INFORMATION-CALCULATION SYSTEM FOR HYGIENIC CHARACTERISTICS OF WELDING ELECTRODES

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A computer system is presented comprising indicators of emission levels and chemical composition of fumes that pollute the work zone air in coated-electrode welding, as well as a system for calculation of the required ventilation air exchange. They can be applied to calculate the content of harmful substances in the work zone air when using different types of ventilation (local and general) and to select the type of the ventilation system for welding under different conditions.

Keywords: *arc welding, coated electrodes, hygienic characteristics, welding fumes, prediction,, ventilation*

The main means of worker protection from welding fumes (WF) contaminating the air in production facilities in electric arc welding is exhaust system of ventilation. Effectiveness of WF removal from the work place depends on the correct selection of the kind of ventilation system and its efficiency, which is calculated on the basis of experimental data on intensity of WF component evolution.

This work considers the developed computer information-calculation system (ICS) which allows obtaining information about the characteristics of levels of WF harmful component emissions in manual arc welding in different modes, predicting concentration of WF and gases (carbon oxide and nitrogen dioxide) in the work zone air, as well as calculation of the required air exchange and selection of the kind of ventilation system.

Main functions of ICS «Welding hygiene» are as follows:

- entering and editing information on initial data and hygienic characteristics of welding electrodes;
- information storage and displaying;
- searching for the necessary information;
- predicting the concentration of WF, manganese, carbon oxide and nitrogen dioxide in the work zone air, depending on welding mode and distance to the welding arc;
- calculation of characteristics of ventilation air exchange, i.e. quantity of air, required for dilution of harmful substances in the work zone air to threshold limit concentrations (TLC);
- issuing recommendations on selection of a ventilation system or means of individual protection of respiratory organs.

ICS includes the following subsystems: selection of electrode grade; selection of welding mode; selection of welding conditions (without ventilation, with general or local ventilation).

Compared to the known information systems [1–4] ICS «Welding hygiene» developed by us gives more complete information in a more understandable form about the initial characteristics of welding electrodes (purpose, coating type, kind of current, welding mode) and general characteristics of WF emission levels: intensity of formation (V_f, g/min), specific evolution (G_f, g/kg), coefficient of intensity of formation (β_f, g/(kW·h)) and coefficient of specific evolution (γ_f, g/(kW·kg)). The system gives the data on experimental and calculated WF concentrations in the working zone air at different distances to the welding arc in case of availability of general, local ventilation and without it, which are used to select the most effective ventilation system. ICS allows performing hygienic assessment of known coated-electrode grades for welding low-carbon and low-alloyed steels and eventually provide recommendations on selection of the respective ventilation system (local or general).

ICS «Welding hygiene» data base contains information on quality characteristics of WF emissions: their composition for low-carbon, low-alloyed, medium-alloyed and high-alloyed steels. On the other hand, it presents results of investigations of the dependencies of concentrations of WF, manganese as the determinant toxic component in welding of low-carbon and low-alloyed steels [5], as well as gases (carbon oxide and nitrogen oxides), characteristic for welding with electrodes not containing any fluorides in their coating. These dependencies are used by the computer system for selection of the kind of ventilation system, ensuring WF content in accordance with the standard requirements [6].

Searching for information in the data base is performed by the specified welding electrode grade. Search result is documented in the form of an output document (Figure 1).

Results of computer system functioning can provide hygienic parameters, characterizing the composition, level of WF emissions, and can allow calculation of the required air exchange of general ventilation taking into account the LTC of harmful substances. The air exchange is presented in the form of two characteristics: first — quantity of ventilated air per one kilogram of electrodes consumed in welding (Q_m, m^3/kg), the second one is the same per a unit of

Figure 1. Output document of ICS «Welding hygiene»

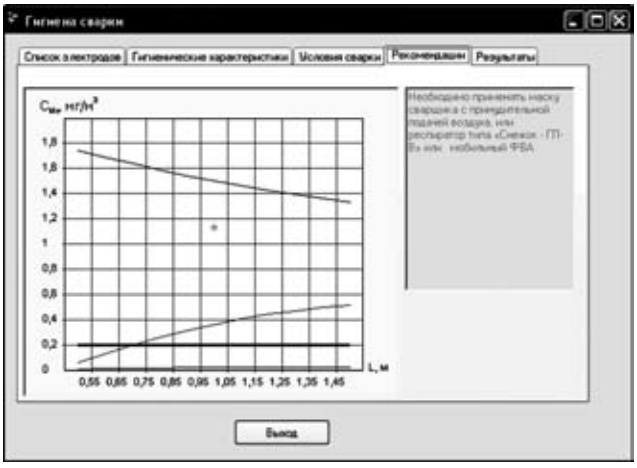

Figure 2. Graphic dependencies of ICS and recommendations on selection of the kind of ventilation system and (or) means of individual protection of respiratory organs

welding time (Q_t, m^3/h). By the values of these characteristics ICS allows performing comparative hygienic assessment of welding electrodes of various grades, including local electrodes, against foreign electrodes, using Q_t value.

Manganese concentration in the work zone air can be derived by calculation by the data of its formation intensity, using graphic and analytical dependencies obtained in [5]. For this purpose graphic information (Figure 2) was included into the data base of «Welding hygiene» system. This information allows determination of manganese concentration (C_{Mn}) in the required point depending on ventilation conditions (general, local or no ventilation), welding mode and distance from the arc L.

In addition, the right-hand part of ICS window (see Figure 2) presents text information on recommendations for normalizing the content of harmful substances in the working zone air. These recommendations determine in which cases general ventilation and in which cases local ventilation should be used, which depends on electrode grade, welding mode parameters and distance from the welding arc to the required point. If there is no local ventilation device in the work place, ICS proposes application of an independent filter-ventilation unit. Now, if local ventilation does not ensure harmful substances content in this point below the TLC, it is proposed to use the means for individual protection of respiratory organs (filter respirator or welding face shield with a system of clean air feeding to the breathing zone).

Alternatively, the graphic dependencies given in ICS (see Figure 2) show how and to what extent WF impact on the body of workers being near the welding station can be reduced by changing the welding mode parameters and distance from these workers to the welding arc.

This system will be useful for welding fabrication specialists and labour safety units in enterprises applying arc welding. It will provide them with systematized information on hygienic characteristics of welding electrodes with the purpose of selection of the least hazardous grades, will enable adequate selection of systems of work place ventilation and individual protection of respiratory organs. As a result, it will enable increasing the level of protection of workers of welding professions and lowering the risk of development of their occupational diseases.

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