "Strakhovoe obozrenie", "Russkiy vestnik strakhovaniya."

In the early days of the establishment of Soviet government in October 1917 the nationalizing of banks began but insurance companies continued to operate in a variety of legal forms, because V.I. Lenin and the Commissioner for Insurance, M.T. Elizarov defended the need to maintain the system of insurance existed before the revolution and considered nationalization of the insurance business as premature. In March 1918 the government was even given instruction to stop unauthorized actions against insurance companies and county insurance companies. However, on November 28, 1918, People's Commissars adopted a decree "On organization of insurance business in the Russian republic." According to this decree insurance holding in all forms and types declared as a state monopoly. All private insure companies were eliminated and their property was nationalized[5].

State monopoly ceased in 1988 with the adoption of the Law of the USSR "On Cooperation", which provided an opportunity to co-operatives to insure property and other property interests in public insurance companies, and to create cooperative insurance institutions[5].

Then a number of legislative acts were adopted, that accelerate the process of de-monopolization of insurance in Russia. The decision of the Council of Ministers on August 16, 1990 N 835 “On measures for de-monopolization of the economy,” found that competing state, stock, mutual and co-operative companies can operate at the insurance market.

Thus, in the late 80’s - early 90-ies of XX century the state monopoly on insurance business was eliminated.

In the 80’s the conditions of mutual and voluntary insurance of property of citizens and cooperation, mandatory insurance of passengers were significantly improved, new types of personal and property insurance were implemented. Also the gradual spread of insurance on the property of state facilities began, introduced voluntary insurance of this property was implemented[6].

REFERENCES

[1] S.V. Ermasov, N.B. Ermasova. Strakhovanie: uchebnik/ S.V. Ermasov, N.B. Ermasova. - 2-nd izd., pererab. i dop. – M.: Vysshee obrazovanie, 2008. – 613 p.

[2] .V. Moiseenko. Preemstvennost traditsii rossiiskokgo strakhovogo dela– ot manifesta Ekateriny Velikoi do nashikh dnei / Strakhovoi rynok Rossiiskoi Federatsii v usloviyakh vstuplenia v VTO: sostoyanie i perspektivy razvitiya: materialy Mezhdunarodnoi nauchno-prakticheskoi konferencii (5 – 7 iyunya 2012 g., Nizhnii Novgorod) / gl. red. V.I. Mineev, otv. red. O.L. Domnina, E.V. Zlobin; VGAVT, ROSGOSSTRAKH. – Nizhnii Novgorod, 2012. – 653 p.

[3] .I. Railyan. O nachalakh pravovogo regulirovaniya strakhovogo dela v Rossiiskoi Imperii. / Vestnik finansovoi akademii– Moskva– №3, 2007. – 100-104 p.

[4] .Y. Gracheva, O.V. Boltinova Pravovye osnovy strakhovaniya. Uchebnoe posobie / E.Y. Gracheva, O.V. Boltinova – M.: Prospekt, 2011. – 128 p

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[1] Willis BA, Mineral Processing Technology, Oxford, Perganom Press, 1979, p. 35 *(for the chapter in the book)*

[2] Ernst, *Research Policy*, 30 (2001) 143-157 *(for the article in the magazine)*

[3] http://www.vanguard.edu/psychology/apa.pdf (retrieval date) *(for web content)*

[4] Regulation on the mode and procedure of risk assessment in the workplace and in the work environment ("Official Gazette of RS". No. 72/06, 84/06 and 30/10) *(for the document without the author)*

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