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(54) **Water-soluble casting core**

(57) A core for use in investment casting comprises a ceramic material and a binder such as sodium aluminate which is soluble in water and stable up to such temperatures that the core is refractory above 800°C. Such a core is manufactured by forming the mix of the ceramic material and binder into a granulated semi-dry powder which is then pressed in a die from which it is removed and dried and then fired before use. Alternatively the ceramic material and binder are mixed with an additional organic binder with the resultant mix being granulated and injected under pressure into a die. After removal from the die the core is fired to burn out the organic binder. When such cores are used they can be leached out after casting with a hot solution of dilute boric acid or other weak acid which acts to neutralise any sodium hydroxide formed.

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SPECIFICATION

Improvements in or relating to casting cores

The invention is concerned with improvements in or relating to casting cores and is particularly, but not exclusively, concerned with investment casting cores and methods of manufacturing same.

The ceramic cores presently used in investment casing, for example for the casting of turbine blades, etc. in the aerospace industry, are normally formed from a material or materials which is or are soluble in caustic alkali. The use of the latter however is not appropriate when it is desired to cast certain alloys because of chemical attack by the caustic alkali.

According to the present invention there is provided a core for use in a casting, said core being formed of a ceramic material and a binder which is stable up to such temperatures that the core is refractory above 800°C, and which is soluble in water.

Preferably the binder is sodium aluminate.

The present invention also provides a method of manufacturing a core for use in casting, said method comprising mixing a ceramic material with a binder which is soluble in water, and solidifying the mix to form a core which is refractory above temperatures of 800°C by virtue of the temperature stability of the binder.

Preferably the mix is formed as a granulated semi-dry powder and is pressed in a die to form the core. Alternatively, the mix is formed as a granulated powder and is mixed with an additional organic binder, the latter mix being granulated and injected under pressure into a die to form a core, the core subsequently being fired to remove the additional organic binder.

An embodiment of the present invention will now be described by way of example only.

A core for investment casting of light alloys comprises a ceramic grain, for example zircon or alumina, bound together with a water soluble binder. The latter preferably is sodium aluminate as this compound is stable up to 1800°C and imparts stability to the formed core at temperatures well in excess of 1000°C.

In one method of manufacturing such a core, the ceramic grain is coated with a solution of sodium aluminate and sodium phosphate by mixing, together with a release agent such as magnesium stearate. After mixing, the paste formed is dried overnight, then recrushed to a sieve size of −60 mesh. This powder is then mixed with 7.5% volume by weight of a saturated solution of sodium aluminate and after thorough mixing in, for example, a z-blade mixer, the semi-dry powder is granulated and pressed in a steel or hard alloy die at a pressure of $\frac{1}{4}$-$\frac{1}{2}$ ton per square inch. The core is then removed from the die and dried.

Before use, the core is fired to 800°C for one half to one hour. Cores based on sodium aluminate are found to become slowly insoluble under normal conditions due to reaction with atmospheric H_2O and CO_2 and this firing reconverts any hydrolysed and carbonated sodium aluminate back to the metal aluminate. The core is then ready for metal pouring, for example in a ceramic shell or resin-sand mould.

In an alternative manufacturing method, the ceramic grain having a particle size distribution to provide a good packing density, is given an initial coating of sodium aluminate as in the previous method. After drying the powder is recrushed and blended with a solution of a suitable organic binder and sodium aluminate.

This solution is prepared by firstly dissolving sodium aluminate in water, cooling and filtering. A known quantity of polyethylene glycol is melted and three parts by volume of the sodium aluminate solution are added to seven parts by volume of the molten polyethylene glycol with constant stirring. The two liquids are found to be perfectly miscible. Up to 0.5% of a suitable surfactant may be added to aid dispersion.

The coated ceramic grain is then added to the mixture prepared as in the preceding paragraph in a jacket-heated mixer and stirred constantly to give a filler loading of 70% by volume (greater than 80% by weight). After cooling, the mix is granulated and is injected under pressure using a heated barrel injection moulding machine into a steel or hard alloy die. After removal from the die the core is fired to 800°C to burn out the organic binder and to convert the precipitated sodium aluminate into a dimensionally stable cementing agent for the ceramic grain. The rate of firing, especially over the range 0-500°C, is critical in ensuring that the organic component of the binder does not disrupt the core during burning out, and is dependent on the core size and shape. For certain applications it may be necessary to add a plasticizer, for example a phthalate, and/or a release agent such as a stearate, to the binder and ceramic powder mix.

After casting, the core is leached out in a hot solution of dilute boric acid or other weak acid. The acid is necessary to neutralize the sodium hydroxide produced by the reaction of the sodium aluminate and water and thus to prevent attack on the alloy. When the sodium aluminate dissolves the core collapses and the ceramic grain slurry may be readily removed from the casting.

It is to be appreciated that the use of such a core is not restricted to investment casing and may find use in die casting, shell casting, and sand casting.

CLAIMS

1. A core for use in casting, said core being formed of a ceramic material and a binder which is stable up to such temperatures that the core is refractory above 800°C, and which is soluble in water.

2. A core according to claim 1, wherein the binder is sodium aluminate.

3. A method of manufacturing a core for use in casting, said method comprising mixing a ceramic material with a binder which is soluble in water, and solidifying the mix to form a core which is refractory above a temperature of 800°C by virtue of the temperature stability of the binder.

4. A method according to claim 3, wherein the

mix is formed as a granulated semi-dry powder and is pressed in a die to form the core.

5. A method according to claim 4, wherein the mix is formed as the granulated semi-dry powder by mixing the ceramic material with a solution of sodium aluminate and sodium phosphate together with a release agent, so as to coat the ceramic material, the latter mix being dried, crushed to a powder, mixed with a saturated solution of sodium aluminate, and granulated.

6. A method according to claim 4 or 5, wherein the semi-dry powder is pressed in the die at a pressure of $\frac{1}{4}$-$\frac{1}{2}$ tons per square inch.

7. A method according to any of claims 3 to 6, wherein the core is subsequently fired.

8. A method according to claim 7, wherein the core is fired to a temperature of 800°C for a time of between one half hour and one hour.

9. A method according to claim 3, wherein the mix is formed as a granulated powder and is mixed with an additional organic binder, the latter mix being granulated and injected under pressure into a die to form a core, the core subsequently being fired to remove an additional organic binder.

10. A method according to claim 9, wherein the additional organic binder is formed into a solution with sodium aluminate prior to mixing with the granulated powder.

11. A method according to claim 10, wherein the organic binder is polyethylene glycol.

12. A method according to claim 10 or 11, wherein a plasticiser is added to the mix of the ceramic material and the binder.

13. A method according to any of claims 10-12 wherein a release agent is added to the mix of the ceramic material and the binder.

14. A core for use in casting according to claim 1 and substantially as hereinbefore described.

15. A method of manufacturing a core for use in casting substantially as hereinbefore described.

16. Any novel subject matter or combination including novel subject matter herein disclosed, whether or not within the scope of or relating to the same invention as any of the preceding claims.

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