AN IMPROVED PROCESS FOR THE MANUFACTURE
OF Kh3O* POWDER AT THE BROVARY POWDER
METALLURGY FACTORY

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The work described below was undertaken with the aim of improving the process of diffusional im-
pregnation from point sources, as used at the Brovary Powder Metallurgy Factory (BPMF) for the manu-
facture of Kh30 powder [1]. A drawback of the technique being used at present at the factory is the high
ammonium chloride content of the charge (12%), which necessitates washing the steel powder to remove
excess chlorides. Before the washing operation, the powder contains 1.5-2.0% of chlorine. A laboratory
investigation [2] has shown that the amount of ammonium chloride in the charge can be reduced in order to
eliminate this disadvantage. Homogeneous Kh30 powder is obtained when the charge contains as little as
0.5% NH4Cl [2]. However, this amount of ammonium chloride is insufficient for the generation of a protec-
tive atmosphere preventing the converted natural gas used in the process from entering the container,
and consequently the sponge undergoes carburization and oxidation. In this connection, it was decided to inves-
tigate the effects of different methods of sealing of containers upon the severity of carburization and oxi-
dation of the sponge.

The effects of the degree of container gas-tightness were studied by employing two methods of con-
tainer closure, namely weld and liquid sealing; in addition, to obtain a basis for comparison, parallel exper-
iments were carried out with the existing method of closure. Cylindrical containers of the same size (dia-
meter 100 mm, height 120 mm) were used in all experiments. In the weld-sealed containers, only one
small orifice, of 2- to 2.5-mm diameter, was retained. In these experiments, the lowest degrees of car-
burization and oxidation were found to be exhibited by steel powder produced in containers with liquid seals,
and the highest by powder produced in containers with the normal type of closure. Intermediate degrees of
oxidation and carburization of powder were obtained with weld-sealed containers. This was due to the fact
that weld sealing and the presence of a small orifice resulted in an intermediate degree of gas-tightness
compared with the other two methods of closure, employing sand and liquid seals.

On the basis of this investigation, a modified process was developed at the BPMF involving the use
of charges of minimum ammonium chloride content combined with liquid sealing of containers during the
diffusional-impregnation operation. The new variant of the process proved to be satisfactory in pilot-plant
trials, and is now being used in production. A flow sheet illustrating the manufacture of Kh30 powder at the
BPMF by the improved process is shown in Fig. 1.

In the new process charge materials are mixed in a vane mixer of 100-liter capacity. The metal
powders are mixed first, for 15-20 min, after which ammonium chloride and ammonium bicarbonate are
added to them, and mixing is continued for another 15 min. The weight of a single mixer charge is 160 kg.

For the liquid seals of containers, use is made of sodium silicate mass, to GOST 8263-56 standard,

* A 30% Cr steel – Translator.

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The thickness of the liquid seal has a pronounced influence upon the properties of the resultant powder. Increasing the seal thickness lowers the degree of carburization of the sponge and increases the amount of chlorides remaining in the powder. Consequently, seal thicknesses of more than 10-15 mm are not recommended.

Diffusional impregnation is performed in pusher-type continuous furnaces. The temperature outside the muffle is 1200-1220°, and there is a temperature drop of 50-60 deg C between the outer and inner muffle walls. A tray-pushing period lasts 50 min, which corresponds to a total residence time of trays in the hot zone of the furnace of 5 h. The alloy sponge produced is crushed and milled, first in a hammer mill and then in a ball mill, and the resultant powder is screened in a vibratory sieving machine.

The chemical compositions and processing characteristics of several industrial batches of Kh30 powder produced in liquid-sealed containers are listed in Table 1. Included for purposes of comparison are corresponding data for powders produced in containers without liquid seals. Compared with the old process, diffusional impregnation in containers with liquid seals improves the compressibility of Kh30 powder, increases its apparent density, and decreases its carbon and chlorine contents by factors of three and 10-20, respectively.

A comparison of the microstructures of industrial batches of Kh30 powder produced in containers with and without liquid seals is shown in Fig. 2, from which it can be seen that powder manufactured by the old method has a much higher carbide phase content (Fig. 2a).