United States Patent Office 3,549,408 Patented Dec. 22, 1970

3,549,408

IMPREGNATION OF A MATERIAL BASED ON CARBON BY MOLTEN METALS

Roger Bonne, Aulnay-sous-Bois, Maurice Jacquot, Neuilly Plaisance, and Jacques Fourre, Epinay-sur-Seine, France, assignors to Societe Le Carbone Lorraine, Paris, France, a French body corporate

No Drawing. Filed Mar. 1, 1968, Ser. No. 709,787
Claims priority, application France, Apr. 14, 1967, 107,782
Int. Cl. B44d *1/092*; C23c *1/00*
U.S. Cl. 117—47 1 Claim

ABSTRACT OF THE DISCLOSURE

The invention relates to a method of impregnating carbon or graphite with metal by forcing molten metal into the pores under pressure, in which method the pressure necessary for impregnation is lowered and the force which tends to cause the metal to re-emerge is reduced by applying boric acid or ammonium phosphate to lower the surface tension of the metal-carbon couple. Application may be by previous introduction into the carbon and a preferred amount is from 0.05 to 5% by weight of impregnated product.

The method of impregnating carbon, e.g. graphite with metal by forcing molten metal into the pores under pressure is improved by applying a surface tension lowering substance. This substance may be applied to the carbon, e.g. graphite prior to the injection of the molten metal. The substance may be boric acid or ammonium phosphate amounting to 0.05 to 5% by weight of the product.

The present invention relates to a method of impregnating carbon material with molten metal and to the products thereof.

The introduction of metals into the porosity of graphite by forcing the molten metal to penetrate into the pores is known. It has been described in particular in French Pats. Nos. 1,240,638 filed on July 29. 1959 and entitled: "New material for rocket nozzles and its method of manufacture" and its first addition No. 87,076 filed on Dec. 24, 1964, and No. 1,368,129, filed on Mar. 18, 1963 and entitled: "Method of metallic impregnation and members impregnated according to the method."

It is known that in general, molten metals do not wet carbon, that is to say, a drop of molten metal placed on a carbon surface has no tendency to spread out; similarly, of a molten metal contained in a carbon tube is considered, the surface tension of the molten metal A is responsible for a force f tending to cause the metal to emerge from the tube and equal to:

$f=2\pi r$ A, where r is the radius of the tube

In order to balance this force, it is necessary to apply a pressure p on the metal, such that:

$$f=\pi r^2 p$$

At equilibrium,

$$p=\frac{2A}{r}$$

and in order to cause a molten metal ot penetrate into a carbon tube, it is necessary to apply a pressure P greater than p.

It is seen that the pressure to be applied is greater as the radius of the tube is smaller.

For the sake of argument the porosity of a block of industrial carbon may be likened to channels of circular section. In order to impregnate such a block with a molten metal, it is necessary to apply a pressure which depends upon the minimal diameter of the channels.

When the impregnation by the molten metal is terminated, if pressure ceases to be exerted, the metal contained in the porosity is subjected to a force which tends to make it re-emerge, and if one imagines a porosity having no narrowing, the block will be completely emptied. In fact, the molten metal contained in cavities which communicate with adjacent cavities through a constriction is held therein, the force which it would have to be exert to emerge being greater than the force which drives it (i.e. the metal) out of the cavity. In practice, for two qualities of industrial carbons having the same total porosity accessible to the molten metal, one having a regular and largely open porosity, the other a "closed" porosity (irregular cavities separated by constrictions), it is established that the volume of metal found after depression, extraction of the pieces of molten metal and solidification of the metal in the carbon, is greater in carbon with closed porosity than in carbon with open porosity. In practice, it is established that, according to the qualities of carbons which have not been specially treated, 30 to 50% of the porosity is emptied in the course of expansion.

It is an object of the present invention to provide an improved method for impregnating carbon materials with molten metal which reduces these disadvantages.

According to the invention there is provided a method of impregnating carbon with metal by forcing the molten metal into the carbon, the improvement comprising applying to the carbon a substance selected from the group consisting of boric acid and ammonium phosphate and comprising between 0.05 and 5% by weight of the treated carbon, which lowers the surface tension of the metal-carbon couple.

It is found that by adding these substances in small quantities, they act on the surface tension of the metal and carbon couple, so that, during a metallic impregnation, the carbon retains the maximum of metal for a given total porosity. These additives may be introduced previously into the carbons and graphites by a suitable treatment.

It has been ascertained that the addition of boron in the form of boric acid, into a carbonaceous mixture, leads, after being shaped and baked, to an industrial carbon such that the surface tension of the metal-carbon couple thus obtained is lowered. The consequence of this is a lowering in the pressure necessary for impregnation and a reduction in the force which tends to make the metal re-emerge, this factor being the most important because it is difficult to influence by external means.

A similar effect is obtained by introducing phosphorus into the carbonaceous mixture in the form of ammonium phosphate.

The content of boric acid or ammonium phosphate may vary from 0.05 to 5%, expressed as ratio by weight.

In order that the invention may be more clearly understood, a specific example will now be described purely by way of non-limiting illustration.

The results of an impregnation with molten copper on two similar carbons have been compared. The carbons differed by the incorporation in one of them of 5% boric acid, this corresponding to a weight ratio of 0.85% boron.

After baking, the two carbons had the same characteristics of porosity, viz, 35%, and the carbon with boric acid contained 0.45% boron after baking.

Impregnation with molten copper gave the following results:

	Percent	
	Carbon without boric acid	Carbon with boric acid
Initial porosity	35	35
Average ratio of copper (weight of copper/weight of the impregnated product)	55	62
Residual porosity	17	10

An increase in the weight ratio of copper and a substantial reduction of the residual porosity over the product of the conventional process are thus achieved.

Similar results have been obtained in using ammonium phosphate.

It will be apparent that various modifications and changes could be made in the embodiment described without departing from the inventive concept which is defined in scope by the appended claims.

We claim:

1. In the method of impregnating carbon with metal by forcing the molten metal into the carbon, the improvement comprising applying to the carbon a substance selected from the group consisting of boric acid and ammonium phosphate and comprising between 0.05 and 5% by weight of the treated carbon, which lowers the surface tension of the metal-carbon couple.

References Cited

UNITED STATES PATENTS

2,422,215	6/1947	Amberg et al.	117—47
2,983,034	5/1961	Humenik et al.	117—228X
3,160,519	12/1964	Parisot et al.	117—160X
3,288,573	11/1966	Abos	117—160X
3,390,013	6/1968	Rubisch	117—228X
3,396,054	8/1968	Gremion	117—228X

FOREIGN PATENTS

669,472	8/1963	Canada	117—160

WILLIAM D. MARTIN, Primary Examiner

H. J. GWINNELL, Assistant Examiner

U.S. Cl. X.R.

117—160, 169