CHOOSING FLUXES FOR LEAD-PLATING PARTS OF CARBON STEEL

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UDC 669.48

To deposit a lead coating on tubes, tube grids, shells, and other parts and units of chemical equipment, the technique of leading with fluxes is used. By comparison with tinning, in fluxed leading the labor and consumption of short-supply and expensive tin are considerably reduced.

We have studied the effect of the flux composition on the wetting of steel with type S–1 lead (99.985% Pb) in hot leading. The optimum flux composition was chosen by evaluating the wetting of the base metal with the liquid coating, which is characterized by the wetting angle.

Experiments were performed on a special set-up for determining boundary wetting angles by the method of projecting and photographing the profile of an immobile drop under vacuum conditions (10^{-2} mm Hg), that is, under conditions where the rate of lead spreading reaches a maximum [1]. The experiments showed that even under vacuum conditions at a temperature up to 500°C it is impossible to obtain satisfactory wetting of steel with lead. Therefore further experiments were conducted with the use of fluxes—metal salts which react chemically with steel and lead (Zn, Sn), only with lead (Mg, Na, Cd), or only with steel (Mn, B).

Steel plates 5 × 18 × 20 mm in size, made up from type St3 steel, were ground flat, surface treated with micron abrasive paper, degreased with acetone, and washed with ethyl alcohol. The lead was melted into drops, drops of weight 1 g were collected, and they were degreased in a similar manner.

The set-up (see Fig. 1) consisted of a tube furnace, 4, with a thermoregulator, 5, into which was placed a porcelain tube containing the sample, 3, a light source, 6 — a special lamp with a point light source, focussing lenses, 2, a fore-vacuum pump VN-461, 8, a VT-2A device for measuring vacuum, 7, and a screen, 1. The porcelain tube had vacuum joints at the ends, with sight glasses for illuminating and photographing the drop.

A steel plate, coated with the flux, together with a lead sample was placed in the center of the tube, and gas was pumped out of the tube to a vacuum of 10^{-2} mm Hg. Depending on the melting point of the flux, the sample was heated to 500-850°C. The lead was kept in the molten state until a constant wetting angle of the steel with the lead was established, which was readily seen on the screen. The image of the drop projected on the screen was photographed, then the furnace was cooled, while maintaining the vacuum, to a temperature of 100°C. The value of the boundary wetting angle was determined from the results of four

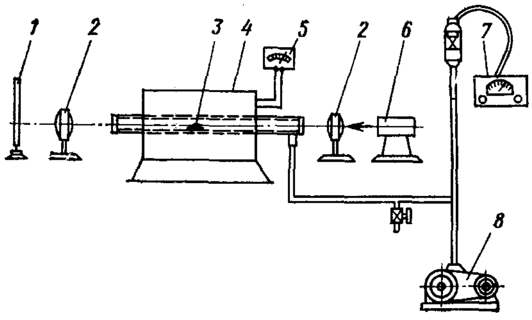

Fig. 1. Scheme of set-up for determining boundary wetting angles.

Translated from Khimicheskoe i Neftyanoe Mashinostroenie, No. 8, pp. 32-33, August, 1974.

TABLE 1

Flux composition	Temperature °C of fusion of flux	Temperature °C of sample heating	Boundary wetting angle, in°
100 Wt.% $ZnCl_2$	280	500	30–33
100 Wt.% $SnCl_2$	247	500	30–35
71 Wt.% $ZnCl_2$, 29 Wt.% NH_4Cl	180	500	0
84 Wt.% $ZnCl_2$, 16 Wt.% NH_4Cl	189	500	0
78 Wt.% $ZnCl_2$, 2 Wt.% $SnCl_2$, 20 Wt.% NH_4Cl	260	500	0
50 Wt.% $Cd(CH_3COOH)_2$, 50 Wt.% NH_4Cl	—	600	23–29
100 Wt.% NaCl	800	850	30–35
44 Wt.% NaCl, 56 Wt.% $MgCl_2$	430	700	34–40
100 Wt.% $MgCl_2$	650	800	37–42
100 Wt.% H_3BO_3	600	800	42–47

Note. Mean values of four or five measurements are given.

or five measurements of a photographed drop. Observation of the wetting process showed that when samples were heated to 330-350°C the boundary wetting angle decreased only slightly, and then abruptly changed to a minimum.

Further heating of the samples to 500-850°C had little effect on the magnitude of the boundary angle. Results of measuring these angles on samples with various fluxes (see Table 1) showed that when the steel surface is coated with fluxes which contain metal chlorides that react only with lead or only with steel, it is not possible to obtain complete wetting of the steel (boundary angle 23° or more).

Complete wetting of the base metal with lead and good spreadability of the liquid coating is attained when one uses fluxes which contain chlorides of zinc and tin with additions of ammonium chloride, that is, chlorides of metals which react chemically with lead and steel.

The results we have obtained confirm the basic position of flux theory [2], that in hot coating the main components of the fluxes should be salts of metals which dissolve in the liquid coating and form an intermetallic phase with the base.

On the basis of the experimental data, in hot leading of parts of carbon steels it is recommended to use a flux of the following optimum composition: 78% by wt. $ZnCl_2$, 2% by wt. $SnCl_2$, and 20% by wt. NH_4Cl.

The use of a flux in leading parts of carbon steels instead of preliminary tinning of the steel surface makes it possible to make a saving of up to 0.6 kg of type POS-30 solder per m^2.

LITERATURE CITED

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