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(54) FLUIDIZED BED PROCESS PARTICULARLY FOR COMBUSTION OR GASIFICATION OF UNDRIED ENERGY WOOD FROM THINNING AS WELL AS GREEN BIOMASS

(57) In a fluidized bed process, particularly for combustion or gasification of undried logging residues and energy wood from thinning as well as green biomass, readily refinable material, rich in calcium and/or magnesium, is added to the bed material in a content of 30 to 100% of the amount of ash from fuel, in order to bind the halogen and alkali components contained in the fuel, directly or indirectly, to the ash fraction being formed. The process preferably comprises a system for recovering latent heat from water vapour contained in flue gas. The solution enables combustion of fresh undried wood material, particularly rich in chlorine and alkali, in a boiler having a high efficiency and simultaneously a reduced susceptibility to corrosion of the materials used, whereby the degree of utilization, the reliability, as well as the costs for repair and maintenance of the boiler are improved to a substantial extent.

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Description

Field of the invention

[0001] The invention relates to the utilization of undried logging residues and energy wood from thinning as well as green biomass in the production of energy and product gas, as well as the application of a fluidized bed process in this context.

Background of the invention

[0002] Combustion of logging residues, including knot and top material, has recently become more common and will be more and more important in the future, in an attempt to find ways of increasing the value added to the fuel value of stemwood. Chipping and utilization of green logging residues or energy wood from thinning is also becoming more common, because the energy content of freshly cut fuel wood is 15 to 25% higher than that of wood which has been dried in stacks, typically for about a year. During the year, decay fungus and volatile organic compounds reduce the heat value of wood by the above-mentioned percentage.

[0003] Combustion or gasification of fresh cut green biomass is more advantageous than before because energy production plants are now commonly equipped, in many cases in connection with investments in flue gas scrubbers, with apparatus for recovering the latent heat of water vapour contained in the flue gas (the energy needed for vaporization) by condensation, and for transferring a major part of it to, for example, a district heating network. This solution increases the degree of efficiency of the plant to a great extent, because the content of water bound in the fuel and being vaporized is high, in many cases higher than 50%.

[0004] With the use of fresh wood chips, increasing amounts of green biomass from needles and other material with high contents of alkali and halogens, particularly chlorine, enter the utilization process.

[0005] Halogens, particularly in combination with alkali metals and in the presence of water vapour, tend to cause corrosion in boiler structures, for example on the surfaces of superheater pipes but also elsewhere, in metal structures as well as fire-resistant structures. They also cause soiling of the boiler by forming chemically and structurally complex deposits on the surfaces of metal structures, for example in heat exchangers. Thus, the heat transfer phenomena are substantially reduced, whereby the efficiency of the plant decreases.

[0006] The above-mentioned phenomena cause an increasing need for maintenance and repair and, in the worst case, a premature shutdown of the boiler. Increasing combustion of various waste fractions and also of biomasses from cropland causes increasing alkali load on and exposure to corrosion of boilers and the materials used in them, which, in turn, leads to the use of expensive special alloys in boiler structures, in order to maintain the degree of utilization and the reliability of the boiler on an acceptable level.

[0007] Halogens, sulphur, fine particulate matter and many other harmful substances can be efficiently removed by a flue gas scrubber, if one is in use. However, sulphur and halogen compounds have already done damage in the boiler materials, so that the flue gas scrubber is a solution merely for removing these substances from the flue gases to be released into the open air.

[0008] For utilizing wood chips and corresponding fuels, various types of plants are used, such as grate, drum, fluidized bed, and stoker boilers.

[0009] Fluidized bed reactors are used, for example, for combustion and gasification of solid or semi-solid organic material for producing energy or product gas. The application of fluidized bed technology has become more common as o a result of technological and economic benefits provided by it, and the development of the technology involved. If necessary, several solid or semi-solid fuels, such as peat, wood chips, cultivated plants, as well as various waste fractions, such as waste wood or sewage sludge, may be burnt or gasified simultaneously in a fluidized bed. The fuels may also have very different moisture and ash contents, as well as chemical compositions. The treatment in the fluidized bed may be combustion, for example, in a so-called circulating fluidized bed (CFB) or a bubbling fluidized bed (BFB), which are techniques requiring different apparatuses.

[0010] Although the fuels may have very different properties, the degree of combustion is good and the process is relatively smooth, because each solid particle to be burnt will be surrounded by combustion gas in the bed and be simultaneously heated to a temperature corresponding to pyrolysis.

[0011] In gasification, combustion does not take place, or it is incomplete. Thus, the fluidizing gas is low-oxygen or oxygen-free and contains, among other things, carbon dioxide, water vapour and nitrogen.

[0012] The bed material to be fluidized is, in many cases, common sand rich in quartz, but it may also be different inorganic material with suitable particle size and other properties. In CFB reactors, the bed typically consists mostly of ash, while the rest of the bed material is also finer, having a particle size in the range of 0.1 to 0.3 mm. In BFB reactors, the typical particle size range is 1 to 3 mm.

[0013] In addition to the above-mentioned problems of corrosion and soiling caused by alkali and halogens, sintering

of the bed sand is caused by said compounds, such as potassium chloride, in the fluidized bed process. However, in view of its versatile applicability, generally good degree of combustion and smooth operation, the fluidized bed process is a good solution. Therefore, it would be very advantageous to find a solution by which the above-mentioned problems relating to the utilization of green logging residues and energy wood from thinning, as well as green biomass, could be largely eliminated.

Summary of the invention

[0014] It is an aim of the invention to present a fluidized bed process by which it is possible to largely eliminate the above-mentioned problems relating to the utilization of undried logging residues and energy wood from thinning, as well as green biomass.

[0015] The fluidized bed process according to the invention, particularly for the combustion or gasification of undried logging residues and energy wood from thinning, as well as green biomass, is characterized in what will be presented in claim 1 of the appended claims. The other claims define some possible embodiments of the invention.

Detailed description of the invention

[0016] In the solution according to the invention, readily refinable material that is rich in calcium and/or magnesium is added, in a content of 30 to 100% of the amount of ash from fuel, to the bed material of the fluidized bed process, in order to bind the halogen and alkali components contained in the fuel directly or indirectly to the ash fraction being formed. The solution enables combustion of fresh undried wood material, particularly rich in chlorine and alkali, in a boiler having a high efficiency and simultaneously a reduced susceptibility to corrosion of the materials used, thereby improving the degree of utilization, the reliability, as well as the costs for repair and maintenance of the boiler to a substantial extent.

[0017] In fluidized bed boilers, conventional bed sand, rich in quartz, is a hard and relatively inert material, but at temperatures typical for the bed, it reacts with fuel-based alkali metals, calcium and other substances, forming a partial smelt which is capable of sintering bed sand particles together so that after a sufficiently long exposure time they are no longer capable of fluidizing.

[0018] When the bed sand is replaced, in whole or in part, with minerals or materials according to the present invention which are clearly softer than conventional bed sand, the tendency of partial smelting is decreased. This is because several materials rich in Ca and Mg but low in silicon or aluminium can efficiently react with corroding substances, such as chlorine and sulphur compounds, to form e.g. alkaline earth fluorides, chlorides and sulphates. These compounds do not form a highly viscous partial smelt but tend, in different states, to be entrained in the exiting flue gas flow, whereby the potential of corrosion and soiling of the boiler is significantly reduced.

[0019] The resulting alkaline earth halogenide and sulphate compounds are collected as solid ash particles on filters, from which they are removed together with other ash particles. The ash obtained is, at its best, an excellent fertilizer which can be utilized in separate processes. Linked to this is our previous patent application FI 20150289.

[0020] Furthermore, alkaline earth oxides are very good catalysts which are capable of catalysing pyrolysis and thereby make it possible to run the bed in a larger range of temperatures, which may bring various benefits, including benefits relating to environmental technology. In gasification processes, alkaline earth oxides are capable of catalysing splitting of long-chain tar compounds to shorter chains, which may significantly boost the gasification process.

[0021] The basis of the invention is that in a fluidized bed combustion or gasification process, known as such, the bed material used is a suitable material that is readily refined under bed conditions, forming a large reactive specific surface, and is capable of reacting efficiently with corrosive fuel-based components. Essential factors in the disintegration of the bed material particles are grinding, refining, chemical decomposition, and fragmentation as the temperature or volume are changed.

[0022] Preferably, the bed material has a high content of calcium and/or magnesium but a low content of alkali metals, silicon and aluminium. With respect to density and the particle size range used, the bed material according to the invention does not, when supplied, differ significantly from conventional bed sand, rich in quartz.

[0023] The readily refinable component of the bed material preferably comprises calcium carbonate (calcite) $CaCO_3$, calcium magnesium carbonate (dolomite) $CaMg(CO_3)_2$, or magnesium carbonate (magnesite) $(Mg,Fe)CO_3$. The readily refinable component may also comprise waste material or a side product rich in CaO or MgO, such as incompletely calcined dolomite or calcite from lime burning kilns, fire-resistant dolomite or magnesite brick waste, steelmill ladle rich in calcium, converter or electric furnace slag, or sand from talcum production, rich in magnesite. Any of these materials may be combined to form readily refinable components which are capable of reacting efficiently with harmful substances, such as halogens and sulphur, contained in fuel.

[0024] The bed material according to the invention is chemically decomposed in the bed according to the following reactions (oxidizing conditions):

$$CaCO_3 \rightarrow CaO + CO_2$$

$$CaMg(CO_3)_2 \rightarrow CaO + MgO + 2CO_2$$

$$MgCO_3 \rightarrow MgO + CO_2$$

[0025] At first, decomposition takes place in the surface part of the particle, but it preferably proceeds so that the whole particle is entirely decomposed thanks to simultaneous comminuting, whereby a fresh chemically undecomposed surface is exposed to chemical decomposition by the effect of heat, whereafter the surface may react with said corrosive harmful substances, for example as follows:

$$MgO + Cl_2 \rightarrow MgCl_2 + ½O_2$$

$$CaO + SO_3 \rightarrow CaSO_4$$

$$CaO + F_2 \rightarrow CaF_2 + ½O_2$$

[0026] The supplied bed sand does not need to undergo complete chemical degradation. A particle which has not undergone complete degradation, comprises an original inner part of e.g. a carbonate, and a surface part of the corresponding oxide which is reactive and capable of reacting with, *inter alia,* halogens, typically chlorine.

[0027] The channels for feeding inorganic bed materials may include not only the actual system for feeding bed sand but also the system for feeding fuel. Furthermore, an extra channel may be used for supplying additives, particularly in some larger plants.

[0028] Hard particles may be introduced in the bed so that their content in the bed does not exceed 50 wt-%. These may consist of quartz, conventional bed sand, olivine, corundum, granulated blast furnace slag, or any particles having a hardness value exceeding 4 on the Mohs scale.

[0029] The invention may vary within the scope defined by the appended claims.

Claims

1. A fluidized bed process particularly for combustion or gasification of undried logging residues and energy wood from thinning as well as green biomass, **characterized in that** readily refinable material, rich in calcium and/or magnesium, is added to the bed material in a content of 30 to 100% of the amount of ash from fuel, in order to bind halogen and alkali components contained in the fuel, directly or indirectly, to the ash fraction being formed.

2. The fluidized bed process according to claim 1, **characterized in that** it comprises a system for recovering latent heat from the water vapour contained in the flue gas.

3. The fluidized bed process according to claim 2, **characterized in that** the system for recovering latent heat from the water vapour contained in the flue gas is connected to a flue gas scrubber.

4. The fluidized bed process according to claim 1, **characterized in that** one or more of the following is added to the bed material: calcite, dolomite, magnesite, incompletely calcined calcite or dolomite waste material, dolomite or magnesite brick waste material, steelmill ladle rich in calcium, converter or electric furnace slag, magnesite sand from talcum production.

5. The fluidized bed process according to claim 1, **characterized in that** the content of said biofuels in the fuel, in dry weight, is at least 50%.

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EUROPEAN SEARCH REPORT

Application Number
EP 18 16 8199

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2012/113987 A1 (TEKNOLOGIAN TUTKIMUSKESKUS VTT [FI]; MOILANEN ANTERO [FI]; VAINIKKA PA) 30 August 2012 (2012-08-30) * page 1, line 10 - page 2, line 11 * * page 2, line 24 - line 36 * * page 3, line 20 - page 4, line 3 * * page 4, line 26 - line 30 * * page 5, line 1 - line 31 * * page 7, line 27 - page 8, line 13 * * page 8, line 31 - page 9, line 1 * * page 9, line 12 - page 10, line 10 * * page 12, line 14 - page 13, line 2 * -----	1-5	INV. F23C10/00 F23G7/10
X	EP 2 302 017 A2 (RENTECH INC [US]) 30 March 2011 (2011-03-30) * paragraph [0001]; figure 1 * * paragraph [0010] * * paragraph [0014] - paragraph [0020] * * paragraph [0034] * * paragraph [0044] - paragraph [0049]; table 2 * -----	1-3,5	TECHNICAL FIELDS SEARCHED (IPC) F23C F23G F23J
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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
Munich	9 August 2018	Hauck, Gunther

CATEGORY OF CITED DOCUMENTS

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Application Number
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TECHNICAL FIELDS SEARCHED (IPC)

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