The present invention relates to foundry cores. More particularly, it relates to an additive for foundry cores which improves their tensile strength and baking properties.

In foundry practice, "cores" are aggregates of inert matter such as sand, of somewhat porous structure, having controlled mechanical strength sufficient to permit the core to be assembled without breakage as a part of a mold and to form molten metal into a desired shape. In the production of foundry cores, various materials are incorporated into the sand and baked therewith to bond the sand together and to give it the desired structure and mechanical properties. Among such materials are cereal products, water glass, drying oils, resins, sulfate liquor, proteinaceous materials, molasses, clays, wood flour, gela- tinalized starches, dextrinized starches, and a variety of other substances and combinations thereof. All of the materials heretofore employed have a tendency, when baked, to develop peak tensile strengths over a narrow range of baking time, which necessitates rigid control of the baking operation. The present invention involves a novel additive for core binders of the prior-art type, whereby the baking time during which peak strength is maintained is greatly extended, and whereby the peak strength itself is substantially improved.

One object of the present invention is to improve the baking of foundry cores.

Another object is to render the baking time of foundry cores less critical.

Another object is to extend the range of baking times within which the peak strength of foundry cores is at a maximum.

Another object is to increase the baked strength of foundry cores.

Other objects of the invention will be apparent from the present description and claims.

In accordance with the present invention, a novel modifier is incorporated into a foundry core, prior to baking, the said foundry core containing a core binder or core binders of the prior art types, and the said modifier being an end liquor produced by hydrolyzing a sugar beet waste liquor and removing a portion of the resulting glutamic acid therefrom.

The modifier or additive of the present invention is commonly referred to in the art as a "glutamic acid end liquor." Such end liquors are a final by-product obtained in the recovery of glutamic acid from sugar beet waste liquors, such as Steffen's filtrate, barium filtrate, and the like. The sugar beet waste liquor is subjected to hydrolysis by heating in the presence of a strong acid such as sulfuric acid or hydrochloric acid, or more commonly in the presence of a strong alkali such as sodium hydroxide, potassium hydroxide, barium hydroxide, or the like. The glutamic acid precursor substances contained therein are converted thereby into glutamic acid. The resulting hydrolyzate is acidified to around pH 3 to 7, preferably around 5 to 6, concentrated to around 80% dry solids by weight, and filtered or centrifuged to remove the resulting crop of inorganic salts. The partially desalted liquor is then further acidified as necessary to around pH 5.2, at which point the gelatinized starch is thereby formed therefrom at ordinary or somewhat reduced temperatures. When the glutamic acid crystals are removed from the crystallization mixture, the remaining liquid is the glutamic acid end liquor employed in the present invention.

Glutamic acid end liquor in its natural state has a pH around 3.2. In this condition, it has been found to be most effective in foundry cores for extending the range of baking time for maximum tensile strength. For improving the tensile strength of the baked cores, however, the end liquor is somewhat more effective at higher pH ranges up to and around neutrality, and when used for these purposes the end liquor should be adjusted in pH, preferably to the range of about 6 to about 8, by adding thereto a suitable base such as sodium hydroxide, potassium hydroxide, or the like.

The glutamic acid end liquor is ordinarily incorporated into the foundry core in a proportion between about 0.1 and about 1% by weight, preferably between about 0.25 and 0.5% by weight, of the total core, dry basis.

In preparing a core according to the present invention, a sand of suitable grade is mixed with water, a glutamic acid end liquor, and a core binder of a conventional type and in a conventional proportion. It is preferred to first blend the sand with any other dry ingredients, then add a mixture of water, end liquor, and any other non-dry ingredients, and complete the blending. The total proportion of water in the mixture is suitably between about 2 and about 6%, based on the dry weight of sand, preferably between about 3 and about 5%. Conventional core binders, including all of the examples set forth hereinafore, are employed in a proportion between about 0.1 and about 5%, optimally between about 0.5 and about 1.5%, dry sand basis. The use of mixing can be altered if desired without materially impairing the desirable results obtained by the present invention. The completed mixture is formed into cores in a conventional manner, and the cores are thereafter baked under conventional conditions prior to use.

In baking cores, the temperature and time required vary widely according to the size of the core, the surface-to-volume ratio, the water content, the type of sand, and the nature of the primary core binder. Laboratory cores are ordinarily baked at temperatures between about 300 and about 600°F, and the maximum tensile strength is ordinarily reached after a baking time in the range of 10 to 100 minutes. The baking temperature is preferably about 350 and about 450°F, and for smaller cores a baking time of around 10 to 30 minutes is ordinarily sufficient. For commercial cores, the baking time may range up to 24 hours or longer, and temperatures up to 600°F are sometimes used to speed up the process. In the present invention, it is found that the maximum tensile strength is reached rapidly (around 10 minutes for laboratory cores), and is maintained essentially constant for an extended period of time (approaching an hour for laboratory cores). At the same time, the maximum tensile strength is materially increased.

The present invention is especially useful in conjunction with the core binders of Neukom, comprising essentially alcalimetal phosphate-modified starches, described in copending Neukom application Serial No. 706,-155, filed December 30, 1937. The Neukom core binders are prepared by impregnating ungelatinized starch with an aqueous solution of an alkalimetal orthophosphate salt having a pH between about 4 and about 7, drying to a moisture content below about 15% by weight at a temperature below the level at which the starch gelatinizes, then heating at a temperature between about 120 and about 175°F. For a period of about 1 to about 15 hours, whereby the starch is converted into a form which disperses readily in cold water to yield viscous, stable dispersions. The preferred starches obtained thereby...
are the sodium, potassium, and lithium orthophosphate-modified starches.

The invention is also useful in conjunction with the improved core binder of John W. Frieders, comprising essentially an alkali-metal orthophosphate derivative of gelatinized amylose, prepared in the Neukom manner and described in application Serial No. 705,794, filed December 30, 1957; and in conjunction with the improved core binder of Sietsma, comprising gelatinized amylopectin substantially free from amylose, described in application Serial No. 705,793, filed December 30, 1957. In these cases, as well as in conjunction with the other core binders of the prior art, glutamic acid end liquids exhibit the remarkable property of extending the range of baking time in which the maximum tensile strength of the core is maintained, and in addition increase the magnitude of the said tensile strength. This is in contrast to the prior art, in which a wide variety of materials, principally humectants, have been tested for the purpose, but with greatly inferior results, as the examples given below will demonstrate.

Example 1

A series of tests were carried out to compare glutamic acid end liquor with a variety of prior-art humectants in a core formulation containing a Neukom-type sodium orthophosphate-modified starch as the primary core binder. The phosphate-modified starch contained 4.04% phosphorus and had a viscosity of 6310 cp. at 25° C. in 5% aqueous dispersion. The sand employed was Ottawa 50, having an AFS grain fineness of 70. The core mixtures were prepared from 1.25% of the phosphate-modified starch, 0.25% of the end liquor or conventional humectant, and water to a total moisture content of 4%, based in each case on the dry weight of sand. The dry ingredients were then mixed and mulling was resumed for 6 minutes. The complete mixtures were discharged from the miller and stored in sealed cans until used to make cores. The retained water content was about 3.5%.

The various mixtures were formed into standard test cores, then baked over a series of baking periods at 425° F., except the cores containing sorbitol, which were baked at 450° F. The baked cores were tested according to the standard method defined in the “Foundry Sand Handbook,” 6th edition, 1952, published by the American Foundrymen’s Society, Chicago. In each case the cores were prepared and tested in triplicate, and the reported results are the average of three tests. The results show that end liquor maintains the cores at a high and uniform level of tensile strength over an extended range of baking time, while the controls exhibit a sharp decline after about 25 minutes:

<table>
<thead>
<tr>
<th>Humectant: End Liquor, p.p.l.</th>
<th>Tensile Strength at Break</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baking Time, min.</td>
</tr>
<tr>
<td>5</td>
<td>192</td>
</tr>
<tr>
<td>10</td>
<td>220</td>
</tr>
<tr>
<td>15</td>
<td>227</td>
</tr>
<tr>
<td>20</td>
<td>227</td>
</tr>
<tr>
<td>25</td>
<td>210</td>
</tr>
<tr>
<td>30</td>
<td>210</td>
</tr>
<tr>
<td>40</td>
<td>190</td>
</tr>
</tbody>
</table>

Example 2

A further series of tests were carried out using a glutamic acid end liquor which had been adjusted to a pH near neutrality by addition of sodium hydroxide thereto. The cores were prepared generally in accordance with the procedure and under the conditions given in the previous example, except as noted in the table of data given below. The glutamic acid end liquor, prior to use, was adjusted to pH 6.8 or 6.9, this being the approximate pH level of an aqueous solution of the phosphate-modified starch employed as the primary core binder. The results show a marked increase in tensile strength arising from the addition of end liquor to the core mixture:

<table>
<thead>
<tr>
<th>Prop’n of End Liquor, percent</th>
<th>pH of End Liquor</th>
<th>Phosphate-Modified Starch, percent</th>
<th>Baking Time, min.</th>
<th>Tensile Strength, p.s.i.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>6.8</td>
<td>0.25</td>
<td>1</td>
<td>120</td>
</tr>
<tr>
<td>0.25</td>
<td>6.9</td>
<td>0.25</td>
<td>1</td>
<td>125</td>
</tr>
<tr>
<td>0.25</td>
<td>6.9</td>
<td>0.25</td>
<td>5</td>
<td>263</td>
</tr>
<tr>
<td>0.25</td>
<td>6.9</td>
<td>0.25</td>
<td>10</td>
<td>125</td>
</tr>
<tr>
<td>0.25</td>
<td>6.9</td>
<td>0.25</td>
<td>20</td>
<td>133</td>
</tr>
</tbody>
</table>

While the invention has been described with reference to certain specific prior-art core binders, certain specific glutamic acid end liquids, and other details of process and composition, such matters are to be understood as being illustrative only, and not as limitations upon the scope of the invention. Numerous modifications and equivalents of the invention will be apparent from the foregoing description to those skilled in the art.

In accordance with the foregoing description, the following claims particularly specify and distinctly claim the subject matter of the invention:

What is claimed is:

1. In a foundry core comprising sand and a core binder, said core binder consisting essentially of a starch composition selected from the group consisting of gelatinized starch, gelatinized amylopectin, phosphate-modified starch, phosphate-modified amyllose, and mixtures thereof, a modifier consisting essentially of a glutamic acid end liquor obtained from hydrolyzed sugar beet waste liquor.

2. A modifier in a foundry core as in claim 1 wherein said glutamic acid end liquor has a pH of about 3.2.

3. A modifier in a foundry core as in claim 1 wherein said glutamic acid end liquor has been adjusted to a pH between about 6 and about 8.

4. A foundry core consisting essentially of sand and a core binder, and between about 0.1 and about 1%, based on the dry weight of sand, of a glutamic acid end liquor obtained from hydrolyzed sugar beet waste liquor, said core binder consisting essentially of a starch composition selected from the group consisting of gelatinized starch, gelatinized amylopectin, phosphate-modified starch, phosphate-modified amyllose, and mixtures thereof.

5. In a foundry phosphate-modified starch core consisting essentially of sand and a core binder, a modifier, in a proportion between about 0.1 and about 1%, based on the dry weight of sand, consisting essentially of an end liquor produced by hydrolyzing a sugar beet waste liquor and removing a portion of the glutamic acid therefrom.

6. A foundry core which consists essentially of sand and an alkali-metal orthophosphate-modified starch prepared by soaking ungelatinized starch in an aqueous alkali-metal orthophosphate solution having a pH between about 4 and about 7, baking the soaked starch to a moisture content less than about 15% by weight at a temperature below the gelatinization point thereof, and baking the dried starch at a temperature between about 120 and about 175° C. for a period of about 1 to about 15 hours, and in combination therewith a glutamic acid end liquor obtained by hydrolyzing a sugar beet waste liquor and separating a portion of the glutamic acid therefrom.

7. A foundry core which consists essentially of sand and an alkali-metal orthophosphate-modified amyllose prepared by soaking gelatinized amyllose in an aqueous alkali-metal orthophosphate solution having a pH between about 4 and about 7, baking the soaked amyllose to a moisture content less than about 15% by weight, and baking the dried amyllose at a temperature between about 120 and about 175° C. for a period of about 1 to about 15 hours, and in combination therewith a glutamic acid
5. End liquor obtained by hydrolyzing a sugar beet waste liquor and separating a portion of the glutamic acid therefrom.

8. A foundry core which consists essentially of sand, gelatinized amyllopectin substantially free from amyllose, and a glutamic acid end liquor obtained by hydrolyzing a sugar beet waste liquor and separating a portion of the glutamic acid therefrom.

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CERTIFICATE OF CORRECTION

Patent No. 2,988,453

Forest A. Hgian et al.

June 13, 1961

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 31, for "fineness" read -- fineness --;
column 4, line 29, for "fountry" read -- foundry --; line 36, for "foundary" read -- foundry --; lines 49 and 50, for "In a foundry phosphate-modified starch core consisting essentially of sand and a core binder" read -- In a foundry core consisting essentially of sand and a phosphate-modified starch core binder --.

Signed and sealed this 27th day of November 1962.

(SEAL)
Attest:

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