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Research for conducting experiments to determine the adhesive ability of release coatings for die casting molds of aluminum alloys

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Erosion resistance of separating coatings determines the possibility of formation of scratches on the surface of technological equipment (rods, sliders) and the surface of the casting; helps to reduce the intensity of thermal shock on the surface of the mold when pouring a liquid melt. This technological indicator affects the quality of the surface and the density of the casting, since the washable separating coating, getting into the casting material, leads to a deterioration in the appearance and an increase in gas porosity. The erosion resistance of release coatings is directly related to their adhesive and cohesive properties.

The adhesive ability of the investigated separating coatings was studied by the method of parallel cuts. Water-based separating coatings preliminarily selected for research, diluted with water in a ratio of 1:20, were applied using a manual type sprayer to plates made of sheet steel grade St3 GOST 380–2005 with a size of 90×40 mm and a thickness of 3.0 ± 0.1 mm, previously cleaned with emery skins with a grain size of 240 and heated in an oven model SNOL-3.5 to a temperature of 250 °C. Grinding sandpaper grain number 280, according to the information specified in GOST 3647–80, provides microroughnesses on the plate surface with an average size of protrusions in height and depressions from 50 microns to 63 microns. Determination of the actual roughness parameter after cleaning of metal plates was carried out using a Surftest SJ-210 model profilometer (Japan). Figure 1.1 shows the appearance of the Surftest SJ-210 profilometer.

Figure 1.1 – Appearance of the device model Surftest SJ-210

The measurement range of the portable profilometer shown in Figure 1.1 is from 0 to 360 μm. The roughness of each sample was measured in 3 places in different directions, in order to eliminate the influence of the direction of irregularities on the controlled indicator, after which the arithmetic mean value of the roughness on the surface of the plate was calculated and then the resulting value was rounded up to the nearest higher value in accordance with GOST 2789–73 "Surface roughness. Parameters and characteristics". The performed measurements and processing of the obtained results showed that the value of the roughness of the working surface of the metal plate is 63 μm.

Then the plates with a separating coating layer applied to them were placed back into the dryer and kept at a temperature of 250 °C for 10 minutes. Exposure of metal plates in a furnace at a given temperature was carried out in order to remove the diluent through its complete evaporation. After the exposure time, the plates were removed from the dryer and cooled in air to room temperature. Thus, on the surface of the plate, only the release coating layer, represented by the lubricant base, remains.

The adhesion of the investigated release coating was determined on 3 samples using adhesive tape based on polyethylene terephthalate. On the sample surface area at a distance of at least 10 mm from the edge of the plate, five parallel cuts were made to the metal at a distance of 1, 2, and 3 mm from each other. Then, a strip of adhesive tape measuring 40×100 mm was applied perpendicular to the incisions and pressed tightly, leaving one end of the strip unglued. With a quick and sharp movement, perpendicular to the surface of the plate, the tape was torn off from the release coating layer. Then, a visual inspection of the surface of the tape was carried out, on which traces of a separating coating remained and compared with the images proposed in GOST 15140–78 "Paint and varnish materials. Methods for determining adhesion", with assignment of points on a three-point scale.

The results of the study of the adhesion ability of release coatings are shown in Table 1.1.

Table 1.1 – Adhesion ability of the studied separating coatings

Release number	Separating coatings based on:	Score
1	Mineral Oil Vapor	2
2	Mountain wax B40, Belarus	2
3	Firm "Petrofer", Germany	3
4	Firms "Eutektika", Belarus	3
5*	Fuse-based lubricant	3

It can be seen (Table 1.1) that release coatings prepared on the basis of petroleum products have a lower score (Vapor oil and mountain wax). This indicates that they have a lower adhesive ability to the metal surface of the plate. An imported analogue (Petrofer lubricant) and a domestic separating coating from "Eutektika" based on PMS300 polymethylsiloxane fluid showed the best results. This can be explained by the fact that the base of the above-mentioned separating coatings has a higher thermal resistance compared to petroleum products. It has been established that the developed composition based on the fuse adhesive strength is not inferior to the imported analogue and the previously developed domestic composition of the release coating.

In addition to the visual assessment of the release coating layer using a microscope, images of the layers formed on the tooling after the application of release coatings were obtained. The torn off tape was placed under a microscope, which was connected to a personal computer (PC). The PC software, in turn, made it possible to process and record the microscopic images of the release layer remaining on the tape. Figure 1.2 shows the appearance of metal steel plates after applying a layer of the test separating coating on them and holding them in an oven.

1 - a layer of release coating based on Vapor mineral oil; 2 – mountain wax based release coa; 3 – Petrofer release coat; 4 – Eutektika release coat; 5 – fuse release coat

Figure 1.2 – Appearance of metal steel plates after applying a layer of the test separating coating on them and holding in an oven

Examination of the surface of the metal plates shows that there are traces of the applied separating coating on the surface, expressed in drops of various sizes and fineness. It is shown (Figure 1.2) that the best hiding power is possessed by: the "Petrofer" separating coating, as well as the fuse-

based separating coating, since fine droplets with an average diameter of 1 mm to 2 mm are found on the surface of the plates. There are 3 to 5 drops per 1 cm^2 of the metal plate surface. At the same time, the number of these drops on the surface exceeds the number of drops obtained on other plates using other compositions of separating coatings. An intermediate position is occupied by a separating coating layer obtained using a lubricant based on a lubricant manufactured by "Eutektika". When using this lubricant, the droplet size is on average 1.5 mm and their number is not inferior to the value obtained when using foreign lubricant and fuse-based lubricant. The worst result was obtained with a release coat based on mountain wax and Vapor mineral oil. The drops are larger than 2.5 mm and their number does not exceed 1 drop per 1 cm^2 of the sample surface. Thus, the study of the hiding power of the studied compositions of release coatings shows that in order to obtain a more uniform and finely dispersed layer with good adhesion to the surface of the tooling, it is advisable to use a release coating obtained on the basis of fuse.