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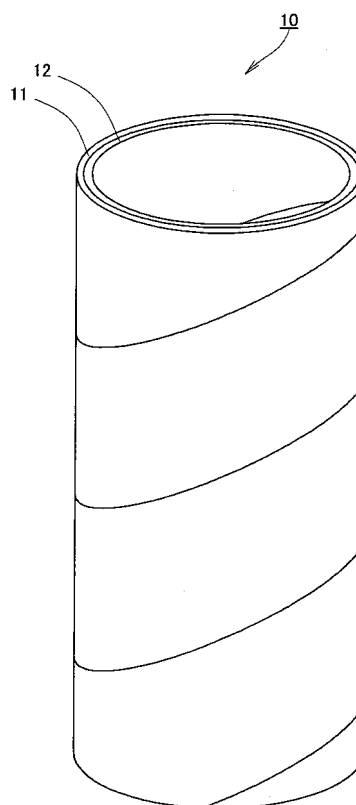
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(54) **COMPONENT FOR CASTING PRODUCTION AND METHOD FOR PRODUCING SAME**

(57) A process of producing a part for casting including the step of preparing a raw material slurry containing inorganic fibers, organic fibers, a thermosetting resin, a papermaking binder, and a sulfonate-based and/or a cellulose-based dispersant. The raw material slurry preferably further contains an inorganic powder and/or a water repellant.

Fig. 1



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Description

Technical Field

5 **[0001]** The present invention relates to a part for producing castings (hereinafter "part for casting" or simply "part") that can be use as a runner, etc. in the production of castings and a process of making the part.

Background Art

10 **[0002]** Applicant has proposed in JP 2004-174605A a technique relating to a part for casting that can be used as a runner, etc. in the production of castings. The technique provides a tube formed of base paper containing organic fiber, inorganic fiber, and a binder, in which the tube is light, easy to handle, and easy to dispose of after use for casting as compared with historically used refractory materials.

15 Disclosure of the Invention

[0003] It is desirable that such a part for casting containing organic fiber, inorganic fiber, and a binder has a minimized content of the organic fiber in order to reduce the generation of combustion gas (hereinafter sometimes referred simply to as "gas") accompanying thermal decomposition of the organic fiber during casting. If the organic fiber content is reduced, however, the components will have poor dispersibility, tending to result in poor formation to yield a high proportion of defective castings. In the case of making base paper by papermaking, in particular, reduction in organic fiber content is liable to produce wavy paper.

[0004] The present invention relates to a satisfactory part for casting and a process of producing the part, in which a specific dispersant is used to allow for reducing an organic fiber content. The invention also relates to a satisfactory part for casting having a reduced organic fiber content and a process of producing the part.

[0005] The present inventors have found that a satisfactory part for casting can be obtained by using a specific dispersant even when an organic fiber content is reduced and completed the invention.

[0006] Based on the above finding, the present invention provides a process of producing a part for casting including the step of preparing a raw material slurry containing inorganic fibers, organic fibers, a thermosetting resin, a papermaking binder, and a sulfonate-based and/or a cellulose-based dispersant.

[0007] The present invention also provides a part for casting containing inorganic fibers, organic fibers, a thermosetting resin, a papermaking binder, and a sulfonate-based and/or a cellulose-based dispersant.

Brief Description of the Drawing

35 **[0008]**

Fig. 1 is a schematic perspective of an embodiment of the present invention.

Fig. 2 is a cross-section schematically illustrating a casting mold that is used to evaluate blowback in Examples.

Detailed Description of the Invention

[0009] The present invention will be described based on its preferred embodiments with reference to the accompanying drawings.

45 **[0010]** The part for casting according to the invention is first described based on its preferred embodiment. The part 10 of the embodiment shown in Fig. 1 contains inorganic powder, inorganic fibers, organic fibers, a thermosetting resin, a papermaking binder, and a water repellant and, in addition, 0.001% to 10% by mass, preferably 0.01 % to 10% by mass, of a sulfonate-based and/or a cellulose-based dispersant based on 100% by mass of the total of the inorganic powder, inorganic fibers, organic fibers, thermosetting resin, papermaking binder, and water repellant. Use of such amount of a dispersant enables production of a good part while minimizing the content of the organic fibers.

[0011] Examples of the sulfonate-based dispersant include a sodium β -naphthalenesulfonate-formalin condensate, sodium ligninsulfonate, a sodium melaminesulfonate-formalin condensate, an aromatic aminosulfonic acid sodium salt polymer, sodium polystyrenesulfonate, a styrenesulfonic acid-sodium maleinsulfonate copolymer, sodium polycyclopentadienesulfonate, and an aliphatic dienesulfonic acid sodium salt polymer. Preferred of them is a sodium β -naphthalenesulfonate-formalin condensate having a degree of polycondensation of 3 to 6 for consideration of the formation of wet base paper (a wet mat of fiber).

[0012] The cellulose-based dispersant preferably has high water solubility and preferably dissolves completely in a 1% by mass aqueous solution. Such a cellulose-based dispersant is exemplified by cellulose propylene oxide adduct

derivatives, e.g., hydroxypropyl cellulose and hydroxypropylmethyl cellulose. Hydroxypropyl cellulose is preferred for consideration of the formation of wet base paper (a wet fiber mat).

[0013] The dispersants can be used either individually or as a combination of two or more thereof.

[0014] The ratio of the inorganic powder/inorganic fibers/organic fibers/thermosetting resin (solid content)/papermaking binder (solid content)/water repellent in the part for casting of the invention is 0-70%/1-60%/1-40%/1-40%/1-10%/0-5% by mass, preferably 40-70%/1-10%/1-25%/1-25%/1-10%/0-5% by mass, more preferably 50-70%/1-8%/1-20%/10-25%/3-7%/0-1% by mass, taking the total of these components as 100% by mass. The content of the inorganic powder being within the range recited, the part has good shape retention during pouring, and a fiber molded article has good surface conditions and good release from a mold. With the content of the inorganic fibers being within the range recited, good papermaking properties and good shape retention during pouring are obtained. With the organic fiber content being in the range recited, good papermaking properties are obtained, and combustion gas generation during pouring can be held down so as to prevent a blowback (a back-flow of molten metal). The thermosetting resin content falling in that range, the casting mold has good molding properties, and a fiber molded article has good shape retention after pouring and good surface smoothness. The papermaking binder content being in that range, the binder makes the powder component in the slurry cling to the fibers while causing the fibers to moderately intermingle with one another to form flocks optimum for sheet formation and thereby securing good yield. With the water repellent content being in the range recited, the base paper formed by papermaking can be converted into a part for casting with a minimum amount of an adhesive because the adhesive applied is prevented from penetrating into the base paper. Furthermore, after the part for casting is buried in molding sand, the water content of the molding sand is prevented from penetrating into the part.

[0015] Examples of the inorganic powder include obsidian, mullite, and graphite including flaky graphite and earthy graphite. One or more than one kind of the inorganic powders can be selected for use. In the case where a casting has a carbon content of 4.2% by mass or less, carburizing (penetration of carbon into a casting to make the casting brittle) occurs. In that case, inorganic powder having a silica content should be used to prevent carburizing from a casting carbide. It is preferred to use obsidian, mullite, etc. as an inorganic powder. When the carbon content of the casting is 4.2% by mass or more, the part does not need to contain inorganic powder.

[0016] The inorganic fiber serves mainly to constitute the skeleton of the part. For example, it does not burn even with the heat of molten metal and continues serving to retain the shape of the part during casting. Examples of the inorganic fiber include artificial mineral fibers, such as carbon fiber and rock wool, ceramic fibers, and natural mineral fibers. They can be used either alone or in combination of two or more thereof. Carbon fiber that maintains high strength even in high temperatures, such as pitch-based carbon fiber or polyacrylonitrile (PAN)-based carbon fiber, is preferred for effectively reducing thermal shrinkage accompanying carbonization of the thermosetting resin. PAN-based carbon fiber is especially preferred.

[0017] The inorganic fiber preferably has an average length of 0.1 to 10 mm, more preferably 0.5 to 8 mm, in view of the quality of a fiber molded product obtained by papermaking technique. Continuous fibers of 10 mm or longer may be used as cut in a slurry in a refiner, etc. to have an average fiber length controlled to 0.1 to 10 mm.

[0018] Examples of the organic fibers include pulp fibers, fibrillated synthetic fibers, and regenerated fibers (e.g., rayon fiber). These fibers are used either individually or as a mixture of two or more thereof. Preferred of them is pulp fiber from the viewpoint of sheet forming properties, strength after drying, and cost.

[0019] Examples of the pulp fibers include not only wood pulp but non-wood pulp, such as cotton pulp, linter pulp, bamboo, and straw. These kinds of pulp, whether virgin or recycled, can be used either alone or in combination thereof. From the standpoint of availability, environmental conservation, and reduction of production cost, used paper pulp is preferred.

[0020] It is preferred for the organic fibers to have an average length of 0.1 to 20 mm, more preferably 0.5 to 10 mm, from the viewpoint of surface smoothness and impact strength of the resulting base sheet.

[0021] The thermosetting resin is a component necessary to retain the low- and high-temperature strength of the part 10 and to provide a paper tube with good surface properties which contribute to improve the surface smoothness of a casting. The thermosetting resins include phenol resins, epoxy resins, and furan resins. Phenol resins are preferred in view of reduced generation of combustible gas, resistance to burning, and a high carbon residue content after thermal decomposition (carbonization) as high as 25% or more to form a carbonized film to provide a casting with an improved casting surface. As used herein the terms "carbon residue content" refers to a value obtained by heating a thermosetting resin sample in a nitrogen atmosphere from room temperature up to 1200°C at a rate of temperature rise of 50°C/min, measuring the mass of the residue, and dividing the mass of the residue with the mass before heating. The mass after heating is lighter than that before heating because combustion gas is released from the resin during heating. Usable phenol resins include novolak phenol resins requiring a curing agent and resol type phenol resins requiring no curing agent. In order to minimize elution of free phenol into white water, it is preferred to use a low-release phenol resin, such as high-molecular-weight resol phenol resins synthesized using a basic catalyst or an acidic catalyst. In using a novolak phenol resin, a curing agent is needed. Since the curing agent easily dissolves in water, it is preferably applied to the surface of a dewatered fiber mat. Preferred examples of the curing agent include hexamethylenetetramine. The ther-

mosetting resins can be used either individually or as a combination of two or more thereof.

[0022] Examples of the combustion gas include carbon monoxide, carbon dioxide, and hydrocarbons such as methane and ethylene.

[0023] Examples of the papermaking binder include natural polymers such as starch, gelatin, guar gum, and carboxymethyl cellulose (CMC); water soluble synthetic polymers such as KAIMEN (polyamideamine-epichlorohydrin resin), polyvinyl alcohol (PVA), polyacrylamide (PAM), and polyethylene oxide (PEO); styrene-butadiene latices, acrylonitrile-butadiene latices, acrylic latices, and vinyl acetate latices; and inorganic binders such as colloidal silica and alumina-based binders. Preferred of them are KAIMEN, CMC, and acrylic latices for their powder-fixing properties. The papermaking binder is preferably used in an amount of 0.01% to 5%, more preferably 0.02% to 1%, on a solid basis based on the mass of the organic fibers. These papermaking binders can be used either individually or as a combination of two or more thereof.

[0024] The part 10 can contain a water repellant to prevent penetration of the adhesive described *supra* into base paper and to prevent loss of strength due to moisture absorption. Silicone surface active agents, fluorine-containing surface active agents, fat and oil type surface active agents, hydrophobic surface active agents, and hydrophobic polymers can be used as a water repellant. The water repellant is preferably applied to both the inner and outer sides of the part 10 and dried to prevent deterioration of strength due to moisture absorption. The water repellant is advisably used in the form of an aqueous solution or emulsion that is convenient to handle upon use. The water repellants may be used either individually or as a combination of two or more thereof. Silicone, fluorine-containing or fat and oil type emulsions are preferably used. When the water repellant is added to a slurry, particularly preferred is an alkyl ketene dimer (AKD), which exhibits excellent water repellency in a neutral region at a small amount and is superior in acid resistance and alkali resistance to rosin, etc. The water repellant may be added in an adequate amount to a raw material slurry or applied to the part. Coating techniques include spraying, brush coating, dipping, and pouring. Spraying, dipping or pouring is preferred for productivity. Coating by "pouring" as used here is achieved by hosing a pumped liquid over the part to be coated. In cases where the part for casting is used in a dry working environment or when the thermosetting resin serves for water repellency depending on its kind or amount used, the water repellant may be dispensed with.

[0025] The part 10 may contain other components such as a flocculant and a colorant in appropriate amounts in addition to the above described components.

[0026] The part 10 preferably has a surface roughness Ra of 20 μm or less, more preferably 10 μm or less. The surface roughness Ra is measured, e.g., with Surtronic 10 from Rank Taylor Hobson.

[0027] The part 10 is preferably formed of base paper containing the aforementioned components. The base paper preferably has a tensile strength of 40 N/15 mm or more, more preferably 80 N/15 mm or more. The tensile strength is measured in a tensile test of a 15 mm wide specimen cut out of 0.7 mm thick base paper on a Tensilon universal tester RTA500 from A & D Co., Ltd. When the thickness of a sample is not 0.7 mm, the tensile strength as measured is converted to strength per unit cross-sectional area for comparison. Base paper having a tensile strength within the above range does not tear or break when spirally wound to make paper tubing as a part for casting as in the present embodiment.

[0028] To secure strength, the part 10 preferably has a compressive strength of 20 N or higher, more preferably 40 N or higher, before use in casting. The term "compressive strength" as used herein is a compressive strength of the wall of tubing measured as follows. A 60 mm wide specimen cut out of a part for casting is set on a compressive strength testing instrument (e.g., a Tensilon universal tester RTA 500 from A & D) with its cut area horizontal and compressed at a rate of 10 mm/min.

[0029] While the thickness of the part 10 is subject to variation according to where it is applied, it is preferably 0.5 to 6 mm, more preferably 1 to 3 mm, for securing strength required of a part for casting and air permeability and reducing the production cost.

[0030] It is preferred for the part 10 before use in casting to have a water content of not more than 20% by mass, more preferably 10% by mass or less, to minimize water vapor generation on contact with molten metal. Water vapor generation causes blowback (back flow) of molten metal from the pour spout.

[0031] A preferred embodiment of the process of producing a part for casting according to the present invention will then be described with reference to the production of the part 10.

The part 10 is composed of two tubular paper plies 11 and 12 each formed of spirally wound base paper. The production of the part 10 starts with preparation of base paper for making the tubular paper plies 11 and 12.

[0032] Respective raw material slurries for the base paper for making the tubular paper plies 11 and 12 are prepared from the above-described inorganic powder, inorganic fibers, organic fibers, thermosetting resin, papermaking binder, and dispersant. Each of the slurries is converted to a sheet form (wet fiber mat), dewatered, and dried in accordance with a wet papermaking technique to obtain base paper.

[0033] Examples of the dispersing medium of the slurry include water, white water, and solvents such as ethanol and methanol. Water is preferred in view of stability in wet fiber mat formation and dewatering, stability of quality of the resulting base paper, cost, and ease of handling.

[0034] If desired, the slurry can contain additives including a flocculant and an antiseptic.

[0035] The slurry thus prepared is then converted into base paper for making paper tubing by a papermaking process. Papermaking can be carried out by any technique selected from, for example, continuous papermaking methods using a cylinder paper machine, a Fourdrinier paper machine, a short-wire paper machine or a twin-wire paper machine, and batchwise papermaking methods including manual papermaking.

[0036] In order for the base paper to keep the shape retention and mechanical strength after papermaking, the wet fiber mat is dewatered to reduce its water content preferably to 30% or smaller, more preferably to 10% or smaller. Dewatering of the fiber layer can be conducted by, for example, suction, blowing pressurized air or pressing with a pressure roll or a pressure plate.

[0037] The dewatered fiber mat is forwarded to a drying step. Any means for drying that has conventionally been used to dry paper can be used in the drying step.

[0038] The base paper after dewatering and drying preferably has a tensile strength of 40 N/15 mm or more, more preferably 80 N/15 mm, to be wound into tubing. The tensile strength is measured in a tensile test of a 15 mm wide specimen cut out of 0.7 mm thick base paper on the above mentioned Tensilon universal tester. When the thickness of samples to be measured is not 0.7 mm, the tensile strength as measured is converted to strength per unit cross-sectional area for comparison.

[0039] The base paper after dewatering and drying preferably has a buckling strength of 3 N or higher, more preferably 4 N or higher, in view of the strength of the resulting part for casting. The buckling strength is measured by a 3-point bending test as follows. A specimen of base sheet measuring 60 mm in width and 100 mm in length is set on a tester with a 40 mm span length, and compressed from above by an indenter having a width of 60 mm and a diameter of 6 mm at the tip. From the same viewpoint, the base paper after dewatering and drying preferably has a buckling displacement of 3 mm or more, more preferably 5 mm or more. The term "buckling displacement" means the amount of displacement of base paper at the maximum stress point in the above described 3-point bending test.

[0040] It is preferred that the base paper after dewatering and drying generates not more than 250 cc/g, more preferably not more than 200 cc/g, of combustion gas per unit mass of the part at 1000°C. The amount of combustion gas generated is measured using equipment for measuring the amount of generated combustion gas (No. 682 Gas Pressure Tester from Harry W. Dietert Co.). The amount of combustion gas generated is preferably as small as possible. The practically reachable lower limit is 0.1 to 1 cc/g.

[0041] The base paper after dewatering and drying preferably has a surface roughness Ra of 20 μm or less, more preferably 10 μm or less. The surface roughness Ra is measured, e.g., with Surtronic 10 from Rank Taylor Hobson.

[0042] In the case where the water repellant is used, the base paper after dewatering and drying preferably has water repellency of 15% or less, more preferably 10% or less. The water repellency of base paper is measured, e.g., in accordance with the method specified in JIS P8140, paper and board - determination of water absorptiveness - Cobb method. The contact time between a test piece and water was set at 60 seconds.

[0043] The base sheet after dewatering and drying preferably has a density of 0.62 to 0.9 g/m³, more preferably 0.64 to 0.75 g/m³. With this density, break of base paper during winding into tubing due to insufficient strength and difficulty in winding due to excessive bending stiffness of base paper are avoided.

[0044] The resulting webs of base paper was each slit into a strip of predetermined width, and the strips are successively lap-wound helically with an overlap between adjacent turns either in the same direction or different directions to be shaped into a tubular form. When wound in the same direction, the outer strip is preferably wound in a manner to cover the exposed edge of the preceding turns of the inner strip. In lap winding, an adhesive is applied as appropriate to form tubing. The width of the strips, the width of overlap, the inner diameter of paper tubing, and the like are decided according to the mass of a casting (i.e., the amount of molten metal passing the paper tube) and required sand-pressure strength of the paper tube (i.e., the strength withstanding the pressure in making a sand mold).

[0045] After completion of lap-winding all the plies, the tubing is dried by heating at a prescribed temperature and cut to length to complete the production of a part for casting.

[0046] The part for casting of the present embodiment is excellent in that the amount of combustion gas it generates during casting is reduced because of its reduced organic fiber content, and yet it retains good formation.

[0047] The part 10 for casting of the present embodiment generates not more than 250 l/m², preferably not more than 150 l/m², of combustion gas at 1000°C, wherein "m²" is the unit of the surface area of the part 10 at an average diameter. The term "average diameter" as used herein denotes a diameter calculated by (inner diameter + outer diameter)/2. The amount of combustion gas generated is preferably as small as possible. The practically reachable lower limit is 1 to 10 l/m². The amount of combustion gas generated at 1000°C is measured using equipment for measuring the amount of generated combustion gas (No. 682 Gas Pressure Tester from Harry W. Dietert Co.).

[0048] As understood from the above description, the amount of combustion gas generated from base paper is given in cubic centimeter per gram, while that from a part for casting is in liter per square meter. This is because a part having a smaller inner diameter is more liable to cause blowback (back-flow of molten metal) than a part having a larger inner diameter with the base paper making them being equal, i.e., with the amount of gas generation given in cc/g being equal. That is, the amount given in cc/g is not enough to evaluate proneness to blowback. The reason a part with a smaller

inner diameter is more prone to cause a blowback is that the volume of molten metal present in a tubular part is relatively smaller and therefore relatively lighter to be blown up than in a larger-diameter tubular part.

[0049] In addition to the above, being light-weight and easy to cut to length with a convenient device, the part for casting according to the present invention enjoys the same advantage of ease of handling as of this type of conventional parts.

[0050] The present invention is not limited to the foregoing embodiments, and various changes and modifications can be made therein without departing from the spirit and scope thereof.

[0051] For example, while in the foregoing embodiments the part for casting is composed of two tubular paper plies, it may be composed of three or more tubular paper plies. The ply structure is selected as appropriate to required sand-pressure strength, required high-temperature strength, the thickness of base paper, and so forth. The term "high-temperature strength" as used herein refers to mechanical strength of a part on contact with molten metal.

[0052] While in the foregoing embodiments the part for casting is formed of base paper previously prepared by a papermaking technique, it is possible to make the part by a conventionally known pulp molding technique using the same raw material slurry as described.

Examples

[0053] The present invention will now be illustrated in greater detail with reference to Examples, but it should be understood that the invention is not limited thereto. Unless otherwise noted, all the percents are by mass.

Example 1

[0054] A sample sheet for evaluation was prepared using the following raw materials of base paper for tubular paper plies. The resulting sheet of base paper was evaluated for formation (waviness and disperse state of inorganic powder, etc.), surface roughness, and generation of combustion gas in accordance with the methods described below. The results obtained are shown in Table 1.

[0055]

Composition of base paper for tubular paper plies (sample for evaluation)

(1) Inorganic powder: obsidian powder (average particle size: 30 μ m)	65.5% by mass
(2) Inorganic fiber: carbon fiber (length: 3 mm; Torayca chopped fiber, available from Toray Industries, Inc.)	4% by mass
(3) Organic fiber: used paper	12% by mass
(4) Thermosetting resin: resol phenol resin (Bellpearl S-890 from Air Water Bellpearl Inc.)	18% by mass
(5) Papermaking binder: KAIMEN	0.25% by mass
(6) Papermaking binder: CMC	0.25% by mass
(7) Water repellent	not added
Total of (1) to (7): 100% by mass	
(8) Dispersant: sodium β -naphthalenesulfonate-formalin condensate (Demol N from Kao Corp.)	0.5% by mass

The dispersant (8) was added in an amount of 0.5% by mass based on the total (100% by mass) of the components (1) to (7).

[0056] In a 2-liter juicer-mixer were put 100 g, in total, of the components (1) to (7) and 0.5 g of the dispersant (8) in accordance with the composition above together with 1.9 liters of water and agitated for 3 minutes to prepare a stock slurry. The stock slurry was poured into a papermaking tester (size of paper made: 250 mm (W) x 250 mm (L); wire: 40 mesh; capacity: 15 liters) together with 13-liter of diluted water, stirred, and allowed to stand for 1 minute. White water was drained through the wire to form a wet fiber mat, which was pressed under 0.1 MPa and dried in a dryer at 105°C for 30 minutes to obtain a sample sheet of base paper.

(a) Evaluation of waviness

[0057] The waviness on the top side (opposite to the wire side) of the sample paper was evaluated by scoring from 1 to 5 based on the number of projections of 1 mm or more in height counted on that side.

Scoring system:

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0: 50 or more projections

1: 40 to 49 projections

5 2: 30 to 39 projections

3: 20 to 29 projections

10 4: 10 to 19 projections

5: 9 or less projections

(b) Disperse state of inorganic fibers

15 **[0058]** The disperse state of inorganic fibers was evaluated by scoring from 1 to 5 based on the number of flocks of inorganic fibers appearing on the back side (wire side) of sample paper.

0: 50 or more flocks of carbon fibers

20 1: 40 to 49 flocks of carbon fibers

2: 30 to 39 flocks of carbon fibers

25 3: 20 to 29 flocks of carbon fibers

4: 10 to 19 flocks of carbon fibers

5: 9 or less flocks of carbon fibers

30 (c) Disperse state of inorganic powder and thermosetting resin

[0059] The area ratio of flocks of the inorganic powder and the thermosetting resin was measured on the back side (wire side) of the sample paper and scored for evaluation. When these components are poorly dispersed, they gather on the wire side of paper.

35 0: the area ratio of the inorganic powder and thermosetting resin flocks is 80% to 100%.

1: the area ratio of the inorganic powder and thermosetting resin flocks is 60% to 79%.

40 2: the area ratio of the inorganic powder and thermosetting resin flocks is 40% to 59%.

3: the area ratio of the inorganic powder and thermosetting resin flocks is 20% to 39%.

45 4: the area ratio of the inorganic powder and thermosetting resin flocks is 10% to 19%.

5: the area ratio of the inorganic powder and thermosetting resin flocks is 9% or less.

Flocks of the inorganic powder are recognizable with the naked eye as flocks of whitish powder. Flocks of the thermosetting resin are recognizable with the naked eye as flocks of yellow powder.

50 (d) Evaluation of formation

[0060] The formation was evaluated by the sum of the scores obtained in the evaluations (a) to (c). A higher score means better formation, and a lower score means poor formation.

55 (e) Evaluation of surface roughness

[0061] The surface roughness Ra was measured with Surtronic 10 from Rank Taylor Hobson in accordance with the

operation manual.

(f) Evaluation of combustion gas generation

[0062] The amount of combustion gas generated was measured using an instrument for measuring the amount of generated combustion gas (No. 682 Gas Pressure Tester from Harry W. Dietert Co.) as follows. The furnace inner temperature was set at 1000°C. One-tenth gram (nominal mass) of the sample was weighed out with precision of milligram and placed on the mount of the instrument, and the amount of combustion gas generated was measured in accordance with the instruction manual. The amount of combustion gas generated was calculated as programmed based on the integration of the rate of combustion gas generation. Calculation was made based on the amount of combustion gas after an elapse of 30 seconds. The rate of combustion gas generation and the amount of combustion gas generated were analyzed on Chromato Pack C-R4A from Shimadzu Corp.

Example 2

[0063] A sample sheet of base paper was prepared in the same manner as in Example 1, except for replacing the dispersant of Example 1 with the one described below. The resulting paper was evaluated in the same manner as in Example 1. The results obtained are shown in Table 1.

Dispersant: hydroxypropyl cellulose (Klucel H from Hercules). This dispersant, being sparingly soluble, was preliminarily diluted with water to a 1% concentration and then added to a 0.5% by mass on a solid basis.

Comparative Example 1

[0064] A sample sheet of base paper was prepared in the same manner as in Example 1, except for using no dispersant, and a part for casting was formed of the resulting base paper in the same manner as in Example 1. The resulting paper was evaluated in the same manner as in Example 1. The results obtained are shown in Table 1.

Comparative Example 2

[0065] A sample sheet of base paper was prepared in the same manner as in Example 1, except for using the following raw materials of base paper for tubular paper plies. In Comparative Example 2, the amount of the organic fiber was doubled, and any dispersant was not added.

Composition of base paper for tubular paper plies (sample for evaluation)

(1) Inorganic powder: obsidian powder (average particle size: 30 μm)	48% by mass
(2) Inorganic fiber: carbon fiber (length: 3 mm; Torayca chopped fiber, available from Toray Industries, Inc.)	9.5% by mass
(3) Organic fiber: used paper	24% by mass
(4) Thermosetting resin: resol phenol resin (Bellpearl S-890 from Air Water Bellpearl Inc.)	18% by mass
(5) Papermaking binder: KAIMEN	0.25% by mass
(6) Papermaking binder: CMC	0.25% by mass
(7) Water repellent	not added
(8) Dispersant	not added
Total of (1) to (8): 100% by mass	

[0066]

Table 1

	Formation					Surface Roughness Ra (μm)	Combustion Gas from Paper (cc/g)
	Waviness	Dispersed State			Overall Judgement		
		Inorganic Powder	Inorganic Fiber	Thermo-setting Resin			
Example 1	4	4	4	5	17	4.2	190

(continued)

	Formation					Surface Roughness Ra (μm)	Combustion Gas from Paper (cc/g)
	Waviness	Dispersed State			Overall Judgement		
		Inorganic Powder	Inorganic Fiber	Thermo-setting Resin			
Example 2	5	5	4	5	19	9.5	198
Comp. Example 1	1	2	2	2	7	23.8	202
Comp. Example 2	5	4	5	5	19	8.0	268

[0067] As is apparent from Table 1, the base paper obtained in each Example was proved better in formation and surface roughness and to generate a reduced amount of combustion gas as compared with that of Comparative Example 1. In Comparative Example 2, base paper with good formation and surface roughness was obtained owing to the use of double the amount of organic fibers used in Example 1 but, in turn, produced an increased amount of combustion gas.

Example 3

[0068] A two-ply tubular part for casting (paper tube) as illustrated in Fig. 1 was formed of base paper having the following composition. The resulting part was evaluated for combustion gas generation and blowback in accordance with the method described below. The results obtained are shown in Table 2.

[0069]

Composition of base paper for paper tube

(1) Inorganic powder: obsidian (Nice Catch Flower # 330 from Kinsei Matec Co., Ltd.)	57.3% by mass
(2) Inorganic fiber: carbon fiber (Pyrofil TR03CM from Mitsubishi Chemical Industries, Co., Ltd.)	7.2% by mass
(3) Organic fiber: recycled paper	11.5% by mass
(4) Thermosetting resin: resol phenol resin (Bellpearl S-890 from Air Water Bellpearl Inc.)	17.5% by mass
(5) Papermaking binder: KAIMEN	3.0% by mass
(6) Papermaking binder: CMC	3.0% by mass
(7) Water repellent: alkyl ketene dimer	0.5% by mass
Total of (1) to (7): 100% by mass	
(8) Dispersant: sodium β-naphthalenesulfonate-formalin condensate (Demol N from Kao Corp.)	0.5% by mass

The dispersant (8) was added in an amount of 0.5% by mass based on the total (100% by mass) of the components (1) to (7).

[0070] In a 2-liter juicer-mixer were put 100 g, in total, of the components (1) to (7) and 0.5 g of the dispersant (8) in accordance with the composition above together with 1.9 liters of water and agitated for 3 minutes to prepare a stock slurry. The stock slurry was poured into a papermaking tester (size of paper made: 250 mm (W) x 250 mm (L); wire: 40 mesh; capacity: 15 liters) together with 13-liter of diluted water, stirred, and allowed to stand for 1 minute. White water was drained through the wire to form a wet fiber mat, which was pressed under 0.1 MPa and dried in a dryer at 105°C for 30 minutes to obtain a sample sheet of base paper.

Form of part for casting:

[0071] The base paper for tubing (thickness; 0.7 mm) was slit into strips having widths of 80 mm and 82 mm. The 80 mm wide strip was spirally lap-wound onto a mandrel having an outer diameter of 50 mm as a first ply. The 82 mm wide strip was spirally lap-wound on the first ply while applying an adhesive to the 82 mm wide strip in a manner as to cover the exposed edge of the 80 mm strip to make a paper tube as a part for casting shown in Fig. 1.

Adhesive: phenol resin emulsion (PR-51464 from Sumitomo Bakelite Co., Ltd.)

Total thickness: 1.4 mm

Inner diameter: 50 mm

(a) Evaluation of combustion gas generation

[0072] The amount of combustion gas generated was measured using an instrument for measuring the amount of generated combustion gas (No. 682 Gas Pressure Tester from Harry W. Dietert Co.) as follows. The furnace inner temperature was set at 1000°C. One-tenth (0.1) gram (nominal mass) of the sample was weighed out with precision of milligram and placed on the mount of the instrument, and the amount of combustion gas generated was measured in accordance with the instruction manual. The amount of combustion gas generated was calculated as programmed based on the integration of the rate of combustion gas generation. Calculation was made based on the amount of combustion gas after an elapse of 30 seconds. The rate of combustion gas generation and the amount of combustion gas generated were analyzed on Chromato Pack C-R4A from Shimadzu Corp.

(b) Evaluation of blowback

[0073] A casting mold 1 illustrated in Fig. 2 was made by burying paper tubes 2 to 4 measuring 50 cm, 30 cm, and 5 cm in length, respectively, all having an inner diameter of 50 mm, connected with pottery elbows, in the hatched portion of cured sand (molding sand) containing a furan resin. Two hundred fifty kilograms of molten metal at 1400°C was poured in the mold through the pour spout 5, and a blowback from the pour spout was observed with the naked eye and rated as follows.

good: a slight flame generated

bad: an about one-meter column of flame generated

Comparative Example 3

[0074] A two-ply tubular part for casting (paper tube) was made in the same manner as in Example 3, except that base paper was prepared using the following composition (the amount of the organic fibers was doubled, and any dispersant was not used). The resulting part for casting was evaluated in the same manner as in Example 3. The results are shown in Table 2.

[0075]

Composition of base paper for paper tube

(1) Inorganic powder: mullite (Mullite MM#200 from MC Kosan K.K.)	47.6% by mass
(2) Inorganic fiber: carbon fiber (Pyrofil TR03CM from Mitsubishi Chemical Industries, Co., Ltd.)	4.2% by mass
(3) Organic fiber: recycled paper	25.0% by mass
(4) Thermosetting resin: resol phenol resin (Bellpearl S-890 from Air Water Bellpearl Inc.)	16.7% by mass
(5) Papermaking binder: KAIMEN	3.0% by mass
(6) Papermaking binder: CMC	3.0% by mass
(7) Water repellent: alkyl ketene dimer	0.5% by mass
Total of (1) to (7): 100% by mass	

[0076]

Table 2

	Combustion Gas from Paper (cc/g)	Combustion Gas from Part for Casting (l/m ²)	Blowback
Example 3	230	225.0	good
Comparative Example 3	260	315.8	bad

[0077] As can be seen from Table 2, the parts for casting obtained in Example show a reduction of combustion gas generation and prevent a blowback.

Industrial Applicability

[0078] The present invention provides a part for casting which has a reduced content of organic fibers while retaining excellent formation so as to reduce generation of combustion gas during casting. The invention also provides a process

for advantageously making a part for casting having the above effects.

[0079] The present invention is applicable to various casting mold parts constituting a casting mold, such as a pouring cup, a runner, a gate, a gas vent, a feeder, and a mold cavity, and production of such parts.

Claims

1. A process of producing a part for casting comprising the step of preparing a raw material slurry comprising inorganic fibers, organic fibers, a thermosetting resin, a papermaking binder, and a sulfonate-based and/or a cellulose-based dispersant.
2. The process of producing a part for casting according to claim 1, wherein the raw material slurry further comprises an inorganic powder and/or a water repellant.
3. The process of producing a part for casting according to claim 2, wherein the mass content of the inorganic powder is 0% to 70%, the mass content of the inorganic fibers is 1% to 60%, the mass content of the organic fibers is 1% to 40%, the mass content of the thermosetting resin is 1% to 40%, the mass content of the papermaking binder is 1% to 10%, and the mass content of the water repellant is 0% to 5%, the total of the inorganic powder, the inorganic fibers, the organic fibers, the thermosetting resin, the papermaking binder, and the water repellant being 100%.
4. The process of producing a part for casting according to any one of claims 1 to 3, wherein the sulfonate-based dispersant is a sodium β -naphthalenesulfonate-formalin condensate having a degree of polycondensation of 3 to 6.
5. The process of producing a part for casting according to any one of claims 1 to 3, wherein the cellulose-based dispersant is a propylene oxide adduct derivative of cellulose.
6. The process of producing a part for casting according to any one of claims 2 to 4, wherein the raw material slurry contains at least one of obsidian, mullite, and graphite as the inorganic powder, at least one of carbon fiber, rock wool, and ceramic fiber as the inorganic fibers, and at least one of a phenol resin, an epoxy resin, and a furan resin as the thermosetting resin.
7. A part for casting comprising inorganic fibers, organic fibers, a thermosetting resin, a papermaking binder, and a sulfonate-based and/or a cellulose-based dispersant.
8. The part for casting according to claim 7, which generates not more than 250 l/m² of combustion gas at 1000°C.
9. The part for casting according to claim 7 or 8, which further comprises an inorganic powder and/or a water repellant.
10. The part for casting according to claim 9, wherein the mass content of the inorganic powder is 0% to 70%, the mass content of the inorganic fibers is 1% to 60%, the mass content of the organic fibers is 1% to 40%, the mass content of the thermosetting resin is 1% to 40%, the mass content of the papermaking binder is 1% to 10%, and the mass content of the water repellant is 0% to 5%, the total of the inorganic powder, the inorganic fibers, the organic fibers, the thermosetting resin, the papermaking binder, and the water repellant being 100%.
11. The part for casting according to any one of claims 7 to 10, wherein the sulfonate-based dispersant is a sodium β -naphthalenesulfonate-formalin condensate having a degree of polycondensation of 3 to 6.
12. The part for casting according to any one of claims 7 to 10, wherein the cellulose-based dispersant is a propylene oxide adduct derivative of cellulose.
13. The part for casting according to any one of claims 9 to 12, wherein the raw material slurry contains at least one of obsidian, mullite, and graphite as the inorganic powder, at least one of carbon fiber, rock wool, and ceramic fiber as the inorganic fibers, and at least one of a phenol resin, an epoxy resin, and a furan resin as the thermosetting resin.

Fig. 1

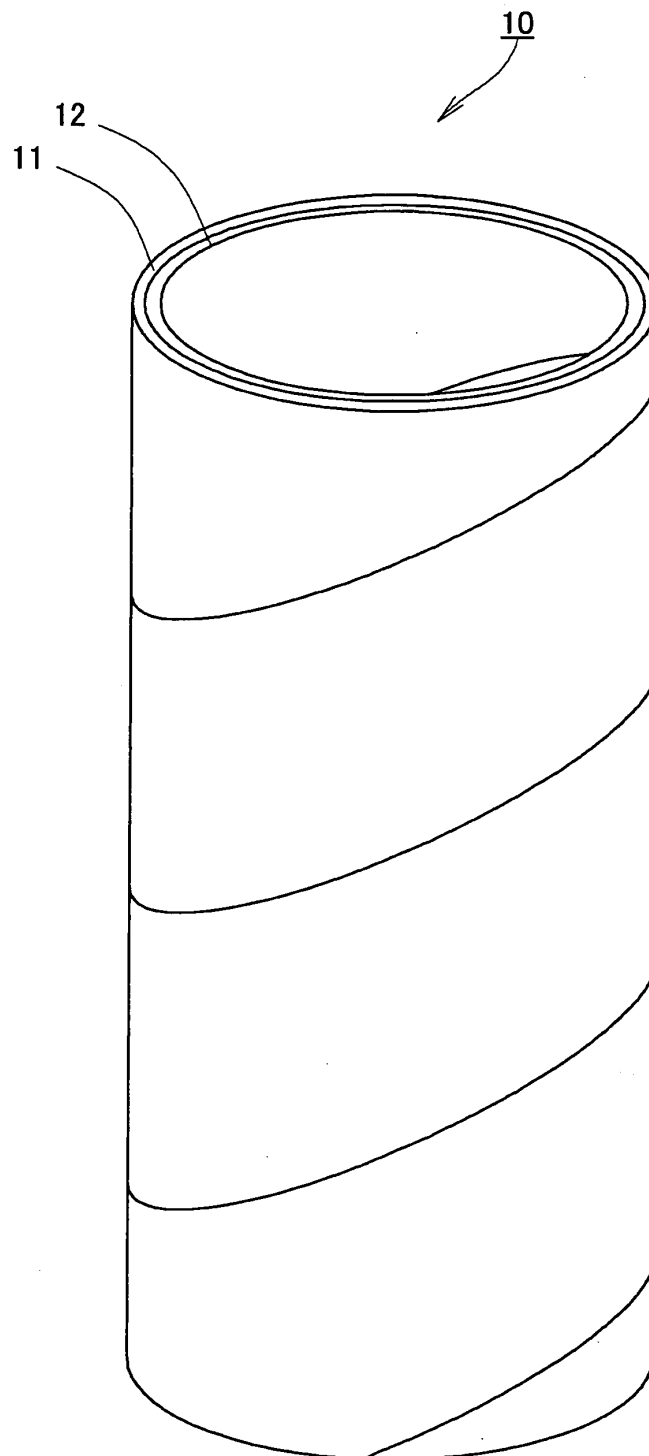
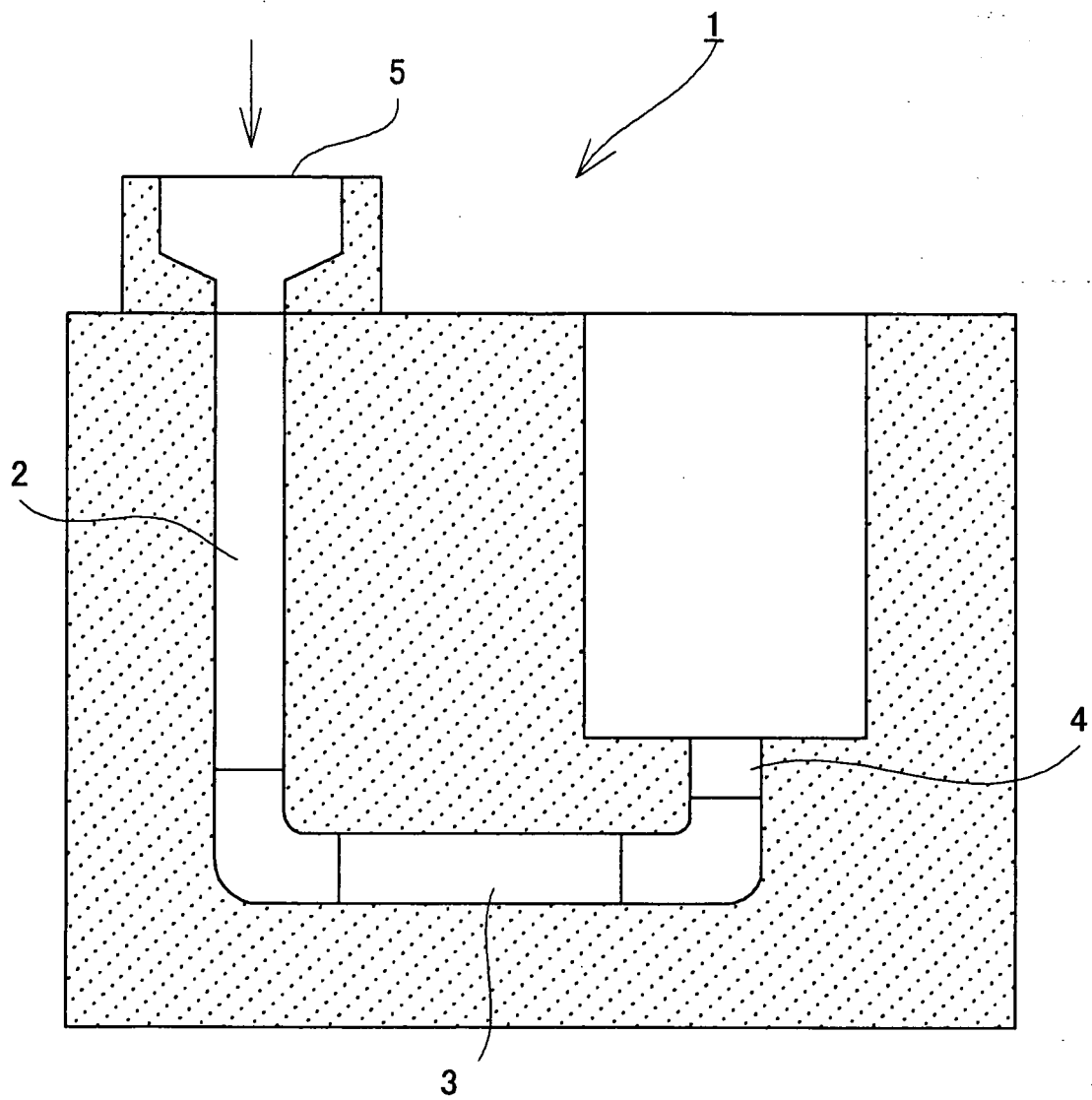


Fig. 2



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/323797

A. CLASSIFICATION OF SUBJECT MATTER

B22C1/00(2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B22C1/00-9/30

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2007
 Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005-153003 A (Kao Corp.), 16 June, 2005 (16.06.05), (Family: none)	1-13
A	JP 9-253792 A (Nissan Motor Co., Ltd.), 30 September, 1997 (30.09.97), (Family: none)	1-13

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

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"&" document member of the same patent family

Date of the actual completion of the international search
22 February, 2007 (22.02.07)Date of mailing of the international search report
06 March, 2007 (06.03.07)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2004174605 A [0002]