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(54) **A moulding material and a method for casting, and an additive for the moulding material**

(57) A moulding material for casting iron contains sand and a carbonaceous material, the carbonaceous material comprising pit coal. The main component of the carbonaceous material, relatively to each of the components of the carbonaceous material, is coke.

Also provided is a use of such a moulding material, a method for casting iron and an additive for the moulding material.

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Description

Field of the Invention

[0001] The present invention relates to a moulding material and a method for casting iron, the moulding material containing sand and a carbonaceous material, which comprises pit coal. The invention further concerns an additive for a moulding material, the additive containing a carbonaceous material which comprises pit coal.

Background

[0002] In the casting of iron in green sand moulds, it is known to form a moulding material that contains about 80-90% by weight of sand, about 5-11% by weight of binder (usually bentonite), about 3-4% by weight of water and about 2-6% by weight of carbonaceous material.

[0003] In commercially used moulding materials, the carbonaceous material consists mainly of powdered coal, or alternatively a coal dust replacement. A problem associated with this kind of carbonaceous material is that it contains a certain amount, usually about 30% by weight, of volatile compounds (such as VOC - volatile organic compounds), which are set free as the moulding material is heated, and which cause emissions from the foundry plant. However, these volatile organic compounds have a beneficial effect on the casting performance by reducing the adherence of, for example, the moulding material to the cast object, thus reducing the amount of moulding sand that has to be removed from the cast object in subsequent production stages.

[0004] In Dempsey, LaFay, Neltner, Taulbee: Understanding Properties of Carbonaceous Additives and Their Potential to Emit Benzene, AFS Transactions, 97-107, pp. 109-117, a casting method is shown in which anthracite, metallurgical coke and lignite are added to a mixture of carbonaceous material, the main component of which is pit coal.

[0005] In LaFay, Neltner, Taulbee, Wellbruck, Ashburn: Applying Emission Characteristics of Seacoal and Seacoal Supplements for the Foundry Industry, AFTS Transactions, 99-23, pp. 7-10, casting methods are shown in which a carbonaceous material that contains respectively about one half of pit coal and one half of natural asphalt (Gilsonite) and one half of pit coal and one half of anthracite.

[0006] In LaFay, Neltner, Taulbee, Wellbrock, Ashburn: Evaluating Benzene Emissions During Casting of Aluminum and Iron, AFS Transactions, 99-01, pp. 745-750, a casting method is shown in which 2% pit coal is added to the moulding material.

[0007] In LaFay, Neltner, Taulbee, Wellbrock: Evaluating Emission Characteristics of Seacoal and Seacoal Supplements Using Advanced Analytical Techniques, AFS Transactions, 00-46, pp. 713-718, a casting method is shown in which 2% carbonaceous material is added to the moulding material and in which the percentages of weight of the carbonaceous material are about 67% anthracite and 22% pit coal.

[0008] In LaFay, Neltner: Green Sand Without Seacoal, AFS Transactions, 04-111, pp. 671-681, casting methods are shown in which cellulose, anthracite and lignite are analyzed as substitutes for pit coal, and in which it is found that wholly replacing the pit coal will result in reduced casting performance (adherence of sand).

[0009] In Moore, Brown: Coal in Greensand Systems - A new look at a very old practice, Foundry Trade Journal, June 2005, an admixture of 3-5% coke to the moulding material is shown.

[0010] Accordingly, there is a need for an improved moulding material and an improved casting method, which combine low emissions of volatile organic compounds with reduced adherence of sand to the cast article.

Summary of the Invention

[0011] An object of the present invention is to provide a moulding material, a method for casting and an additive for such a moulding material, which partly or entirely eliminate the problems associated with prior art. A particular object is to provide a moulding material, a casting process and an additive, which reduce the emissions of volatile organic compounds, in combination with a low adherence of sand to the cast article.

[0012] The invention is defined in the appended independent claims. Embodiments are outlined in the dependent claims and in the following description.

[0013] Thus, a moulding material for casting iron is provided, which moulding material contains sand and a carbonaceous material, the carbonaceous material constituting 0.5-10% by weight of the moulding material and containing pit coal. The carbonaceous material contains, relatively to each of the components of the carbonaceous material, mainly coke in proportion by weight.

[0014] A moulding material of this kind can be made acceptable in terms of both emissions and the adherence of moulding material to the cast object.

[0015] According to embodiments, 40% by weight or more, preferably 50% by weight or more, of the carbonaceous material, can be coke. The lower limit for the amount of coke is not critical for the performance of the moulding sand in

terms of adherence, but can be chosen based on the permissible amount of emissions.

[0016] According to further embodiments, 60% by weight or more, preferably 70% by weight or more, of the carbonaceous material can be coke.

[0017] According to further embodiments, 99% by weight or less, preferably 95% by weight or less, 90% by weight or less, 80% by weight or less, 75% by weight or less or 70% by weight or less, of the carbonaceous material can be coke.

[0018] According to further embodiments, the remaining part of the carbonaceous material can be pit coal, or pit coal and coal dust replacement.

[0019] According to embodiments, 30% by weight or less, preferably 20% by weight or less, 15% by weight or less, 10% by weight or less, of the carbonaceous material can be pit coal, or pit coal and coal dust replacement.

[0020] According to further embodiments, the moulding material can contain 25% by weight or less, preferably 6% by weight or less, 4% by weight or less or 2.5% by weight or less, of carbonaceous material.

[0021] According to further embodiments, the moulding material can contain 0.5% by weight or more, 1% by weight or more, 1.5% by weight or more, 2% by weight or more, 2.5% by weight or more, 3% by weight or more, 3.5% by weight or more, 4% by weight or more or 4.5% by weight or more, of carbonaceous material.

[0022] According to further embodiments, the moulding material can contain a binder, for example about 4-15% by weight, preferably 5-11% by weight, of binder. The binder can be bentonite.

[0023] According to further embodiments, the moulding material can contain graphite, preferably in an amount of up to about 0.5-2% by weight of the moulding material. By adding graphite the moulding material is made more fluid and thus becomes easier to handle.

[0024] According to further embodiments, the remaining part of the moulding material, in addition to the components referred to above, can be sand, which part preferably constitutes 80-95% by weight, preferably 80-90% by weight of the moulding material.

[0025] According to a second aspect, use of a moulding material as described above for casting iron objects is provided.

[0026] According to a third aspect, a process is provided for casting iron in a moulding material containing sand and a carbonaceous material, which constitutes 0.5% by weight of the moulding material and comprises pit coal. The process comprises mixing coke into the moulding material, so that the main component by weight of the carbonaceous material, in proportion to each of the components of the carbonaceous material, is coke.

[0027] According to a fourth aspect, an additive for a moulding material intended for casting iron is provided. The additive contains a carbonaceous material comprising pit coal and is distinguished in that the carbonaceous material, relatively to each of the components of the carbonaceous material, mainly contains coke in proportion by weight.

[0028] According to one embodiment, the remaining part of the carbonaceous material of the additive is pit coal, or pit coal and coal dust replacement.

[0029] According to one embodiment, the additive contains a binder.

[0030] According to one embodiment, the binder comprises bentonite.

[0031] According to one embodiment, the additive contains graphite.

[0032] The advantages obtained by means of the additive described above will be apparent, for example, from the above description of the moulding material according to the invention. Moreover, the conceivable amounts contained in the additive will be apparent from said description and the description below.

Description of Embodiments

[0033] Tests were made consisting in the casting of brake discs of grey cast iron with a weight of 6.2 kg. A basic mixture for a moulding material, consisting of synthetic moulding sand, mixed from virgin materials, was prepared, wherein quartz-felspar was mixed with 5% by weight of soda-treated calcium bentonite and water, and then stored for one month. The amount of water was chosen so as to provide a suitable consistency of the moulding sand, and the amount of added water was about 2.3-3.1% by weight. The basic mixture was mixed with different additives. The final amount of sand (percentage by dry weight) can be calculated from the tables below, since it constitutes the remaining part not stated in the tables. All weight parts in the tables relate to the dry weight composition of the mixtures.

[0034] Additions to the basic mixture of moulding sand were made according to the following:

[0035] In a first sample, "Sample 1", a moulding material made up of a basic mixture and 4% by weight of coke was prepared. The carbonaceous material in this moulding material thus consisted of 100% by weight coke.

[0036] In a second sample, "Sample 2", a moulding material made up of a basic mixture, 3% by weight coke and 1% by weight graphite. The carbonaceous material in this moulding material thus consisted of 75% by weight coke and 25% by weight graphite.

[0037] In a third sample, "Sample 3", a moulding material made up of a basic mixture and 4% by weight of powdered coal. The carbonaceous material in this moulding material thus consisted of 100% by weight of powdered coal.

[0038] In a fourth sample, "Sample 4", use was made of a commercially used circulating, i.e. recycled, moulding material, with a measured carbon content of about 4.5% by weight. The carbonaceous material added in this moulding

material was made up of powdered coal and coal dust replacement. Furthermore, this moulding material contains, due to the circulation, a small amount of coke, which is formed when the moulding material is heated during casting and the powdered coal and coal dust replacement are converted into coke. In addition, this moulding material contains carbonaceous rests from polymere-containing binders used during the manufacture of mould cores.

[0039] In a fifth sample, "Sample 5", a moulding sand made up of a basic mixture and 4% by weight coke and 1.5% by weight of powdered coal was prepared. The carbonaceous material in this moulding material thus consisted of 73% by weight coke and 27% by weight powdered coal.

[0040] In a sixth sample, "Sample 6", the moulding material of Sample 2 was used, wherein 0.5% by weight powdered coal was added. The carbonaceous material in this moulding material thus consisted of 67% by weight coke, 22% by weight graphite and 11% by weight powdered coal.

[0041] In a seventh sample, "Sample 7", the moulding material of Sample 2 was used, wherein a basic mixture was added to obtain a total amount of coke representing 1.5% by weight and a total amount of graphite representing 0.5% by weight. Furthermore, 0.5% by weight of powdered coal was added. The carbonaceous material in this moulding material thus consisted of 60% by weight coke, 20% by weight graphite and 20% by weight powdered coal.

[0042] In an eighth sample, "Sample 8", a moulding material according to the EU project GO-APIC (Proj. No. G1RD-CT-2000-00235) was used. The carbonaceous material in this moulding material was made up of a graphite-zeolite blend, and thus contained no coke.

[0043] Upon casting, the cast article was left to cool for 40 minutes in the mould, following which one form part was removed and placed on its end on the other form part for 20 minutes, to allow volatile organic compounds set free by the form parts to be collected by the ventilating hood and measured in the ventilating duct.

[0044] After a total time of one hour, the cast article was separated from the moulds and vibrated on a separating device for one minute, and then left to cool completely.

[0045] When the cast articles had reached room temperature, they were vibrated for another minute on the separating device and then blasted. Weighing of the cast articles was carried out after the first minute on the separating device.

[0046] In samples 1-4, the volatile organic compounds were measured by means of a ventilating hood provided with FID instruments, which measure the content of volatile organic compounds in the ventilating duct. Furthermore, the amount of sand was measured after the first separation.

[0047] In sample 8, only the amount of sand was measured following the first separation. Table 1 shows the results of the measurements for Samples 1-4.

Table 1: Results for Samples 1-4

Sample		1	2	3	4
Bentonite	[% by weight]	5.1	5.1	5.1	6.5
Coke	[% by weight]	4	3	0	-*
Pit coal/ Coal dust replacement	[% by weight]	0	0	4	-*
Graphite	[% by weight]	0	1	0	-*
Carbon content	[% by weight]	3.2	2.9	3.0	4.5
VOC max	[ppm]	0.05	0.01	24	19
Sand amount	[% by weight]	8.5	6.2	1.7	2.2
* No content data available, since the sample was a reference sample with recycled moulding material.					

[0048] Table 1 shows that a moulding material with no admixture of pit coal results in an unacceptably large amount of adhering moulding material. Thus, Samples 1 and 2 are unacceptable from the point of view of productivity, since an excessive amount of adhering sand is obtained.

[0049] Table 1 further shows that a moulding material in which pit coal constitutes a small proportion of the carbonaceous material results in low emissions of volatile organic compounds. Thus, Samples 3 and 4 are unacceptable from the point of view of emissions.

[0050] Table 2 illustrates the results of the measurements for Samples 5-8.

Table 2: Results for Samples 5-8

Sample		5	6	7	8
Bentonite	[% by weight]	5.1	5.1	5.1	6.8
Coke	[% by weight]	4	3	1.5	0
Hard coal/ Coal dust replacement	[% by weight]	1.5	0.5	0.5	0
Graphite	[% by weight]	0	1	0.5	< 2.0
Carbon content	[% by weight]	4,1	3.2	1.9	< 1.0
Sand amount	[% by weight]	1.3	3.0	6.6	6.0

[0051] Table 2 shows that a moulding material in which the main component of the carbonaceous material is coke, with the admixture of pit coal, results in an acceptable amount of adhering moulding material.

[0052] Because the emissions of volatile organic compounds are directly proportional to the amount of powdered coal/ coal dust replacement, it is found that Samples 5-7 should be acceptable also from the point of view of emissions.

[0053] Thus, the conclusion is that a moulding material which contains sand and carbonaceous material, and in which the carbonaceous material contains pit coal and/or coal dust replacement, the main component of the carbonaceous material being coke, can be made acceptable both in terms of emissions and in terms of adherence.

[0054] The extensive adherence of moulding material in Sample 7 is likely due to the fact that the total amount of carbonaceous material was too small, approximately 1.9% by weight. A likely remedy to this problem would be to add more coke, thereby increasing the carbon content. Another measure available would be to add zeolites, as shown, for example, in EP-1 469 960 A1.

Claims

1. A moulding material for casting iron, which moulding material contains sand and a carbonaceous material, the carbonaceous material constituting 0.5-10% by weight of the moulding material and containing pit coal, **characterised in that** the carbonaceous material, relatively to each of the components of the carbonaceous material, contains mainly coke in proportion by weight.

2. A moulding material according to claim 1, wherein 40% by weight or more, preferably 50% by weight or more, of the carbonaceous material is coke.

3. A moulding material according to claim 2, wherein 60% by weight or more, preferably 70% by weight or more, of the carbonaceous material is coke.

4. A moulding material according to any one of the preceding claims, wherein less than 99% by weight, preferably 95% by weight or less, 90% by weight or less, 80% by weight or less, 75% by weight or less or 70% by weight or less, of the carbonaceous material is coke.

5. A moulding material according to any one of claims 1, 3 and 4, wherein the remaining part of the carbonaceous material is pit coal, or pit coal and coal dust replacement.

6. A moulding material according to claim 5, wherein less than 30% by weight, preferably 20% by weight or less, 15% by weight or less, 10% by weight or less, of the carbonaceous material is pit coal, or pit coal and coal dust replacement.

7. A moulding material according to any one of the preceding claims, wherein the moulding material contains 10% by weight or less, preferably 6% by weight or less, 4% by weight or less or 2.5% by weight or less, of carbonaceous material.

8. A moulding material according to any one of claims 1-6, wherein the moulding material contains 0.5% by weight or more, 1% by weight or more, 1.5% by weight or more, 2% by weight or more, 2.5% by weight or more, 3% by weight or more, 3.5% by weight or more, 4% by weight or more or 4.5% by weight or more, of carbonaceous material.

9. A moulding material according to any one of the preceding claims, wherein the moulding material contains a binder.

10. A moulding material according to claim 9, wherein the moulding material contains about 4-15% by weight, preferably 5-11% by weight, of binder.

11. A moulding material according to claim 9 or 10, wherein the binder comprises bentonite.

12. A moulding material according to any one of the preceding claims, wherein the moulding material contains graphite, preferably in an amount of up to about 0.5-2% by weight of the moulding material.

13. A moulding material according to any one of the preceding claims, wherein the remaining part of the moulding material is sand, which part preferably constitutes 80-95% by weight, preferably 80-90% by weight, of the moulding material.

14. Use of a moulding material according to any one of the preceding claims.

15. A method for casting iron in a moulding material containing sand and a carbonaceous material, which constitutes 0.5-10% by weight of the moulding material and comprises pit coal, **characterised in that** the method comprises mixing coke into the moulding material, so that the main component of the carbonaceous material in proportion by weight, relatively to each of the components of the carbonaceous material, is coke.

16. An additive for a moulding material intended for casting iron, which additive contains a carbonaceous material comprising pit coal, **characterised in that** the carbonaceous material, relatively to each of the components of the carbonaceous material, contains mainly coke in proportion by weight.

17. An additive according to claim 16, wherein the remaining part of the carbonaceous material is pit coal, or pit coal and coal dust replacement.

18. An additive according to claim 16 or 17, wherein the additive contains a binder.

19. An additive according to claim 18, wherein the binder comprises bentonite.

20. An additive according to claims 16-19, wherein the additive contains graphite.

European Patent Office

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Application Number
EP 06 12 6676

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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Application Number
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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