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Coke oven with optimized control and method of control

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US 4287024 A
Buss et al. "Thyssen Still OTTO/PACTI non-recovery cock making system" Iron and Steel Engineer, January 1999, Pages 33-38.

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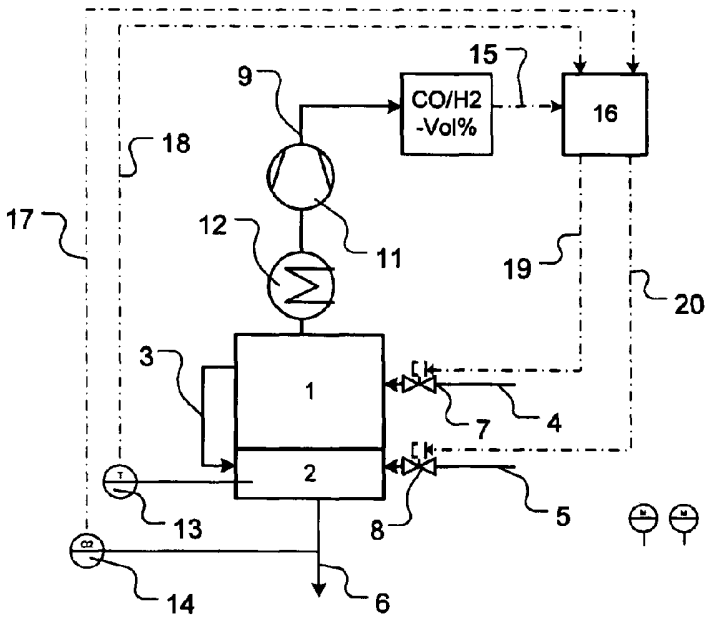
(54) Title: COKE OVEN WITH OPTIMIZED CONTROL AND METHOD OF CONTROL

(54) Bezeichnung: KOKSOFEN MIT OPTIMIERTER STEUERUNG UND VERFAHREN ZUR STEUERUNG



(57) Abstract: The invention relates to a coking oven in flat-form construction, a non-recovery or heat-recovery coking oven, which has at least one measuring apparatus for measuring the concentration of gaseous constituents of the coke oven retort, the coke oven hearth and/or the off gas duct, and in which, on the basis of these data, a process control computer determines and regulates the optimal supply of primary and/or secondary air. Also embraced by the invention is a coking method employing a coking oven of this kind.

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WO 2007/087839 A1

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Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

(57) Zusammenfassung: Die Erfindung betrifft einen Verkokungsofen in Flachbauweise, einen so genannten Non-Recovery- oder Heat-Recovery-Verkokungsofen, der mindestens eine Messvorrichtung zur Konzentrationsmessung von Gasbestandteilen der Koksofenkammer, der Koksofensohle und/oder des Abgaskanals aufweist und bei welchem auf Basis dieser Daten über einen Prozessrechner die optimale Zuführung von Primär-und/oder Sekundärluft ermittelt und geregelt wird. Ebenso ist von der Erfindung ein Verkokungsverfahren unter Einsatz eines solchen Verkokungsofens umfasst.

[0001] Coke Oven with Optimised Control and Method for Control

[0002] This invention relates to a coke oven built in flat-type construction, i.e. a so-called non-recovery or heat-recovery coke oven consisting of at least one measuring device to measure the concentration of gas constituents in the coke oven chamber, coke oven sole and/or waste gas channel, and wherein the optimal supply of primary and/or secondary air is determined and controlled via a process computer on the basis of this data. This invention also covers a cokemaking process utilising a coke oven of this type.

[0003] Heating of heat-recovery ovens is usually performed by combustion of gas evolving on cokemaking and/or by burning the portions of light-volatile matter of coal to be carbonised. Combustion is controlled in such a manner that part of the gas above the coal charge burns off with primary air in the oven chamber. This partly burnt gas is fed through gas channels that are also designated as "downcomers" to the oven sole and completely burnt there by the addition of further combustion air, which is called secondary air.

[0004] In this way, heat is directly supplied from the top and indirectly from the bottom to the coal charge, thus taking a positive impact on the coking rate and, thereby, on the performance rate of coke ovens. To execute the method it is required to exactly rate and variably control the supplied primary and secondary air throughout the coking time that may take up to 96 hours. Heat-recovery and non-recovery coke ovens in flat-type construction are widely described in prior art disclosures. For example, reference is taken to US 4,344,820, US 4,287,024, US 5,114,542, GB 1 555 400 or CA 2 052 177 C.

[0005] According to the conventional state of the art in technology, primary air is sucked in from the atmosphere through ports in the doors. Secondary air is sucked in through ports near to ground and conducted through channels into the heating flues which mainly extend horizontally under the coke oven chamber. The ports for primary and secondary air are either opened permanently or provided with flaps designed to adjust the amount of air to be aspirated.

[0006] As the coke oven batteries are very extensive, and since usually a very high temperature prevails therein and because a serious development of dust is encountered, only manually adjustable venting flaps are disclosed in prior art technology. US Patent No. 5,928,476 describes such a coke oven battery, wherein

three manually operable ports are provided in each coke oven door, in which or in front of which one plate or disk each adapted to the port cross-section and supported at a central axle is arranged. These port flaps can be varied in their position manually through levers.

[0007] The German patent DE102005055483.0-24 of the applicant discloses a central adjusting element that permits a continuous control of primary and secondary air.

[0008] In practice, however, it became evident that varying coal qualities due to different coal crushing degrees, coal moisture or inert portions, etc. were difficult to master with prior art coke ovens and that unnecessarily long coking times had to be planned to attain high coke quality.

[0009] Now, therefore, the present invention seeks to remedy the described deficiencies in an economic manner and to assure an optimised supply of primary air and/or secondary air in order to improve coke oven performance rate and, thereby, coking time, too.

[00010] In one broad aspect, the present invention provides a coke oven built in flat-type construction, i.e. a so-called non-recovery or heat-recovery coke oven including a coke oven chamber and a coke oven sole including channels, with the coke oven chamber and the coke oven sole being connected to each other via gas channels, and wherein opening ports for the supply of primary air and one or more opening port(s) or channel(s) for the supply of secondary air into the coke oven sole are provided in the oven wall or in the oven door, and wherein shutoff devices are arranged in front of the opening ports or in the lines conducing to these opening ports.

[00011] Accordingly,

- at least one measuring device to measure the concentration of gas constituents in the coke oven chamber, coke oven sole and/or gas channels is linked to the coke oven, and
- this measuring device in turn is connected to a computer unit in such a way that this computer unit can receive data and measured results from the measuring device, and
- the computer unit is linked to one or more adjusting device(s) of the shutoff devices, with said shutoff devices representing valves, flaps, slide gates, or the like.

2006337510 13 May 2011

[00012] An improved variant resides in arranging a temperature measuring device in the coke oven sole or in the waste gas channel of the coke oven, wherein said temperature measuring device is also connected to the computer unit in such a way that it can receive data and measuring results from the temperature measuring device.

[00013] The measuring devices ideally represent analysers to measure hydrogen, nitrogen, carbon monoxide or carbon dioxide, said measuring devices being connected via a line to the coke oven chamber. The concentration of these main constituents or of one of these main constituents correlates very well with the coking state of the coke cake.

[00014] Above all it is hydrogen burning off as the last coal constituent that is an ideal indicator to indicate the end of coking time. Hence, with the coke oven embodying this invention, it is possible to control the cokemaking process in such a manner that the end of the coking time is achieved, in a way, concurrently to achieving 0 % by vol. of H_2. For is H_2 has burnt off prematurely, this leads to an increased combustion and/or incineration of coke valuables which represents an economic drawback.

[00015] In another variant of this invention, the measuring device is a lambda probe arranged in the coke oven sole or in the waste gas channel to determine the content of oxygen. By means of the lambda probe, and by a feedback with the control of secondary air, it can be assured that a complete combustion will always occur in the coke oven sole without too drastic a drop in temperature which would lead to a prolongation in coking time.

[00016] With an advanced variant of this invention, at least one analyser for the determination of hydrogen, nitrogen, carbon monoxide or carbon dioxide as well as a lambda probe for the determination of oxygen are provided for.

[00016a] In another broad aspect, there is provided a coke oven built in flat-type construction (i.e. a non-recovery and/or heat-recovery coke oven) including a coke oven chamber and a coke oven sole including channels, with the coke oven chamber and coke oven sole being connected to each other via gas channels, and wherein one or several opening port(s) or channel(s) for supplying primary air and one or more opening port(s) or channel(s) for supplying secondary air into the coke oven sole are provided for in the oven wall and/or oven door, and wherein shutoff devices are arranged in front of these opening ports or in the lines conducing to these opening ports,

wherein

the coke oven

- is connected with at least one measuring device to measure the concentration of

gas constituents of at least one of the coke oven chamber and coke oven sole, and

- this measuring device in turn is linked to a computer unit in such a way that this computer unit can receive data and measured results from the measuring device, and

- this computer unit is connected via control lines to one or more adjusting device(s) of said shutoff devices, with the shutoff devices representing valves, flaps, slide gates or the like.

[00017] Furthermore, this invention covers a method for coal carbonisation in which the afore-mentioned coke oven is implemented in one of the disclosed embodiments, wherein

- the oven is charged with coal and wherein the cokemaking process is started,
- the concentration of one or more gas constituent(s) is analysed during carbonisation,
- this data are transmitted to a computer unit,
- this computer unit determines the supply of primary and/or secondary air on the basis of stored discrete values or model computations, and

- this computer unit activates the control elements of the shutoff devices for primary and/or secondary air via control lines, and thus
- it regulates the primary and/or secondary air.

[00018] In an improved variant of this method,

- the temperature in the coke oven sole and/or waste gas channel is determined, and
- this data is transmitted to a computer unit, and
- subsequently this computer unit determines the supply of primary and/or secondary air on the basis of stored discrete values or model computations, and
- the control elements of the shutoff devices for primary and/or secondary air are controlled via control lines, and thus
- the primary and/or secondary air is controlled and regulated

during coal carbonisation.

[00019] The method embodying this invention is applied in such a manner that during coal carbonisation the mean temperature in the coke oven sole falls by 350°C to 400°C and does not fall under 1000°C. Furthermore, an optimisation resides in controlling and regulating the oxygen concentration in the waste gas channel at a constant level within a range of 7.5 to 8.5 percent by volume.

[00020] The invention is described by taking an example based upon the variant of the embodiment shown in Fig.1, with the invention not being restricted to the example of this embodiment. Fig. 1 illustrates a coke oven consisting of a coke oven chamber 1 and a coke oven sole 2, wherein the individual chambers or channels of the coke oven sole 2 are not illustrated. Via gas channel 3 the coke oven chamber 1 is connected to the coke oven sole 2. Primary air can be supplied through line 4 into the coke oven chamber 1, with a control flap 7 being arranged in the line 4. Secondary air can be supplied through line 5 into the coke oven sole 2, with a control flap 8 being arranged in the line 5. Line 9 serves for taking a small gas volume stream from coke oven chamber 1 and connects coke oven chamber 1 with an analyser 10 which in the illustrated example is suitable for H_2 measurement. The gas to be measured and conveyed in line 9 is aspirated by means of compressor 11 and conveyed to the analyser 10. A heat exchanger 12 is installed upstream to compressor 11 to cool the gas. Via line 21, the gas volume stream is passed back into the coke oven chamber 1.

2006337510 13 May 2011

[00021] Furthermore, the temperature measuring device 13 arranged in the coke oven sole 2 and the lambda probe 14 arranged in the waste gas channel 6 are schematically illustrated. Via the data buses 17 and 18, the measured values are transmitted to the computer unit 16 which also receives the measured values from the analyser 10 via data bus 15. Via control lines 19, the computer unit 16 controls the control flap 7 and thus regulates the volume stream of primary air and, respectively, the temperature in the coke oven chamber 1. Furthermore, the computer unit 16 controls the control flap 8 via the control line 20, thereby regulating the volume stream of secondary air and, thus, the temperature in the coke oven sole 2 as well as the content of oxygen in the waste gas channel 6.

[00022] By applying the method described hereinabove and the device embodying this invention, it was managed to reduce the coking time substantially. Now it is possible to reliably achieve a coking time of less than 48 hours, which represents a remarkable increase in oven performance rate as compared with the state of the art in technology.

[00023] The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as, an acknowledgement or admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

[00024] Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

[00025] Whilst the present invention has been hereinbefore described with reference to a particular embodiment, it will be understood that numerous variations and modifications will be envisaged by persons skilled in art. All such variations and modifications should be considered to fall within the scope of the invention as broadly hereinbefore described and as hereinafter claimed.

1	List of Reference Numbers
1	Coke oven chamber
2	Coke oven sole
3	Gas channel
4	Line (primary air)
5	Line (secondary air)
6	Waste gas channel
7	Shutoff element (primary air)
8	Shutoff element (secondary air)
9	Line
10	Analyser
11	Compressor
12	Heat exchanger
13	Temperature measuring instrument
14	Lambda probe
15	Data bus
16	Computer unit
17	Data bus
18	Data bus
19	Data bus
20	Data bus

Patent Claims

1. A coke oven built in flat-type construction (i.e. a non-recovery and/or heat-recovery coke oven) including a coke oven chamber and a coke oven sole including channels, with the coke oven chamber and coke oven sole being connected to each other via gas channels, and wherein one or several opening port(s) or channel(s) for supplying primary air and one or more opening port(s) or channel(s) for supplying secondary air into the coke oven sole are provided for in the oven wall and/or oven door, and wherein shutoff devices are arranged in front of these opening ports or in the lines conducing to these opening ports,
wherein
the coke oven
- is connected with at least one measuring device to measure the concentration of gas constituents of at least one of the coke oven chamber and the coke oven sole, and
- this measuring device in turn is linked to a computer unit in such a way that this computer unit can receive data and measured results from the measuring device, and
- this computer unit is connected via control lines to one or more adjusting device(s) of said shutoff devices, with the shutoff devices representing valves, flaps, slide gates or the like.

2. A coke oven according to claim 1, wherein the coke oven includes a further measuring device to measure the concentration of gas constituents of a waste gas channel.

3. A coke oven according to claim 2, wherein the further measuring device is a lambda probe for the determination of oxygen and arranged in the waste gas channel.

4. A coke oven according to claim 1,
wherein
a temperature measuring device is arranged in the coke oven sole or in the waste gas channel, said temperature measuring device also being connected to the computer unit in such a way that it can receive data and measured results from the temperature measuring device.

5. A coke oven according to any of the preceding claims 1 to 4,

2006337510 12 Aug 2011

wherein
the measuring device is an analyser for the determination of hydrogen, nitrogen, carbon monoxide or carbon dioxide.

6. A coke oven according to claim 4,
wherein
the analyser is linked via a line to the coke oven chamber.

7. A coke oven according to any of the preceding claims 1 to 4,
wherein
the measuring device is a lambda probe for the determination of oxygen and arranged in the coke oven sole.

8. A coke oven according to any of the preceding claims 5 or 7,
wherein
an analyser for the determination of hydrogen, nitrogen, carbon monoxide or carbon dioxide as well as a lambda probe for the determination of oxygen are provided for.

9. A method for coal carbonisation,
wherein
a coke oven according to any of the preceding claims is implemented, with
- said oven being charged with coal and the cokemaking process being started,
- the concentration of one or more gas constituent(s) being analysed during carbonisation,
- this data being transmitted to a computer unit,
- this computer unit determining the supply of primary and/or secondary air on the basis of stored discrete values or model computations, and
- activating the control elements of said shutoff devices for primary and/or secondary air via control lines, thus
- regulating the primary and/or secondary air.

10. A method for coal carbonisation according to claim 9,
wherein
- the temperature in the coke oven sole and/or waste gas channel is determined, and
- this data are transmitted to a computer unit,

- this computer unit determines the supply of primary and/or secondary air on the basis of stored discrete values or model computations, and
- activates the control elements of the shutoff devices for primary and/or secondary air via control lines, thus
- regulating the primary and/or secondary air

during coal carbonisation.

11. A method for coal carbonisation according to any of the preceding claims 9 or 10, wherein
the mean temperature in the coke oven sole during coal carbonisation falls by 350°C to 400°C and does not fall under 1000°C.

12. A method for coal carbonisation according to any of the preceding claims 9 to 11, wherein
the concentration of oxygen in the waste gas channel constantly lies in the range of 7.5 to 8.5 percent by volume.

13. A coke oven substantially as hereinbefore described with reference to the accompanying drawings and/or examples.

14. A method substantially as hereinbefore described with reference to the accompanying drawings and/or examples.

Fig. 1