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(54) METHOD AND DEVICE FOR PRODUCING POWER BY MEANS OF OXIDATION OF FUEL IN A CHEMICAL LOOP

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(57) **ABSTRACT**

The invention relates to a method for producing power from at least one fuel, said method including: a step of oxidizing said fuel by means of placing it in contact with at least one oxygen loaded solid compound and of concomitantly reducing said solid compound.

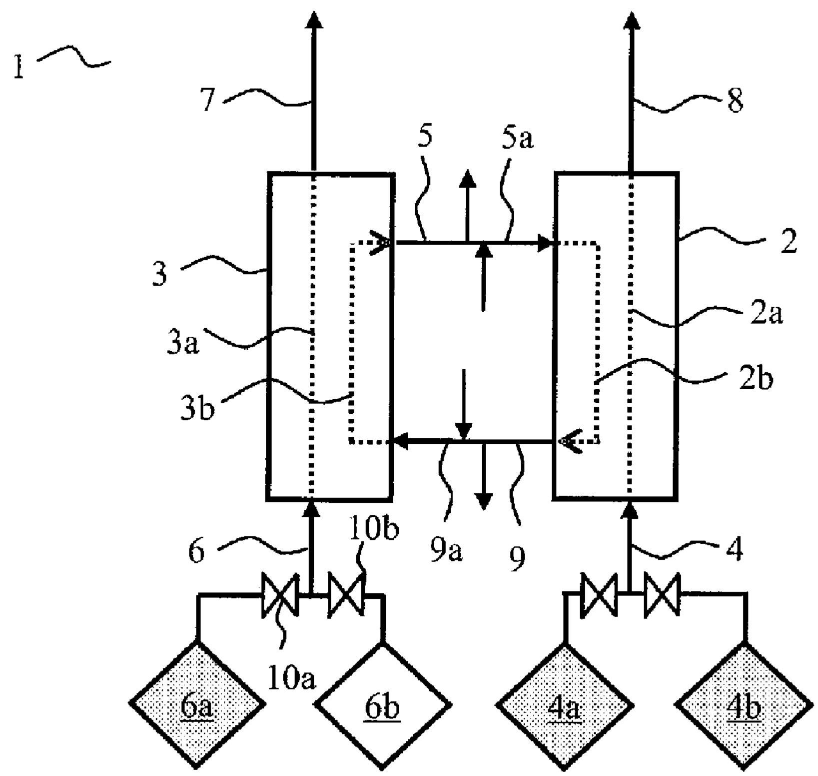

FIG. 1

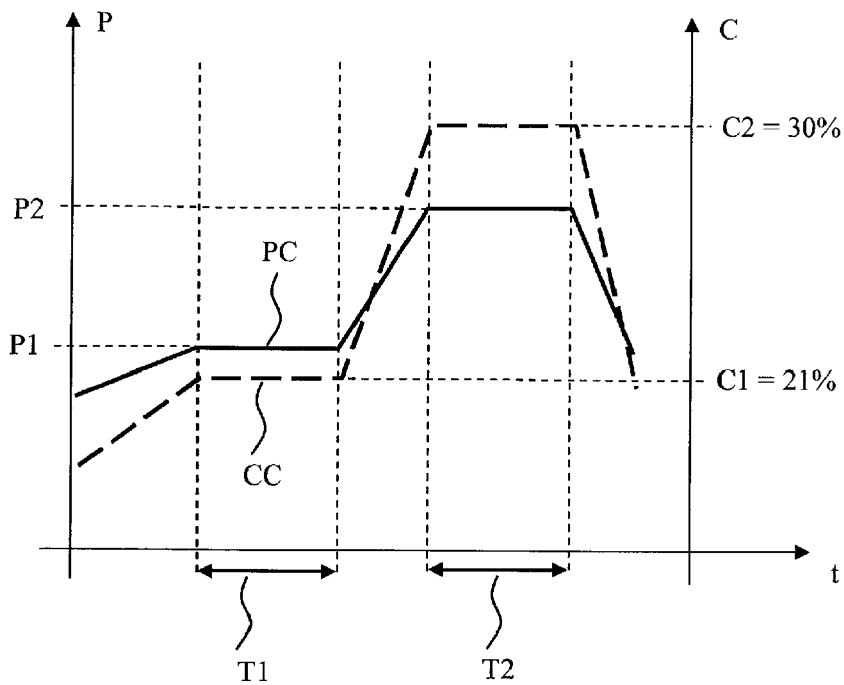

FIG. 2

METHOD AND DEVICE FOR PRODUCING POWER BY MEANS OF OXIDATION OF FUEL IN A CHEMICAL LOOP

[0001] The present invention relates to a process and a device for the production of energy by oxidation of a fuel in a chemical loop.

[0002] Chemical looping techniques have appeared comparatively recently in the field of the oxidation of fuels. They employ a solid active compound, generally a metal, which chemically fixes atmospheric oxygen and is subsequently used to oxidize a solid, liquid or gaseous compound, generally carbon-based. Generally, said active compound circulates in a loop, from a reactor where it is oxidized on contact with air to at least one other reactor where it is reduced during the oxidation reaction of the fuel. This oxidation of the compound regenerates it. It can again be used to fix oxygen. The active compound is generally used in the form of a fluidized and circulating bed of particles. It is easily separated from gas mixtures, for example by a cyclone. The regeneration of the solid active compound is generally highly exothermic. The heat given off is converted to energy (steam, mechanical or electrical power, for example). In other configurations, the same principle is employed, not by fluidized beds of the particles of these compounds but by regenerative fixed beds comprising these compounds. Oxidizing or reducing gases are then passed alternately over these beds. One possible implementation consists in using rotating compartments (which are brought into contact alternately with oxidizing or reducing gases).

[0003] Mention may in particular be made of the document WO2007104655A1, which describes a power plant including a thermochemical loop, comprising oxidation and reduction chambers, cyclones for separating solid particles from the effluent gases, heat exchangers and means for producing electrical energy from the thermal energy given off. Application WO2008036902, "Chemical looping combustion", exhibits an implementation of the chemical looping principle, in particular by virtue of a reactor composed of rotating compartments.

[0004] The advantage of the chemical looping techniques applied to the oxidation of a fuel lies in the fact that the products of the oxidation (mainly water and carbon dioxide or CO_2) readily lend themselves to capture of the CO_2 as they comprise no or little nitrogen, if the system is airtight with respect to the surroundings. In contrast, a large amount of this nitrogen is found in the effluent products from a conventional combustion with air. Another specific advantage of the chemical loops is that they require only air as oxidant, in comparison with other techniques for the oxidation of fuels which facilitate the capture of CO_2, such as oxy-combustion or pre-combustion, which can use a flow concentrated in oxygen.

[0005] For a plant for the production of energy (electricity, work or heat), the main element in the design is the maximum power which has to be produced. The size of the chemical loop is deduced therefrom (capacity of the reactors, amount of oxygen-transporting active compound, size of the items of equipment, and the like). Once this design has been implemented, the maximum power, the "peak" power, of the plant is set at a value which can no longer be exceeded. In fact, the plant will in general produce a lower power, that is to say that it is most of the time oversized. It will possibly be pushed to its production maximum only at certain times and this maximum will not change over time unless the plant is significantly modified, with consequent capital costs.

[0006] An aim of the present invention is to overcome all or part of the disadvantages of the prior art, in particular the unalterable aspect of the maximum power produced (related to the size of the items of equipment installed) and the oversizing of the plants which may result therefrom.

[0007] The invention relates first to a process for the production of energy from at least one fuel, comprising:

- **[0008]** a stage a) of oxidation of said fuel by bringing into contact with at least one oxygen-charged solid compound and of concomitant reduction of said solid compound;
- **[0009]** a stage b) of recovery of said solid compound reduced in stage a);
- **[0010]** a stage c), which is exothermic, of oxidation of a non-zero fraction of said solid compound recovered in stage b) by bringing it into contact with at least one oxygen-comprising gas; and
- **[0011]** a stage d) of recovery of said oxidized solid compound resulting from stage c) and of use in stage a) of a non-zero fraction of said oxidized solid compound;

the heat given off in stage c) being at least partially recovered in order to carry out said production of energy;

said process being characterized in that the oxygen-comprising gas 6 is alternately, according to the energy power desired, air or a gas comprising a concentration by volume of oxygen of between 22% and 100%.

[0012] In other words, during a period T of production of energy, there is:

- **[0013]** a first period T**1** of production during which the oxygen-comprising gas **6** is air; energy at a power P**1** is produced during this period T**1**; and
- **[0014]** a second period T**2** of production during which the oxygen-comprising gas **6** is a gas comprising a concentration by volume of oxygen of between 22% and 100%; energy at a power P**2** is produced during this period T**2**;

with T=T**1**+T**2** and P**2**>P**1**.

[0015] The fuel can be solid, liquid or gaseous, or polyphase. It can be a conventional fuel, such as natural gas or naphtha, or a bleed or flue gases from another process, or also charcoal, coke, petroleum coke, biomass and its derivatives or oil residues.

[0016] In stage a), the fuel is brought into contact with at least one oxygen-transporting solid compound. This contacting operation can be carried out in several installments and/or with a sufficient residence time, and/or with a given excess of one of the reactants (fuel or transporting solid compound), until a certain degree of reaction is obtained. This solid compound can in particular be metal, in a sometimes oxidized, sometimes reduced form. The fuel reacts with an oxidized form of the solid compounds. In this instance, a relative meaning should be given to "oxidized" and "reduced". The essential point is that at least a fraction of the solid compound can release oxygen on changing to a lower oxidation state. The oxidation/reduction reactions may not be complete. The oxidation/reduction reaction results, on the one hand, in the solid compound in a reduced form and, on the other hand, in effluent products which are the products of the oxidation of said fuel.

[0017] In stage b), the solid compound is recovered in a reduced form, for example by virtue of a solid/gas physical separation.

[0018] In stage c), at least a portion of the reduced solid compound, optionally supplemented by an extra contribution of solid compound, is brought into contact with an oxygen-comprising gas. In the prior art, this gas is air. On contact with this gas, the solid compound changes to a higher oxidation state and for this reason fixes oxygen. This contacting operation can be carried out in several installments and/or with a sufficient residence time, and/or with a given excess of one of the reactants (oxygen-comprising gas or transporting solid compound), until a certain degree of reaction is obtained. This reaction results, on the one hand, in the solid compound in an oxidized form and, on the other hand, in effluent products which are the incoming gas depleted in oxygen with respect to its initial content.

[0019] On conclusion of this regeneration, after a recovery forming the subject of stage d), it is again ready, optionally after being supplemented with solid compound, to be used for the oxidation of said fuel (stage a)).

[0020] It is seen that stages a) to d) form a loop from the viewpoint of the oxygen-transporting solid compound or compounds. At certain stages, they are oxidized and, at others, reduced. Generally, the solid compound or compounds is/are circulated from one reactor to another and thus the loop is also physical (the solid compounds are transported). It would also be possible to leave them in place and to circulate the other compounds. Various means known to a person skilled in the art can be employed to ensure airtightness during stages a) and d), such as robust siphons, airtight intermediate chambers having an alternative opening (lock hoppers), or others.

[0021] Said oxygen-transporting solid compound or compounds are generally employed in the form of solid particles. These particles are composed of the solid compound or compounds, optionally agglomerated by a binder material according to techniques known to a person skilled in the art. This attempts in particular to:

- **[0022]** give them a specific capacity (per unit of weight) to fix and to release the oxygen which is as high as possible,
- **[0023]** confer on them a good mechanical strength, in particular towards attrition,
- **[0024]** promote the kinetics of reaction between said particles and said fuel, and between said particles and the oxygen-comprising gas.

[0025] The particles are generally employed in the form of a fluidized bed, for example fluidized by injections of steam or gas rich in CO_2 or fuel gas or recycled effluent products into a reactor (stage a)), and injections of air or another oxygen-comprising gas or steam into another reactor (stage b)). This steam can be produced in the heat exchangers. This fluidized bed circulates from the regions where the reduction of said particles, that is to say the oxidation of said fuel, takes place towards the regions where the regeneration of said particles, that is to say the oxidation of the active compounds present therein, takes place.

[0026] The particles are generally separated from the other products of the oxidation of the fuel by physical separation, for example in a cyclone. They are also separated from possible other solids originating from the oxidation of the fuel (ash and/or soot and/or unconverted solid fuel). It is the same during the regeneration of said particles. Other separation elements can be provided in order to separate the possible solid products of the reactions from the oxygen-transporting active compound, so as to recover the carrier material and increase the conversion efficiency.

[0027] In general, the oxidation of the oxygen-transporting solid compound is exothermic, just like that of the fuel. Nevertheless, it takes place at high temperature.

[0028] A portion of the heat given off by the chemical reactions carried out is recovered by heat exchange. There may be many heat exchanges, so as to recover the heat at the place where it occurs. The heat can be recovered in particular in or around the reaction media or else in the primary, secondary and/or regeneration effluent products. The thermal energy is partly transferred to one or more heat-exchange fluids, such as steam or hot oil, according to methods known to a person skilled in the art. These fluids, optionally produced at different pressure and/or temperature levels, can be used as is or to produce mechanical and/or electrical energy.

[0029] During a first period of time where it is desired to produce a given energy power, use is made, in stage c), of air, optionally pretreated, in order to regenerate the oxygen-transporting solid compound or compounds. The power delivered is adjusted by using other parameters, in particular the flow rate of fuel and solid compound in the loop. The inventors have established that if, during a second given period, it is desired to increase the power produced, it is advantageous to use, in stage c), at least one gas comprising between 22% and 100% of oxygen by volume. In this gas, the remainder to 100% by volume is composed of gases which do not react with the solid compound or compounds (nitrogen, argon, CO_2, and the like). This gas can be a mixture of air and relatively pure oxygen. In stage c), the solid compound can be brought into contact with several oxygen-comprising gases, some being air and others being gases comprising between 22% and 100% of oxygen by volume.

[0030] The first period and the second period are not necessarily successive. The second period is not necessarily subsequent to the first period.

[0031] All this implies having available a source of gas richer in oxygen than air, which has a capital cost, if a source is not available, and an operating cost. On the other hand, this makes it possible to increase the maximum power produced, without having to enlarge the plant in which the process is carried out. Thus, the plant can be designed not with regard to a peak power but with regard to a lower power. In this way, the initial capital cost of the energy production unit may be reduced.

[0032] The gaseous effluent products resulting from stage a) of the oxidation of the fuel are analogous to the flue gases from a conventional combustion using air as oxidant, but comprise little or no nitrogen. Their CO_2 concentration is also greater. After condensation of the water (for example by cooling), they are thus particularly suitable for subjecting to capture of the CO_2 by any technique known to a person skilled in the art (washing with amines, adsorption, permeation, cryogenic distillation, and the like).

[0033] Furthermore, the gaseous effluent products resulting from the regeneration of the solid compounds in stage c) are depleted in oxygen. By producing a sufficient depletion, the invention exhibits the additional advantage of providing a residual gas which can be used in inerting applications.

[0034] According to specific embodiments, the invention can in addition comprise one or more of the following characteristics:

[0035] during said second period of production of energy, said oxygen-comprising gas has a concentration of oxygen by volume of between 23% and 40%.

[0036] during said first period of production of energy, said fuel is of a first given type and, during said second period of production of energy, said fuel is of a second given type which is more reactive in stage a) than said first type. In order to determine if one fuel is more reactive than another, the following calorimetric experiment is carried out successively on the two test fuels. An amount of fuel equivalent in NCV (net calorific value) to a value chosen in advance is placed in a bomb calorimeter. The oxygen-transporting compound, in the form under which it is employed in stage a) of the process according to the invention, that is to say an oxidized form, is added thereto in a stoichiometric amount. The two reactants are initially at 20° C. The curve of rise in the temperature as a function of the time is subsequently measured. The curves obtained for the two fuels are compared on the same graph. It will be said that the more reactive is that for which the initial rise in the temperature is faster, that is to say that for which the curve of temperature is higher during at least a certain interval of time.

[0037] said first type of fuel is sub-bituminous coal and said second type of carbon-based fuel is lignite or coal or HFO (heavy fuel oil) or LPG (liquefied petroleum gas) or natural gas.

[0038] during said first period (T**1**) of production of energy at said first power (P**1**), use is made of a first flow rate of said solid compound in stage a) and of a second flow rate of said solid compound in stage c) and, during said second period (T**2**) of production of energy at said second power (P**2**), use is made of a third flow rate of said solid compound in stage a) and of a fourth flow rate of said solid compound in stage c), the ratio of said third flow rate to said first flow rate and the ratio of said fourth flow rate to said second flow rate being greater than or equal to the ratio of said second power (P**2**) to said first power (P**1**). The first and second flow rates are generally similar values. If they differ, it is because the solid compound has been bled or an extra contribution has been made. It is the same for the third and fourth flow rates of solid compound.

[0039] During said second period of production of energy, more energy per unit of time is released by the chemical reactions in the oxidation and reduction reactors. Adaptations known to a person skilled in the art can be produced in the plant in order to remove this additional power. For example, there may be additional heat exchangers which come into operation during this second period, in a heat-exchange fluid circuit shared or not shared with the main circuit. In another example, the flow rate by weight of heat-exchange fluid passing through the same heat exchangers may be accordingly increased during this second period. In another example, the control parameters of the heat-exchange fluid circuit change in this second period, so that the heat-exchange fluid is hotter on exiting from the heat exchangers than during the first period (thus storing up more thermal energy). In another example, the pressure of the heat-exchange fluid circuit increases during this second period, so as to promote the presence of liquid phase in this circuit, with a higher specific heat, which may be better in removing the additional power produced.

[0040] The advantage of using a gas for which the concentration of oxygen by volume is between 23% and 40% is that of limiting the risk of an excessively high rise in the temperature during stage c). This might necessitate adapting the reactor or reactors in which the exothermic regeneration (stage c)) of the solid compound or compounds is carried out, with negative effects on the capital costs.

[0041] The invention also relates to a device for the production of energy, comprising at least:

[0042] one reactor for the oxidation of fuel connected at the inlet to one or more sources of fuel and to at least one pipe suitable for conveying and intended to convey an oxygen-transporting solid compound to said oxidation reactor, said reactor having at least one outlet for gases resulting from the oxidation of said fuel;

[0043] one reactor for regeneration of said oxygen-transporting solid compound, connected at the inlet to a source of air and to at least one pipe suitable for conveying and intended to convey said oxygen-transporting solid compound from an outlet of said oxidation reactor to said regeneration reactor, said reactor having at least one outlet for gases resulting from the regeneration of said oxygen-transporting solid compound;

[0044] means for recovery of said solid compound at the outlet of said oxidation and regeneration reactors; and

[0045] heat exchangers capable of converting and intended to convert, into energy, the heat given off in said regeneration reactor; said pipe capable of conveying and intended to convey an oxygen-transporting solid compound to said oxidation reactor being connected to an outlet of said regeneration reactor;

said device being characterized in that it additionally comprises:

[0046] a source of a gas having a concentration of oxygen by volume of between 22% and 100% connected to an inlet of said regeneration reactor; and

[0047] means which make it possible to selectively open or close said connections between said regeneration reactor and said source of air, on the one hand, and said regeneration reactor and said source of a gas having a concentration of oxygen by volume of between 22% and 100%, on the other hand.

[0048] Connection by pipe between the reactors means that there is connection by a system of pipes capable of transporting a material stream. This connection system can comprise valves, intermediate storages, bypasses, heat exchangers or compressors but not chemical reactors. "Reactor" shall be taken in the definition of the invention in the broad sense of "unit". They can thus have a complex structure known to a person skilled in the art and in particular can comprise several receivers.

[0049] The device can also comprise means for injection of an extra contribution of oxygen-transporting solid compound, or bleeding means, for example on the pipes connecting the reactors.

[0050] The means for recovery of the oxygen-transporting solid compound can be of any nature capable of isolating solid particles in gas streams, for example systems known as "cyclones". The means which make it possible to select one or other of the sources of oxygen-comprising gas to be injected into the regeneration reactor, or to mix the gases resulting from these sources, are generally valves subjected to a control system.

[0051] According to specific embodiments, the invention can additionally comprise the following characteristic: said source of a gas having a concentration of oxygen by volume of between 22% and 100% is capable of providing and is intended to provide a gas for which the concentration of oxygen by volume is between 23% and 40%.

[0052] Other distinctive features and advantages of the invention will become apparent on reading the following description, made with reference to the figures, where:

[0053] FIG. **1** represents a plant employing the process according to the invention,

[0054] FIG. **2** is a diagram illustrating the choice of the oxygen-comprising gas employed in stage c).

[0055] In the example illustrated by FIG. **1**, a fuel oil **4** and ilmenite **5***a* are introduced into a reactor **2**. The oxidation of the fuel oil **2***a* on contact with the ilmenite **2***b* in the reactor **2** produces primary effluent products **8** and ilmenite in reduced form **9**. These primary effluent products are favorable to the capture of CO_2 in the sense that they comprise little or no nitrogen. This capturing can be carried out by one or more known techniques for the separation of CO_2, optionally preceded by condensation of the water present in the effluent products **8**. A non-zero fraction **9***a* of this ilmenite **9**, preferably of approximately 100%, is introduced into the reactor **3**, where an oxygen-comprising gas **6** is also introduced. Highly exothermic oxidation of the ilmenite **3***b* takes place on contact with this gas **3***a* in the reactor **3**. This reaction produces a gas **7** which is depleted in oxygen with respect to the gas **6** entering the reactor **3**. The ilmenite **3***b* is recharged with oxygen and is recovered in an oxidized form **5**. A non-zero fraction **5***a* of the latter, preferably of approximately 100%, is introduced into the reactor **3**.

[0056] The oxygen-transporting compound, in this instance ilmenite, produces a chemical loop by passing through the states **5***a*, **2***b*, **9**, **9***a*, **3***b* and **5**. The ilmenite is recovered at the outlet of the reactors **2** and **3** by techniques known to a person skilled in the art, for example cyclones (not represented). An extra contribution of product, or a bleeding, may prove to be necessary in order to maintain the amount (weight) and the quality of the oxygen transporter.

[0057] The heat given off by the reactions in the reactor **2** is recovered by heat exchange in the reactor **2**. In addition, it can also be recovered in the reactor **2** and/or on the hot solid or gaseous products which circulate between the reactors. In practice, this heat is used to heat water in order to produce steam, which can subsequently be completely or partially converted to mechanical and/or electrical energy.

[0058] The oxygen-comprising gas **6** can be prepared from a source of air **6***a* and/or by mixing this air **6***a* with relatively pure oxygen produced by an air separation unit **6***b*. The change from feeding the reactor **3** with air **6***a* to feeding with a mixture of air and oxygen will regenerate a greater amount of ilmenite **9***a*. More oxidized ilmenite **5** is obtained and it is possible to inject a greater amount **5***a* thereof into the reactor **2**. Thus, all things otherwise being equal, the change from feeding the reactor **3** with air to feeding with oxygen makes it possible to oxidize more fuel and to generate more energy.

[0059] In a specific configuration of the example illustrated in FIG. **1**, the fuel **4** is natural gas and the content of oxygen by volume in the flow **6** is 30%. In comparison with a configuration in which the flow **6** would be exclusively air, the invention makes it possible to oxidize 60% more natural gas and thus to produce approximately 60% more energy in the same plant.

[0060] The increase in the production of energy made possible by the change in nature of the oxygen-comprising gas **6** can be further increased by changing the nature of the fuel **4** sent to the reactor **2**.

[0061] A diagrammatic representation has been given, in FIG. **2**, of a possible change as a function of the time in the concentration of oxygen by volume C in the gas **6** sent to the reactor **3** and in the power P, in kW or MW (amount of energy produced per unit of time), produced by the plant. Thus, during a period of time T**1**, the gas **6** sent to the reactor **3** is air (C**1**) originating from the source **4***a* (air, optionally pretreated). The plant then produces a power P**1**. This period T**1** generally corresponds to the normal operation of the plant. If, for one reason or another, it is desired to satisfy a peak in consumption corresponding to a power P**2** during a period of time T**2**, the nature of the gas **6** sent to the reactor **3** is changed. The gas **6** (C**2**) then originates from a source of oxygen **6***b* or from a mixture of **6***a* and **6***b*. During this time T**2**, the amount of fuel **4** injected into the reactor **2** is also increased, in order to deliver this power P**2** to the system. The period T**2** is not necessarily subsequent to the period T**1**. T**2** is simply a period of time during which it is desired to produce a power P**2** greater than that which is obtained under conditions of operating with air. P**2** is often referred to as peak power. Thus, the plant can be designed in order to satisfy the need for power P**1**. The change to gas comprising between 22% and 100% of oxygen by volume makes it possible to satisfy a greater need P**2** without having to modify the plant.

[0062] For example, a power plant using natural gas as fuel **4** produces, during the period T**1**, a useful thermal power P**1**=200 MWth (thermal megawatts) with air as oxidant **6** (C**1**=21%). In this case, the amount of natural gas **4** consumed is 21 635 Sm^3/h (cubic meters per hour taken under standard temperature and pressure conditions, i.e. 0° C. and 1 atmosphere) on entering the reactor **2**. The amount of air **6** is 206 049 Sm^3/h, including 43 270 Sm^3/h of oxygen.

[0063] During the period T**2**, additional oxygen (26 492 Sm^3/h) is added to these 206 049 Sm^3/h of air, so that the concentration of oxygen by volume of 6 is equal to 30% (C**2**=30%). In this case, the total flow rate of oxidant **6** is 232 541 Sm^3/h. The amount **4** of natural gas to be oxidized in the reactor **2** can increase to 34 881 Sm^3/h. The power plant will then be capable of thus producing P**2**=322 MWth of useful thermal power.

[0064] During the period T**2**, the flow rates of solid compound employed in (entering) the reactors **2** and **3** are increased by 65% with respect to the same flow rates considered during the period T**1**. This increase is greater than the P**2**/P**1** ratio of increase in the power produced, which is approximately 60%.

1-7. (canceled)

8. A process for the production of energy from at least one fuel, comprising:

a. the oxidation of at least one fuel by bringing into contact with at least one oxygen-charged solid compound and of the concomitant reduction of said solid compound;

b. recovering said reduced solid compound;

c. the exothermic oxidation of a non-zero fraction of said recovered solid compound by bringing said recovered solid compound into contact with at least one oxygen-comprising gas; and

d. recovering said oxidized solid compound, and of using a non-zero fraction of said oxidized solid compound in step a);

the heat given off in step c) being at least partially recovered in order to carry out a production of energy;

wherein the oxygen-comprising gas is alternately, according to the energy power desired, air or a gas comprising a concentration by volume of oxygen of between 22% and 100%.

9. The process of claim **8**, wherein the oxygen-comprising gas is alternately, according to the energy power desired, air or a gas comprising a concentration of oxygen by volume of between 23% and 40%.

10. The process of claim **8**, wherein:

during the period during which the oxygen-comprising gas is air, said fuel is of a first given type; and

during the period during which the oxygen-comprising gas is a gas comprising a concentration of oxygen by volume of between 22% and 100% or 23% and 40%, said fuel is of a second given type which is more reactive in step a) than said first type.

11. The process of claim **10**, wherein said first type of fuel is sub bituminous coal and said second type of carbon-based fuel is lignite or coal or HFO (heavy fuel oil) or LPG (liquefied petroleum gas) or natural gas.

12. The process of claim **8**, wherein:

during the period during which the oxygen-comprising gas is air, use is made of a first flow rate of said solid compound in step a) and of a second flow rate of said solid compound in step c); and

during the period during which the oxygen-comprising gas is a gas comprising a concentration of oxygen by volume of between 22% and 100% or 23% and 40%, use is made of a third flow rate of said solid compound in step a) and of a fourth flow rate of said solid compound in step c), the ratio of said third flow rate to said first flow rate and the ratio of said fourth flow rate to said second flow rate being greater than or equal to the ratio of a second power (P**2**) to said first power (P**1**).

13. A device for the production of energy, comprising:

one reactor for the oxidation of fuel connected at the inlet to one or more sources of fuel and to at least one pipe suitable for conveying and intended to convey an oxygen-transporting solid compound to said oxidation reactor, said reactor having at least one outlet for gases resulting from the oxidation of said fuel;

one reactor for regeneration of said oxygen-transporting solid compound, connected at the inlet to a source of air and to at least one pipe suitable for conveying and intended to convey said oxygen-transporting solid compound from an outlet of said oxidation reactor to said regeneration reactor, said reactor having at least one outlet for gases resulting from the regeneration of said oxygen-transporting solid compound;

means for recovery of said solid compound at the outlet of said oxidation and regeneration reactors; and

heat exchangers capable of converting and intended to convert, into energy, the heat given off in said regeneration reactor;

said pipe capable of conveying and intended to convey an oxygen-transporting solid compound to said oxidation reactor being connected to an outlet of said regeneration reactor;

said device being characterized in that it additionally comprises:

a source of a gas having a concentration of oxygen by volume of between 22% and 100% connected to an inlet of said regeneration reactor; and

means which make it possible to selectively open or close said connections between said regeneration reactor and said source of air, on the one hand, and said regeneration reactor and said source of a gas having a concentration of oxygen by volume of between 22% and 100%, on the other hand.

14. The device of claim **13**, wherein said source of a gas having a concentration of oxygen by volume of between 22% and 100% is capable of providing and is intended to provide a gas for which the concentration of oxygen by volume is between 23% and 40%.

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