Title: PROCESSING SYSTEM FOR MANUFACTURING OF COMPOSITE CEMENTITIOUS MATERIALS WITH REDUCED CARBON DIOXIDE EMISSIONS

Abstract: A processing arrangement for manufacturing of composite cementitious materials such as hydraulic blended cements with significantly reduced Portland clinker minerals content and correspondingly with an increased amount of supplementary cementitious materials as e.g. fly ash, blast furnace slag, fine quartz, granitic quarry fines etc. and highly reactive pozzolans or mineral fillers as e.g. fly ash, blast furnace slag, fine quartz, granitic quarry fines etc., for direct replacement of Portland cement in concrete, comprising a silo for Portland cement, a silo for fly ash or other type of supplementary materials and a silo for cement kiln dust or other type of setting time regulating agent, a storage unit for polymer additive, proportioning means, mixing means, grinding devices and discharge means. The invention is characterized in, that the arrangement is equipped with a milling unit (6) for pregrinding said supplementary materials and a milling equipment (9) for pregrinding the Portland cement, which pregrinding equipments (6,9) are followed by a grinding equipment (13) for grinding of the preground components and in that said pregrinding equipments (6,9) are adapted to work as an open circuit or a closed circuit for the material being ground.
Processing system for manufacturing of composite cementitious materials with reduced carbon dioxide emissions.

The present invention relates to the processing system for manufacturing of composite cementitious materials as hydraulic blended cements with significantly reduced Portland clinker minerals content and correspondingly with an increased amount of supplementary cementitious materials as e.g. fly ash, blast furnace slag, fine quartz, granitic quarry fines etc., and highly reactive pozzolans or mineral fillers as e.g. fly ash, blast furnace slag, fine quartz, granitic quarry fines etc. for direct replacement of a part of Portland cement in concrete mixtures, and therefore characterized by significantly improved environmental profile.

It is well known that each ton of production of Standard Portland Cement is accompanied by the release of about one ton of carbon dioxide and that about half of this comes from the decarbonation of limestone in the kiln and the other half from energy consumption, primarily in the kiln.

It follows that the only way in which the cement industry can achieve meaningful reductions in carbon dioxide emissions is via reduction of Portland clinker production and an increased use of fillers.

The traditional plants for production of blended cement include intergrinding of Portland cement clinker with different types of microfillers, e.g. blast furnace slag, fly ash, limestone, etc. mainly in the rotating ball mills. Such methods are not providing more than 20-25% of Portland clinker replacement by fly ash and approximately 30-50% by
blast furnace slag, without a significant negative influence on the cement performance, such as a sharp increase of setting time, a very low strength development during the curing period 0-28 days, etc. It takes up to 3 times longer time, such as 2 - 3 months, to achieve a 28-days strength of traditionally Portland cement concretes.

At the same time high volume fly ash (HVFA) cements do have significant benefits in comparison with traditional Portland cements.

Introduction of fly ash or other types of fillers, e.g. fines from granitic quarries or fines quartz sand for replacement of Portland cement directly in the concrete mixer in amounts more that 15-20% is not efficient and could negatively influence performance of the concrete (reduced strength, etc).

Existing methods of grinding and mechanical activation of said fillers could give some improvement, as described in US patent 6,630,022, but it looks economically ineffective and allows only a 20% of Portland cement replacement without a reduction of the concrete compressive strength.

In the application PCT/SE2003/001099 there is described a process for producing blended cement, where the cement contains Portland Cement mixed thoroughly with a microfiller and possibly a water reducing agent to a dry cement mixture and fine supplementary cementitious materials selected from the materials blast furnace slag, fly ash, quartz, silica and amorphous silicon dioxide. According to said application, supplementary materials are being subjected to a grinding in a dry state and the supplementary ground materials are then
being subjected to a grinding together with at least 20 % by weight of the total grinding mass of a highly reactive cement mixture in a dry state. A polymer in the form of a powdery water-reducing agent is also added.

A problem in producing such a cement mixture is that in order to obtain the desired result, the fineness of the components must be strictly controlled. This is especially true for a plant where the cement mixture is produced in a continuous way.

The present invention offers such a plant.

The present invention thus refers to a processing arrangement for manufacturing of composite cementitious materials such as hydraulic blended cements with significantly reduced Portland clinker minerals content and correspondingly with an increased amount of supplementary cementitious materials as e.g. fly ash, blast furnace slag, fine quartz, granitic quarry fines etc. and highly reactive pozzolans or mineral fillers as e.g. fly ash, blast furnace slag, fine quartz, granitic quarry fines etc., for direct replacement of Portland cement in concrete, comprising a silo for Portland cement, a silo for fly ash or other type of supplementary materials and a silo for cement kiln dust or other type of setting time regulating agent, a storage unit for polymer additive, proportioning means, mixing means, grinding devices and discharge means, and is characterised in, that the arrangement is equipped with a milling unit for pregrinding said supplementary materials and a milling equipment for pregrinding the Portland cement, which pregrinding equipments are followed by a grinding equipment for grinding of the pre-ground components and in that said pregrinding equipments are
adapted to work as an open circuit or a closed circuit for the material being grinded.

The invention will now be described in more detail below in connection with an examplifying embodiment of the invention, where

Figure 1 is schematically shows a processing system in accordance with the present invention.

In figure 1 the following reference numerals indicate the following apparatuses: 1 denotes a feed station for a drying unit, 2 denotes a drying unit (rotary dryer or fluid bed dryer), 3 denotes a silo for slag and/or fly ash, 4 denotes a silo for additives, 5 denotes a intermediate silo for dried sand, 6 denotes a milling unit for pre-grinding of quartz sand, 7 denotes an air classifier with cyclone and dust collector, 8 denotes a silo for Portland cement, 9 denotes a milling unit for pre-grinding of part of Portland cement before mixing with other components before processing, 10 denotes a intermediate silo for ungrounded part of Portland cement and preground sand, slag and additives, 11 denotes an air classifier with cyclone and dust collector, 12 denotes a rotary mixer, 13 denotes vibrating mills for processing of raw materials feed (installed parallel or in series), 14 denotes a silo for the final product, blended cement, 15 denotes an intermediate silo for pre-ground portion of cement and 16 denotes a silo for preground quarts and 17 denotes a silo for the mixture of materials prior to a final milling.

According to a preferred embodiment there is provided a unit 21 for carbon removal from fly ash, which unit is adapted to
lower the carbon content in the fly ash below 4 weight%. The unit may operate according to any suitable known technique for carbon removal.

As is apparent from the application the quarts in the above example can be any suitable supplementary material.

According to the above said, sand, slag, additives in the form of for example a water reducing agent and Portland cement is fed into the present arrangement.

Regarding the quarts, or sand, the sand is first fed from a feeding station 1 to a drying unit 2, where it is dried. Thereafter it is fed to a silo 5. Slag, or any other suitable additive, is fed from a silo 3 to a conduit merging with a conduit from said silo 5 for sand. The mixture of sand and slag is fed to a milling unit 6. After that the sand and slag have been preground, the material is fed to a silo 16 and further on to a silo 10.

Regarding the Portland cement, the cement is fed from a silo 8 to silo 10. Additives like water reducing agents are also fed to the last mentioned silo 10 as well as sand and slag being preground in the milling equipment 6. Portland cement is also fed from silo 8 to a milling equipment 9. From milling equipment 9 the cement is fed to a silo 15 for preground cement. The materials in silos 10 and 15 are fed to a rotary mixer 12 and further on to a silo 17.

From silo 17 the mixture of materials is fed to a final milling equipment 13. After being milled in equipment 13 the final material is fed to a silo 14.
According to the invention the arrangement is thus equipped with a milling unit 6 for pregrinding said supplementary materials and a milling equipment 11 for pregrinding the Portland cement, which pregrinding equipments are followed by a grinding equipment 13 for grinding of the pregrounded components.

According to a very important feature of the present invention said pregrinding equipments 2, 9 are adapted to work as an open circuit or a closed circuit for the material being ground. The closed circuit in milling equipment 6 comprises a conduit 18 from the milling equipment to an air classifier 19 being able to sort out to large fractions of the material being grounded back to the mill via a conduit 20.

The closed circuit in milling equipment 9 comprises in a corresponding way a conduit 21 from the milling equipment to an air classifier 22 being able to sort out to large fractions of the material being grounded back to the mill via a conduit 23.

To both milling equipments there are connected a cyclone and a dust collector. The material collected there is fed to a respective downstream silo in the main flow.

According to a preferred embodiment of the invention, the said milling equipment 6 for said supplementary material is arranged to pregrind the supplementary material to a fineness of 100 - 300 microns.

According to another preferred embodiment of the invention, the said milling equipment for portland cement is arranged to
pregrind the Portland cement to a fineness of an average particle size of 10 - 30 microns.

Since only material fractions that are too large will be sorted out in the air classifiers, the circuits will be open when there are no such materials leaving the respective milling equipment 6, 9.

According to still another preferred embodiment, the arrangement comprises a unit for drying the supplementary material and fillers to a moisture content of less than 0.2 weight%, which unit is located upstream of the milling equipment.

Thus, the present invention gives a production plant, or arrangement, in which production of the cement material mentioned in the introductory portion of the application can be performed in a continuous way.

The scope of this invention should not be limited by the example presented by drawings given above but rather by the following claims.
Claims:

1. A processing arrangement for manufacturing of composite cementitious materials such as hydraulic blended cements with significantly reduced Portland clinker minerals content and correspondingly with an increased amount of supplementary cementitious materials as e.g. fly ash, blast furnace slag, fine quartz, granitic quarry fines etc. and highly reactive pozzolans or mineral fillers as e.g. fly ash, blast furnace slag, fine quartz, granitic quarry fines etc., for direct replacement of Portland cement in concrete, comprising a silo for Portland cement, a silo for fly ash or other type of supplementary materials and a silo for cement kiln dust or other type of setting time regulating agent, a storage unit for polymer additive, proportioning means, mixing means, grinding devices and discharge means, characterized in, that the arrangement is equipped with a milling unit (6) for pregrinding said supplementary materials and a milling equipment (9) for pregrinding the Portland cement, which pregrinding equipments (6,9) are followed by a grinding equipment (13) for grinding of the preground components and in that said pregrinding equipments (6,9) are adapted to work as an open circuit or a closed circuit for the material being grinded.

2. A processing arrangement according to claim 1, characterized in, that said closed circuit includes an air classifier (19;22) able to sort out to large fractions of the material being grinded.

3. A processing arrangement according to claim 1 or 2, characterized in, that the said milling equipment (6) for said supplementary material is arranged to
pregrind the supplementary material to a fineness of 100 - 300 microns.

4. A processing arrangement according to claim 1, 2 or 3, characterised in, that the said milling equipment (9) for portland cement is arranged to pregrind the Portland cement to a fineness of an average particle size of 10 - 30 microns.

5. A processing arrangement according to claim 1, 2, 3 or 4, characterised in, that, the arrangement comprises a unit (2) for drying the supplementary material and fillers to a moisture content of less than 0.2 weight %, which unit is located upstream of the milling equipment (6).

6. A processing arrangement according to claim 1, 2, 3, 4 or 5, characterised in, that, the arrangement comprises a unit (21) for carbon removal from fly ash, which unit is adapted to lower the carbon content in the fly ash below 4 weight %.
A. CLASSIFICATION OF SUBJECT MATTER

IPC7: C04B 40/00, C04B 7/52, C04B 18/08
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)

IPC7: C04B

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

SE, DK, FI, NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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