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(54) Title: NEW REFRACTORY COMPOSITIONS

(57) Abstract

Storable, aqueous, refractory suspensions containing refractory materials, water, and an inorganic binder of aluminum monophosphate, sodium silicate, or potassium silicate; and processes of using the composition to form shell molds.

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NEW REFRACTORY COMPOSITIONS

BACKGROUND OF THE INVENTION

This invention relates to the preparation of shell molds and to compositions useful in the manufacture of refractory coatings. In particular, this invention relates to aqueous suspensions of refractory materials.

The investment cast process has proven to be of high value in the preparation of castings of numerous items, particularly small and intricate castings. It produces castings with high dimensional accuracy, superior surface and excellent shape.

In this process, an expendable pattern is made of wax or a plastic material. These expendable patterns are given repeated coatings of refractory materials in order to prepare a shell mold. Normally the coatings are obtained by applying a slurry of the refractory material in hydrolyzed ethyl silicate or colloidal silica, which can be catalyzed with an amine or dried to form a hard shell. Once the shell has formed, the pattern is removed by use of heat or solvent resulting in the desired mold.

The strength of the shell mold apparently is caused by the silane bond formed by the silica contained in the ethyl silicate or colloidal silica in the refractory slurry used to coat the expendable pattern and to form the shell mold. The number of layers of refractory forming the coating determines the strength of the shell. Thin shells require the support of sand when the metal is poured into them during the casting of the required parts, whereas thicker shells produced from five to ten coatings normally do not require this support being strong enough to support the poured metal.

While the product of the investment casting process is excellent, the cost of the process has limited its use. This high cost is, at least, partially caused by the need to use the described slurry of the refractory material which need be prepared at the site of the casting operation.

It is, therefore, an object of the present invention to develop a procedure for preparing shell molds that does not use a slurry of the refractory materials in hydrolyzed ethyl silicate or colloidal silica.

It is another object of the present invention to devise compositions containing refractory materials that can be transported distances and stored so as to eliminate the need to prepare the composition at the site of the casting.

Another object is to lower the cost of performing the investment casting process.

Other objects will become apparent from the ensuing description.

SUMMARY OF THE INVENTION

It has now been found that storable aqueous suspensions of refractory materials containing an inorganic binder selected from the group consisting of aluminum monophosphate, sodium silicate and potassium silicate can be prepared as a premix refractory composition useful for the preparation of shell molds. These aqueous refractory suspensions can be shipped, ready for use at the casting site and only require mixing before being applied to the expendable pattern in the preparation of shell molds.

DETAILED DESCRIPTION

The aqueous refractory suspensions of the present invention contain as their essential components

water, refractory materials and an inorganic binder selected from the group consisting of aluminum phosphate, sodium silicate and potassium silicate. In addition, other minor components, such as wetting agents, suspending agents, viscosity modifiers, preservatives, organic binders and other like materials known to the art for the preparation of such suspensions can be present in a total amount that should not exceed five weight percent of the suspension, preferably less than two percent by weight of the suspension. These materials improve the quality of the suspension by modifying the viscosity and surface tension of the water. Among materials that can be used are fluorinated surfactants such as the ZONYL brand products, alkylphenols such as nonylphenol, sodium lauryl sulfate, alkylarylsodium sulfonate, polyethylene glycol ether of primary and secondary alcohols, alkyl phenol ethoxylate, cellulose materials such as methocell, hydroxyethylcellulose, carboxymethylcellulose and the like. The advantage of using a small amount of an organic binder is that while the inorganic binder of the present aqueous refractory suspension will not burn out when heating the shell mold and will cause solubilization of the prior coating when the multiple coatings are being applied, the organic or secondary binder will not be solubilized by subsequent coatings, but it will burn out during the heating phase. In order to obtain a strong shell mold it is necessary to apply several coats of the refractory suspension. If the coat being applied solubilizes the prior coat, then the new coat will not remain firm and it will be difficult to build up a sufficient thickness of refractory material. Organic binders include polyvinylacetate emulsions, acrylic emulsions and polyvinyl alcohol. The amount of water in the suspensions is that necessary to form a suspension of the refractory material and binder.

Normally the water will constitute between about 20 and about 35 weight percent of the suspension.

The refractory material to be used in the present emulsions can be selected from the broad classification known to the art. Included are quartz, silica, zirconia, zircon, mullite, aluminosilicates, alumina fused silica and others. The refractory material constitutes the major amount of the present aqueous dispersion, i.e. from about 50 to about 75 weight percent, preferably about 60 to about 70 weight percent.

It has been found in preparing and testing the compositions of the present compositions that it is desirable that the refractory be present in more than one shape. This is particularly useful in the preparation of castings of intricate design where it imparts improved dimensional strength to the shell mold. Thus, the presence of from about one to about ten weight percent of the refractory material, in the form of fibres, in the present composition is a preferred option. Fibres normally have a length of about from less than about 0.25 to about 0.50 inches. Other shapes are possible.

The inorganic binder component of the present refractory suspension constitutes about five to about ten weight percent of the suspension, i.e., it is normally present in an amount of from about 10 to about 25 weight percent of the refractory material. The exact amount of each component may vary with the identity of the specific components without changing the usefulness of this suspension.

The following Examples illustrate refractory compositions within the scope of the present invention:

EXAMPLE 1

Component	Amount (Pounds)
Aluminum silicate mineral	437
Aluminum silicate fibres	9
Aluminum silicate spheres	100
Sodium silicate	80
Suspending agent	1
Attapulgite clay	2
Bactericide	0.8
Defoaming Agent	0.6
Water	199.6

EXAMPLE 2

Component	Amount (Pounds)
Aluminum silicate mineral	665
Aluminum silicate fibres	9
Sodium silicate	80
Suspending agent	1
Attapulgite clay	2
Bactericide	0.8
Defoaming Agent	0.6
Water	191.6

EXAMPLE 3

Component	Amount (Pounds)
Aluminum silicate mineral	500
Aluminum silicate spheres	100
Sodium silicate	80
Suspending agent	1
Attapulgite clay	2
Bactericide	0.8
Defoaming Agent	2.5
Polyvinyl Acetate Emulsion	9.0
Water	237.4

EXAMPLE 4

Component	Amount (Pounds)
Aluminum silicate mineral	500
Aluminum silicate spheres	100
Aluminum silicate fibres	9.0
Aluminum phosphate	80
Attapulgite clay	3
Bactericide	0.8
Defoaming agent	2.5
Water	191.6

EXAMPLE 5

Component	Amount (Pounds)
Aluminum silicate mineral	500
Aluminum silicate spheres	100
Sodium silicate	80
Suspending agent	1
Attapulgite clay	2
Bactericide	0.8
Defoaming agent	2.5
Polyvinyl acetate emulsion	9.0
Water	237.4

EXAMPLE 6

Component	Amount (Pounds)
Aluminum silicate mineral	340
Aluminum silicate spheres	200
Aluminum silicate fibres	9
Defoaming agent	4
Aluminum phosphate	75
Polyvinyl acetate emulsion	9
Water	191.6

EXAMPLE 7

Component	Amount (Pounds)
Aluminum silicate mineral	500
Aluminum silicate spheres	100
Aluminum silicate fibres	9.0
Potassium silicate	80
Attapulgite clay	3
Bactericide	0.8
Defoaming agent	2.5
Water	191.6

EXAMPLE 8

Component	Amount (Pounds)
Aluminum silicate mineral	500
Aluminum silicate spheres	100
Potassium silicate	80
Suspending agent	1
Attapulgite clay	2
Bactericide	0.8
Defoaming agent	2.5
Polyvinyl acetate emulsion	9.0
Water	237.4

EXAMPLE 9

Component	Amount (Pounds)
Aluminum silicate mineral	570
Aluminum phosphate	75
Water	225

The refractory material used in these Examples was aluminum silicate; however, it can be replaced with other refractory materials without other modification. In addition, the following products were used in preparing the products of the Examples:

KYANITE Aluminum Silicate Mineral
ZEOSPHERES Aluminum Silicate Spheres
VFS 110 Aluminum Silicate Fibres

KELZAN Suspending Agent
ATTAGEL 50 Attapulgite Clay
DOWICIDE A Bactericide
TROY-D126 Defoaming Agent

Shell molds were prepared by applying several coatings of the above-identified suspensions to polystyrene patterns. The patterns were removed by heating and castings were prepared by pouring aluminum, iron and steel into the mold. All of the castings obtained from molds prepared from the above-identified mold were satisfactory meeting the requirements of shape and strength.

In preparing shells by the application of the present refractory suspension, it is necessary to form multiple coatings of the refractory material on the pattern. In doing so, it is necessary to dry each coating prior to the application of the next coating. Drying can be readily accomplished by air or other means. The number of coats of refractory to be applied to the pattern is a function of the strength required for the shell mold. Three or four coatings of refractory on an expanded polystyrene pattern will create a thickness of 1/8"-1/4". At that time, the polystyrene can be removed by the use of solvent or by heating the shell in a furnace at a temperature of about 600°F to about 2,000°F. Additional heating of the shell at these temperatures will remove any organic or other material that is deposited in the pores of the shell. In addition, the heating will increase the strength of the shell. Heating to 700°F will impart sufficient strength to the shell to allow the casting of steel.

As previously indicated, the present refractory suspensions constitute a sufficient cost savings over the use of slurries of ethyl silicate and colloidal silicate. The fact that the shell molds obtained by use of the present aqueous suspensions have

sufficient strength after heating to 700°F represents a significant savings in energy costs since the slurry technique produces shell molds which need be heated to about 1,200°F to 1,800°F so as to develop adequate strength for the pouring of castings.

CLAIMS:

1. A storable aqueous suspension of refractory materials useful for the preparation of shell molds which comprises refractory materials, water and an inorganic binder selected from the group consisting of aluminum monophosphate, sodium silicate and potassium silicate.

2. The storable aqueous suspension of Claim 1 wherein the refractory material comprises from about 50 to about 75 weight percent of the aqueous suspension.

3. The storable aqueous suspension of Claim 2 wherein the inorganic binder comprises from about 10 to about 25 weight percent of the refractory material.

4. The storable aqueous suspension of Claim 3 which comprises from about 60 to about 70 weight percent of refractory material, from about five to about ten weight percent of the inorganic binder and sufficient water to form a suspension of the refractory material and the inorganic binder.

5. The storable aqueous suspension of Claim 4 wherein the inorganic binder is aluminum monophosphate.

6. The storable aqueous suspension of Claim 4 wherein the inorganic binder is sodium silicate.

7. The storable aqueous suspension of Claim 4 wherein the inorganic binder is potassium silicate.

8. The storable aqueous suspension of Claim 4 which contains up to about two weight percent of additives selected from the group consisting of wetting agents, suspending agents, viscosity modifiers, preservatives and organic binders.

9. In a method for making a shell mold by the application of refractory material to an expendable pattern, the improvement which comprises applying to the surface of the pattern an aqueous suspension comprising refractory material, water and a binder selected from the group consisting of aluminum monophosphate, sodium silicate and potassium silicate, drying the wet coating and repeating the application and drying until the shell mold is of the desired thickness.

10. The method of Claim 9 wherein the refractory material comprises about 50 to about 75 weight percent of the aqueous suspension.

11. The method of Claim 10 wherein the inorganic binder comprises from about 10 to about 25 weight percent of the refractory material.

12. The method of Claim 11 wherein the aqueous suspension comprises from about 60 to about 70 weight percent of refractory material from about five to about ten weight percent of the inorganic binder and sufficient water to form a suspension of the refractory material and the inorganic binder.

13. The method of Claim 11 wherein the inorganic binder is aluminum monophosphate.

14. The method of Claim 11 wherein the inorganic binder is sodium silicate.

15. The method of Claim 11 wherein the inorganic binder is potassium silicate.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US88/02844

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC: C04B 28/26, 28/34, 12/02, 12/04

U.S. CL. 106/38.22, 38.27, 38.3, 84, 85

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	106/38.22, 38.27, 38.3, 84, 85

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

U.S. Automated Patent System Database Word Search

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X Y	US, A, 4,363,665, (Barrier et al), 14 December 1982 (See entire document)	1-4,6,7,9-12 14,15 1-15
Y	US, A, 3,959,002, (Esper), 25 May 1976 (See especially column 2, lines 45-46)	5,13
Y	US, A, 4,644,014, (Thomson et al), 17 February 1987, (See especially column 4, lines 11-15)	1-8
Y	US, A, 4,014,704, (Miller), 29 March 1977, (See especially claim 1)	8

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
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