

1

2,817,128

## FOUNDRY SAND COMPOSITIONS AND PROCESS OF MAKING

John A. Wickett, Longmeadow, Mass., assignor to Monsanto Chemical Company, St. Louis, Mo., a corporation of Delaware

No Drawing. Application May 15, 1952,  
Serial No. 288,044

17 Claims. (Cl. 22—193)

This invention relates to foundry sand compositions for preparing molds and cores. More particularly, the invention relates to modified foundry sand compositions which have better workability characteristics and produce fewer defecting moldings.

In preparing molds and cores for casting hot metals, it is the usual practice to use a sand base consisting substantially of silica which is as free as possible from contaminating organic impurities. To prepare molds, the sand is mixed with small percentages of clay and water and frequently a flour or cereal. The mixture is tamped into a flask or mold box against a pattern to form the mold. Molten metal is then cast into the mold. If a sand core is needed, an added firing step is required prior to the casting of the molten metal.

A major problem in the use of sand molds is the formulation of the sand compositions used to prepare the molds. Basically, the compositions comprise sand, clay and water but if only these ingredients are used, every step is extremely critical, i. e., the purity and amounts of each ingredient must be rigidly controlled, the mixing process must be carried out in a strict cycle permitting substantially no variation and the tamping process requires great care.

Many attempts have been made to improve the workability of the basic sand mold compositions and thereby render the process less critical. Most beneficial of these have been the addition of various flours or cereals, carbonaceous materials such as sea coal, and natural resins such as asphalt, bitumens, etc. The addition of these materials increases the strength of the molds and improves the surface thereof. But such compositions still require careful control of water and clay content, mixing action and tamping steps.

One object of this invention is to provide a new foundry sand mold composition.

A further object is to provide foundry sand mold compositions having improved workability.

Another object is to provide a modified foundry sand mold composition which will not ball up in mixing operations.

Still another object is to provide a foundry sand mold composition which will tolerate more water and enable a more thorough distribution of the water throughout the composition and still produce satisfactory castings.

These and other objects are attained by incorporating a synthetic polyelectrolyte into the usual sand mold compositions comprising sand, clay and water and, if desired, other additives such as flour, cereal, wood fibers, asphalts, etc. By the word "polyelectrolyte" as used in this specification it is intended to mean a polymeric composition which has electrolytic properties and which when dissolved or dispersed in water forms polymeric ions each containing a large number of electrolytic sites.

The following examples are given in illustration and are not intended as limitations on the scope of this invention. Where parts are mentioned, they are parts by weight.

2

### Example I

Mix together in a standard muller, 675 parts of spent sand, 125 parts of bentonite and 0.5 part of the sodium salt of partially hydrolyzed polyacrylonitrile until the dry ingredients appear to be thoroughly comingled. Then add to the mixture, 200 parts of new foundry sand containing about 40 parts of water and mull the ingredients together until a uniform mixture of all ingredients is obtained.

Sieve a portion of the mixture on a #6 screen to determine the clay ball content of the mixture. Under standard operating conditions without the polyelectrolyte, the clay ball content will range from 4% to 5%. Using the mixture containing the polyelectrolyte, the clay ball content ranges from 0.1% to 0.5%.

Prepare a standard mold from the mixture of the example by a conventional tamping or ramming process in a flask or mold box. The tamping of the sand composition into the flask produced a uniform sand mold in which no evidence can be found of localized concentration of any of the ingredients of the sand mold composition. Using the standard mix without the polyelectrolyte, it is often found that water or clay, or both, are evenly distributed throughout the mold and these spots of concentration of water or clay are more dense rendering the mold uneven. The green compressive strength of the mold containing the polyelectrolyte is about 18.5 p. s. i. whereas the same composition without the polyelectrolyte gives a mold having a green strength of about 16.7 p. s. i.

The difference in uniformity between molds containing polyelectrolyte and molds containing no polyelectrolyte is illustrated by testing a vertical cross-section of such molds with a penetrometer. To perform the tests, molds are prepared in a test box having removable sides. The sides are removed and tested for hardness after which the molds are carefully cut in two by a vertical cut from top to bottom and the exposed cross-section is tested. Molds prepared from compositions containing the polyelectrolyte have a uniform hardness from top to bottom and from center to sides whether tested on the exterior mold surfaces or on cross-sections of the molds. Molds prepared from the same compositions except for the polyelectrolyte, frequently have localized spots of extreme hardness generally near the bottom of the mold. Hard spots are also found at localized concentrations of clay, water, or both. Such uneven distribution of clay and water is not found in compositions containing the polyelectrolyte.

### Example II

Prepare a sand mold composition from a standard silica sand and bentonite using 8 parts of bentonite to 88 parts of sand and about 4 parts of water. Divide this into 4 equal parts. Prepare a mold from portion 1 without further additions. To portion 2, add 0.2% by weight of a sodium salt of a hydrolyzed polyacrylonitrile. Mix the ingredients together and prepare a mold therefrom. To portion 3, add 1.5% water by weight, mix and prepare a mold. To portion 4, add 1.5% by weight of water and 0.2% by weight of the sodium salt of hydrolyzed polyacrylonitrile. Cast malleable iron into the molds.

Portion 1 of the example is a standard sand mold composition. Molds prepared from it have a compressive green strength of about 10 p. s. i., a permeability of about 70 and a hardness of from 55 to 75, each of the figures given being determined by standard American Foundry Association tests. The molds generally have a number of voids and the castings produced therefrom exhibit considerable surface roughness which must be removed in a finishing operation.

Molds prepared from portion 2 have a compressive

green strength of about 8, a permeability of about 60 and a hardness of from 60 to 65. Substantially no voids were found in the molds and castings made therefrom are excellent showing little or no roughness and thus needing little or no finishing.

Molds prepared from portion 3 have a compressive green strength of about 9, a permeability of about 40 and a hardness of from 60 to 86. The molds contain a number of voids and castings made therefrom show very bad penetration of the molds by the metal accompanied by burning-on of the sand.

Molds prepared from portion 4 have a compressive green strength of about 7, a permeability of about 50 and a hardness of from 50 to 65. A few voids are noticed in the molds. Castings prepared from the molds are quite similar to those prepared from portion 1. They are slightly rough as would be expected from the appearance of a few voids in the mold surfaces but there was no penetration of the molds by the molten steel and no burning-on of the sand.

This set of experiments shows that when 0.2% by weight of a polyelectrolyte is added to a sand mold composition, the amount of water in the sand composition becomes much less critical and permits a partial relaxation of the strict control of water content hitherto necessary for the production of sand molds.

In the preparation of the molds from the various portions of Example II, it is found that the compositions containing no polyelectrolyte presented some difficulty in the tamping operation. The compositions did not tamp evenly unless they were loaded evenly into the flask and then tamped with care. Those portions containing the polyelectrolyte could be quickly loaded into the flasks without much attention being given to spreading them therein and they tamped quickly into a uniformly compacted mass.

Molds prepared from portions 2 and 4, when cut in two and tested for hardness on the vertical plane, show substantially no difference in hardness from one location to another.

Molds prepared from portions 1 and 3 are considerably harder at the bottom and grow progressively softer towards the top.

From experiments 1 and 2, it is seen that the addition of a polyelectrolyte to a sand mold composition eases the critical nature of water control in the compositions, prevents clay balling almost completely and at least partially eliminates the appearance of voids in the molds. Furthermore, when the amount of polyelectrolyte is restricted to 0.05% by weight, the green strength of the molds is not lowered and may even be raised by the presence of the polyelectrolyte.

The polyelectrolyte used in Examples I and II was the sodium salt of a polyacrylonitrile having an average degree of polymerization of about 1000 and which had been simultaneously hydrated and hydrolyzed so that about 25% of the original nitrile groups had been converted to amide groups and 75% of the original nitrile groups had been converted to carboxyl groups.

#### Example III

Mix 100 parts of foundry sand containing about 2% by weight of clay with 5.7 parts of water and 0.05 part of a copolymer of vinyl acetate and maleic anhydride. The mixing operation should be carried out by mulling the sand and dry copolymer polyelectrolyte together for about two minutes, then adding the water and continuing the mulling for about four minutes. The composition produced has an unusually dry feel, flows evenly and uniformly and contains substantially no clay balls. The composition packs easily and uniformly in molding flasks whether the packing is done by jolting, slinging, squeezing or tamping methods. The molds thus prepared have a green compressive strength of from 7.0 to 7.8 p. s. i. and a green permeability of 80. Substantially

no flaws appear in the molds. These results are unusual since the amount of water used is about 25% more than the normal amount.

When a composition similar to that of Example III is prepared without the polyelectrolyte, it is quite wet, contains numerous clay balls, rams unevenly in molding boxes or flasks and produces green molds having numerous flaws. The molds so produced have a green compressive strength of from 7.0 to 7.3 and a permeability of about 96.

The polyelectrolytes of this invention are also beneficial in the treatment of foundry sand compositions containing bituminous additives. It is found that, in spite of the bituminous coating on the sand and clay particles, the polyelectrolytes continue to operate to produce a more uniform, dryer and freer flowing composition which produces molds having substantially no surface flaws.

#### Example IV

Mix together in the dry pulverulent state, 100 parts of clean, moist silica sand, 0.036 part of corn flour, 0.178 part of asphalt, 0.043 part of sea coal, 0.32 part of clay and 0.05 part of a vinyl acetate-maleic anhydride copolymer in a standard muller for 2 minutes. Add 2.2 parts of water and continue mulling for about 4 minutes. A free flowing composition is obtained which feels dry to the touch and is easily rammed in standard operations. Molds prepared therefrom have substantially no surface flaws. They have a green compressive strength of about 9.6 and a permeability of about 102.

On analysis, the composition of Example IV is found to have about 4.0% moisture.

Using the same combination and adding about 0.8 part more of water, substantially the same results are obtained.

When Example IV is repeated without the added polyelectrolyte, the molds prepared from the mulled composition have higher green strength and higher permeability but poorer packing qualities or flowability and numerous flaws.

For optimum results, the amount of polyelectrolyte used should be controlled within the limits of 0.02 to 0.1 part per 100 parts of sand. Within these limits, slight effects on green compressive strength and permeability are observed, and the workability of the compositions is greatly improved, i. e., the amount of water used becomes less critical, the ramming or tamping operation becomes less critical and finishing operations may be substantially eliminated due to the near perfection of the surfaces of the molds. More polyelectrolyte may be used up to at least 1.0 part at the expense of green strength but with the advantage of the permissibility of using even greater amounts of water.

The polyelectrolytes which are operable are water-soluble polymers and copolymers of organic compounds having weight-average molecular weights of at least 10,000 and having a substantially linear continuous carbon chain derived by the polymerization of aliphatic unsaturated groups.

One type of compound useful in the practice of the invention is the equimolar copolymer of a polycarboxylic acid derivative and at least one other monomer copolymerizable therewith. The polycarboxylic acid derivative may be maleic anhydride, maleic acid, fumaric acid, itaconic acid, citraconic acid, aconitic acid, the amides of these acids, the alkali metal, alkaline earth metal, and ammonium salts of these acids, the partial alkyl esters, salts of the partial alkyl esters and the substituted amides of these polycarboxylic acids. The carboxylic acid, carboxylic acid salt, amide and substituted amide radicals are the ionizable groups which contribute to the hydrophilic properties and tend to make the polymers water-soluble. The hydrophilic properties may be entirely, or in part, due to the comonomer when acrylic acid, acrylamide, acrylic acid salts of alkali metals and ammonium,

N-substituted acrylamide and the corresponding derivatives of methacrylic, crotonic or other polymerizable acids are used. Thus, a copolymer of a dialkyl maleate and acrylic acid will be a water-soluble polyelectrolyte. When the hydrophilic maleic acid derivatives are used, hydrophobic comonomers may be used, for example ethylene, propylene, isobutylene, styrene, alpha-methylstyrene, vinyl acetate, vinyl chloride, vinyl formate, vinyl alkyl ethers, alkyl acrylates and alkyl methacrylates. In the practice of this invention, the dibasic acid derivatives of the copolymers may be maleic acid, maleic anhydride, sodium maleate, potassium maleate, ammonium maleate, calcium maleate, monosodium maleate, monopotassium maleate, monoammonium maleate, monocalcium maleate, and a monoalkyl maleate, maleic acid amide, the partial amide of maleic acid, the N-alkyl substituted maleic acid amide, the N-aminoethyl maleamide, the N-aminoethyl maleimide, the alkyl aminoalkyl maleamides, and the corresponding derivatives of itaconic, citraconic, fumaric and aconitic acids. Any of the said polybasic acid derivatives may be copolymerized with any of the other monomers described above, and any other which forms a copolymer with dibasic acid derivatives in equimolar proportions. The polybasic acid derivatives may be copolymers with a plurality of comonomers, in which case the total molar proportions of the comonomers will be equimolar with respect to the polybasic acid derivatives. Although these copolymers may be prepared by direct polymerization of the various monomers, frequently they are more easily prepared by an after reaction of other copolymers. For example, copolymers of maleic anhydride and another monomer may be converted to maleic acid copolymers by reaction with water and to metal salt copolymers by reaction with alkali metal compounds, alkaline earth metal compounds or ammonium compounds.

Certain of the hydrophilic derivatives of unsaturated polycarboxylic acids may be polymerizable in less than equimolar proportions with certain of the less hydrophobic comonomers, for example vinyl formate and vinyl acetate, or with monomers with ionizable groups such as acrylic acid, the alkali metal and ammonium salts of acrylic acid, acrylamides, and the various N-substituted acrylamides, methacrylic acid, the alkali metal and ammonium salts of methacrylic acid, methylacrylamide and the various N-substituted methacrylamides, crotonic acids and the alkali metal and ammonium salts of crotonic acids, the crotonamides and the N-substituted crotonamides, vinyl sulfonic acid, vinyl phosphonic acid and vinyl pyrrolidone. The hydrophilic derivatives of polycarboxylic acids include the half alkyl esters of maleic acid, and the partial alkyl esters of fumaric, itaconic, citraconic and aconitic acids. When less than 50 mol percent of these hydrophilic polybasic acid derivatives are used, and especially with the hydrophobic monomers, such as vinyl acetate and vinyl formate, the minimum proportion of polybasic acid derivative is that which will render the copolymer water-soluble.

Another modification of the copolymers of the various unsaturated polycarboxylic acid derivatives are those wherein more than 50 mol percent of the polycarboxylic acid derivative is copolymerized therein. This type of which fumaric acid and itaconic acid are examples of the hydrophilic monomer, may involve a wide variation with respect to the non-hydrophilic monomer, ethylene, propylene, isobutylene, styrene, alpha-methyl styrene, vinyl acetate, vinyl formate, vinyl alkyl ethers, alkyl acrylates and alkyl methacrylates being useful. If desired, the comonomer may be one which contributes to the hydrophilic property, for example vinyl alcohols, acrylic acid, methacrylic acid, acrylamide, methacrylamide and the various amides which have alkyl, aminoalkyl, or alkylaminoalkyl substituents on the nitrogen atom. The proportions of these various comonomers contemplate the use of more than 50 mol percent of the polybasic acid derivatives and less than 50 mol percent of the comono-

mer. The comonomer may be used in relatively small proportions, depending upon the hydrophilic or hydrophobic nature of the comonomer; sufficient total hydrophilic groups in both monomers must be present to render the resultant copolymer soluble in water under the conditions of use. This type of copolymer may involve a plurality of the polycarboxylic acid derivatives and/or a plurality of the comonomers.

Other suitable polyelectrolytic polymers are the polymers of acrylic or methacrylic acid derivatives, for example acrylic acid, the alkali metal and ammonium salts of acrylic acid, methacrylic acid, the alkali metal and ammonium salts of methacrylic acid, acrylamide, methacrylamide, the N-alkyl substituted amides, the N-aminoalkyl amides, and the corresponding N-alkylaminoalkyl substituted amides, the aminoalkyl acrylates, the aminoalkyl methacrylamides and the N-alkyl substituted aminoalkyl esters of either acrylic or methacrylic acids. These polymeric compositions may be the homopolymers or they may be copolymers with other copolymerizing monomers such as ethylene, propylene, isobutylene, styrene, alpha-methylstyrene, vinyl acetate, vinyl formate, alkyl ethers, acrylonitrile, methacrylonitrile, vinyl chloride, vinylidene chloride, the alkyl acrylates, the alkyl methacrylates, the alkyl maleates, and the alkyl fumarates, and other olefinic monomers copolymerizable therewith. The copolymers of this type having at least 50 mol percent of the acrylic or methacrylic acid derivatives, are preferred, and especially when the comonomer is hydrophobic or has no ionizable groups. Polymers of this type may be prepared directly by the polymerization of suitable monomers, or by the after chemical reaction of other polymers, for example by the hydrolysis of acrylonitrile or methacrylonitrile polymers.

Other useful polymeric polyelectrolytes are the polymers which derive their hydrophilic characteristics from the presence of amine radicals. These include the polyvinyl pyridines, the poly-N-vinyl amines, the poly-N-allylamines, the heterocyclic nitrogen compounds wherein the nitrogen is a tertiary amino group, and the amine and ammonium salts of said cyclic compounds. The vinyl amines may be present in copolymers with vinyl acetate, vinyl formate, vinyl chloride, acrylonitrile, styrene, esters of acrylic acid, esters of methacrylic acid, and other monomers capable of existing in copolymeric form with the N-vinyl amines. Included within the scope of this type of polymeric polyelectrolyte are the products derived by the hydrolysis of amides and imides, such as N-vinylformamide, N-vinylacetamide, N-vinylbenzamide, N-vinyl-N-methylformamide, N-vinyl-N-methacetamide, N-vinyl-N-methylbenzamide, N-vinylphthalimide, N-vinylsuccinimide, N-vinylidiformamide, and N-vinyldiacetamide. Similarly, copolymers of these various amides with other polymerizable monomers may be first prepared and subsequently hydrolyzed to the corresponding vinyl amide derivatives. The polyallylamines and polymethallylamines and copolymers thereof may be prepared by copolymerizing acrylonitrile or methacrylonitrile, alone or in the presence of other monomers, and then by dehydrogenation converted into amine-containing polymers.

Another important class of polymeric polyelectrolytes are the polymers of vinyl substituted amides, such as vinyl pyrrolidone, vinyl piperidone, the alkyl substituted products thereof, N-vinyl-N-methylformamide, N-vinylformamide, N-vinylacetamide, and other vinyl substituted amides, the polymers of which are water-soluble. Useful compounds include homopolymers and copolymers with vinyl acetate, acrylonitrile, isobutylene, ethylene, styrene, vinyl chloride, vinylidene chloride, vinyl formate, vinyl alkyl ethers, alkyl acrylates, alkyl methacrylates, and copolymers with the more hydrophilic monomers, such as acrylic acid, methacrylic acid, acrylamide, methacrylamide, the various substituted amides, monoalkyl esters of maleic acid, the aminoalkyl esters of acrylic acid or

other polymerizable acids, the alkali metal and ammonium salts of acrylic or other polymerizable acids, and other polymerizable compounds with ionizable functions.

Another class of polymeric polyelectrolytes are the polymers of vinyl sulfonic acid, and the copolymers of vinyl sulfonic acid with one or more polymerizable organic monomers, for example vinyl chloride, acrylonitrile, styrene, vinyl acetate and other polymerizable mono-olefinic compounds. Although the polymers and copolymers of vinyl sulfonic acid may be prepared by direct polymerization, they are more easily prepared by indirect methods. For example, polymers and copolymers of vinyl sulfonyl chloride may be first prepared and then hydrolyzed for conversion into vinyl sulfonic acid polymers, the vinyl sulfonic acid salt polymers, the vinyl sulfonic acid amides, and other vinyl sulfonic acid derivatives capable of ionization in aqueous solutions. Another useful indirect method of preparing this class of polymeric polyelectrolytes involves the preparation of polymers of unsaturated hydrocarbons, for example ethylene, propylene, isobutylene, styrene, alpha-methylstyrene, and others, or the copolymers of the said unsaturated hydrocarbons and other polymerizable mono-olefinic compounds such as vinyl chloride, acrylonitrile, vinyl acetate, methyl methacrylates, alkyl acrylates and others, and thereafter introducing the sulfonic acid nuclei by a conventional sulfonation reaction. The sulfonic acid groups so introduced may be converted to sulfonic acid salts, acid amides or other electrolytic grouping. The copolymers of this type may involve the use of a plurality of sulfonic acid monomers and/or a plurality of the conventional comonomers as described.

As described above in conjunction with the various types of polyelectrolyte polymers suitable for the practice of this invention, the hydrophilic polymer may be prepared directly by the polymerization or copolymerization of one or more of the various available organic monomers with aliphatic unsaturation, if the said compounds contain a hydrophilic group, for example carboxyl groups. Generally, more types of polyelectrolytic polymers can be prepared by subsequent reactions of polymers and copolymers. For example, polymers containing nitrile groups may be hydrolyzed to form water-soluble amide and carboxy-containing polymers or hydrogenated to form amine-containing polymers. Similarly, copolymers of maleic anhydride and vinyl acetate may be hydrolyzed to form polymers containing hydrophilic lactone rings. Other hydrophilic polymers may be prepared by the hydrolysis of copolymers of vinyl acetate wherein the acetyl groups are removed leaving hydroxy groups which promote the solubilization effect to polyelectrolytic groups present. By other reactions non-hydrophilic polymers may be converted into lactam or amide-containing polymers which are more hydrophilic. Polyvinyl alcohol, not in itself a polyelectrolyte, may be converted into polyelectrolytes by esterification with dibasic acids, one of said carboxylic acid groups reacting with the alcohol radical and the other providing the hydrophilic characteristics by a carboxy group on the side chain. Still another type of polymer may be prepared by reacting halogen-containing polymers, for example the polymers or copolymers of vinyl chloroacetate or vinyl chloroethyl ether, with amines to form amine salt radicals and quaternary ammonium radicals whereby hydrophilic characteristics are introduced into what otherwise would be an insoluble polymer. Other soluble polymers may be prepared by the ammonolysis of ketone-containing polymers, for example polyvinyl methyl ketone. Similarly, active halogen atoms may be reacted with bisulfite to substitute sulfonic acid group for the reactive halogens. Other types of polymers prepared by the subsequent reaction of previously prepared polymers have been explained above in connection with the sulfonic and sulfonic acid salts of polymeric hydrocarbons and in connection with the vinyl amine polymers by hydrolysis of the N-vinyl amides.

Thus, the various polyelectrolytes of the types described

above are ethylenic polymers having numerous side chains distributed along a substantially linear continuous carbon atom molecule. The side chains may be hydrocarbon groups, carboxylic acid groups or derivatives thereof, sulfonic acid groups, or derivatives thereof, phosphonic acid or derivatives thereof, heterocyclic nitrogen groups, aminoalkyl groups, alkoxy radicals and other organic groups, the number of which groups and the relative proportions of hydrophilic and hydrophobic groups being such as to provide a water-soluble polymeric compound having a substantially large number of ionizable radicals. The length of the said continuous carbon chain must be such as to provide compounds having a weight-average molecular weight of at least 10,000.

The expression "water-soluble polymers" as intended by its use in this specification and its appended claims includes those which form homogeneous mixtures with water, the difficultly soluble polymers which expand in the presence of water and dissolve to at least some extent, and even some which are apparently insoluble in distilled water but which tend to dissolve in foundry sand water. This solubility enables the movement of the molecules within the sand mass through the medium of the moisture therein.

The sand mold compositions of this invention contain four essential ingredients, i. e. silica sand, clay, water and polyelectrolyte. Other ingredients conventionally used in foundry practice may be present including thermoplastic and thermosetting natural and synthetic resins, flour or cereals, sea coal, fly ash, zirconite, etc.

The sand may be any one of the commonly used washed silica sands such as Geauga float sand, Ottawa bonding sand, New Jersey silica sand, Ottawa silica sand, Portage crude sand, Juniata bank sand, Ohio Geauga sand, Providence core sand, Wisconsin silica bank sand, etc. These sands are sometimes washed to free them from organic impurities and only incompletely dried. The sands generally contain part of the moisture necessary to prepare good molds.

The crude or washed sands may contain some clay which may be sufficient for particular types of casting. However, it is generally desirable to add clay to the sand. Various bentonites, fire clays, etc. are useful for this purpose. The amount of clay based on 100 parts of sand should run between 1.0 and 25 parts. Less than 1.0 part prevents the development of adequate green strength and hardened strength of the molds. More than 15 parts provides a dense impermeable mold which prevents escape of gases during the casting operation. For some purposes, such a dense mold may be desirable so that up to 25 parts of clay may be used.

Associated with the clay, however, is the problem of balling in the mixing operation. To minimize balling, the clay is generally mixed dry with the sand for a short time and then the water is added, followed by continued mulling. Even with extreme care in the water addition, balling is present to a considerable extent. The addition of as little as 0.05 part of polyelectrolyte substantially prevents the balling and makes the mixing process much less critical.

Prior to this invention, water has presented many difficulties in standard foundry practice. It is essential to the composition but the amount used had to be confined within narrow limits. Frequently, it is found necessary to control the amount of water within 0.5 part, e. g. from 4.0 to 4.5 or from 3.0 to 3.5 parts. With the addition of the polyelectrolyte, much larger quantities of water may be tolerated. The most striking advantage of the use of polyelectrolytes in relation to the water is found in the ramming operation. In this operation, the sand is rammed in a flask or mold box around a pattern by tamping, jolting, slinging, squeezing, etc. methods. Without the polyelectrolyte it is found that local areas of high water content cannot readily be eliminated. These high water areas ram to a relatively dense impervious condi-

tion. Low water areas do not ram well and there is relatively little cohesion between particles resulting in weak sections of the mold and flaws. In addition, excessive water in the usual molding sands which is turned to steam by the temperature of the cast metal, causes blows or flaws in the castings. When a polyelectrolyte is used, even with an excess of water, substantially no blows occur. With the addition of the polyelectrolyte, substantially all these difficulties vanish, ramming becomes non-critical, molds of uniform density and strength are produced and substantially no flaws appear on the molds.

The various advantages listed above may be summed up as a remarkable increase in flowability of the foundry sand compositions obtained by the addition thereto of minor amounts of the polyelectrolytes of this invention. Since a high degree of flowability is required in the foundry industry, any large increase therein is of paramount importance.

It is obvious that variations may be made in the products and processes of this invention without departing from the spirit and scope thereof as defined in the appended claims.

What is claimed is:

1. A foundry sand mold composition consisting essentially of foundry sand, clay, water and a polymeric water-soluble electrolyte having a weight-average molecular weight of at least 10,000 and containing a substantially linear continuous carbon chain derived by the polymerization of an aliphatic unsaturated group, said composition having the sand in a major proportion, the clay in a minor proportion and the electrolyte in the amount of about 0.02 to 1%.

2. A composition as in claim 1 wherein the electrolyte is a sodium salt of a partially hydrolyzed acrylonitrile polymer.

3. A composition as in claim 1 wherein the electrolyte is a copolymer of vinyl acetate and maleic anhydride.

4. A foundry sand mold composition consisting of foundry sand, clay, water, cereal and a polymeric water-soluble electrolyte having a weight-average molecular weight of at least 10,000 and containing a substantially linear continuous carbon chain derived by the polymerization of an aliphatic unsaturated group, said composition having the said sand in a major proportion, the clay in a minor proportion and the electrolyte in the amount of 0.02 to 1%.

5. A foundry sand mold composition consisting of foundry sand, clay, water, cereal, asphalt and a polymeric water-soluble electrolyte having a weight-average molecular weight of at least 10,000 and containing a substantially linear continuous carbon chain derived by the polymerization of an aliphatic unsaturated group, said composition having the said sand in a major proportion, the clay in a minor proportion and the electrolyte in the amount of 0.02 to 1%.

6. A process for preparing foundry sand mold compositions which comprises mixing foundry sand and clay with a polymeric electrolyte to obtain a homogeneous mixture and thereafter adding water with continued mixing whereby a foundry sand mold composition of high flowability is obtained, said synthetic polymeric electrolyte being a water-soluble polymer having a weight-average molecular weight of at least 10,000 and containing a substantially linear continuous carbon chain derived by the polymerization of an aliphatic unsaturated group, said composition having the said sand in a major proportion, the clay in a minor proportion and the electrolyte in the amount of 0.02 to 1%.

7. A process as in claim 6 wherein the polymeric electrolyte is a sodium salt of a partially hydrolyzed acrylonitrile polymer.

8. A process as in claim 6 wherein the polymeric electrolyte is a copolymer of vinyl acetate and maleic anhydride.

9. A process as in claim 8 wherein cereal and asphalt are mixed with the sand, clay and polymeric electrolyte prior to the addition of the water.

10. A process of making a foundry sand mold which comprises mixing foundry sand, clay and a polymeric electrolyte to obtain a homogeneous mixture thereof, adding water to the mixture with continued mixing, flowing the mixture into a flask and ramming the mixture in the flask whereby a mold having uniform hardness is obtained, said polymeric electrolyte being a water-soluble polymer having a weight-average molecular weight of at least 10,000 and containing a substantially linear continuous carbon chain derived by the polymerization of an aliphatic unsaturated group.

11. A process as in claim 10 wherein the polymeric electrolyte is a sodium salt of a partially hydrolyzed acrylonitrile polymer.

12. A process as in claim 10 wherein the polymeric electrolyte is a copolymer of vinyl acetate and maleic anhydride.

13. A process as in claim 12 wherein cereal and asphalt are added to the mixture prior to the addition of the water.

14. A foundry sand mold comprising essentially a rammed mixture of foundry sand, clay, water and a polymeric electrolyte, said mold being of substantially uniform hardness from top to bottom on the surface and in cross-section, said polymeric electrolyte being a water-soluble polymer having a weight-average molecular weight of at least 10,000 and containing a substantially linear continuous carbon chain derived by the polymerization of an aliphatic unsaturated group, said composition having the said sand in a major proportion, the clay in a minor proportion and the electrolyte in the amount of 0.02 to 1%.

15. A foundry sand mold as in claim 14 wherein the polymeric electrolyte is a sodium salt of a partially hydrolyzed acrylonitrile polymer.

16. A foundry sand mold as in claim 14 wherein the polymeric electrolyte is a copolymer of vinyl acetate and maleic anhydride.

17. A foundry sand mold as in claim 16 which contains cereal and asphalt in addition to the sand, clay, water and polymeric electrolyte.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

|    |           |                   |               |
|----|-----------|-------------------|---------------|
| 55 | 2,313,697 | Juppenlatz        | Mar. 9, 1943  |
|    | 2,368,322 | Passelecq         | Jan. 30, 1945 |
|    | 2,392,510 | Stoody            | Jan. 8, 1946  |
|    | 2,529,835 | Dailey et al.     | Nov. 14, 1950 |
|    | 2,537,960 | Billington et al. | Jan. 16, 1951 |
| 60 | 2,550,371 | Naps et al.       | Apr. 24, 1951 |
|    | 2,552,775 | Fischer et al.    | May 15, 1951  |
|    | 2,625,471 | Mowry et al.      | Jan. 13, 1953 |
|    | 2,625,529 | Hedrick et al.    | Jan. 13, 1953 |

##### FOREIGN PATENTS

|         |         |             |
|---------|---------|-------------|
| 501,726 | Belgium | May 7, 1951 |
|---------|---------|-------------|

##### OTHER REFERENCES

Chemistry, January 1952, pages 1-8.