[1.]Aleksandar MAJSTOROVIĆ, [2.]Mladen TODIĆ, [3.]Predrag ILIĆ,
[4.]Ljiljana ERIĆ, [5.]Dijana VUKAJLOVIĆ, [6.]Branka ĆULIBRK

THE IMPACT OF ENVIRONMENTAL PARAMETERS AND MAINTENANCE ON THE COMPRESSED MEDICAL AIR QUALITY

[1.]City Hall, Dep. for Civil Protection & Professional Territorial Fire Brigades, Banja Luka, BOSNIA & HERZEGOVINA
[2.]University in Banja Luka, Faculty of Mechanical Engineering, Banja Luka, BOSNIA & HERZEGOVINA
[3,4.]PSI Institute for Protection and Ecology of the Republic of Srpska, Banja Luka, BOSNIA & HERZEGOVINA
[5,6.] Institute of Public Health of Republika Srpska, Banja Luka, BOSNIA & HERZEGOVINA

Abstract: Compressed medical air[1] must meet certain criteria defined by European standard EN 12021[2], it shouldn't have any flavours or smell (odour). During filling bottle of breathing apparatus cylinders, it should be taken into account that vehicle exhaust gases, vapours of hazardous liquids, smoke and other harmful substances are not in the vicinity of the suction pipe cause they may get inside the cylinder of breathing apparatus and with their presence disrupt the microclimate (strictly defined parameters of medical air) and directly endanger the user. This isn't the case with cylinders which are the subject of this research. However, with physical-chemical and microbiological results samples of CMA, it can be said with responsibility that the user of the bottle / cylinder for the isulation devices did not comply the above when charging them with the CMA nor did it replace the filters of the high-pressure compressor in accordance with the manufacturer's instructions. This directly threatened his own health, but also the health of other users. Irresponsibility in maintain compressors of high-pressure, brought to creation of gram-positive bacterias and mildews as well as strain of pathogenic bacterias in CMA inside of the bottle/cylinder. The metabolism of the bacterias inside of the bottle/cylinder also reflected on the physical-chemical characteristics of CMA.
Keywords: EN 12021, environment, maintain, security, health

1. INTRODUCTION

Using the breathing apparatus, a user is completely isolated from the atmosphere environment, as well as from the affecting of contaminated atmosphere. They are used in the environments with the lower concentration of oxygen in the air, or where concentration of toxic gases are over permitted limits etc. in the fire.

As it was mentioned in the previous chapters, users of breathing apparatus are completely isolated from external factors, so that during this isolation they are placed in a specific working environment in which they are exposed to specific microclimate conditions.

It is obligatory before immediate cylinder filling to be sure about not smoking in the vicinity of the suction port of the compressor and pre-filter of the compressor; not using volatile, irritant and aggressive substances such as thinner or other solvents, and also not to burn a fire or other vehicles.

In this way a majority of hazardous substances which can reach the inside part of the cylinders of breathing apparatus can be eliminated and as such can harm the quality of compressed medical air in them. Also, if it is possible, it is necessary to avoid filling the bottles of breathing apparatus at very low temperatures and high air pollution concentration.

Occurrence of non-pathogenic microorganisms in compressed medical air can be caused by inadequate and replacement of compressor filters. If these filters have not been changed according to manufacturers' advice, then they represent a convenient surrounding for microorganism development. The inside part of the filter possesses humidity and is protected from sunlight so all conditions for life and microorganisms are filled.

The quality of the compressed medical air, which is used in breathing apparatus (SCBA), and also in diving apparatus (SCUBA), is regulated by the European standard EN 12021 (t. 1).[18]

The breathing process depends on the percentage of moisture in the air (regulates physical stress) and on condensation and freezing during the use and storage as well.

Particular attention should be paid to the maintenance and regular servicing of compressors and breathing apparatus, which eliminate the sudden appearance of a system failure.[17]

[1] Compressed medical air - fully filtered air from various impurities and larger particles, ready for use (in hospitals, insulating appliances).
[2] EN12021 – European Standard for compressed medical air.

Table 1. The Composition of medical air according to: [18]

Composition of compressed medical air	JUS standard	dr Gošović	Bauer	EN 12021
Oxygen O_2	20-21 %	20-22 %	20-21 %	20-22 %
Moisture	50 mg/m^3	No limit	30 mg/m^3	200 bars 50 mg/m^3
				300 bars 35 mg/m^3
Carbon monoxide CO	0.001 % (10 ppm)	0.001 % (10 ppm)	0.001 % (10 ppm)	5 mg/m^3
Carbon dioxide CO_2	0.05 % (500 ppm)	0.05 % (500 ppm)	0.04 % (400 ppm)	500 mg/m^3
Oil vapours	0.3 mg/m^3	0.5 mg/m^3	0.25 mg/m^3	0,5 mg/m^3

According to an „unwritten rule", i.e. according to internal agreement within fire units (professional, territorial, industrial) and voluntary fire departments, CMA in cylinders is replaced every 3 months, 6 months, one year because there is no manual which strictly defines the time when the air should be replaced in cylinders.
Usually the air in cylinders is replaced according to „individual judgment" i.e. after smelling „unpleasant odour" during control emission of air from a cylinder.
That indicates that there have been some changes in the quality of air inside the cylinder with the compressed air.[17, 18]

2. GETTING OF COMPRESSED MEDICAL AIR

During the compression of medical air in medical air compressors, the air from the surrounding area must go through the system of filters where the extraction of dust and larger particles of dust, micronic dust, oil and water vapours (a result of lubrication, abrasion and high pressure compaction) micronic particles of oil and water, take place and therefore, at the end of its cycle the air goes through the chemical procedure of removing excess moisture and other harmful additives. The last cycle takes place in the filter cartridges which have limited lifetime and which ought to be replaced regularly because they cannot fully filter harmful components from air because of saturation. Non-pathogenic and pathogenic microorganisms and also moulds can, of course, occur in these filter cartridges (and in other filters too) due to improper use and servicing and because of the presence of moisture. Due to too high concentration of harmful components of air and the mentioned microorganisms, user's health is directly endangered.[17, 18]

3. ANOTHER SECTION OF YOUR PAPER

Taking into account the above mentioned, when examining the bottles/cylinders of the isolation devices that are the subject of this research, a very unpleasant odor was observed when releasing the CMA from it into the environment. The unpleasant smell was an indicator of the physical-chemical and microbiological process that took place in the interior of these three bottles / cylinders during six months, with the presence of high pressure (300 bar), which was proved by analyzes of the samples taken.
By collecting information from the user, it has become apparent that the user has not adhered to the above-mentioned instructions when filling the bottles/cylinders, as well as the instructions from the manufacturer of the compressor for the regular replacement of oils and filters on the high pressure compressor.
The subject of this study was three semi-composite bottles/cylinders, of which samples were taken from one bottle only, while in the others the substitutions of medical oxygen and CMA were compared with the bottle / cylinder from which the samples were taken.

Figure 1. Physical-chemical sampling.

Figure 2. Microbiological sampling.

Physical-chemical (Figure 1) and microbiological (Figure 2) sampling were performed in the following ways:

— After the first sampling, complete contents of the bottles / cylinders that were the subject of environmental research were dropped and then the interior of the bottles filled 99-99.5% with medical oxygen. It is known

that 99 ÷ 99.5% of medical oxygen destroys the microorganisms, but also the tissues of living organisms if their exposure is higher.

— After the second sampling, complete contents of the bottle / cylinder (99 ÷ 99.5% medical oxygen) were dropped, which were the subject of environmental research and then filled with CMA at the Banja Luka Fire Brigade Station.

— The third sample for physical-chemical and microbiological analysis was taken immediately after filling CMA at the Compression Station of the Fire Brigade Banja Luka.

≡ PHYSICAL-CHEMICAL ANALYSIS OF CMA

The physical-chemical analysis of compressed medical air was performed using the Gasmet DX-4030, and the results obtained were reported at the Institute for Protection and Ecology of Republic of Srpska in Banja Luka.

Table 2. Results of physico-chemical analysis of CMA

Substance name	Allowed value		Measured values (ppm)		
	ppm	mg/m^3	12.03.2018	13.03.2018	16.03.2018
Carbon dioxide (A)			8,45	35,87	103,6
Carbon monoxide	50	55	2,02	16,79	1,88
Azot-Suboxide (A)	-	-	-	1,65	0,21
Methane (A)			7,14	2,12	0,94
Nitrogen dioxide	1	2	**2,41**	**32,05**	**3,66**
Sulfur oxide (S)	2	5	0,15	3,78	0,02
Acetaldehyde	50	90	0,31	3,78	1,26
Acetone	244	590	-	5,34	0,51
Formaldehyde (C, K, F)	1.2	1.5	**5,79**	3,06	0,18
Benzene (C)	1	3	**14,62**	0,62	0,58
Toluene (K)	100	375	8,85	2,10	1,48
M-xylene (K)	100	435	2,38	3,25	0,31
Isopropanol	400	980	2,05	1,61	0,07
Ammonia (S)	25	18	1,10	0,71	0,69
Acrolein (S)	0.1	0.25	**5,95**	**7,36**	**4,49**
Ethyl acetate	400	1400	1,20	0,67	0,54
Phenol (K)	5	19	1,39	1,02	1,71
Pyridine (K)	5	15	0,52	11,01	1,20
Carbonate sulfide (K)	10	30	9,93	3,07	0,36
Trichlorethylene (K)	25	130	2,58	0,75	0,24
Stiren (K, S)	50	215	1,76	1,73	0,98
Hydrochloric acid (C)	5	7	-	**7,19**	0,85
Methanol (I)	200	260	0,228	1,47	1,21
Ethanol	1000	1900	2,346	-	0,79

- A - the substance is not toxic and MPC[3] is not established for it, but its presence in large quantities can cause choking.
- C - the substance in which the carcinogenic effect is only proven in animals.
- K - the property of matter to absorb through the skin.
- S - a substance that makes a person sensitive and irritable.

By inspecting the obtained results, it can be stated that:

— First sampling of increased concentrations of azotidoxide, formaldehyde, benzene and acrolein above the permissible limits that may have been introduced into the interior of the bottle/cylinder from the environment or resulted from the direct consequence of non-use of adequate oil for high pressure compressors or by non-compliance with the replacement term of it according to the manufacturer's recommendation.

— Second sampling of increased concentrations of azotoxide and acroeline (even in relation to the first sample) as well as hydrogen chloride above the permissible limits, although the inside of the bottle / cylinder was filled with 99 to 99.5% of the medical oxygen.

— Third sampling of increased concentrations of azotin and acrolein, which can be related to low temperatures, so there was an increased need for heating, resulting in an increase of these two components above the permissible limits in CMA coming from the environment.

The results obtained, for easier comparison, can also be shown using the diagram.

[3] MPC – maximum permissible concentration.

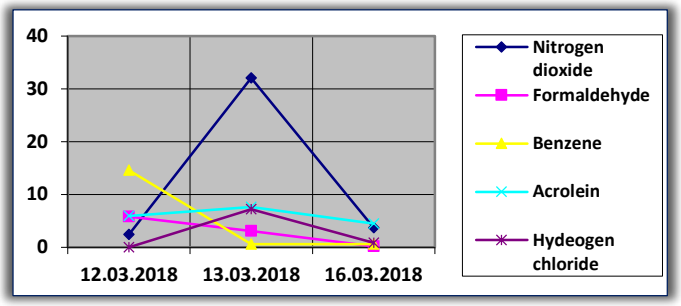

Diagram 1. Increased concentration of individual components in CMA

— Nitrogen dioxide NO2 – is a brownish-black coloured gas, which becomes colourless when is cooled and is very toxic. Easily releases oxygen, which acts as a strong oxidizing agent and generates explosive mixtures with many gases and organic matters where the main component is of "acid rain".

— Formaldehyde HCHO – is a clear, very weak, easy evaporable acid of strong odour, very toxic. It is irritant to the mucous membrane of eyes and upper respiratory tract. There are inflammable processes after a longer exposure. When swallowing this liquid, symptoms similar to acid intoxication occur such as sore throat, stomach pain, cramps, vomiting, and in serious cases it could be fatal. It is produced by oxidation of methyl alcohol and is used for getting many organic compounds, synthetic resins in leather industry, alimentary industry and in medicine (as a disinfectant).

— Benzene C6H6 – is a colourless, easy evaporated and flammable liquid with pleasant smell, very toxic and irritates the skin. Poisoning can be acute and chronic. The acute poisoning is manifested as the narcotic state of slight intoxication, headache, dizziness, muscle spasm, loss of consciousness, and can cause death in severe cases. Chronic poisoning is mainly industrial, since benzene affects the bone marrow causing anaemia, profuse bleeding and death. It is produced in a dry distillation of coal in coke ovens, and is used as a solvent for oils, fats, waxes and obtaining other compounds (nitrobenzene, aniline, phenol, detergents and DDT).

— Acrolein CH2-CHCHO – is a colourless, yellowish liquid with a piercing, disagreeable, acrid smell, very toxic and dangerous. Above the liquid surface, a highly-flammable explosive and toxic vapour are formed which react with oxidants. It irritates eyes and upper airways. It can cause severe burns on eyes, while if inhaled in large quantities, it can cause upper airways and lungs damage. It is produced by heating saturated and animal fats at high temperatures and is applicable in the artificial resin industry.

— Hydrogen chloride HCl (hydrochloric acid) – is a colourless or light yellow non-flammable liquid, which smokes in the air and is very toxic. Its presence may be the cause of many dangers. When it comes in contact with various metals it leads to development of flammable and explosive hydrogen. Vapours of this acid are harmful for a human organism. Skin exposure to it may have resulted in severe burns. Hydrochloric acid is produced by synthesis of hydrogen chloride and water. It is used in the paint and paper industry, metallurgy etc.[14]

≡ MICROBIOLOGICAL ANALYSIS OF CMA

As one of the elements of life and work environment, air does not have its microbial flora and fauna because it represents a very unpleasant environment for life and growth of microorganisms. However, a large number of microorganisms are transmitted over air, which can cause various diseases in people, animals or plants. Microorganisms cannot be cultivated in air and its environment because they decay relatively soon while their existence depends on characteristics, temperature and moisture of air.

With bacteriological control of air, information is collected regarding state and distribution of potential agents, revealing their identity in people's living and inanimate environment. These analyses can be conducted on a regular basis (in health institutions, pharmaceutical and alimentary factories) and occasionally (depending on epidemiologic situation).

The samples of air for analysis can be taken in various ways. During the preparation of medical air samples from BA cylinders, a method of directing certain amount of air with air intake on the surface of Petri cup with universal pad (picture 1) without inhibitors or indicators was used for cultivation of a large number of microorganisms. [17]

The microbiological analysis of compressed medical air was carried out using Air IDEAL air sampling units at a constant flow of CMA in the amount of 50 l / min, and the obtained results from the Petri Dish were processed and read out at the Public Health Institute of Republic of Srpska in Banja Luka.

The microorganisms found in the samples of medical air are ubiquitous , and their concentration in air was specified after counting and reading table for reading CFU which were delivered together with the mentioned above measuring equipment.[17]

Table 2. Results of physico-chemical analysis of CMA

Date of sampling	Total number of colonies (cfu)	The most probable number of bacteria in m^3	Isolated microorganisms
05.03.2018	10	203	Staphylococcus aureus, Kocuria rhizophila, Gram pozitiv bacterias and mould
13.03.2018	23	480	Gram pozitiv bacterias and mould Dermacoccus nishinomiyaensis Granulicatella adiacens Kocuria rosea
26.03.2018	3	60	Kocuria rosea Gram pozitiv bacterias and mould

In CMA samples, the following non-pathogenic Gram positive microorganisms were isolated: Rhizophila Kocuria, Dermacoccus nishinomiyaensis, Granulicatella adiacens, Kocuria rosea and mold, and one pathogenic microorganism-Staphylococcus aureus. The obtained results, for easier comparison, can also be displayed using a diagram.

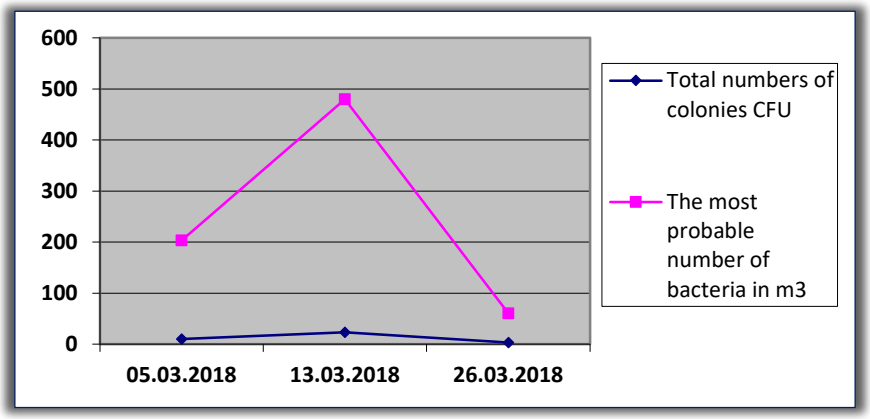

Diagram 2. Increased concentrations of individual components in CMA

— Kocuria rhizophila belongs to the genus Kocuria (family of Micrococcaceae, micro-coccineae subunit, Order of Actinomycetales). It is Gram-positive aerobic cocci catalase positive and urease positive. It belongs to saprophytes. It is best grown at a temperature of 37°C for 48 h. [5]

It is found in soil, dust, water and air, it is part of the normal mammalian skin flora. This bacterium is located in the mouth, mucous membranes and upper respiratory tract, the coagulase is negative, sensitive to bacitracin, and forms a light yellow colony on a nutrient agar. [11]

It is known as Micrococcus luteus, but in 2003 it was reclassified as Kocuria rhizophila. [9]

— Dermacoccus nishinomiyaensis belongs to the genus Dermacoccus and the Dermacoccaceae family. [8] It belongs to saprophytes. It is Gram-positive aerobic cocci, catalase positive and oxidase positive. The optimum growth temperature is 25-37°C. It forms a light-orange colony on a nutrient agar. Dermacoccus nishinomiyaensi is isolated from the skin of mammals and from water. It once belonged to a species of the genus Micrococcus and has little medical significance. [19, 20]

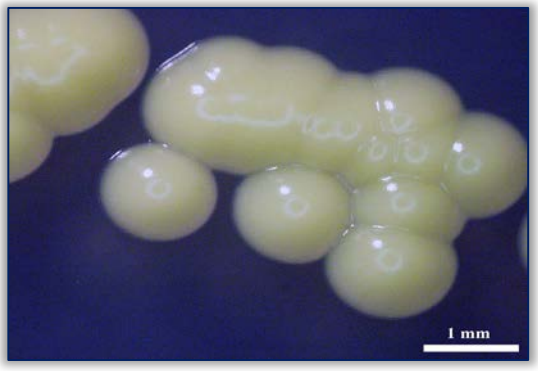

Figure 3. Colonies of bacteria rhizophila Kocuria

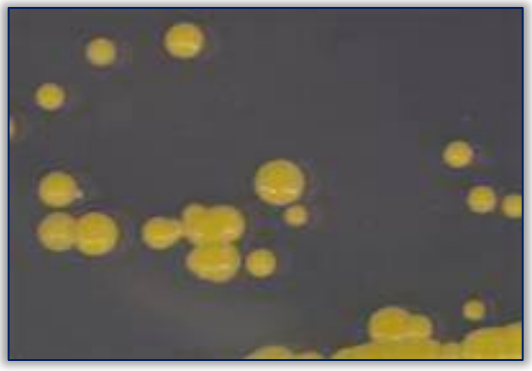

Figure 4. Colony of bacteria Dermacoccus nishinomiyaensis

Granulicatella adiacens are Gram positive bacteria, morphologically similar to streptococci. Sometimes it appears as a cocci, coccobacilli or cells arranged in a chain shape. Cellular morphology depends on growth conditions. [3]

For these types of microorganisms it is known to cause infections in humans and organisms that have developed bloodstream. [7]

Genus Granulicatella is an integral part of the flora of the upper respiratory, gastrointestinal and urogenital tract of humans. Normal flora means microorganisms located in a certain part of the body, which under normal conditions will not cause infection. Granulicatella adiacens was earlier belonging to the genus Abiotrophia. The word "Abiotrophia" in translation means nutritional deficiency. [2] Granulicatella adiacens is found in the oral cavity, intestines and urogenital tract of humans [4]. In these parts of the body it causes endovascular, central nervous system, eye, urogenital tract and bone joints system infection, associated with diseases such as endocarditis, bacteremia and septic arthritis. [2]

— Kocuria rosea belongs to the genus Kocuria (family Micrococcaceae, suborder Micrococcineae, Actinomycetales order). It belongs to saprophytes. This is Gram positive aerobic cocci, positive catalase and oxidase positive. Kocuria rosea best grows at 25-37°C. It is widespread in nature, it is most commonly associated with coagulant-negative Staphylococcus spp on human and mammalia skin. [15] It causes an infection of immune-compromised persons. [4]

Kocuria rosea is capable of biodegrading malachite green, azo dyes, triphenylmethane, as well as some other industrial colors. [6] It has also been found to have the ability to hydrolyze keratin through the production of keratinase. [1]

— Staphylococci areus gram-positive bacteria in the form of ball, which are clustered in the form of clusters or flocks. They do not have flagels, they are porous and are classified among optional anaerobic bacteria. The production of catalase is a biochemical characteristic of all staphylococci. The Staphylococcus genus includes 32 species and subspecies, of which the most prominent causes of the disease are S. aureus, S. epidermidis and S. saprophyticus. Most species reproduce at a temperature of 6-40°C, the optimum is between 30-37°C. They tolerate high concentrations of NaCl, and grow and multiply at pH = 4.2-9.3.

Genus Staphylococcus belongs to the family Micrococcacea. Staphylococci are Gram positive, immobile, optional anaerobic cocci. They grow well on all substrates and they are not choosy. In liquid media, they cause diffuse blur. On solid substrates, they form round, smooth, shiny colonies from white to golden-yellow. They grow on substrates with high concentrations of NaCl 7.5-10%. Most species reproduce at a temperature of 6-40˚C, the optimum is between 30-37˚C. [16]

Staphylococcus aureus can cause damage to almost all organs and tissues of the human organism due to the synthesis of a large number of exoproduct and the possession of structural elements that all together, directly or indirectly, increase virulence. Although the effect of invasive and toxic substances cannot be separated completely, in some diseases the dominant share in the development of clinical picture has certain toxins. Therefore, the disease caused by S. aureus can be divided into toxemic and suppurative. Among the toxemic are: staphylococcal food poisoning, scalded skin syndrome and toxic shock syndrome. The second group consists of diseases in which the staphylococcus is directly present in a region of skin infection, respiratory tract infections, urogenital tract infection, sinusitis, osteomyelitis, septic arthritis, endocarditis, septicemia, and other. Staphylococcus aureus is one of the most common causes of food intoxication. It is found in dust, air, water, food, various objects, equipment and clothing. About 50% of the human population has Staphylococcus aureus in the composition of normal microflora of respiratory organs and skin.

Staphylococcus aureus synthesizes several different toxins, some of which are very dangerous to human and animal health.[12, 13]

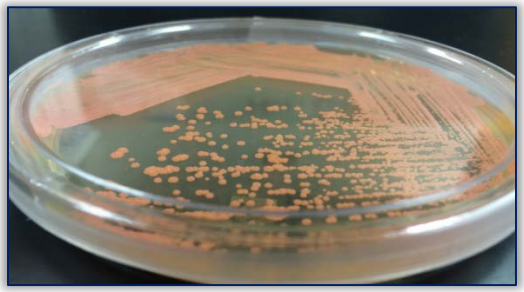

Figure 5. Colony of bacteria Kocuria rosea

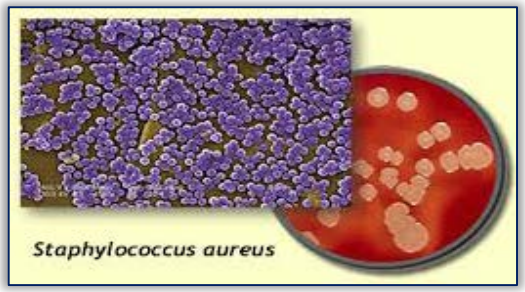

Figure 6. Colonies of Staphylococcus aureus bacteria

— Mould is a microscopic fungus that grows in the form of hyphae which have been mutually connected forming a mycelium .The mould mycelium secrets hydrolytic enzymes which decomposes organic compounds in simple sugar. The excreted substances have been preparing food for fungi absorbed by the hyphae. Depending on the spores, there are various colours of moulds like red, yellow, green etc. Moulds are constantly in struggle with bacteria, struggling for survival, they secrete substances that are poisonous for bacteria, and they are called antibiotics.

Some types of moulds are useful (fermentation of kefir and some types of cheese), while some others are harmful for people's lives. They irritate the mucous membrane of eyes, a nose and a throat, causing allergies and fall of immunity. Wet and dump places are useful for mould growth process, while spores have been spreading by airflow. As it is known to us, there are 100 000 types of moulds.

Characteristic of certain types of bacteria is their shape, which can be round, rod-shaped, spiral. They may appear individually, arranged in pairs, chains, clusters, tetrads and Sarcinae.

Possible forms of bacteria are: 1. Coccus (Round); 2. Coupled (diplcoccus); 3. Streptococcus (spherical); 4. Staphylococcus (clusters); Sarcinae (tied in bundles of eight); 6. Bacillus (rod, cylinder); 7. Diplobaccilus (after being multified they remain individual sticks or tied in two); 8. Bacillus in palisades (one next to another as a fence); 9. Streptobacillus (rod-shaped bound in chains); 10. Spirilliae-vibrio (spirals wrapped around an imaginary axis, while vibrio is comma- shaped); 11. Spirillum (spiral has the most 3 to 4 curves); 12. Spirochetae (they have 10 to 15 spiral curves); 13. Aricula (square bacteria). [14]

Regarding the fact that bacteria multiplicate dividing, i.e. splitting cells on two equal parts which again split, it is said that multiplication of bacteria carries out in geometric progression:

$$1 => 2 => 4 => 8 => 16 => 32 => 64 => 128 => \cdots \quad (1)$$

The time elapsed when a cell splits into two is called the time of one generation and it can be calculated using the following formula:

$$G = \frac{t}{\frac{\log b - \log B}{\log n}} \quad (2)$$

where: B – number of bacteria at the beginning of given period of time, b – number of bacteria at the end of given period of time, t – given period of time, n – number of generations, G – time of one generation.[3]

4. CONCLUSIONS

This analysis was conducted in order to increase safety of users in accidental situations and diagrams formed with the analysis will indicate of physical, chemical and microbiological qualities of medical air in composite and steel cylinders.

The safety of respiratory organs during firemen's interventions is very demanding as physical, chemical and microbiological parameters of CMA. Supply of up-to-date equipment, education and trainings reduce the risks of users' getting hurt and damages to the equipment. This indicates that we are responsible to keep precise records of periodical and regular control and conduct educations of personnel in charge of technical functionality and also comply with the manufacturer's recommendations on timely replacement of pieces on insulating apparatus, which directly reflects on the reliability itself during use and on the safety of users.

The CMA analysis should be conducted at least once a year after servicing medical air compressor, which would increase the safety of users.[17, 18] Analyzing physical and chemical results, it can be noted that individual components of KMV are unfavorable for users of bottle/cylinder insulation devices in the first, and especially in the second sampling, although the bottle/cylinder was filled with 99 ÷ 99.5% of medical oxygen, which can represent the parameters for future research.

As it was mentioned – microorganisms cannot multiply in air and its environment, they decay relatively quickly while their existence depends on its characteristics and on the temperature and moisture of air. However, while conducting these analysis it was proved that microorganisms can still grow in CMA with constant pressure (of 200 or 300 bars) and with constant moisture of air.[17]

Analyzing the microbiological results it can be concluded that several types of conditionally pathogenic microorganisms and one type of pathogenic microorganisms have been reproduced inside the bottle/cylinder, which can cause various diseases in the first, and especially in the second sampling, in the case of a user, although the bottle / cylinder 99 to 99.5% of medical oxygen was filled. It is known that many microorganisms cannot survive in pure medical oxygen, but for the second microbiological sample, this cannot be said, because in this case the highest concentration of microorganisms is read, which can be the starting point for future research.

Also, the presence of some harmful components in CMA samples, can be attributed to bacteria. Some types of bacteria from ethanol produce acetaldehyde or from CO2 produce methane, formaldehyde and methanol.[14]

Note: This paper is based on the paper presented at INTERNATIONAL CONFERENCE ON APPLIED SCIENCES – ICAS 2018, organized by UNIVERSITY POLITEHNICA TIMISOARA, Faculty of Engineering Hunedoara (ROMANIA) and UNIVERSITY OF BANJA LUKA, Faculty of Mechanical Engineering (BOSNIA & HERZEGOVINA), in cooperation with the Academy of Romanian Scientists, Academy of Sciences Republic of Srpska, Academy of Technical Sciences of Romania – Timisoara Branch and General Association of Romanian Engineers – Hunedoara Branch, in Banja Luka, BOSNIA & HERZEGOVINA, 9 – 11 May 2018.

References

[1] Bernal C. et al. Keratinolytic activity of Kocuria rosea. World journal of microbiology and biotechnology, 2003, 19.3: 255-261.
[2] Bizzarro MJ, Callan DA, Farrel PA, Dembry L-M, Gallagher PG. Granulicatella Adiacens and Early-Onset Sepsis in Neonate. Emrg Infect Dis. 2011. 17(10): 1971-1973.
[3] Collins MD, Lawson PA. The Genus Abiotrophia (Kawamura et al.) is not Monophyletic: Proposal of Granulicatella gen. nov; Granulicatella adiacens comb. nov; Granulicatella Elegans comb. nov. and Granulicatella Balaenopterae comb. nov. International Journal of Systematic and Evolutionary Microbiology. 2000. 50:365-369.
[4] Jorge Salomão Moriera et al. Endocarditis by Kocuria rosea in an immunocompetent child. Brazilian Journal of Infectious Diseases, 2015, 19.1: 82-84.
[5] Madigan MT. Martinko JM. Parker J. Brock biology of microorganisms. Pearson, 2017.
[6] Parshetti Ganesh et al. Biodegradation of Malachite Green by Kocuria rosea MTCC 1532. Acta Chimica Slovenica, 2006, 53.4.
[7] Perkins A, Osorio S, Serrano O, Del Ray MC, Sarria C, Domingo D, Lopez-Brea M. A Case of Endocarditis due to Granulicatella adiacens. Clinical Microbiology and Infection.2003. 9(6): 576-577.
[8] Stackebrandt E. Koch C. Gvozdiak O. Schumann P. Taxonomic Dissection of the Genus Micrococcus: Kocuria gen. nov., Nesterenkonia gen. nov., Kytococcus gen. nov., Dermacoccus gen. nov., and Micrococcus Cohn 1872 gen. emend. International Journal of Systematic and Evolutionary Microbiology, 1995, 45.4: 682-692.
[9] Tang JS. Gillevet PM. Reclassification of ATCC 9341 from Micrococcus luteus to Kocuria rhizophila. International journal of systematic and evolutionary microbiology, 2003, 53.4: 995-997.
[10] Vandana KE, Mukhopadhyay C, Rau NR, Ajith V, Rajath P. Native Valve Endocarditis and Femoral Emolism due to Granulicatella Adiacens: A Rare Case Report. Braz J Infect Dis. 2010. 14(6).
[11] Young M, et al. Genome sequence of the Fleming strain of Micrococcus luteus, a simple free-living actinobacterium. Journal of bacteriology, 2010, 192.3: 841-860.
[12] Berger-Jekic O, Jovanovic M. (1997) Special bacteriology, Contemporary administration, Belgrade.
[13] Džavec E, Melnik JL, Adelberg EA (1995). Medical Microbiology, Contemporary Administration, Belgrade.
[14] Majstorovic A. (2015). "The Safety Using of Breathing Apparatus in Accident's Situations", Lambert Academic Publishing, Saarbrücken, Germany.
[15] Versalovic J (2010) et al. Manual of Clinical Microbiology. Washington, DC, 10th Edition.
[16] Svabic-Vlahovic M. (2005). Medical Microbiology, Contemporary Administration, Belgrade.
[17] Majstorović A. (2013); Microbiological Analysis of Compressed Medical Air. 11th International Conference of Accomplishments in Electrical and Mechanical Engineering and Information Technology; University of Banjaluka; Faculty of Mechanical Engineering; Banja Luka.
[18] Majstorović A. (2014); The Physico-Chemical Analysis of Compressed Medical Air from Breathing apparatus. International Journal of Engineering and Inovative Technology; IJEIT; Largo; Florida; USA.
[19] http://www.edlab.org/glossary/dermacoccus-nishinomiyaensis-micrococcus-nishinomiyaensis/
http://www.edlab.org/glossary/dermacoccus-nishinomiyaensis-micrococcus-nishinomiyaensis/

ISSN 1584 - 2665 (printed version); ISSN 2601 - 2332 (online); ISSN-L 1584 - 2665