Patented Sept. 16, 1941 2,256,046

UNITED STATES PATENT OFFICE

2,256,046

FOUNDRY COMPOSITION

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No Drawing. Application March 14, 1941, Serial No. 383,407

4 Claims. (Cl. 22—188)

My invention relates broadly to compositions of matter and more particularly to such compositions as are used as binders for foundry purposes and to the foundry compositions employing such binders.

One of the objects of my invention is the provision of a foundry composition which is strong yet permeable to the fumes and gases encountered in actual use; which may be readily and accurately prepared so as to have any desired strength according to the needs of the particular type of casting being made; which at the same time, has an unusually high green strength and a high sintering point; and which does not cake or harden in use so that it may be easily recovered for repeated use.

Another object of my invention is to provide a foundry composition, as described above, which can be prepared from readily available and inexpensive materials.

A further object of my invention is to provide a foundry bonding agent in which the ingredients thereof are chemically improved to fulfill the above objects.

A still further object of my invention is to provide a method for treating readily available foundry composition bonding materials to increase both the green strength and the dry strength of any foundry composition in which such bonding materials are used, without affecting the properties of such foundry composition detrimentally in other respects.

Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the combination of elements, mixture of materials and composition of ingredients, and in the several steps and the relation of each of the same to one or more of the others as described herein, the scope of the application of which is indicated in the following claims.

It is conventional practice in the foundry art to mix with clean silica sand a proportionately small part of clay binder and to temper the mixture with a small amount of water to form a workable molding material. As a general rule it has proven advisable to maintain the quantity of tempering water low so as to avoid the danger of having gas flaws form in the casting. Careful selection of the type of clay binding material to be used with the sand is also of great importance. Many factors must be considered in choosing the binding composition if an ideal foundry composition is ultimately to be obtained. One must consider, for example, the type of casting, its composition, the working temperatures, the size of the casting, the contraction of the casting material and the strength of the casting material, both in hot and cold condition. Once such working conditions, along with others not mentioned, have been recognized, the next problem is to select qualities of molding sand and binding clay which will be adaptable for the particular use. Sand of known quality must be selected, and once this has been accomplished, the proper binding agent remains to be chosen. Unfortunately, many satisfactory clay binders are available only at some point distant from the point of foundry operations and great shipping expense makes their use uneconomical. Further, a given clay binder may, when used in a foundry composition, impart certain needed working characteristics to the composition, yet other desirable characteristics may be sacrificed by the use of that particular binder. Certain undesirable qualities possessed by the various clays make their use in foundry molds impractical in some instances.

There are several types of bonding clays now available for foundry practice and probably the most prevalent among these clays are the fire clays which are largely comprised of koalinite and naturally included montmorillonite, illite and baddeleyite. Non-refractory clays are also employed and they are generally of glacial origin and are predominant in minerals of the sericite or illite type. Certain sedimentary clays of greater geological age are also found in the non-refractory group. In these clays may be found a large proportion of the mineral baddeleyite or illite.

Either refractory or non-refractory clays can be obtained from numerous points in the United States. In general such clays have not proven to be highly satisfactory since they fail to give necessary mold strength when used in small amounts. When the proportion of such clays is increased in foundry compositions, the mold permeability is severely decreased and mold dry strength is unduly increased. Molding compositions must be adequately permeable to allow gases and fumes generated during the pouring of a casting to escape. If such gases and fumes are not vented, imperfections in the casting are likely to result. Moreover, it is very essential that a mold composition have a dry strength sufficiently high, yet if possible, low enough to permit the foundryman to remove the casting and used sand from the molding flask without exerting any great effort. Hard baked molding compositions are difficult to shake from the molding flask and from the casting, and thereafter are difficult to crush and recondition when the foundryman seeks to recover the sand for further use in the form of burnt sand. Further, foundry compositions which have an unnecessarily high dry strength encourage the cracking of a casting under certain circumstances, such as when a casting shrinks and becomes over-stressed because of the failure of the molding composition to yield.

Accordingly, since the properties of foundry

compositions fall short in some respects, and because only certain types of foundry binders are economically available at some points, the need for treating clay binders to overcome their deficiencies has been recognized. Work has been done to improve the properties of clays, but this work has usually resulted in the sacrifice of some existing desirable properties while other properties not so acceptable have been improved. For example, it has been learned that the dry strength of certain foundry compositions can be improved by first chemically treating the clay bonding material which is to be used therein. Difficulty has been encountered in chemically treating binder clays, primarily because certain valuable properties are lost while other properties actually are improved. For example, it has been observed that the treating of a clay chemically, to improve the dry strength of a foundry composition in which it is used, almost invariably causes a reduction in green strength of the composition. The converse, that if a clay is chemically treated to improve foundry composition green strength, the dry strength of the composition is impaired, seems also to be the general rule.

Under certain circumstances, there is manifest need for a foundry binder which can be so treated that upon its use in a given molding mixture, the green strength and the dry strength of the mixture will both be increased to meet the requirements demanded by a known set of working conditions.

Accordingly, an object of my invention is to overcome the many difficulties heretofore encountered in using chemically treated binders, by providing a chemical agent which, when applied to a clay bonding agent, will create a chemical cementing reaction between the clay constituents causing an increase in the green bond strength and in the dry bond strength of the clay without affecting other desirable properties of the clay.

Considering now the practice of my invention, I find that clay when treated with a small amount of boric anhydride (B_2O_3) possesses much improved bonding properties. When my treated clay is used as a bonding agent in a molding composition, that composition has, as a result, an increased dry strength, together with an increased green strength. Accordingly a smaller quantity of my treated clay is used to produce the same strength of mold obtained by the use of untreated clay. It follows, therefore, that my treated clay improves mold permeability for the reason that less clay is present in the mold.

In preparing a foundry composition in accordance with my invention, I procure and weigh a quantity of clean silica sand or silica sand containing a certain proportion of burnt sand as desired. I then prepare my foundry binder by combining by weight of sand, approximately 3% to 15% of clay and about ⅛% to 1½% of boric anhydride. Simple calculation shows that the boric anhydride represents .8% to 50% of the binder, with clay representing the remainder. The two binder ingredients are then mixed to uniform consistency. Thereafter, I mix together the weighed sand and my treated binder comprising clay and boric anhydride. The whole is mixed thoroughly in a foundry mixer to form a fairly homogeneous composition. Water is then added in desired amount, usually 2% to 5% by weight. The mixing is continued, producing a uniform molding composition of desired strength and workability. The mold mix, thereafter is ready for use in preparing a sand mold in accordance with well known methods.

Boric anhydride, which is the trioxide of boron, when mixed with a clay binder promotes a chemical cementing reaction between the binder ingredients. Both the dry bond strength and the green bond strength of the clay increase as the proportionate part of boric anhydride in the mixture is increased. Thus, the bonding qualities of many different types of clay can be improved. When powdered boric anhydride is combined in proper proportions with clay, such as kaolinite, swelling montmorillonite clay or non-swelling montmorillonite clay of the colloidal or non-colloidal form, its cementing properties cause the dry bond strength and the green bond strength of these clays to increase considerably. It is to be observed from the following table that both the dry compression strength and the green compression strength of foundry compositions, containing any one of three clay binders each treated with varying percents of powdered boric anhydride, tend to increase uniformly as the percent of boric anhydride is increased:

	Green compression strength	Dry compression strength	Tempering water used
	P. s. i.	*P. s. i.*	*Per cent*
10% Ohio fire clay	7.15	28.1	3¼
plus—			
⅛% powdered boric anhydride	6.83	44.9	3¼
¼% powdered boric anhydride	7.44	56.7	3½
½% powdered boric anhydride	8.25	86.2	3¾
1% powdered boric anhydride	9.02	84.96	4⅛
1½% powdered boric anhydride	9.77	118.08	5
5% Wyoming bentonite	7.19	78.0	3½
plus—			
⅛% powdered boric anhydride	7.40	80.7	3½
¼% powdered boric anyhdride	7.54	146.64	3½
½% powdered boric anhydride	8.09	151.60	3¾
1% powdered boric anyhdride	9.67	156.72	4
1½% powdered boric anhydride	10.25	170.40	4¼
4% Mississippi bentonite	8.60	29.0	2½
plus—			
⅛% powdered boric anhydride	9.55	42.0	2½
¼% powdered boric anhydride	9.34	60.2	2¾
½% powdered boric anhydride	10.45	74.2	2⅞
1% powdered boric anhydride	11.65	87.1	3¼
1½% powdered boric anhydride	12.30	108.0	3¾

In the above tests, the chemical agent was added as a percentage of the total weight of the mixed sand. It was mixed with the clay before the addition of the clay to the sand, and though this sequence is preferred, it is definitely within the scope of the present invention to employ other obvious sequences. For example, the boric anhydride may be added to the sand before or after clay is added, or as a separate part along with a desired part of clay. Further, the chemical may be dissolved in the tempering agent before the agent is added to sand or to a mixture of sand and clay. Thus, by selecting proper proportions of sand, clay, clay treating agent, and moistening agent, one to the other, a highly satisfactory foundry composition of known characteristics can be made. The foundryman can adapt a chosen clay binder, by chemically treating it with proper amounts of boric anhydride, to produce a pre-selected green strength, yet maintain a satisfactory dry strength of mold, or a pre-determined dry strength of mold can be had while the resulting green strength of the mold will also be satisfactory.

It has been a general theory that any improvement in a clay bonding agent depends upon base exchange capacity of the clay. Base exchange

capacity is, for the present purposes, defined as the ability of clay minerals to hold or exchange either basic or acid ions on the surface of the individual clay particles. The base exchange capacity of Ohio fire clay is quite low, being 10.8 m. s/100 gm. The base exchange capacity of bentonite is much higher, being 70 for Wyoming bentonite and 80 for Mississippi bentonite. Previous work has, therefore, indicated that most success is obtained in improving clays by treating the bentonites because of their high base exchange capacity. The present invention is of value for in the practice thereof all three of the above-mentioned clays along with other clays, can be treated to good advantage.

It may be possible that boric anhydride gives such excellent results because it has some readily available oxygen to combine with the clay to form oxide cements. However, it seems more likely that the cementing reaction between the clay binder constituents produces borate compounds which act as cements in the foundry binder. The boric anhydride hydrates to boric acid, when tempering water is added to a foundry mixture in which my treating agent is present. In turn, such boric acid reacts readily with any alkali or alkaline earths that may be present in the clay to form borates. Under certain conditions, boric acid may react with alumina and aluminous compounds, of which the clay binder is comprised to form rather complex aluminum borates. I believe that some such reactions take place in the clay to form borate compounds and these borate compounds act as cements thereby imparting a greater bond strength to the treated clay. It should be observed, however, that an addition of boric acid to one of the test clays in lieu of boron trioxide did not produce the improved bond strength obtained by the use of the latter, and I do not wish to be bound by this explanation.

A mold made of material containing clay treated as set out above is strong and durable. It is well retained in the cope as it is lifted from the drag to remove the pattern. The mold from which the pattern is withdrawn is clean cut and free of edge breaks and cracks. A minimum of repair to the mold, before the casting is poured, therefore, is required. At the same time, however, the mold is readily permeable to the fumes and gases encountered in actual foundry use.

By virtue of the fact that numerous clays from various localities can be used in the practice of my invention, it is possible to select the nearest desirable clay deposit and thereby reduce shipping charges tremendously. Therefore, my invention is capable of broad practice throughout the country at comparatively low cost.

For a heavy casting, such as a machine base, a relatively high percentage of boron trioxide will be used so that the mold dry strength and green strength will be high. Where an intermediate dry strength or green strength is desired, as in the production of medium weight castings, a smaller percentage of boron trioxide is used. When light castings are to be made, still less chemical treating agency will be introduced into the mixture. When the dry strength of mold is sufficiently low, a thin, weak casting can contract upon cooling without the danger of being cracked by an unyielding mold part. The interior part of a low dry strength mold collapses upon cooling and thus allows unimpeded contraction of the casting. The amount of boric anhydride treating agent, too, is governed by the properties of the clay which is treated.

Thus, it will be seen that there is provided in my invention a composition and art of employing the same in which the various objects hereinbefore noted, together with many thoroughly practical advantages are successfully achieved. It will be seen that my bonding composition is well adapted to withstand the many varying conditions of actual operational use in many applications, particularly as a binder in sand.

While my invention is practiced with good results upon clays such as kaolinite, swelling montmorillonite clay, or non-swelling montmorillonite clay of the colloidal or non-colloidal form, I find that other types of clay also can be treated profitably. Further, I find that the presence of boric anhydride in a foundry composition containing a clay binder comprised of two or more clays improves the green strength and dry strength of the composition. Foundry binders comprising any one or more of such clays as kaolinite, swelling montmorillonite clay and non-swelling montmorillonite clay of colloidal or non-colloidal form, are materially improved by treatment with boric anhydride.

Even though my invention has been described in connection with a mold, it will be understood that it is also applicable to other foundry uses. It is suitable for application to the construction of cores and facing materials.

Furthermore, my described bonding material may be used in combination with new silica sand, burnt silica sand, new molding sand, burnt molding sand, lake sand or bank sand. Also, small quantities of auxiliary binders, such as cereal binders, cement, goulac, pitch or rosin and casting cleaning elements, such as sea coal, wood, flour or oils may be added.

While the amount of boron trioxide, as given in the table, amounts to some ⅛% to 1½% of the weight of the sand in the mixture, I find that it is frequently advantageous to extend this range still further.

Since many possible embodiments may be made of my invention and since many changes may be made in the embodiments hereinbefore set forth, it is to be understood that all matter described herein is to be interpreted illustratively and not in a limiting sense.

I claim:

1. In a composition of matter of the class described, a foundry binder consisting of boric anhydride and a preponderance of clay.

2. In a composition of matter of the class described, a foundry binder consisting of boric anhydride and a preponderance of a clay of which montmorillonite is a large constituent.

3. In a composition of matter, a foundry mold composition consisting of a preponderance of sand, together with boric anhydride and clay in such proportions as to give desired strength of mold.

4. In a composition of matter of the class described, a foundry mold consisting of sand, 3% to 15% of a clay, and ⅛% to 1½% of a boron oxide of such character as to form a cement therewith.

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