Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2631908 C 2011/07/12

(11)(21) **2 631 908**

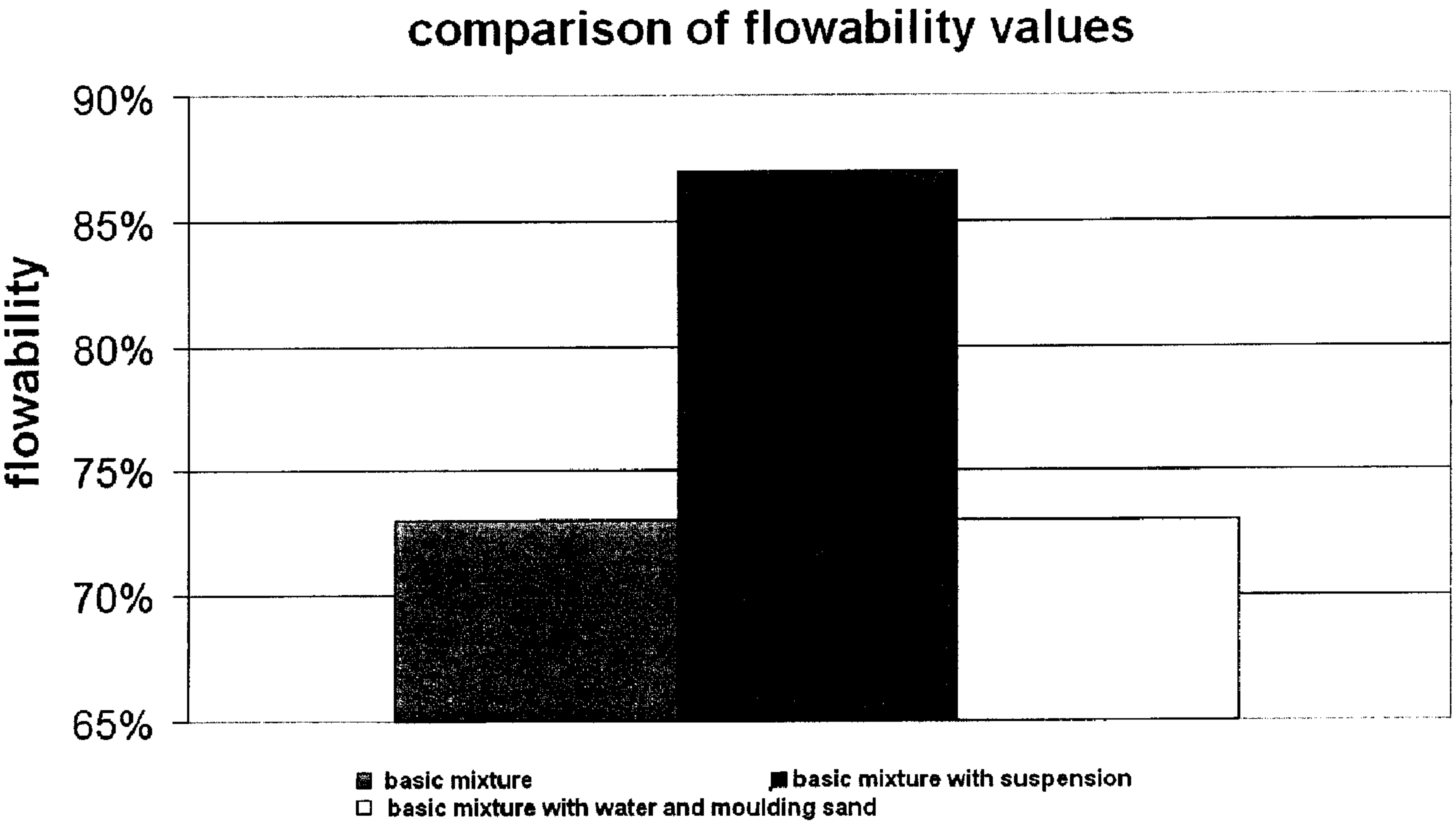
(12) **BREVET CANADIEN**
CANADIAN PATENT

(13) **C**

(22) **Date de dépôt/Filing Date**: 2008/05/21
(41) **Mise à la disp. pub./Open to Public Insp.**: 2008/12/12
(45) **Date de délivrance/Issue Date**: 2011/07/12
(30) **Priorité/Priority**: 2007/06/12 (DE102007027577.5)

(51) **Cl.Int./Int.Cl.** *B22C 1/18* (2006.01),
B22C 9/02 (2006.01)
(72) **Inventeurs/Inventors**:
GERLACH, RALF-JOACHIM, DE;
WEHREN, BETTINA, DE
(73) **Propriétaire/Owner**:
MINELCO GMBH, DE
(74) **Agent**: SMART & BIGGAR

(54) **Titre** : MELANGE DE MATERIAUX DE COULAGE, PIECE COULEE UTILISEE EN FONDERIE ET PROCESSUS DE FABRICATION D'UNE PIECE COULEE
(54) **Title**: MOULDING MATERIAL MIXTURE, MOULDED PART FOR FOUNDRY PURPOSES AND PROCESS OF PRODUCING A MOULDED PART



(57) **Abrégé/Abstract**:

The invention relates to a moulding material mixture for foundry purposes, consisting of a mould sand, a sodium hydroxide solution, a binding agent based on alkali silicate and additives, wherein the mould sand particles comprise a grain size of 0.1 to 1 mm. The moulding material mixture contains 0.1 to 10 percent by weight of sodium hydroxide solution with reference to the weight of the sand and 0.1 to 5 % of binding agent based on alkali silicate with a solid matter percentage of 20 to 70 %, wherein the moulding material mixture, as the additive, contains 0.1 to 3 percent by weight of a suspension with a solid matter percentage of 30 to 70% of amorphous, spherical SiO_2. The amorphous, spherical SiO_2 is contained in the suspension in two grain size classifications with a

(57) **Abrégé(suite)/Abstract(continued):**
first grain size classification A containing SiO_2 particles with a grain size ranging between 1 and 5 micrometers and with a second grain size classification B containing SiO_2 particles with a grain size ranging between 0.01 and 0.05 micrometers. For the volume percentages of the two grain size ranges A, B, the following distribution rule applies: 0.8 to 1.0-1.2 to 1. Furthermore, the invention relates to a moulded part for foundry purposes and to a process of producing said moulted part.

Abstract

The invention relates to a moulding material mixture for foundry purposes, consisting of a mould sand, a sodium hydroxide solution, a binding agent based on alkali silicate and additives, wherein the mould sand particles comprise a grain size of 0.1 to 1 mm. The moulding material mixture contains 0.1 to 10 percent by weight of sodium hydroxide solution with reference to the weight of the sand and 0.1 to 5 % of binding agent based on alkali silicate with a solid matter percentage of 20 to 70 %, wherein the moulding material mixture, as the additive, contains 0.1 to 3 percent by weight of a suspension with a solid matter percentage of 30 to 70% of amorphous, spherical SiO_2. The amorphous, spherical SiO_2 is contained in the suspension in two grain size classifications with a first grain size classification A containing SiO_2 particles with a grain size ranging between 1 and 5 micrometers and with a second grain size classification B containing SiO_2 particles with a grain size ranging between 0.01 and 0.05 micrometers. For the volume percentages of the two grain size ranges A, B, the following distribution rule applies: 0.8 to 1.0-1.2 to 1. Furthermore, the invention relates to a moulded part for foundry purposes and to a process of producing said moulted part.

Moulding material mixture, moulded part for foundry purposes and process of producing a moulded part

The invention relates to a moulding material mixture for foundry purposes, consisting of a mould sand, a sodium hydroxide solution, a binding agent based on alkali silicate and additives as well as to a moulded part intended for foundry purposes and produced by using the moulding material mixture. The invention also relates to a process of producing a moulded part.

Moulding material mixtures of the initially mentioned type are known from DE 102004042535 A1 (AS LÜNGEN GmbH) for example, wherein the binding agent is used in the form of an alkali water glass in connection with a particle-shaped metal oxide, for example silicon oxide, aluminium oxide, titanium oxide or zinc oxide in order to improve the strength of casting moulds both immediately after moulding and precipitation and also after storage and exposure to an increased amount of air humidity. The particle size of the metal oxides preferably amounts to less than 300 µm; according to the examples, the screen residue on a screen with a mesh width of 63 µm amounts to less than 10 percent by weight, preferably less than 8 percent by weight.

A further process of producing moulding material mixtures whose purpose it is to achieve a high strength when combined with a polyphosphate- or borate-containing binding agent is described in US 5,641,015. In column 4, line 39 of the US patent it is mentioned that, as a result of a drying process making use of polyphosphate- or borate-containing binding agent, there is released water which is absorbed by adding silicon dioxide in the finest possible particles. Said silicon dioxide consists of porous primary particles which are produced by a precipitation process, which comprise a grain size ranging between 10 and 60 nm and which are agglomerated into secondary particles with a particle size of several µm (column 3, lines 64-66 of the US patent).

An inorganic binding agent system for moulding materials is described in EP 1095719B1 according to which, in the case of a binding agent based on alkali silicate with added sodium hydroxide solution, it is possible to improve the flow resistance by adding 8 – 10 percent by mass with reference to the binding agent. Said improvement was accompanied by a higher moisture content of the core sand.

In addition to prior art measures of improving the strength value, more particularly the bending strength of moulded parts, it is necessary to take into account further influencing factors which determine the quality of a moulding material mixture:

Most importantly, it is necessary to mention flowability which is known as a significant parameter for the suitability of the moulding material when filling a core shooting machine.

Further important parameters are the precipitation curve and the reduction in sensitivity to air humidity.

However, the main quality characteristic to be achieved by the moulding material mixture is the surface quality of the casting. Unfortunately, under the conditions prevailing in mass production, the prior art processes are not sufficiently stable, so that again and again, the reject quotas and the unacceptable additional costs due to the need for re-treatment are too high. The most suitable standard for assessing the surface quality has been found to be the determination of the surface percentage of sand adhesions on the casting.

It is therefore desirable to provide a new moulding material mixture for foundry purposes and a moulded part which can be produced by means of a simple drying process wherein the above-mentioned criteria, i.e. good flowing characteristics, a high bending strength and a high precipitation speed can be achieved and wherein, at the same time, the surface quality measured by determining the surface percentage of sand adhesions can be improved considerably.

In accordance with one aspect of the present invention, there is provided a moulding material mixture for foundry purposes, consisting of a mould sand, a sodium hydroxide solution, a binding agent based on alkali silicate and additives, wherein the mould sand particles comprise a grain size of 0.1 to 1 mm, that the moulding material mixture contains 0.1 to 10 percent by weight of sodium hydroxide solution with reference to the weight of the sand, the sodium hydroxide solution comprises a concentration of 20 to 40 percent by weight, the moulding material mixture contains 0.1 to 5 % of the binding agent based on alkali silicate with a solid matter percentage of 20 to 70 %, and the moulding material mixture, as the additive, contains 0.1 to 3 percent by weight of a suspension with a solid matter percentage of 30 to 70% of amorphous, spherical SiO_2 in two grain size classifications in the suspension with a first grain size classification A containing SiO_2 particles with a grain size ranging between 1 and 5 micrometers and with a second grain size classification B containing SiO_2 particles with a grain size ranging between 0.01 and 0.05 micrometers and wherein, for the volume percentages of the two grain sizes ranged A, B, the following distribution rule applies: A:B = 0.8:1 to 1.2:1.

In accordance with another aspect of the present invention, there is provided a moulded part for foundry purposes, produced from a moulding material mixture described herein, wherein the surface of the individual mould sand grain in the moulded part comprises a primary structure out of SiO_2 particles with the grain size ranging between 1 and 5 micrometers wherein micrometer-sized amorphous SiO_2 spheres space the individual quarts sand particles from one another and a substructure of SiO_2 particles with the grain size ranging between 0.01 and 0.05 micrometers which are distributed in a binding agent layer which is 0.5 to 2 micrometers thick and is uniformly distributed on mould sand grains, wherein nanometre-sized, amorphous SiO_2 spheres form adjoining peaks and valleys of up to 300 nanometres of height/depth.

In accordance with another aspect of the present invention, there is provided a process of producing a moulded part described herein, comprising providing the mould sand, which is mixed with the sodium hydroxide solution, laced with the binding agent based on alkali silicate, with the binding agent then being uniformly and homogeneously distributed over all the mould sand grains in the form of a binding agent envelope; wherein into the binding agent envelope there is fed a mixture of SiO_2 particles with two grain size classifications and the moulding material mixture is dried to form the moulded part, wherein the binding agent envelope shrinks during the drying process, forming a structure with a maximum height differential of 300 nanometres.

It has been found that the use of an additive consisting of amorphous, spherically formed silicon dioxide achieves the desired advantages if the silicon dioxide grains in the form of the finest particles are added in two close grain spectra in approximately identical volume percentages in the form of a suspension, with a decisive measure consisting in that said suspension is uniformly distributed in the moulding material mixture and that the subsequent drying process results in a specifically designed sub-structure.

Care has to be taken to ensure that no agglomeration of the finest particles takes place during mixing, but that, on the contrary, in the respective grain classification there takes place a uniform distribution of the particles. For this purpose, more particularly, fluid mixers and, amongst these, vane mixers have been found to be particularly suitable under conditions of permanent operation.

When producing the sub-structure, the drying process exerts a major influence on the formation of the roughnesses on the surface of the moulded parts. More particularly, the distribution of the peak and valley structure has to be influenced in such a way that there is achieved a relief structure which comprises a peak/valley differential ratio of a maximum of 300 nm. The drying processes can be both thermal drying and microwave drying, and even under extreme storage conditions at an air humidity in excess of 78 % and storage temperatures in excess of 33 °C it was possible to achieve very good storage characteristics, more particularly without the use of microwave oven drying.

During the drying process, the binding agent layer existing in the moulding material mixture on the particles shrinks while there is formed a sub-structure of peaks and valleys. By means of successive pre-shrinking and subsequent shrinking, there is formed a substructure morphology which is characterised by a peak-valley difference of a maximum of 300 nm as a result of the crack formation during the two-stage shrinking process. During the physical drying process used in the first stage, energy is introduced directly into the moist binding agent envelope. The resulting strengthening of the binding agent envelope (surface), as a result of the subsequent thermal drying process, leads to the formation of cracks in the nano range (sub-structure).

In the drawings, which illustrate exemplary embodiments of the present invention,

Figure 1 shows a comparison of flowability values;

Figure 2 shows a comparison of bending strength with and without additive C;

Figure 3 shows a precipitation curve with a basic mixture with and without additive C;

Figure 4 shows the storability of cores dried in a microwave oven;

Figure 5 shows a storability of thermally dried cores;

Figure 6 shows a comparison of surfaces with sand adhesions; and

Figure 7 shows a comparison of flowability of a basic mixture, a prior art binding agent system, a prior art moulding material mixture and the mixture according to the invention.

In the subsequent examples, exemplary embodiments of the invention are described and compared to other moulding material mixtures and the resulting moulded parts. For standardising purposes, it was decided to use identical basic mixtures of Halten mould sand with a mean grain size of 0.32 mm. The grain size was determined according to *Brunhuber*, 16th edition, page 400. The additive used was the inventive suspension containing 25 % by volume of nanoSiO_2 and 25 % by volume of microSiO_2 as well as 50 % by volume of water.

Flowability is expressed as GF flowability; it was determined according to *Brunhuber,* 16th edition, pages 352/353.

The test specimens were standard test specimens measuring 22.5 x 22.5 x 180 mm which were subjected to the respective test conditions.
To summarize: it was possible to convincingly establish the improvements of the composition of the moulding material mixture in accordance with the invention in respect of flowability and a reduction in degree of moisturing relative to liquid aluminium. As liquid aluminium when used in the casting process comprises greatly moisturising properties relative to silicon dioxide and, more particularly, is inclined to moisturise SiO_2 completely and penetrate intermediate spaces, it was highly surprising that it was possible that, with the inventive moulded part, only very small surface regions of less than 10% where sand was adhering.

In combination with an alkali water glass binding agent which is uniformly distributed on the mould sand particles, it was possible to produce a moulding material mixture based on quartz sand, which, in respect of its flowability, bending strength and precipitation, far exceeded the properties of prior art products, provided the additive was used in the two grain size classifications described herein.

In the prepared moulding material mixture, the micrometer-sized, amorphous SiO_2 spheres are to space the individual moulding sand grains from one another while allowing same to slide off one another more easily. This "roller-skate effect" was confirmed by flowability measurements, for instance by the drastically decreasing stirring resistance while the suspension composed in accordance with the invention and comprising two different grain classifications is introduced into a blade mixer. In the process, power absorption of the vane mixer dropped by more than 50 %, whereas the effect without an additive was less than 10 % with reference to the power absorption before the additive was added.

As far as the mixing process is concerned, it is particularly important to note the metering sequence of the individual components and their mixing period. The metering sequence is as follows: 1. The quartz sand is mixed with sodium solution. 2. An alkali silicate binding agent is added. 3. The inventive additive consisting of suspension with nanoSiO_2, and microSiO_2 plus water is added to the basic mixture.

The mixing time depends on the type of mixing aggregate used and has to be determined experimentally. For the minimum mixing time for the mixture the condition aimed at (homogenisation/uniform distribution) has to be determined.

Examples carried out

The basic mixture used in the tests was Halten mould sand. Below, the experimental procedure will be explained by means of a comparison with a classic binding agent system.

a) Improvement in flowability

To explain the improved flowability, which was achieved by jointly adding nanoSiO_2 (0.01-0.05 μm) and microSiO_2 (1-5 μm), the following test results were compared.

1. the basic mixture without the inventive suspension, hereafter also referred to as additive C;

2. the basic mixture with suspension which is composed of a suspension consisting of 25% nanoSiO_2, 25% microSiO_2 and 50% water, and
3. the basic mixture with a quantity of water equivalent to the suspension.

The term “basic mixture” indicates a mixture of mould sand, NaOH and alkali silicate binding agent in changing compositions.

1. Basic mixture of a classic binding agent system

Haltern mould sand determined by *Brunhuber* p. 400

NaOH	0.20%	GF flowability **73%**
Alali silicate binding agent	1.80%	
Additive:		

GF flowability determined according to *Brunhuber* p, 352.353
$F + [(h_1-h)/(h_1- h_2)]*100\%$

2. Basic mixture + suspension

NaOH	0.20%	
Alkali silicate binding agent	1.80%	GF flowability **87%**
Additive C*	1.00%	

(Additive C: suspension of 25% nanoSiO_2, 25% microSiO_2 and 50% water, with the nanoSiO_2 spheres comprising a mean diameter of 0.03 μm and with the microSiO_2 spheres having a mean diameter of 3 μm).

3. Basic mixture and a quantity of water equivalent to the suspension

NaOH	0.20%	
Alkali silicate binding agent	1.80%	GF flowability **73%**
Water	0.50%	

Figure 1 shows the listed results graphically. When the test results are compared, it can be seen quite clearly that the suspension results in an improvement in flowability. Furthermore, it is clear that the addition of a quantity of water equivalent to the suspension does not exert any influence on flowability.

To permit a comparison with prior art processes, moulding material mixtures such as they are described in DE '535 of AS Luegen and in EP '719 were produced with the same basic mixture and tested as described above. The results are graphically illustrated in Figure 7, with the comparative examples having been selected according to Figure 6.

Mixture **Basic mixture**	**Flowability**
Binding agent system according to EP '719	73%
Moulding material mixture acc. to DE '535	80%
Basic mixture + additive C	87%

Figure 7 shows that by adding, in accordance with the invention, SiO_2 spheres present in two grain classifications, the flowability (according to GF) of the core sand increases. The microSiO_2 spheres are spaced by the nanoSiO_2 and permit the so-called "roller skate effect", i.e. the sand grains roll off as a result of the microSiO_2 spheres arranged between them.

b) **Increase in bending strength**

1. **Basic mixture**

			Bending strength
NaOH	0.20%		
Alkali silicate		Removal strength	**289 N/cm^2**
binding agent	1.40%	Core storage time 1h:	**284 N/cm^2**
Additive	-	Core storage time 3h:	**281 N/cm^2**
		Core storage time 24h:	**287 N/cm^2**

2. **Basic mixture + additive C**

			Bending strength
NaOH	0.20%		
Alkali silicate		Removal strength	**475 N/cm^2**
binding agent	1.40%	Core storage time 1h:	**483 N/cm^2**
Additive C*	1.00%	Core storage time 3h:	**476 N/cm^2**
		Core storage time 24h:	**475 N/cm^2**

(Additive C: Suspension of
25% nanoSiO_2, 25% microSiO_2 and
50% water).

The determined bending strength values are graphically illustrated in Figure 2. A comparison between the bending strength of a basic core sand mixture without additive C and the bending strength of a basic core sand mixture with the additive C (suspension of 25% nanoSiO_2, 25% microSiO_2 and 50% water) clearly shows that by adding an additive in accordance with the invention, the bending strength is increased by 2/3.

c) Increase in precipitation speed

1. Basic mixture

NaOH	0.20%
Alkali silicate binding agent	1.40%
Additive	-

	Removal strength	**Removal strength**	**Removal strength**
1st test bar (after 25 sec)	**64 N/cm²**	**65 N/cm²**	**65 N/cm²**
2nd test bar (after 50 sec)	**62 N/cm²**	**65 N/cm²**	**64 N/cm²**
3rd test bar (after 75 sec)	**63 N/cm²**	**64 N/cm²**	**65 N/cm²**

2. Basic mixture + additive C

NaOH	0.20%
AWB-Al binding agent	1.40%
Additive C*	1.00%

(Additive C: suspension of 25% nanoSiO_2 and 25% microSiO_2 and 50% water)

	Removal strength	**Removal strength**	**Removal strength**
1st test bar (after 25 sec)	**81 N/cm^2**	**84 N/cm^2**	**80 N/cm^2**
2nd test bar (after 50 sec)	**95 N/cm^2**	**92 N/cm^2**	**95 N/cm^2**
3rd test bar (after 75 sec)	**109 N/cm^2**	**102 N/cm^2**	**105 N/cm^2**

The test results are graphically illustrated in Figure 3. Due to the present test rig system, the three simultaneously produced test bars could be tested only individually and at intervals of approx. 25 seconds.

During the determination of the bending strength of the basic mixture, this difference in time is not taken into account either, i.e. the strength of all three test bars was approximately the same.

However, when testing the test bars containing additive C, it was found that the bending strength continuously increases during the test procedure (from the first to the second test bar.

d) Reduction in sensitivity to air humidity

1. Basic mixture

NaOH	0.20%
Alkali silicate binding agent	2.40%
Silicone oil	0.10%

Basic mixture

Core storage time [h] (Storage in in moisture cabinet)	**Bending strength** with Microwave drying	**Bending strength** without Microwave drying
0	289 N/cm^2	57 N/cm^2
1	240 N/cm^2	86 N/cm^2
3	200 N/cm^2	50 N/cm^2
24	25 N/cm^2	22 N/cm^2

2. **Basic mixture + additive C**

NaOH	0.20%
Alkali silicate binding agent	1.40%
Additive C*	1.00

0 (Additive C: Suspension of 25% nanoSiO_2, 25% microSiO_2 and 50% water).

Basic mixture + additive C

Core storage time [h] (Storage in in moisture cabinet)	**Bending strength** with Microwave drying	**Bending strength** without Microwave drying
0	475 N/cm^2	87 N/cm^2
1	409 N/cm^2	106 N/cm^2
3	303 N/cm^2	73 N/cm^2
24	85 N/cm^2	87 N/cm^2

The test results are graphically illustrated in Figures 4 and 5. To be able to asses the storability of the cores, even under extreme conditions (air humidity 78%, temperature 33° C), the cores were stored in a moisture cabinet.

Figures 4 and 5 give the evaluation which shows that additive C has a positive effect on storability.

This effect is particularly obvious if the cores were not dried in a microwave oven (Figure 5).

e) Comparing the surfaces of several castings in respect of sand adhesions

Explanatory notes regarding Figure 6:

For determining the quality of casting surfaces, use was made of trough-shaped cores having the dimensions 150 mm x 80 mm. Said core is mixed out of the moulding material to be tested, in a laboratory vane mixer of *Vogel und Schemann AG.* First the quartz sand was provided and stirred with first NaOH and then water glass being added. After the mixture was stirred for 1 minute, there was added the amorphous silicon dioxide (examples in accordance with the invention) and, for the comparative examples, a polyphosphate solution (according to US 5,641,015 or amorphous SiO_2 in the form of spheres, according to '535) was added while stirring continued. Subsequently, the mixture continued to be stirred by one more minute.

The moulding material mixtures were transferred into the storage bunker of a hot box core casting machine of *Rölperwerk Gießereimaschinen* whose moulding tool was heated to 180°C. The moulding material mixtures were introduced by compressed air (5 bar) into the moulding tool and remained in the moulding tool for a further period of 35 seconds. The moulding tool was opened and the moulded part removed. In order to achieve maximum strength, the moulded part is re-dried in the microwave oven. Subsequently, the casting was cast by open-hand casting.

After the casting had cooled, the moulded part was removed and the casting surface was assessed in respect of type and quantity of sand adhesions.

Casting parameters:

Casting dimensions:	150 x 80 x 40 mm
Casting weight:	900 g
Alloy used:	AlSi 7 mg
Casting temperature:	740 °C
Static casting height:	200 mm

Measured sand adhesions in surface percent with reference to the respective surface

Mixture	**Surface with sand adhesions**
Basic mixture without additive	75%
Basic mixture with percentage of polyphosphate & borate	60% (US '015)
Basic mixture with glass pearls, thickness 100 – 200 µm, according to Table 5 Nr. 3.7 of AS Lüngen DE 102004042535	25% (DE '535)
Inventive Basic mixture with widely spread grain spectrum	<10% (invention) acc. to example a)2

Figure 8 illustrates the moulded part which was used to produce the casting used in this case. The percentages of said adhesions refer to the outer surface in the region of the curved casting region R which occurs as a continuously curved bulge R in the moulded part.

Figure 6 graphically illustrates the test results. The moulding material mixture in accordance with the invention achieves a clearly improved casting surface as compared to the basic mixture according to example A)1, according to US ‘015 (amorphous SiO_2 spheres built up of nano particles) and according to DE ‘535 (amorphous, synthetic silicic acid in spherical form).

Claims

1. A moulding material mixture for foundry purposes, consisting of a mould sand, a sodium hydroxide solution, a binding agent based on alkali silicate and additives, wherein
   the mould sand particles comprise a grain size of 0.1 to 1 mm, that the moulding material mixture contains 0.1 to 10 percent by weight of sodium hydroxide solution with reference to the weight of the sand, the sodium hydroxide solution comprises a concentration of 20 to 40 percent by weight, the moulding material mixture contains 0.1 to 5 % of the binding agent based on alkali silicate with a solid matter percentage of 20 to 70 %, and the moulding material mixture, as the additive, contains 0.1 to 3 percent by weight of a suspension with a solid matter percentage of 30 to 70% of amorphous, spherical SiO_2 in two grain size classifications in the suspension with a first grain size classification A containing SiO_2 particles with a grain size ranging between 1 and 5 micrometers and with a second grain size classification B containing SiO_2 particles with a grain size ranging between 0.01 and 0.05 micrometers and wherein, for the volume percentages of the two grain sizes ranged A, B, the following distribution rule applies: A:B = 0.8:1 to 1.2:1.

2. A moulded part for foundry purposes, produced from a moulding material mixture according to claim 1,
   wherein
   the surface of the individual mould sand grain in the moulded part comprises a primary structure out of SiO_2 particles with the grain size ranging between 1 and 5 micrometers wherein micrometer-sized amorphous SiO_2 spheres space the individual quarts sand particles from one another and
   a substructure of SiO_2 particles with the grain size ranging between 0.01 and 0.05 micrometers which are distributed in a binding agent layer which is 0.5 to 2 micrometers thick and is uniformly distributed on mould sand grains, wherein nanometre-sized, amorphous SiO_2 spheres form adjoining peaks and valleys of up to 300 nanometres of height/depth.

3. A process of producing a moulded part according to claim 2, comprising: providing the mould sand, which is mixed with the sodium hydroxide solution, laced with the binding agent based on alkali silicate, with the binding agent then being uniformly and homogeneously distributed over all the mould sand grains in the form of a binding agent envelope; wherein, into the binding agent envelope there is fed a mixture of SiO_2 particles with two grain size classifications and the moulding material mixture is dried to form the moulded part, wherein the binding agent envelope shrinks during the drying process, forming a structure with a maximum height differential of 300 nanometres.

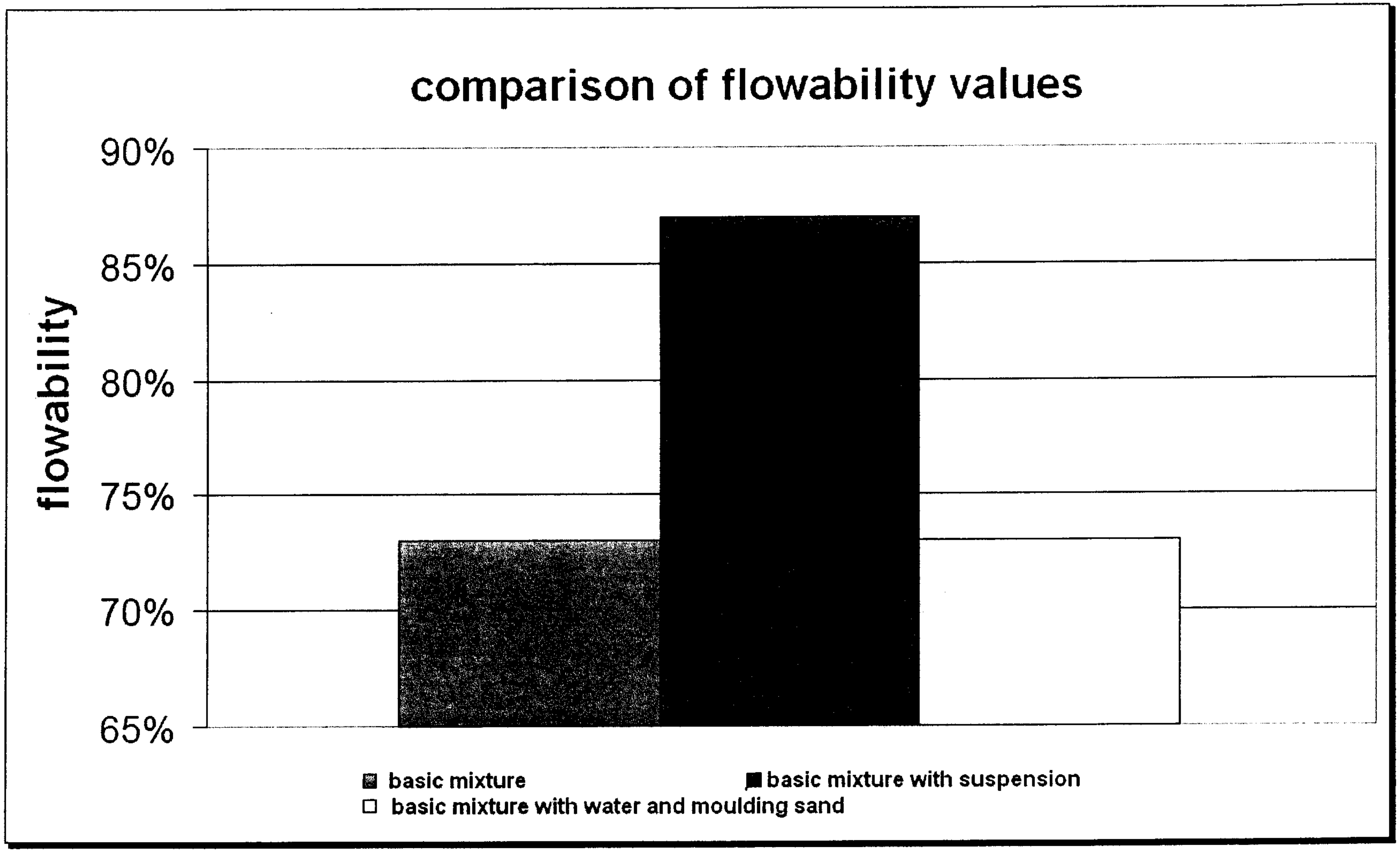
4. The process according to claim 3,
characterised in
that 0.10 to 0.30 % of sodium hydroxide solution is mixed with the mould sand, that then 1 to 4 % of the binding agent on alkali silicate basis is added and that the binding agent is uniformly and homogenously distributed over the mould sand grains in the form of a binding agent envelope with a thickness of 0.5 to 2 micrometers.

5. The process according to claim 3 or claim 4,
characterised in
that, during the drying process, the binding agent envelope shrinks by 50 to 70 percent by volume.

6. The process according to any one of claims 3 to 5,
characterised in
that the drying process is a physical one, wherein the binding agent envelope is pre-shrunk by 40 to 60 percent by volume and wherein the remaining shrinking process takes place thermally.

7. The process according to any one of claims 3 to 6,
characterised in
that the drying process takes place in a microwave oven.

Fig. 1


comparison of flowability values
flowability
90%
85%
80%
75%
70%
65%
basic mixture
basic mixture with suspension
basic mixture with water and moulding sand

20.05.2008

Fig. 2

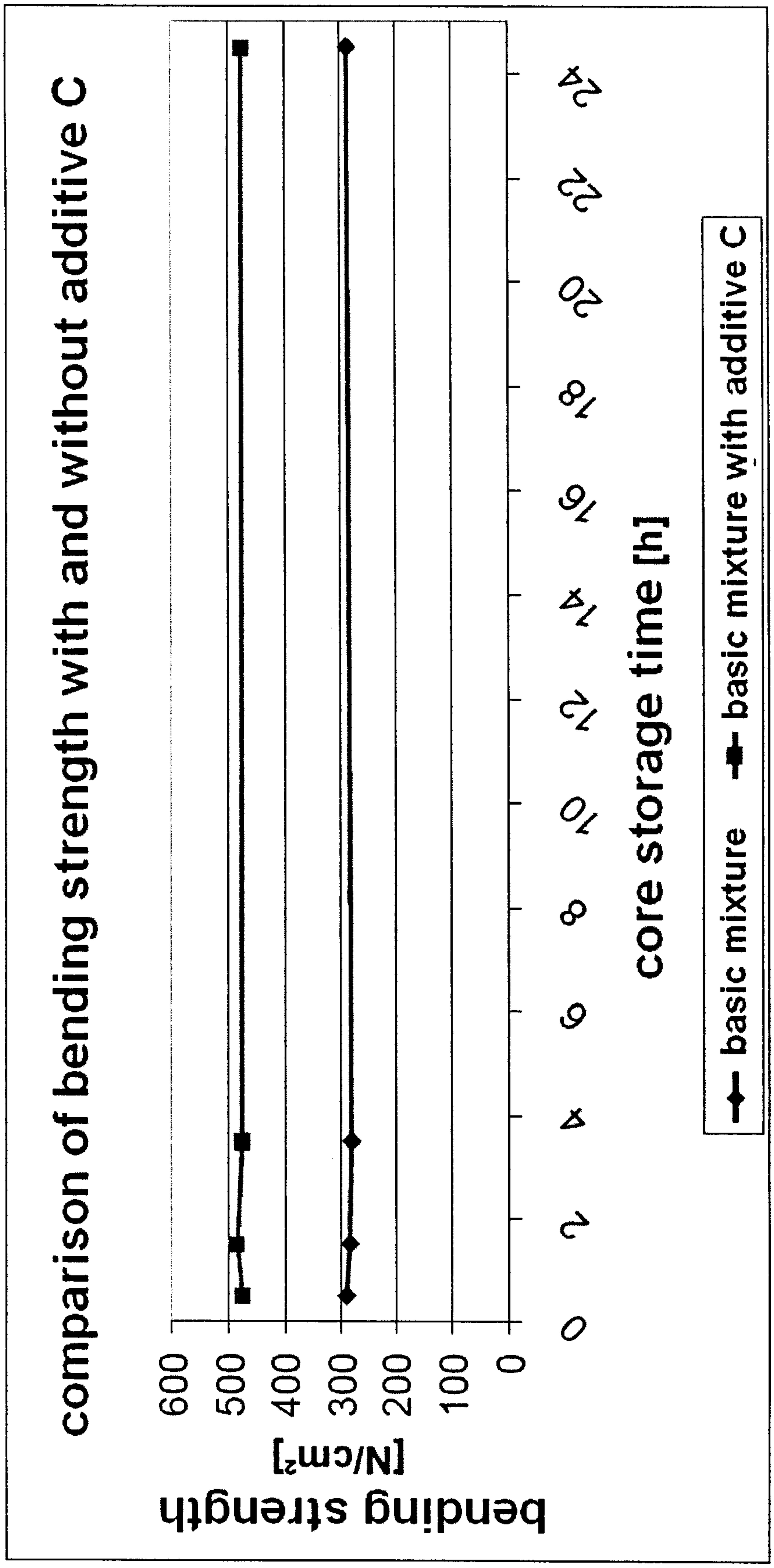
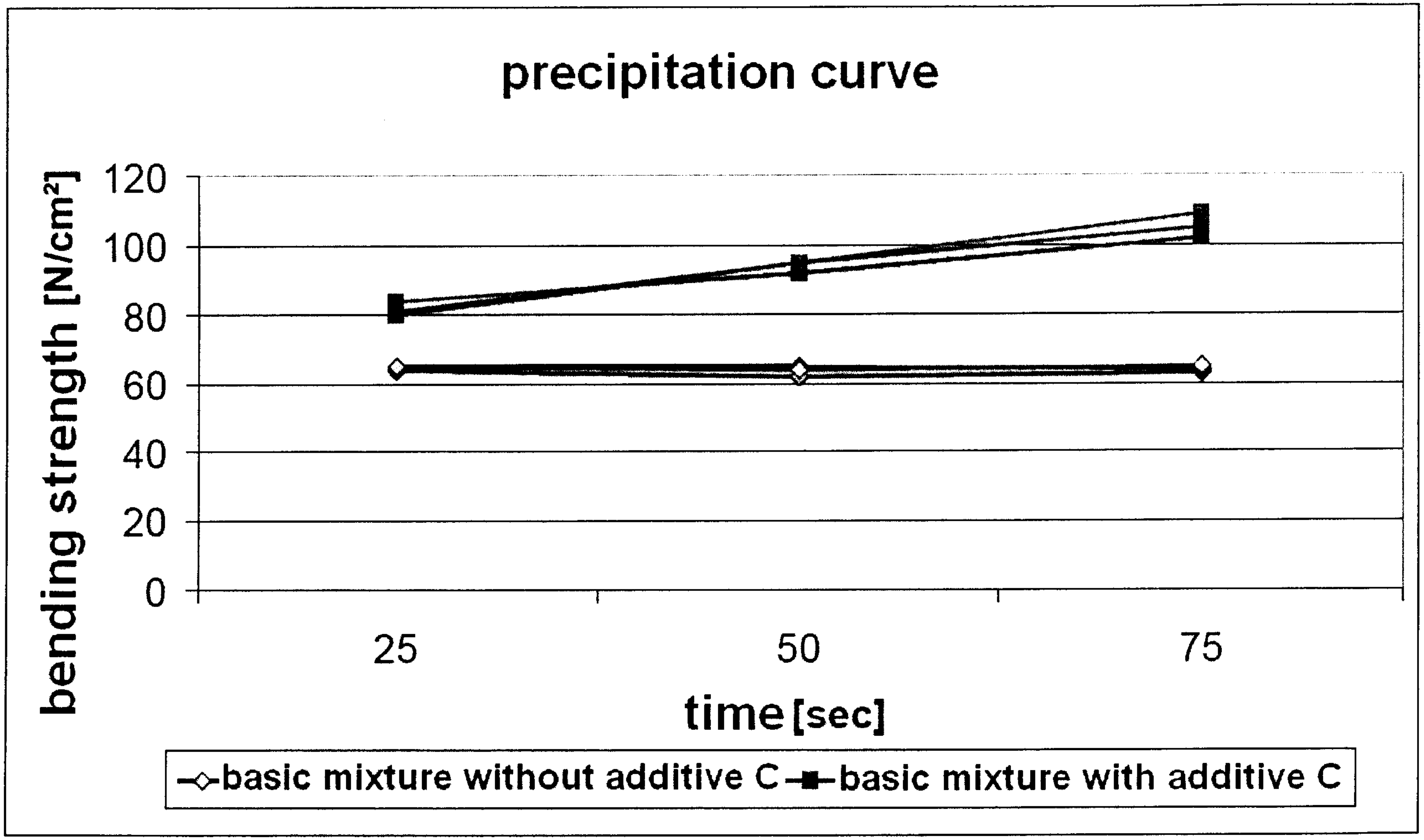
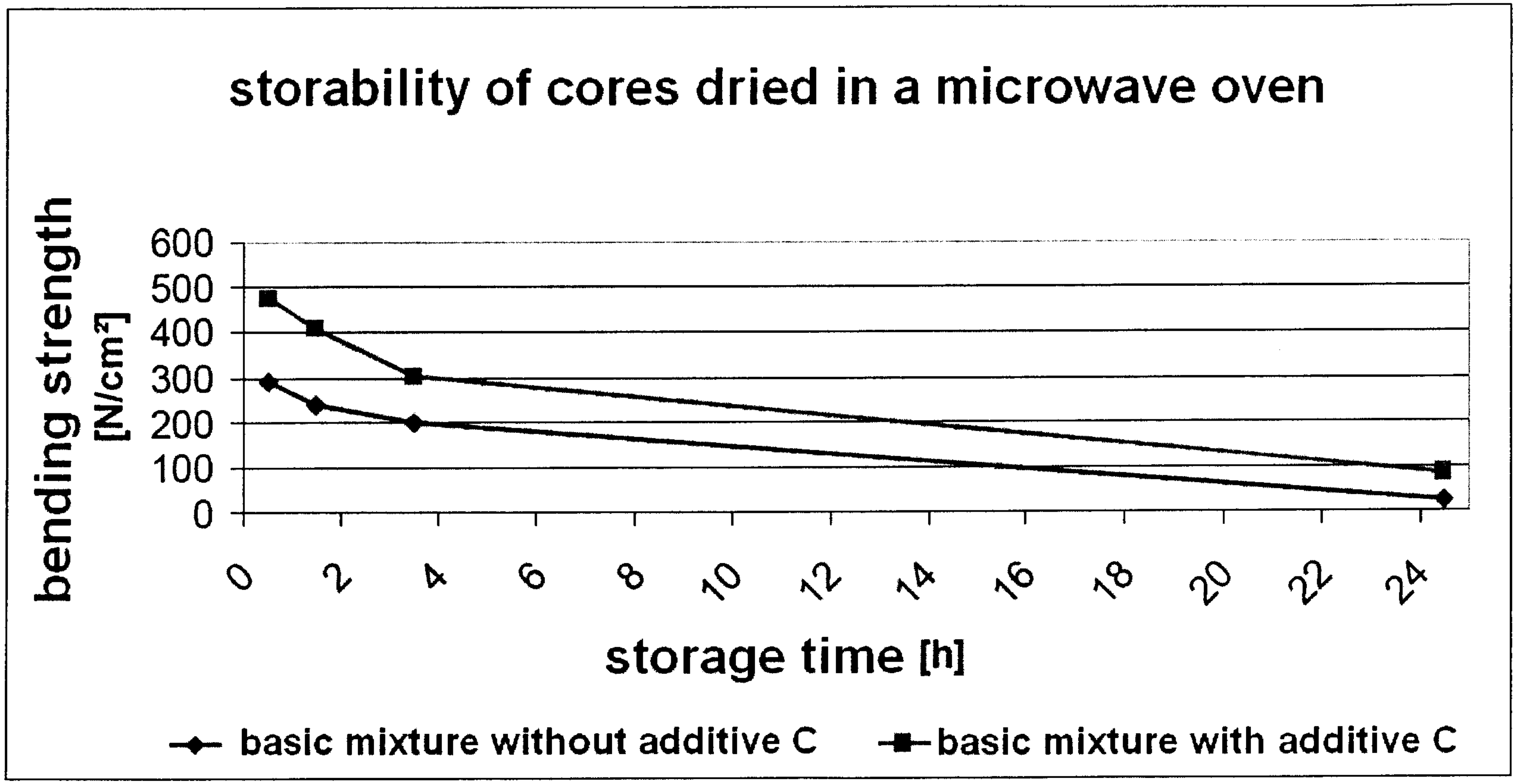


Fig. 3


precipitation curve
bending strength [N/cm²]
120
100
80
60
40
20
0
25
50
75
time [sec]
—◇—basic mixture without additive C
—■—basic mixture with additive C

20.05.2008

Fig. 4



20.05.2008

Fig. 5

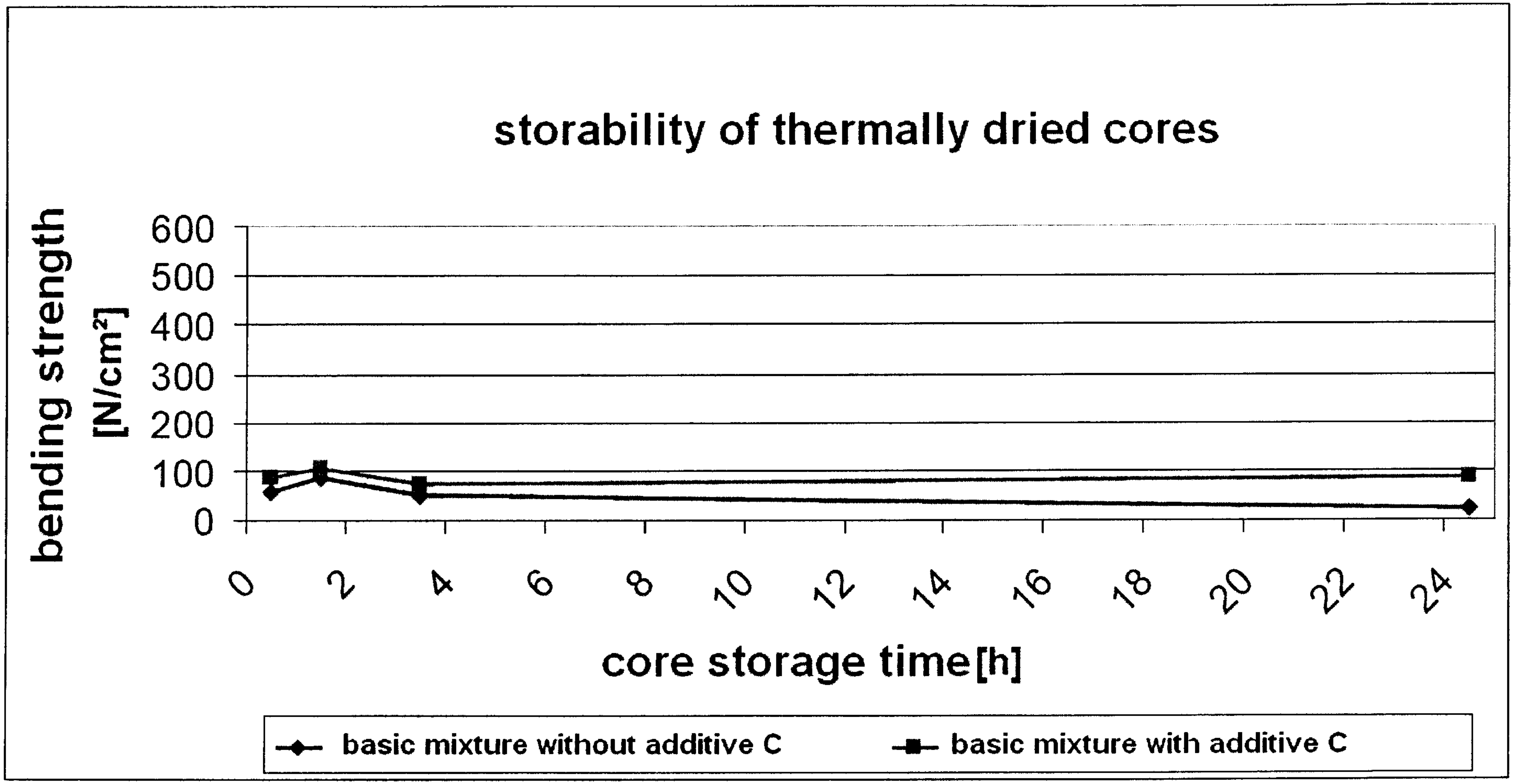


Fig. 6

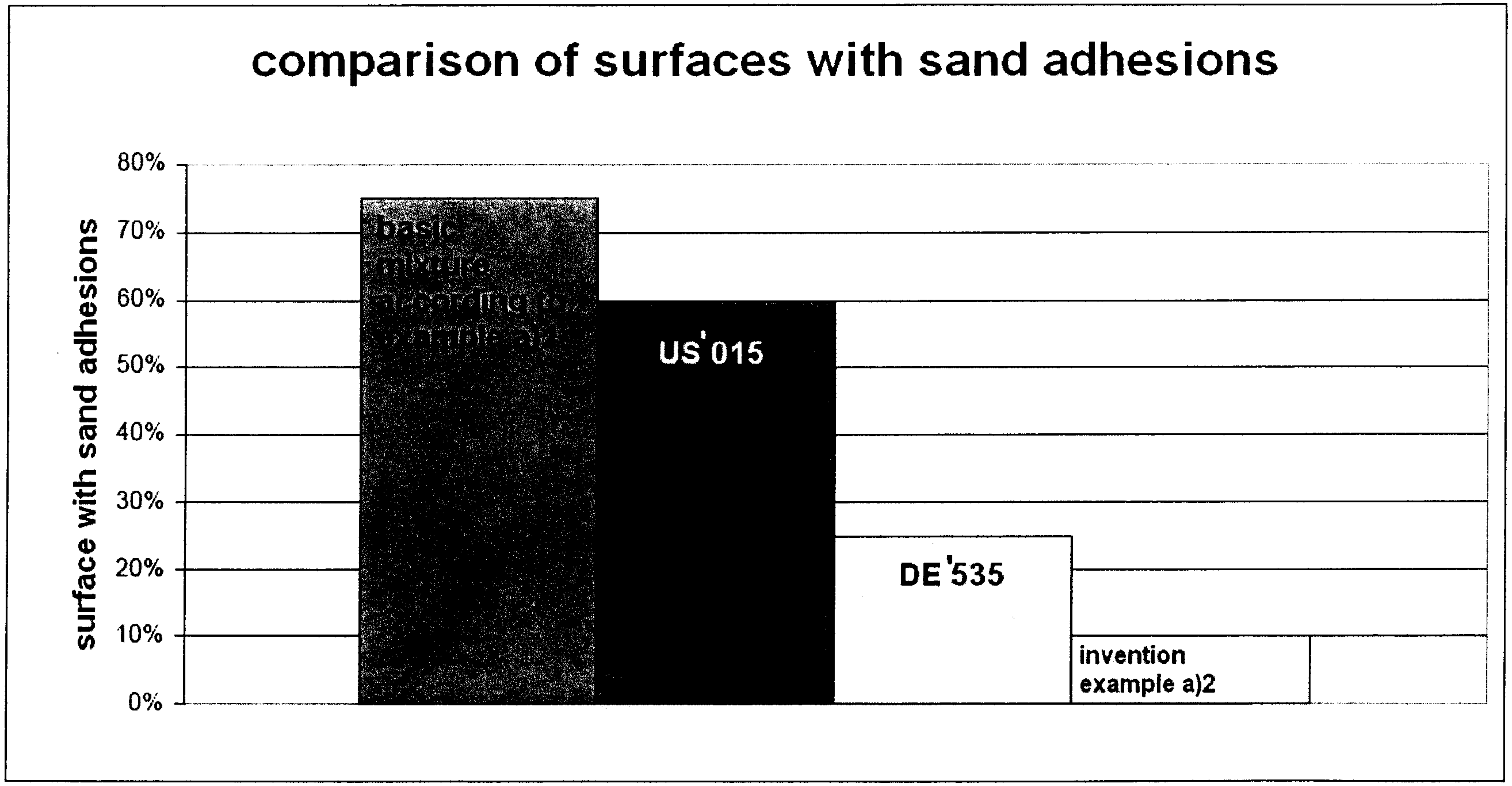

comparison of surfaces with sand adhesions
surface with sand adhesions
80%
70%
60%
50%
40%
30%
20%
10%
0%
basic mixture according to example a)2
US'015
DE'535
invention example a)2

Fig. 7

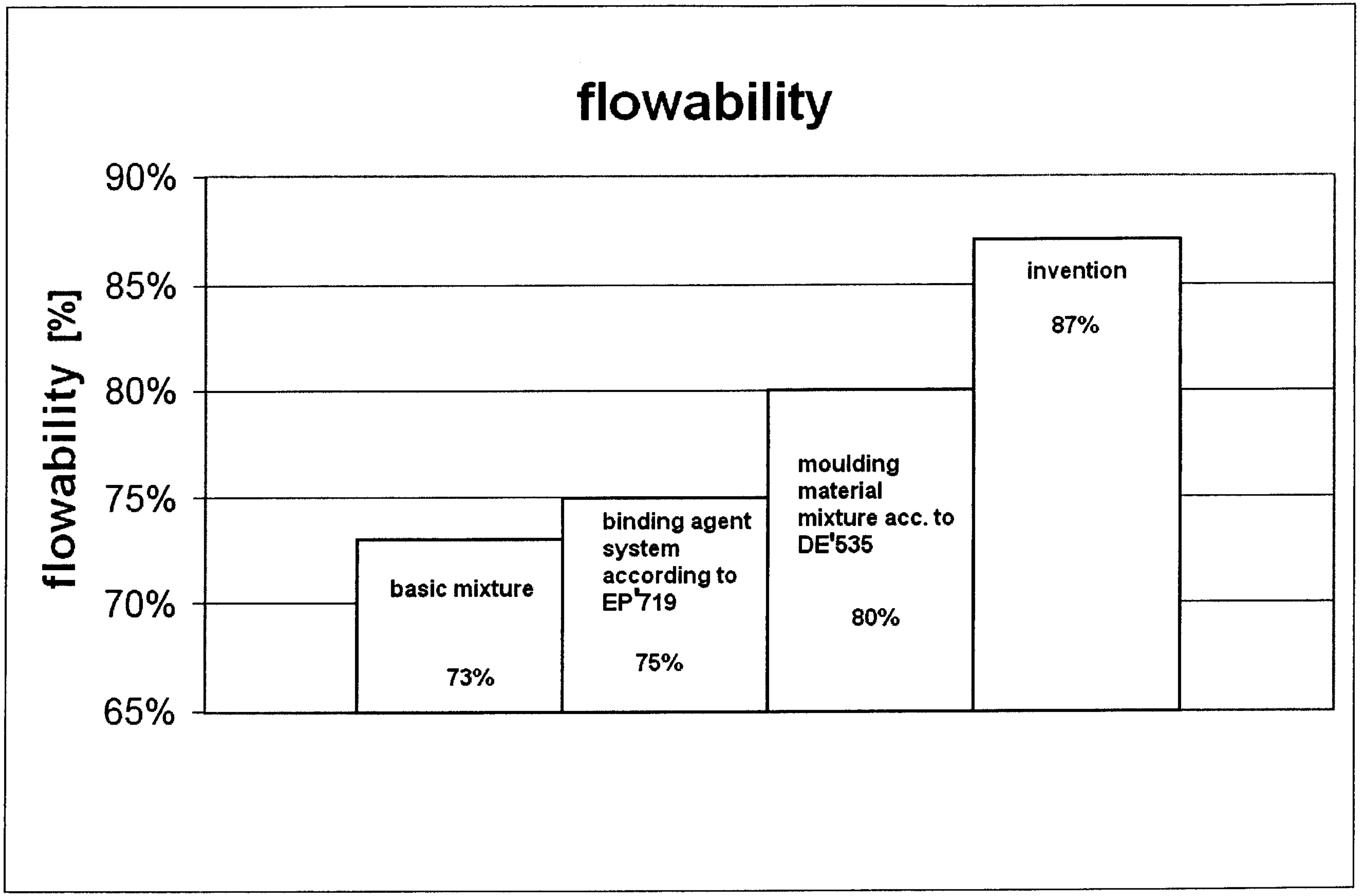
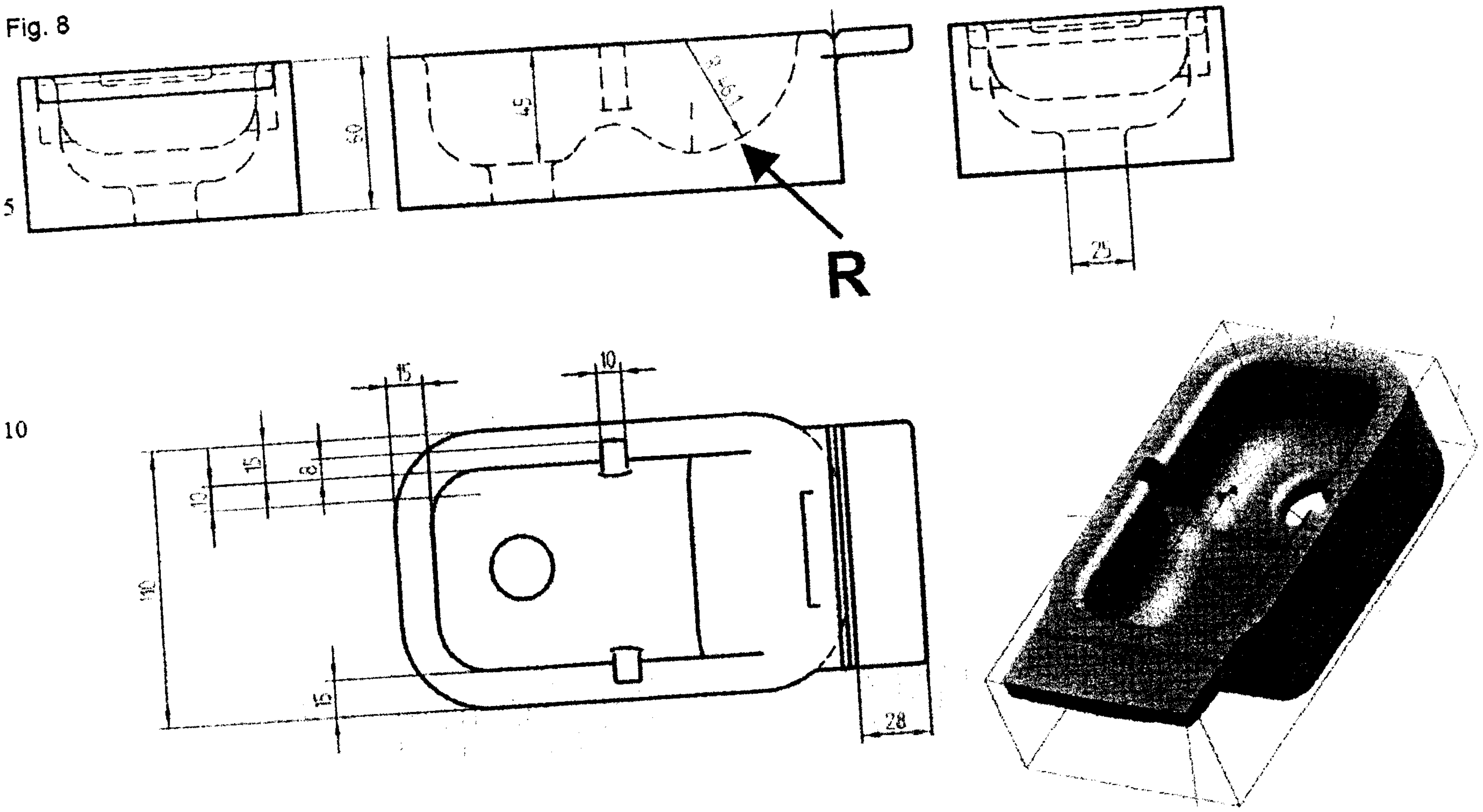

flowability
flowability [%]
90%
85%
80%
75%
70%
65%
basic mixture
73%
binding agent system according to EP'719
75%
moulding material mixture acc. to DE'535
80%
invention
87%

Fig. 8




comparison of flowability values
flowability
90%
85%
80%
75%
70%
65%
▨ basic mixture
■ basic mixture with suspension
□ basic mixture with water and moulding sand