(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 738 149 A1

(12) # EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
04.06.2014 Bulletin 2014/23

(21) Application number: **12832083.5**

(22) Date of filing: **30.08.2012**

(51) Int Cl.:
C04B 38/08 *(2006.01)* ***C04B 33/02*** *(2006.01)*
C04B 33/32 *(2006.01)*

(86) International application number:
PCT/RU2012/000716

(87) International publication number:
WO 2013/039427 (21.03.2013 Gazette 2013/12)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **29.07.2011 RU 2011131733**

(71) Applicants:
- **Kokaya, Eduard Grigorievich**
  Moskovskaya obl. 142704 (RU)
- **Kokaya, Ilya Eduardovich**
  Moscow 111024 (RU)
- **Pribil, Medeya Mikhailovna**
  Moscow, 119991 (RU)

(72) Inventors:
- **Kokaya, Eduard Grigorievich**
  Moskovskaya obl. 142704 (RU)
- **Kokaya, Ilya Eduardovich**
  Moscow 111024 (RU)
- **Pribil, Medeya Mikhailovna**
  Moscow, 119991 (RU)

(74) Representative: **Bucher, Ralf Christian**
Alte Landstraße 23
85521 Ottobrunn (DE)

(54) **METHOD OF MANUFACTURING POROUS CONSTRUCTION ITEMS**

(57) The invention relates to a method of manufacturing porous construction items, such as bricks, ceramic tiles, roof tiles, large-sized wall blocks, pavement items etc. The technical result of the invention is a reduction in energy consumption while preserving the physicochemical properties. The method of manufacturing porous construction items from natural clay raw material that is capable of swelling comprises the preparation of the raw material, moulding, two-stage heating with retention until swelling occurs, and stabilization. Moreover, the first heating stage takes place before the moulding and is carried out simultaneously with the transport of the raw material to the mould filling zone. The moulding takes place in a mould designed as a muffle furnace with a lid, and the second heating stage occurs at a temperature of no less than 1250°C for no less than 10 minutes. Stabilisation occurs in a tilted tunnel furnace, wherein the inside temperature at the entry is no less than 900°C with further cooling of the finished product at a rate of no more than 120 degrees/hour so that the items at the exit are cooled to no more than 30-40°C.

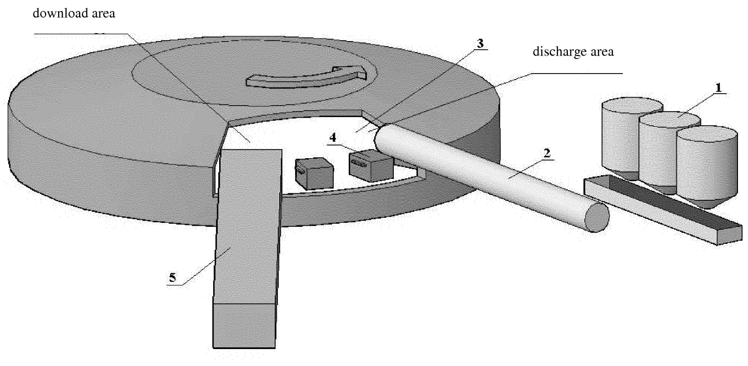

Fig.1

Printed by Jouve, 75001 PARIS (FR)

Description

Field of the invention

[0001] The present invention relates to the field of building and in particular to the manufacture of ceramic products for building, and can find application in the technology of manufacturing bricks, small-scale ceramic blocks, tiles, large-sized building blocks, heat-insulating slabs and shells for pipelines.

Background of the invention

[0002] The prior art describes various methods of manufacturing building products from clay, including essential technological stages as follows: preparing raw material mixture by grinding a clay component, wetting the mixture, pressing blanks, drying and firing them. Similar methods were described, in particular in the RU 2379251 patent of 20.01.2010 disclosing a method comprising wetting and a thorough kneading of clay, preparing a composition with 18-23% humidity, further soft molding of raw bricks that are dried to 2-6% humidity to undergo further firing carried out at a temperature of 950-1150°C; in the RU 2046772 patent of 27.10.1995 disclosing a method of manufacturing a ceramic product, consisting in using a clay-based mixture of a determined composition to press or to mold blanks to be submitted to drying and firing in a tunnel, annular or roller kiln, the firing being carried out in a tunnel kiln for 18-40 hours at the temperature of 950-1000°C, in an annular kiln for 30-55 h at 950-1000°C, and in a roller kiln for 8-12 h at 1020-1080°C.

[0003] The described methods present drawbacks residing in rather low physical and mechanical characteristics of the products obtained and in a high power consumption of the technological process.

[0004] The closest to the present invention as to the combination of essential features is a method for manufacturing porous building products from bloating natural clay raw materials, disclosed in the RU 2132834 patent of 10.07.1999, that comprises molding of blanks with further two-stage heating of them: primary heating to 450 - 600°C at the rate 100 - 120 degrees/min, further heating to 1100 - 1250°C at the rate 150 - 200 degrees/min, hold time until bloating and then shaping in pyroplastic state by pressing or rolling, with further chilling to 500 - 700°C and further cooling at a rate of 60 - 120 degrees/min.

[0005] The above disclosed method presents a disadvantage residing in its high energy consumption and in the complexity of its technological process due to the presence of two stages of shaping, the first one for making blanks and the second one for making products of a given shape.

Description of the invention

[0006] The technical result to get achieved by the present invention is to simplify the technological process of manufacturing porous building products from bloating natural clay raw materials while preserving their physical and mechanical characteristics and, as a result, to reduce the net cost of the products thanks to reduced energy consumption. Furthermore, the present method for manufacturing porous building products from bloating natural clay raw materials is ecologically secure since it is free from such side products as oxides of carbon, nitrogen and its compounds.

[0007] Said technical result is achieved by the fact that in the method for manufacturing porous building products from bloating natural clay raw materials, comprising the steps of preparing raw materials, shaping, two-stage heating with some hold time until the bloating, and a stabilization stage, the first heating stage is carried out before the shaping and is performed simultaneously with the raw material transporting to the area of loading into a mold, the shaping is carried out in the mold realized as a muffle furnace with a cover, the second heating stage is performed at a temperature of at least 1250°C for at least 10 min, and the stabilization takes place in an inclined tunnel furnace, the inside temperature at the entrance of which is at least 900°C, the final product being cooled down at a rate of no more than 120 degrees/h, with the provision of cooling the products at the outlet to no more than 30 - 40°C. With this, the physical and mechanical properties of the final product can vary depending on the volume of raw materials loaded into the mold.

Brief description of the drawings

[0008]

Fig. 1 represents a diagram of the technological process where:

1 is a receiving hopper with a dosing apparatus;

2 is a conveyer with electric heating;

3 is an annular platform;

4 is a mold;

5 is a tunnel furnace.

Preferred embodiment of the invention

[0009] As raw materials for manufacturing porous building products, use can be made of clay shale, argillites, materials of river drift mud streams (Dagestan), mine tailings, stripping dumps of mine managements (Bakal, Chelyabinsk region), existing clay shale open-cut mines and dumps (Zamchalovo, Rostov region) and other clay shale open-cut mines the production waste of which exceeds their output volumes.

Experimentally, shale of fractions 0.5 - 2 mm; 5 - 10 mm; 10 - 20 mm was tested, having the composition as follows:

Table 1

	SiO_2	Al_2O_3	Fe_3O_4	TiO_2	CaO	MgO	CO_3^{2-}	Na_2O	K_2O	P_2O_5	C	ppp
Dagestan	57.34	19.68	7.57	0.93	1.11	1.64	1.2	1.4	3.02	0.22	0.94	4.95
Bakal Chelyabinsk	59.16	19.94	8.15	0.7	1.04	1.82	0.32	1.82	2.52	0.24	<0.1	4.29
Zamchalovo (Rostov)	57.0	20.97	7.57	0.96	0.63	1.48	<0.1	1.16	3.71	0.19	0.35	5.98

[0010] The method for manufacturing porous building products from bloating natural clay raw materials comprises the following technological cycles:

1. Raw material preparation.

[0011] At this stage of the technological process, the raw materials are separated into fractions and, when necessary, they are ground until the necessary particle size. Depending on clay shale deposits and on their size grading, a crushing and sorting unit and a sand washer are provided. In particular, near the river estuaries of Dagestan, the size grading varies from dust-like to 100 mm and more, which enables to sort the raw materials with a sieve and a sand washer, without any additional crushing. In other cases, the crushing and sorting unit can be installed both at the open-cut mine and at a production site.

2. First heating stage.

[0012] At this stage of the technological process, the raw materials are loaded with grabs into the receiving hopper 1 from which they are fed by a dosing apparatus onto a horizontal conveyer that transfers the raw materials into a heat-insulated conveyer 2 with electric heating. The raw material volume fed by the dosing apparatus to the conveyer is determined depending on the density of the final product. Experimental studies carried out showed that if a 5 liter mold is loaded with no more than 2 kg of raw materials, the density of the final item will be 400 kg/m^3. Increasing the volume of the loaded raw materials will increase the density of the final item, in particular, when loading no more than 3 and no more than 4 kg, the density of the final item will be, respectively, 600 and 800 kg/m^3. As a heat-insulated conveyer with electric heating, a screw conveyer can be used, as an example. After passing through this conveyer, the raw materials are heated to 500 - 800°C (the temperature is chosen depending on the necessary production output).

3. Second heating stage and shaping.

[0013] A raw product heated to the necessary temperature is loaded portion-wise into a mold which is represented by a muffle furnace with a cover.

[0014] After loading the raw material into the permanently operating muffle furnace, it is heated to a temperature of at least 1250°C, with a hold time of at least 10 min. During this operation, cracking, bloating and shaping of the item occur with short time intervals. As described heretofore, depending on the volume of raw product loaded into the mold, items with given physical and mechanical characteristics are obtained in said mold closed with a cover. In particular, as a result of laboratory experiments carried out, specimens with the specific weight of 270, 375, 750 kg/m^3 and the strength of 7.9; 10.4 and 2.4 kgf/cm^2, respectively, which demonstrates the possibility to obtain items of any density, including up to the specific weight of the bulk raw material.

[0015] In view of the fact that in oxidation-reduction processes carried out with heat-absorbing reactions occurring in the processes of silication, bloating and sintering of keramzite from clay shale at a temperature range of 450 - 1250°C, the reducing medium contains a necessary amount of oxygen in oxides and in water (in a bound state), there is no need to supply additional oxygen when the raw material is heated by electric power. The absence of additional oxygen supply prevents any entrainment, from the heating area, of small-sized particles that are formed as a result of cracking SiO_2 and other side products such as carbon, nitrogen oxides and compounds of the last, which enables the use of raw materials having fractions of 0.5 to 20 mm. Besides, thanks to the closed space of the mold and to the bubbling effect of the mechanism of bloating, one can create a product of any shape having a pumice-like structure throughout the whole body.

[0016] As a result of the laboratory experiments carried out, specimens of products were obtained with the characteristics as follows:

1. Compressive strength.

[0017]

Specimen No 1 from the raw material with the fraction of 0.5 - 1 mm, the size of 100x100x100 mm, the compressive strength is 10.4 kg/cm^2.

Specimen No 2 from the raw material with the fraction of 10 - 20 mm, the size of 100x100x100 mm, the compressive strength is 7.9 kg/cm^2.

[0018] Said items can find application in low-rise construction (up to two stories) or in framework construction.

2. Heat conduction.

[0019] Heat conduction studies were carried out on the basis of the process of firing a specimen with the size of 100x100x100 mm in a laboratory muffle furnace of 12 1, with the use of a MASTECH MA5838 multimeter, the results of which are given in Table 2.

Table 2

Material name	t_{start}, °C	External temperature of the specimen, after given time*, min					
		10	20	30	40	50	60
Specimen No 1	20	21	22	23	24	25	26
Gas silicate block	17	17	18	18	19	20	21
Expanded-clay lightweight concrete	19	20	21	22	24	25	26
*At the furnace internal temperature of 100 °C and for the heating time to prescribed temperature of 30 min.							

3. Specific weight.

[0020]

Specimen No 1 : 375 kg/m^3.

Specimen No 2 : 750 kg/m^3.

[0021] These studies demonstrate the possibility to obtain products of any density, up to the specific weight of the bulk raw material.

4. Stabilization.

[0022] At this stage of the technological process, the finished product is extracted from the mold, which results in a sharp drop of its temperature on the surface (on the average, to 800°C), allowing to stabilize the external shell of the product for transferring the last to an inclined muffle furnace, the inside temperature at the entrance of which is maintained at least at 900°C to allow heating externally the product to that temperature, and further, in the course of its transfer along the tunnel furnace, the final product is slowly cooled down throughout its whole body. As a rule, the cooling down process lasts 6 to 7 hours when the temperature decreases at a rate of no more than 120 degrees/h, with the provision of the product temperature at the tunnel furnace outlet of no higher than 30 - 40°C.

[0023] The present method for manufacturing porous building products from bloating natural clay raw materials is characterized by the following advantages:

- low prime cost thanks to the exclusion of ventilation and aspiration equipments that are not necessary any more;
- no need to carry out a thorough preparation of raw materials as to particle size grading;
- very low energy losses into environment since it enables to use at maximum the initial energy of raw material heating for obtaining finished products.

[0024] Furthermore, this method for manufacturing porous building products from bloating natural clay raw materials enables to rapidly modify the characteristics of the products to manufacture, such as specific weight that can vary between 200 and 900 kg/m^3.

Claims

1. The method for manufacturing porous building products from bloating natural clay raw materials, comprising the steps of
preparing raw materials,
shaping,
two-stage heating with some hold time until the bloating, and
a stabilization stage,
wherein the first heating stage is carried out before the shaping and is performed simultaneously with the raw material transporting to the area of loading into a mold,
the shaping is carried out in the mold realized as a muffle furnace with a cover,
the second heating stage is performed at a temperature of at least 1250°C for at least 10 min, and
the stabilization takes place in an inclined tunnel furnace, the inside temperature at the entrance of which is at least 900°C,
the final product being cooled down at a rate of no more than 120 degrees/h, with the provision of cooling down the products at the outlet to no more than 30 - 40°C.

2. The method of claim 1, wherein the physical and mechanical properties of the final product can be varied depending on the volume of raw materials loaded into the mold.

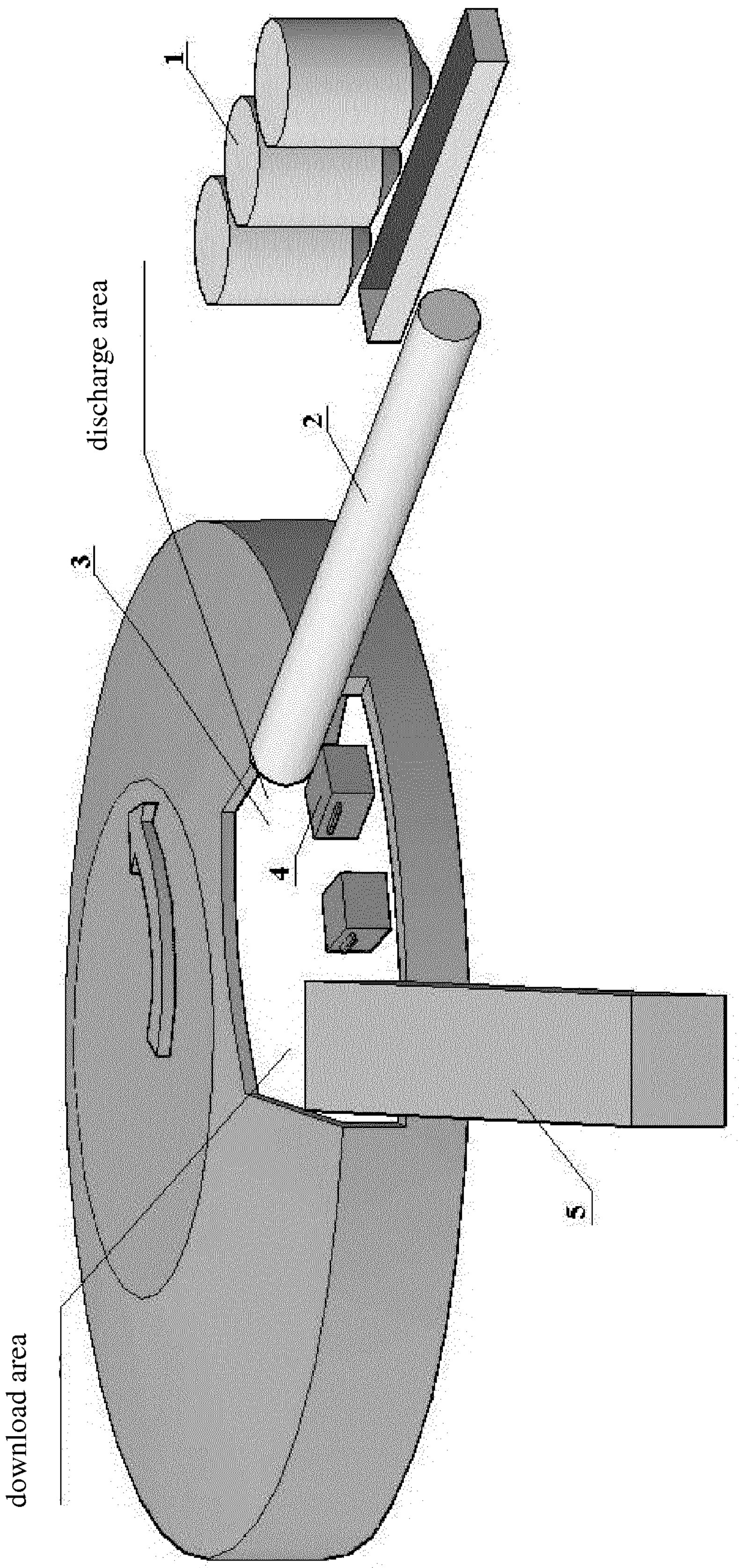

Fig.1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 2012/000716

A. CLASSIFICATION OF SUBJECT MATTER

C04B 38/08 *(2006.01)*
C04B 33/02 *(2006.01)*
C04B 33/32 *(2006.01)*

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)

C04B 38/00, 38/08, 33/00, 33/02, 33/13, 33/32

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

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

PatSearch (RUPTO internal), Esp@cenet, PAJ, USPTO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	RU 21 32834 C1 (EVORENKO GENNADY ISIDOROVICH) 10.07. 1999, the claims	1-2
A	RU 2268248 C1 (TOMSKY POLITEKHNICHESKY UNIVERSITET) 20.01.2006, p. 4, lines 2-55, p. 5, lines 1-27, the claims	1-2
A	RU 2351554 C1 (KATKOV MIKHAIL LVOVICH et al.) 10.04.2009, p. 5, the claims	1-2
A	RU 2168130 C2 (TAMOV MUKHADIN CHASHIFOVICH) 27.05.2001, p. 2, par. 2, the claims	1-2
A	US 4208367 A (JOACHIM WIINNING) 17.06.1980	1-2

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 January 2013 (09.01.2013)	**17 January 2013 (17.01.2013)**
Name and mailing address of the ISA/ Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- RU 2379251 **[0002]**
- RU 2046772 **[0002]**
- RU 2132834 **[0004]**