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Analysis of Lubricating Cooling Liquids Negative Influence to the Human's Health and the Ways of it Reduction

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Abstract. **Lubricating fluids may have a significant negative impact on both people and environment. The study analyses the approaches used to estimate the negative influence of lubricating fluids on the human health and provides the results of the analysis performed. The paper also considers the existing methods of impact reduction of lubricating fluids in mechanical engineering enterprises. The authors of the paper also propose the classification of the ways of minimizing the negative influence of lubricating fluids on the human health.**

Keywords: **lubricating fluids, toxicity, human health, influence, estimation, reduction**

I. Introduction

At present, lubricating fluids are generally used not only in the industry, but also in households. The issue of their negative influence on the human health both in industry and in households has become especially important in recent years due to significant volumes and high toxicity of lubricating fluids.

In general, lubricating fluids are mineral oils or oils with anti-wear additives or water emulsions consisting of water, mineral oils, emulsifiers, inhibitors of corrosion, bactericides or other dangerous components.

Due to their chemical nature, lubricating fluids may exert different negative effects on people, leading to the damage of cardiovascular and respiratory systems, skin damage, toxic poisoning and other adverse effects.

According to the results of many studies, all existing lubricating fluids are toxic and have varying degrees of toxicity (from hypertoxicity to the mid-level of toxicity). They contain components polluting the environment: oil products, ether extracting particles, fatty acids, etc.

That is why it is important to perform the analysis of negative influence of lubricating fluids on the human health and to suggest the ways of its reduction.

II. The Analysis of Negative Influence of Lubricating Fluids on the Human Health and Environment

Lubricating fluids may exert a negative influence on people as a result of direct contact with the skin or the contact through the special protective clothing and also as a result of penetration of gases, aerosols, condensate of lubricating fluids into the human organism through the respiratory system.

The analysis of special features of negative influence of lubricating fluids on the human health shows that it tends to increase the number of occupational diseases of workers in various branches of industry. For example, in the Public Joint Stock Company AVTOVAZ the number of such occupational diseases as bronchitis and eczema tends to increase.

Statistics of diseases caused by the impact of lubricating fluids at Public Joint Stock Company AVTOVAZ (in the period of 2002–2008) is shown in Table 1.

Statistics of distribution of diseases caused by the impact of lubricating fluids at Public Joint Stock Company AVTOVAZ for men and women (in the period of 2002–2012) is shown in Fig. 1.

The influence of used lubricating fluids is especially dangerous both for people and for environment. Fig. 2 shows possible consequences of negative impact.

The influence of lubricating fluids on the human health is well known in industrial conditions. The main consequences of the impact of lubricating fluids are occupational diseases. The data collected from scientific publications in this field of study proves that aerosols of lubricating fluids may cause pneumonia, skin diseases, damage to the heart muscles, liver and kidney [1, 5, 7, 9]. Moreover, it has been found that the products of thermal destruction of harmless components of lubricating fluids as well as possible chemical entities in the area of treatment may also exert a negative impact on the human health.

Due to their chemical nature, lubricating fluids exert a negative impact on the workers in the industrial conditions as a result of direct contact with the skin and as a result of evaporation. The degree of negative impact depends on the chemical composition of lubricating fluids; conditions of treatment of metals; conditions of microclimate.

Lubricating fluids may have a significant negative impact on the environment mainly due to their toxicity. For example, pollution of the environment by lubricating fluids may occur not only in the process of their exploitation, but also due to the evaporation and combustion of lubricating oils. The used lubricating fluids may be considered dangerous toxic waste, the utilization of which is very difficult.

III. The Analysis of the Ways of Minimizing the Negative Influence of Lubricating Fluids

The general ways of minimizing the negative impact of lubricating fluids are shown in Fig. 3.

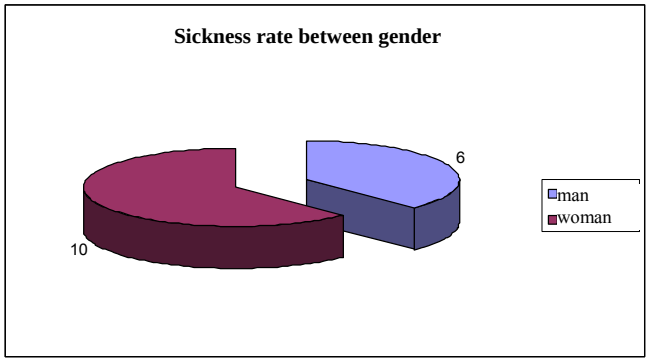

Fig. 1. The distribution of occupational diseases caused by the impact of lubricating fluids at Public Joint Stock Company AVTOVAZ for men and women (in the period of 2002–2012)

It is suggested subdividing the ways of minimizing the impact of lubricating fluids based on their use reduction as follows:

- use of environmentally friendly materials instead of lubricating fluids;
- treatment without lubricating fluids;
- treatment with minimal use of lubricating fluids.

Traditional approach to the reduction of negative influence of lubricating fluids on the environment is their utilization. However, the utilization of used lubricating fluids is not safe and rather expensive.

As an alternative to the expensive and ecologically dangerous process of lubricating fluid utilization, methods are applied to reduce the use of lubricating fluids or fully avoid lubricating fluids in technological operations. According to the data of Swiss company Mikron SA Agno, the average cost of lubricating fluids used for one lathe daily is equal to the sum of 50–250 US dollars. It means that annually Mikron SA Agno spends approximately 12 750–63 730 US dollars for the application of one lathe. For machine building enterprises, the average cost of lubricating fluids used for one lathe is equal to 8000 US dollars annually [13, 15].

If lubricating fluids are not used, it is also possible to increase the quality of manufactured parts, for example, in the study [3] it is shown that chemically active elements of lubricating fluids reduce endurance and corrosion resistance of the surfaces of details. It should be noted that the absence of lubricating fluids in the area of treatment allows using active control in the process of treatment and eliminating the effect of heat shock on the surface of the instrument.

If lubricating fluids are not used in the process of treatment, it is possible to solve the following main problems:

- loss of heat in the area of cutting;
- reduced coefficient of friction in the process of treatment;
- moving off shaving in the area of treatment.

The analysis performed by the authors of the paper shows that at present the technologies of ecologically sound treatment without lubricating fluids account for only 10% of all existing lathe equipment in the Russian Federation and in Western European countries [2-4, 14].

The issues of treatment without lubricating fluids are thoroughly investigated in West European countries, and also in the USA and Japan. In these countries different types of blades and abrasive processing without lubricating fluids are investigated: drilling, turning, grinding, and glazing.

The review of Russian and foreign literature allows pointing out the basis of investigations of dry treatment by using the methods of plastic surface warping and allows determining the ways of solving problems arising in the process of treatment without lubricating fluids. Such a process of treatment is mostly convenient for the primary stage of investigations of processes occurring during the dry treatment because it has no such intensive heat emission and chip forming as cutting or grinding. Thus, the main task is to reduce the coefficient of friction between the instrument and procurement.

Implementation of a new technology allows solving the following problems:

1. Reduction of expenses, because most of lubricating fluids on the basis of oils have a comparatively small flash temperature.
2. Improvement of labour conditions, because lubricating fluid components may cause different occupational diseases.
3. Increase in the level of ecological safety of industrial production because the leakages of lubricating fluids pollute soil, water and air.
4. Reduction of the expenses related to the purchase, storage, transportation and utilization of lubricating fluids.
5. Improvement of the quality of treatment thanks to possibilities of using the means of active control.

It should be noted that the monitoring of the environment is also an efficient way to assess and forecast the changes in the environment and in the level of pollution of biosphere or its separate components under the impact of lubricating fluids. At present, many scientists are investigating different biological indicators as test objects. In the meantime, the estimation of a degree of toxicity of lubricating fluids is somewhat specific and requires a detailed examination.

The analysis of literature sources shows that during the estimation of toxicity of several objects, the biological testing (including also lubricating fluids) is most commonly studied. As test objects it is advisable to use green algae Chlorella (Chlorella vulgaris Beijer), ПНД Ф 14.1:2:4.10-04, 16.1:2:3:3.7-04, and crawfishes Daphnia magna Straus, ПНД Ф Т 14.1:2:4.12-06, 16.1:2:3:3.9-06.

The above-mentioned methods are accredited in Russia. These methods allow obtaining rather high precision of results when conducting research.

Generally, only the use of various methods may give efficient results regarding the significant reduction of negative influence of lubricating fluids.

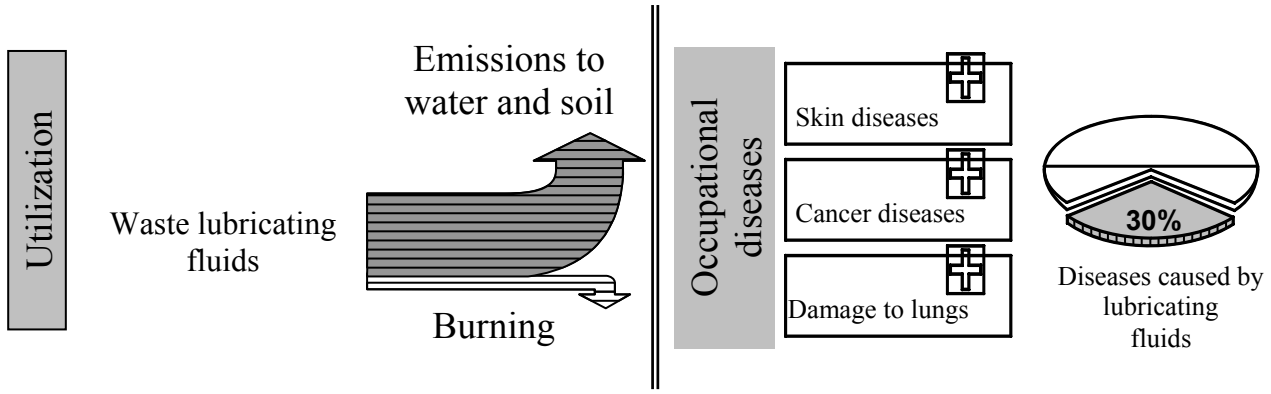

Fig. 2. Possible negative influence of lubricating fluids on the human health and environment

TABLE 1

STATISTICS OF OCCUPATIONAL DISEASES CAUSED BY LUBRICATING FLUIDS AT PUBLIC JOINT STOCK COMPANY AUTOVAZ (2002–2008)

No.	Sex	Production, Department	Profession	Length of Service (years)	Year in which disease is identified	Diagnosis
1	F	Metallurgical Pr., Dept. 12/1	Operator	10	2002	Occupational eczema of the upper extremities
2	M	Metallurgical Pr., Dept. 36/6	Operator	28	2002	Occupational eczema of the upper extremities
3	F	Metallurgical Pr., Dept. 18/6	Grinder	21	2002	Occupational eczema of the upper extremities
4	M	Production of Technological Equipment, Dept. 19/13	Grinder	16	2002	Occupational eczema of the upper extremities
5	F	IP Dept.51/2	Turner	21	2004	Occupational eczema of the upper extremities
1	M	Metallurgical Pr., Dept. 32/2	Adjuster of automatic and semi-automatic assembly lines	29	2005	Occupational dermatitis of the upper extremities
2	F	Metallurgical Pr., Dept. Sh-2	Operator of automatic assembly lines and aggregate mounts	30	2005	Occupational eczema of the upper extremities
3	M	Metallurgical Pr., Dept. 36/2	Tester of engines	20	2005	Occupational eczema of the upper extremities
4	F	Energetic production	Operator of automatic and semi-automatic assembly lines	8	2006	Occupational eczema of the upper extremities
5	M	Metallurgical Pr., Dept. 33/2	Metalworker of mechanical assembly works	27	2006	Occupational eczema of the upper extremities
6	M	Metallurgical Pr., Dept. 33/3	Operator of automatic and semi-automatic assembly lines	28	2006	Occupational eczema of the upper extremities
7	F	Metallurgical Pr., Dept. 33/3	Operator of automatic and semi-automatic assembly lines	28	2007	Occupational diffused eczema
8	F	Metallurgical Pr., Dept. 33/3	Adjuster of automatic and semi-automatic assembly lines	36	2007	Occupational diffused eczema
9	M	Metallurgical Pr., Dept. 33/3	Adjuster of automatic assembly lines and aggregate machine tools	20	2007	Occupational eczema of the upper extremities
10	F	Metallurgical Pr., Dept. 33/1	Operator of automatic and semi-automatic assembly lines	25	2008	Bronchial asthma
11	F	Metallurgical Pr., Dept. 33/8	Operator of automatic and semi-automatic assembly lines	22	2008	Bronchial asthma

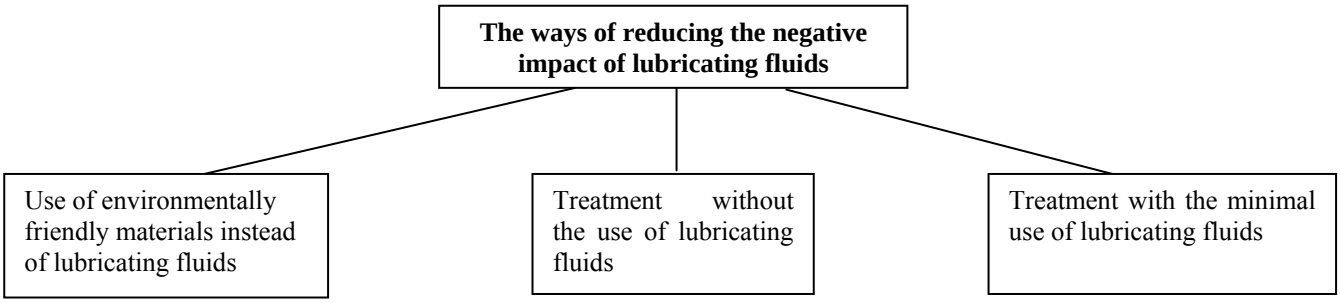

Fig. 3. The main ways of reducing the negative impact of lubricating fluids

IV. CONCLUSIONS

Lubricating fluids are used in the industry in large volumes. Due to high toxicity and other negative characteristics, lubricating fluids may exert a significant negative impact both on the human health and on the environment. The analysis of special features of negative influence of lubricating fluids on the human health shows that occupational diseases of workers tend to increase in different branches of industry. Statistics of the impact of lubricating fluids at Public Joint Stock Company AVTOVAZ is described and analysed.

The general ways of minimizing the negative impact of lubricating fluids are also described. It is suggested subdividing the ways of minimizing the impact of lubricating fluids based on their use reduction as follows: use of environmentally friendly materials instead of lubricating fluids; treatment without lubricating fluids; treatment with minimal use of lubricating fluids.

It is pointed out that as an alternative to the expensive and ecologically dangerous process of lubricating fluid utilization it is reasonable to investigate and implement the methods of reduction of use of lubricating fluids or the full avoidance of lubricating fluids during technological operations.

Monitoring of the environment is also an efficient way to assess and forecast the changes in the environment and in the level of pollution of biosphere or its separate components under the impact of lubricating fluids. Different methods used to monitor the impact of lubricating fluids are discussed.

Generally, only the use of various methods may give efficient results regarding the significant reduction of negative influence of lubricating fluids.

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