United States Patent Office 2,875,073
Patented Feb. 24, 1959

2,875,073

CORE BINDER AND PROCESS OF MAKING CORES

Charles J. Gogek, Brookfield, Ill., assignor to Corn Products Refining Company, New York, N. Y., a corporation of New Jersey

No Drawing. Application May 23, 1955
Serial No. 510,583

4 Claims. (Cl. 106—38.4)

This invention relates to new core binders and to a new process for making cores suitable for use in fabrication of metal castings.

In ordinary practice of making cores, 100 parts of sand is mulled with about 1 part by weight of cereal binder, 3 parts by weight of water is added and mulled into the mixture, followed by addition and mulling of 1 part by weight of core oil. In some cases, where the cores must have special properties, other binders, such as bentonite, may also be used. The mulling period depends on the type of machine used, and the proportion of binders depends on the design of the core, the properties of the binders and on the metal to be poured, all of which are recognized by those skilled in the art. The mulled mixture is rammed or blown into a corebox which is subsequently opened, the core is carefully removed and transferred to a hot oven where it is baked. The variables in these operations are likewise recognized by those skilled in the art. After removal from the oven and cooling, the core is an accurately formed hard object which will withstand rough handling. In use, it must retain its shape as molten metal flows and solidifies around it, and should then collapse to an easily removable mass as the binders slowly burn off.

In the description of ordinary practice given above, the cereal binder, such as pregelatinized starch, is added primarily so that the freshly formed damp core possesses sufficient "wet" or "green strength" to retain its shape until it is placed in the oven. In addition, the baked core must have high "dry" or "baked strength," most of which is provided by the core oil in the typical process described.

The components added for green strength and baked strength may operate against each other. Thus, core oils decease green strength of sand mixtures. This in some instances is a serious disadvantage, and it is one object of this invention to eliminate such disadvantage by replacing the oil with a binder which does not depreciate the green strength.

For foundry use, there is a need for a single dry, free-flowing binder which will impart both green and dry strength to cores. A further object of this invention is to provide an easily prepared, dry, free-flowing binder which imparts both green and dry strength to cores.

Cores liberate gases as molten metal flows around them, and since these gases may be trapped in the castings, any means to minimize the volume of gases evolved is of great importance in enabling foundrymen to fabricate solid metal entirely free from "pin-holes" and "blow-holes." A further object of this invention is to decrease volume of gases liberated by sand cores baked with organic binders, particularly cereal binders and sugars. Further, the invention is useful for decreasing volume of gases liberated by core pastes and core washes containing organic binders when the pasted or washed cores are baked. Further objects will appear hereinafter in the description which follows.

When certain sugars in combination with cereal binder and certain salts or acids are substituted for conventional core oils in typical core sand mixtures, such as those described above, I have unexpectedly found that satisfactory green strength and high baked strength of the cores may be obtained. In addition, I have unexpectedly found that cores prepared using a mixture of cereal binder and certain sugars in combination with certain acids or salts bake just as rapidly or significantly faster than those made with cereal binder and core oil. Further, I have unexpectedly found that baked cores prepared using a mixture of cereal binder and certain sugars in combination with certain acids or salts liberate substantially less gases than those made with cereal binder and certain sugars in the absence of the adjuncts hereinafter specified. These findings constitute a pronounced departure from ordinary foundry practice and would not be anticipated by those skilled in the art. When cereal binder is blended with the sugars hereinafter specified and certain salts, there is obtained a dry, free-flowing composition of matter which is much easier to handle than cereal binder and core oil.

The present invention comprises a mixture of suitable proportions of cereal binder, certain sugars which are specified hereinafter, and an adjunct selected from the group specified hereinafter.

Cereal binders are well known in the art and include pregelatinized starches and pregelatinized starchy flours, the latter usually containing small amounts of protein or fiber. In addition, the term "cereal binder" includes dextrins which may be employed for certain specific uses.

By the term "sugar," I means those mono- and disaccharides of an aldose or ketose character, or such non-reducing saccharides which may be hydrolyzed under conditions of use herein described to give aldose or ketose saccharides. For example, sucrose is effective as a component of the described binder and is claimed in this invention, while sorbitol is not.

The sugars which I prefer are dextrose, sucrose, and fructose or mixtures thereof, but maltose and lactose are also satisfactory though less practicable from cost considerations. Beet or cane molasses (mother liquor in the manufacture of sucrose) and greens and hydrol (mother liquors in the manufacture of dextrose) may likewise be used satisfactorily in conjunction with the chemical adjuncts hereinafter specified although it is realized that molasses and hydrol are not as easily handled, due to their viscous nature, as the sugars aforementioned,

Sirups which may be made by hydrolysis of starch or from cane sugar by appropriate treatments are also effective in carrying out this invention. Dextrose greens or hydrol may be treated to prevent crystallization of the dextrose contained therein by boiling them with acid or alkali in accordance with known methods. These by-products may be less effective than dextrose or sucrose, as is apparent from the data in Table II, but are within the scope of this invention because of their economic advantages.

The chemical adjuncts which are suitable for purposes of my invention are sulfuric acid; phosphoric acid; any chemical or mixture of chemicals which generates either or both of these acids under the conditions of use, such as ammonium sulfate, ammonium acid sulfate, aluminum sulfate, alums, e. g., ammonium aluminum sulfate, ammonium persulfate and the alkali metal persulfates, ammonium sulfamate, and pyrophosphoric acid; hydrochloric acid; sodium chloride; a mixture of paraformaldehyde and ammonium chloride; a mixture of paraformaldehyde and hydrochloric acid; boric acid. The aforementioned compounds may act as catalytic agents to promote condensation of sugars, or may decompose under the conditions used to produce such catalytic agents. However, I do not wish to be limited by any theory of the operation of the aforementioned compounds.

Ammonium sulfate is the preferred adjunct, among the reasons being its effectiveness, cheapness, stability, noncorrosive character and the ease with which it may be blended with the other components of the core.

Obviously, any of the aforementioned adjuncts which are suitable for the purposes of my invention should be used in proportions which yield optimum benefits from their use. These proportions may be different for each adjunct.

The amounts of adjuncts, cereal binders and sugars may vary widely. For 100 parts of sand, 0.25 to 2 parts of cereal binder, 0.5 to 5 parts of sugar and from 0.002 to 0.15 part by weight of adjunct per part by weight of sugar may be used. The amount of water may vary from 1.5 to 6.0 percent of the sand. All parts above-specified are parts by weight. In general, volume of gases liberated by baked cores as well as heating time required for cores to attain peak strengths are decreased as the proportion of the preferred adjunct in the sand is raised. One type of muller may produce a core having a different maximum baked strength than another muller. However, those skilled in the art by means of the teachings of this invention and a few simple tests, will be able to arrive at proportions most suitable for their own operations.

It has been proposed heretofore to use certain carbohydrates with or without core oils in core binders, also to use various adjuncts therein. See for example British Patent 515,470; U. S. Patent 2,215,825; and German Patent 552,380. However, as will be apparent from the information herein set forth, my invention differs radically from the prior art and produces unexpected improvements thereover.

The invention will be further illustrated by the examples set forth below which are intended for illustrative and informative purposes and not in any way limiting the invention.

EXAMPLE 1

This example shows how strength of baked cores is increased when certain adjuncts are used with the binders.

Various core mixtures containing cereal binder, sugar, and sugar in combination with an adjunct were prepared as follows:

A weighed amount of American Foundrymen's Society standard 50–70 sand was poured into a muller. To this was added 1 percent by weight of pregelatinized cereal binder made in accordance with the principles of U. S. Patent 1,939,973 and sold under the trademark Mogul.

Then 1 percent by weight of a sugar (nature of which is described in Table II) was added. This mixture served as the control. Identical mixtures of cereal binder and sand were then made to which was added 1 percent by weight of a mixture prepared by thoroughly blending 100 parts of sugar and the amount of an adjunct as set forth in the table.

In each case the whole mass was mixed for a suitable period, the muller stopped, 3 percent by weight of water added, and the mixture mulled again for a suitable period. Where sulfuric acid, phosphoric acid, pyrophosphoric acid, and hydrochloric acid were employed, these were added as solutions in the water, rather than as a blended mixture with the sugar. Specimen cores were prepared according to a method recommended by the American Foundrymen's Society (Foundry Sand Handbook, sixth edition, published in 1952 by American Foundrymen's Society, Chicago), and were baked in an oven at 400° F.±10° F. for the length of time shown in Table II. Such cores were tested for tensile strength by the method described in the aforementioned handbook, the results being shown in Table II. After the baking was completed, the specimens were removed from the oven, cooled to room temperature, and the breaking strength was determined with an appropriate machine. The results set forth in Table II.

In those cases shown in Table II where a liquid binder was used, cereal binder was mulled with the sand, water was added and mulled, and then the liquid binder was added and mulled. If the adjunct was a dry powder, this was added with the cereal binder; if the adjunct was available as a liquid, it was added dissolved in the water.

EXAMPLE 2

This example reveals the superior green strength properties of cores prepared with cereal binder in combination with a sugar and an adjunct as compared to those prepared with cereal binder used in combination with a core oil. The core sand mixture containing cereal binder, sugar and adjunct was prepared, as described in Example 1. Green strength and dry strength were determined in accordance with procedures described in the Foundry Sand Handbook mentioned above. Results are set forth in Table I, where percentages of binder and adjunct are based on sand.

Table I

GREEN STRENGTH OF CORE MIXTURES AND BAKED STRENGTH OF CORES PREPARED USING TWO BINDER COMBINATIONS

Binders Used	Adjunct Used	Green Strength of Core Mixture, p. s. i.	Tensile Strength of Baked Cores, p. s. i.
1% Cereal binder 0.94% Dextrose hydrate	0.06% $(NH_4)_2SO_4$	0.56	265
1% Cereal binder 1% Core oil	None	0.42	275

EXAMPLE 3

This example shows how volume of gases liberated by a baked core is decreased when the preferred adjunct was used with cereal binder and dextrose.

Several baked cores were prepared in the manner described in Example 1. They were broken in the machine used for testing tensile strength and the two halves were rubbed together to loosen some of the sand. A sample of the loose sand was weighed into a combustion boat and subjected to a temperature of 1850° F. in a combustion furnace, the gas released was collected and measured in accordance with the procedure described in the Foundry Sand Handbook, previously mentioned. The results are listed in Table III where percentages of binder and adjunct are based on weight of sand.

Table II

TENSILE STRENGTH OF BAKED SPECIMEN CORES

Sugar	Chemical Added	Parts of Chemical/100 Parts of Sugar	Baking Time, Hours	Tensile Strength, p.s.i.
Dextrose hydrate	None	0	0.5	120
Do	do	0	1	170
Do	Ammonium sulfate	2	1	170
Do	do	3	0.5	155
Do	do	3	1	230
Do	do	4	1	210
Do	do	5	1	220
Do	do	10	0.5	208
Do	do	10	1	188
Do	do	15	0.5	170
Do	do	15	1	163
Do	Ammonium	2	1	199
Do	Acid sulfate	3	1	225
Do	Ammonium persulfate	1	1	145
Do	do	2	1	240
Do	do	3	1	234
Do	do	5	1	202
Do	Ammonium sulfamate	3	1	225
Do	Sulfuric acid	3	1	260
Do	Phosphoric acid	4	1	232
Do	Pyrophosphoric acid	3	1	217
Do	Hydrochloric acid	0.2	1	232
Do	do	10.0	1	272
Do	Boric acid	10.0	1	199
Do	Sodium chloride	1.0	1	215
Do	Aluminum sulfate	6	1	218
Do	Paraformaldehyde	5.0	1	200
Do	Hydrochloric acid	0.1		
Do	Paraformaldehyde	5.0	1	227
Hydrol (deashed), D. B	Ammonium chloride	0.1		
Do	None	0	0.5	129
Do	do	0	1	167
Do	Ammonium sulfate	3	0.5	127
Hydrol, D. B	do	3	1	221
Do	None	0	0.5	87
Do	do	0	1	158
Do	Ammonium sulfate	3	0.5	113
Alkali treated hydrol	do	3	1	167
Dextrose 2nd greens, D. B	do	3	1	217
Acid treated dextrose greens	do	5	1	269
Corn sirup, D. B. 50 D. E	do	4	1	215
Molasses, D. B	do	7	1	300
Do	None	0	0.5	89
Do	do	0	1	153
Do	Ammonium sulfate	3	0.5	156
Sucrose	do	3	1	158
Do	None	0	0.5	88
Do	do	0	1	172
Do	Ammonium sulfate	3	0.5	243
Maltose	do	3	1	238
Do	None	0	0.5	68
Do	do	0	1	163
Do	Ammonium sulfate	3	0.5	134
Lactose	do	3	1	211
Do	None	0	0.5	58
Do	do	0	1	135
Do	Ammonium sulfate	3	0.5	113
	do	3	1	193

Table III

VOLUME OF GASES LIBERATED PER GRAM OF BAKED CORE AFTER HEATING THE SAND FOR 1 MINUTE AT 1850° F.

Binders Used	Adjunct Used	Gases Evolved Volume in cc.
1% Cereal binder 1% Dextrose hydrate	None	15.5
1% Cereal binder 0.97% Dextrose hydrate	0.03% $(NH_4)_2SO_4$	15.4
1% Cereal binder 0.94% Dextrose hydrate	0.06% $(NH_4)_2SO_4$	12.0
1% Cereal binder 0.91% Dextrose hydrate	0.09% $(NH_4)_2SO_4$	10.1

These results show that the volume of gases liberated by baked cores prepared with cereal binder and dextrose hydrate blended with 9 percent of ammonium sulfate was more than 30 percent less than corresponding cores prepared without the adjunct.

Those skilled in the art of casting metals will recognize that this reduction in the volume of gases liberated by baked cores prepared using cereal binder, sugar, and the preferred adjunct will decrease significantly the number of castings scrapped by reason of gases evolved from the cores.

This is a continuation-in-part of application Serial No. 424,740, filed April 21, 1954, now abandoned.

I claim:

1. A process for producing a core for foundry use which comprises mixing 100 parts of sand, 0.25 to 2 parts of cereal binder, 0.5 to 5 parts of sugar and from 0.002 to 0.15 part of adjunct per part of sugar, and sufficient water to mull the resultant mixture, molding said mixture and baking it at a temperature of at least 350° F.; said sugar-adjunct-binder containing from 1 to 20 parts of adjunct; all parts being on a weight basis; said adjunct being selected from the group consisting of hydrochloric acid; sodium chloride; a mixture consisting of 5 parts by weight of paraformaldehyde and 1 part by weight of ammonium chloride; boric acid; sulfuric acid, phosphoric acid, and salts which produce such acids under said baking conditions.

2. A process for producing a core for foundry use which comprises mixing 100 parts of sand, 0.25 to 2 parts of cereal binder, 0.5 to 5 parts of sugar and from 0.002 to 0.15 part of ammonium sulfate per part of sugar, and sufficient water to mull the resultant mixture, molding said mixture and baking it at a temperature of at least 350° F.; all parts being on a weight basis.

3. A composition for bonding 100 parts of core sand consisting of 0.25 to 2 parts of cereal binder, 0.5 to 5 parts

of sugar and from 0.002 to 0.15 part of adjunct per part of sugar, all parts on dry weight basis, and sufficient water to mull the entire mixture, said adjunct being selected from the group consisting of hydrochloric acid; sodium chloride; a mixture consisting of 5 parts by weight of paraformaldehyde and 1 part by weight of ammonium chloride; boric acid; sulfuric acid, phosphoric acid, and salts which product such acids under baking at temperatures of at least 350° F.

4. A composition for bonding 100 parts of core sand consisting of 0.25 to 2 parts of cereal binder, 0.5 to 5 parts of sugar and from 0.002 to 0.15 part of ammonium sulfate per part of sugar, all parts on dry weight basis, and sufficient water to mull the entire mixture.

References Cited in the file of this patent

UNITED STATES PATENTS

1,431,871	Nagel	Mar. 31, 1925
1,888,441	Weidemann	Nov. 22, 1931
1,938,574	Bauer	Dec. 12, 1933
2,215,825	Wallace	Sept. 24, 1940
2,508,359	Baker	May 23, 1950

FOREIGN PATENTS

515,470	Great Britain	Dec. 6, 1939

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,875,073 February 24, 1959

Charles J. Gogek

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.

In the grant, lines 2 and 3, for "assignor to Corn Products Refining Company, of New York, N. Y., a corporation of New Jersey," read -- assignor to Corn Products Company, a corporation of New Jersey, --; line 12, for "Corn Products Refining Company, its successors" read -- Corn Products Company, its successors --; in the heading to the printed specification, lines 3, 4 and 5, for "assignor to Corn Products Refining Company, New York, N. Y., a corporation of New Jersey" read -- assignor to Corn Products Company, a corporation of New Jersey --; column 6, lines 59 and 60, strike out "said sugar-adjunct-binder containing from 1 to 20 parts of adjunct;".

Signed and sealed this 6th day of October 1959.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents