# Chemical contaminations in a process of polishing with an implementation of liquid LCTS

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**Abstract.** Technological processes of polishing are characterized by a heat discharge in a processing area, resulting in a deformation of metal and an external friction of abrasive grains on a surface. In a case of using liquid lubricant-cooling technological substances (LCTS), heat discharge results in a destruction of components. This leads to a formation of chemical contaminants in a processing area. Qualitative and quantitative composition of contaminations depends on processing parameters: a rotation speed of a wheel, a speed of a longitudinal feed and a depth polishing.

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## Introduction

Technological processes of cutting, polishing, milling and drilling, which use liquid lubricant-cooling technology substances (LCTS) are characterized by a presence of chemical contaminants in the working area. Sources of these contaminations in the air of a processing area are products of LCTS thermal destruction. This significantly aggravate ecological parameters of technological processes and reduces competitiveness, violates basic rules of the international system of quality standards ISO-9000, ISO-14000, OHSAS-18000, the Federal Law of Russia "On technical regulation" from 27 December 2002, No 184-FZ, technical regulations of Custom union "On the security of machines and equipment" (TRCU 010/2011).

Heat sources, appearing during polishing, are deformations of metal and an external friction of abrasive grains on the surface, because mechanical energy in a processing area converses into heat [1,2,3].In contrast to a metal cutting using a tool, in a case of polishing, heat is taken away mainly into a processed component, because the cross-section of removed layer is insignificant and an abrasive wheel is almost not capable of heat transfer.

In a polishing process instantaneous cutting temperature and established temperature of a surface layer is distinguished [4]. Instantaneous temperature occurs in a period of a chip removal by an abrasive grain, than it is increasing almost momentarily and than it is almost instantly taken away to a metal body of a polished component. Instantaneous temperature values can even approach melting temperatures of a metal [5].

An established surface layer temperature of a polished component is low even in a case of polishing without cooling, because of heat, which is produced in boundary surface layers of a polished component, is rapidly taken away to a metal body, and a bigger size of polished component would correspond to a more intense heat transfer from surface layers to inward parts of a component. Moreover, a small portion of heat goes into environment through a radiation heat emission.

High instantaneous temperatures of a surface layer of a component may be caused by following reasons [6]:

1. A selection of incorrect polishing regimes - in the first place due to a very big thickness of a layer, which is removed by one abrasive grain, as a result of which it heats up intensively;
2. An incorrect selection of a polishing wheel (too hard), which forms a high pressure of abrasive grains on a polished metal;
3. An insufficient cooling in a case of solid steels polishing.

Temperature in a processing area also depends on a speed of wheel. In the fig. 1 a relationship between temperature change and rotational speed is shown, temperature in a processing area is changing almost in 2 times, from 200°C to 400°C.

Such high temperatures significantly exceed critical temperatures for the most of liquid LCTS components. In table 1 [7] critical temperatures of components of liquid LCTS are presented.

Exceeding of a critical temperature leads to a decompostion of organic constituent of liquid LCTS, such as vegetable oil, animal fats and an emission of chemical contaminatons in air of a working area, such as oil mist, hydrocarbons, formaldehide etc. [8]. Hydrocarbons emission has a dominating significance in temperature and volume of a total chemical contamination of a working area, which affects labor conditions of workers and causes a contamination of environment.

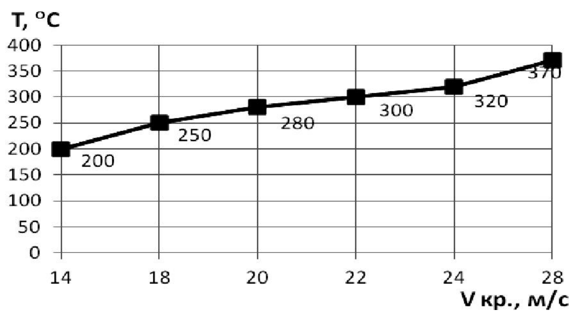


**Fig.1. A relationship between temperature change in a processing area and rotational speed of a wheel**

**Table 1. Maximum temperature of an operation capability of liquid LCTS components $T_к$.**

| Components of liquid LCTS | The temperature $T_к$ C |
|---|---|
| Vegetable oils | 130 |
| Animal fats | 130 |
| Synthetic substances | 200 |
| Additives: | |
| - Chlorine-containing | 500 |
| - Phosphorus-containing | 800 |
| - Sulfur-containing | 900 |

Temperature in a processing area, and, therefore, thermal destruction of LCTS depends on parameters such as a rotation speed of a wheel, a longitudinal feed value and cutting depth [6]. An establishment of qualitative and quantitative relationships between a contamination control of working area by products of a thermal destruction of liquid LCTS and manageable parameters of technological processes creates conditions, in particular, for a creation of automatic control systems for a reduction of working area air contamination and for an improvement of ecological quality parameters of technological processes of polishing in a whole. In order to establish a relationship between chemical contaminants emission in air of the working area and processing parameters, the experimental study was conducted on polishing machine model MD1320B with an implementation of liquid LCTS "Rossoil-500".

For the study of LCTS thermal destruction products in processing area, as an analyzed product of LCTS thermal destruction, unsaturated hydrocarbon class substance was selected - hexane, which takes a significant place in a volume of chemical contaminants, generated during an implementation of liquid LCTS. For a measurement of LCTS thermal destruction products gas analyzer Kolion-1A was used. Experimental studies have been carried out using liquid LCTS "Rossoil-500" in solutions concentrations of 5 and 20 %.

LCTS was fed in a processing area by dosed portions of 50 ml with a change of a percentage of LCTS solution. Measurements were carried out at a distance of 0.3 m from a processing area in order to ensure a uniform preciseness of measurements. A dependence of a concentration of emitted hexane from a speed of a polishing wheel, longitudinal feed and cutting depth at two concentrations of LCTS solution (5 and 20 %) was studied.

In the first phase of the study the relationship between hexane concentration and a speed of a polishing wheel was established (fig.2).

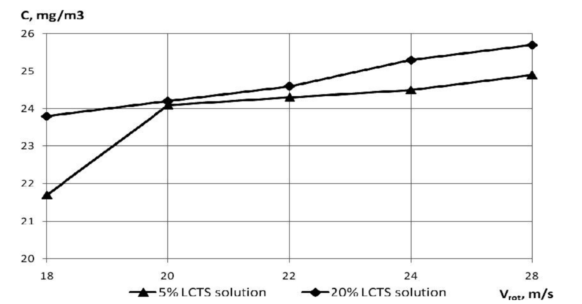


**Fig.2. The relationship of hexane concentration and a speed of a polishing wheel with different LCTS solutions.**

The obtained relationship shows that, with an increase of a rotational speed of a polishing wheel, a smooth increase of hexane concentration air of working area occurs, which is explained by an increase in temperature.

In the fig.3 the relationship between hexane concentration and a speed of a longitudinal feed is presented (fig.3). The established relationship showed that, with an increase in a speed of a longitudinal feed there is a smooth increase of hexane concentration.

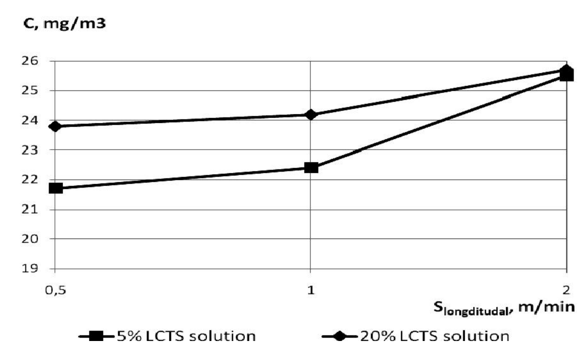


**Fig.3. The relationship between hexane concentration and a speed of a longitudinal feed with different LCTS solutions**

In the fig. 4 the relationship between hexane concentration and a depth of polishing is presented. As it can be seen from the graph, cutting depth also influences a process of chemical contaminations formation in a processing area (in particular, hexane). Moreover, changes in a concentration of LCTS solution from 5 to 20 % do not provide a significant difference in hexane concentration.

Thus, conducted studies allowed to determine the relationships between the hexane concentration and manageable processing parameters: a rotational speed of a wheel, a speed of a longitudinal feed and polishing depth.

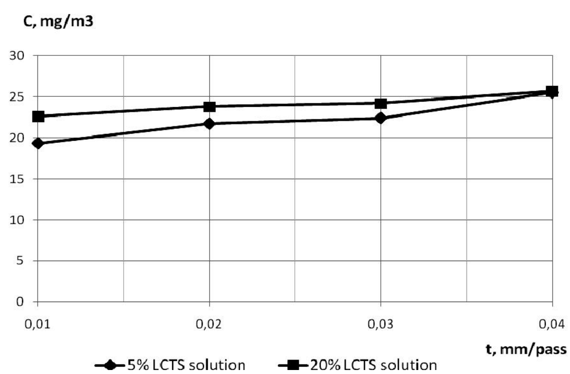


**Fig.4. The relationship between hexane concentration and a depth of polishing with different LCTS solutions**

The established relationship allows to automatically manage chemical contaminations using a traditional manufacturing equipment control system. In that case, a traditional control system should be supplemented wiht hexane sensor and interface, which is forming an additional information for a speed regulator [9,10,11]. An implementation of an automation equipment will allow to reduce an emission of chemical contaminants in air of a working area and thus to improve labor conditions of workers and improve a competitiveness of polishing technological process.

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