FIRE HAZARD ASSESSMENT OF DISPERSED METALS AND THEIR HYDRIDES

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Introduction

Technical documentation for substances and materials should contain information on their fire hazard [1]. Federal Law of the Russian Federation FZ-123 "Technical Regulation On the Requirements of Fire Safety" specifies the list of the fire-and-explosion hazard indices, the methods and test apparatus for their determination. However, the methods for their determination have been developed for the organic substances and do not always take into account the features of the change of the properties of metals and their hydrides after their production and processing.

Results and Discussion

An oxide film is formed on the clean, just processed surface of metals at their contact with air. The primary oxide film, the thickness of which fluctuates in the range of 20-70 Å depending on the metal, is formed actually immediately due to the oxygen adsorption. The heat released often causes the spontaneous ignition of the metals, this very fact determines their elevated activity or "adsorption pyrophorus ability". Further oxidation proceeds more calmly, the oxidation rate being determined by the protective properties of the oxide film. Under certain conditions it is possible to create an oxide film which will provide "passivation" of metals and thus the reduction of the fire-and-explosion hazard. For example, the lower concentration limit of flame propagation (LCLF) of multi-component alloy based on nickel (fraction <40mcm) is 652 g/m^3 for the "fresh" samples of the powder and 750 g/m^3 – for the oxidized samples [2].

However, explosion hazardous properties of not all metals decrease due to their exposure to air. In article [2] it is shown that LCLF of powders of carbonyl iron (CI) of P-10 type gradually increases after they are unloaded out of the technological equipment and exposed to air while LCLF of powders of carbonyl iron (CI) of P-20 type and P-100 type at first substantially reduces (their explosion hazard increases) and then increases (the test data is given in table 1).

The further research into the CI powders properties showed that besides the oxidation level the availability of remains of pentacarbonyl iron (PCI) also influences the change of explosion hazard indices (CI is obtained during the decomposition of PCI). The adsorbed gases and impurities on the surface of the metal powders influence their looseness, ability to form air suspensions and correspondingly the properties of explosion hazard. This parameter of CI powders under investigation changed in relation to the exposure time in air.

The value of self-ignition temperature $T_{см}$ is one of the most important characteristics of flammability. The method for the determination of this characteristic of the metal powders in the temperature range from 25^{o}C to 600 ^{o}C sometimes gives the same results of $T_{см}$ for both pyrophorus and passivated powders.

Nevertheless $T_{см}$ of "freshly produced" powders of some metals, e.g. CI, increases in time at their exposure in air and in 10 – 15 days after their sampling and contact with air it is very complicated to ignite them and the burning does

Table 1. The change of LCLF depending on the exposure time of CI powder in air.

Type of CI	LCLF, g m^{-3}										
	Exposure time in the air (τ), h										
	0	0,5	1	1,5	2	2,5	3	4	20	125	130
P-10	143	250	300	324	360	365	370	379	380	381	381
P-20	165	156	-	-	153	-	161	165	210	223	223
P-100	318	-	-	173	170	170	172	175	224	248	248

not propagate along their surface. As a rule, it is connected with the growth of the oxide film on the surface of the metal particles during their storage in the air or during the process of heating to $T_{см}$. The moisture of the air exerts a very large influence upon the process of growth of oxide surface film on the metal or on the metal hydrides thus substantially governing the pyrophorus properties of hydrides.

Conclusions

1. It is necessary to use additional methods of research simulating the production conditions for the assessment of the fire-and-explosion hazard of metals and their hydrides, the choice of safe conditions of particular technological process accomplishment.

2. When determining the fire-and-explosion hazard of metals and their hydrides it is necessary to assess the dynamics of the change from the first moment of the contact of their surface with air and to make certain requirements not only to the way the samples are selected but also to the way they are stored.

3.The existing standard methods for the determination of the fire-and-explosion hazard of substances and materials do not allow to assess the fire-and-explosion hazard of metals and their hydrides entirely.

References

1. Federal Law of the Russian Federation FZ-123 “Technical Regulation On the Requirements of Fire Safety” – M., FGU VNIIPO, 2008. – 156 p.

2. Smirnova T.M., Chibisov A.L., Shorin A.F. Flammability of CI Powders And Prevention of Explosions of Its Air Suspensions. In the digest “Fire-And-Explosion Hazard of Industrial Processes in Metallurgy”. Theses of the Reports of IV All-Union Conf. –M.: MISiS, 1991.