A NOVELTY IN THE FIELD OF TITANIUM POWDER METALLURGY

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When producing articles of titanium and titanium alloys by conventional technology, 70 to 80% of the input metal is lost as scrap between the ingot and the final product. The yield of usable product does not ordinarily exceed 20 to 25%. (1-2) Powder metallurgy allows a four to five-fold increase in metal utilization and a one and one-half to two-fold decrease in labor consumption when machining articles, thus resulting in a savings of six to ten thousand roubles per ton of final product. (3)

Powder metallurgy permits the production of new types of articles which cannot be made by the conventional methods, for example, porous filter elements. Titanium filters as compared to ceramic filters are characterized by considerably higher mechanical strength, resistant to hydraulic and temperature shocks, and resistant to attack of most aggressive industrial media. With the benefits of increasing equipment life, enhancing equipment capacity and reducing losses of in-process material and products, the savings due to the application of porous titanium elements amounts to from 400 to 1000 roubles per year per 1m² of articles. (4)

The production of filler electrode material for titanium welding can be effected by the extrusion of titanium powders (welding electrodes) or the mixture of powders and carbides and borides of metals (build-up electrodes) with a considerable simplification of technology, improvement of quality and lowering of their cost as compared to conventional methods.

A considerable economical effect is due to the direct use of titanium powders as fillers for corrosion-resisting coatings in
electrode and hard-alloy operations, alloying additives for high-manganese and carbon steels.\(^6\) Titanium powder, for example, improves noticeably physico-chemical and mechanical properties of epoxide resin-based corrosion-resisting coatings. The application of powder as filler allowed use of these coatings as corrosion-proof coatings for metallic and reinforced constructional structures, gas conduits, galvanic baths and various equipment subjected to the attack of acids, alkalines, gases and condensates. The economical effect due to the application of 1 t of titanium powder included in the composition of a coating attains 5-6 thousand roubles per year\(^7\).

There are many known variants of titanium powder production flow sheets.\(^8\) Some of them - grinding of spongy and compact titanium, spraying of liquid metal - have been tested only in laboratory and large-sized laboratory scales. Others - calcium hydride reduction of titanium oxide and electrolysis of melts with a soluble titanium anode - have been put into practice and allow obtaining titanium powders which are applied in many engineering fields.

Titanium powders have been obtained by the reduction of titanium dioxide with calcium and calcium hydride.\(^9\) This technique can also result in obtaining titanium-based alloy powders by calcium hydride reduction of the mixture of titanium oxides and alloying elements.

Pure titanium metal is notable for a high malleability and viscosity, which makes the operation of obtaining powders by mechanical grinding rather difficult. There has been developed the technique of obtaining titanium powders based on the utilization of highly brittle hydrogenated metal and relative simple transformations in the system of titanium-titanium hydride.\(^10\) The main advantage of the method is the facilitation of grinding operation.

There is known the technique of obtaining titanium powders by spraying of liquid metal.\(^11\) The technique consists in melting down a fast rotating rod of titanium or its alloys (up to 15 thousand revolutions per min.) in an electric arc. Molten metal drops thrown away by centrifugal force solidify in a protective atmosphere of argon or helium before they get to the chamber walls.

The recent time has seen the practice of the technique to produce titanium powders by electrolysis of melts with a solute anode of titanium wastes.\(^12\) The main advantage of this process is the attainment of a high purity powder, as far as the impurities of concern, especially oxygen and nitrogen, as well as the possibility to regulate powder properties within wide limits by the change of electrolysis parameters.

Titanium powder particle shape is determined by the method of