

(19)



(11)

**EP 2 574 873 A1**

(12)

**EUROPEAN PATENT APPLICATION**

(43) Date of publication:

**03.04.2013 Bulletin 2013/14**

(51) Int Cl.:

**F27B 1/18** (2006.01)**F27B 1/28** (2006.01)**F27D 17/00** (2006.01)**C21B 7/00** (2006.01)(21) Application number: **11183103.8**(22) Date of filing: **28.09.2011**

(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**

Designated Extension States:

**BA ME**

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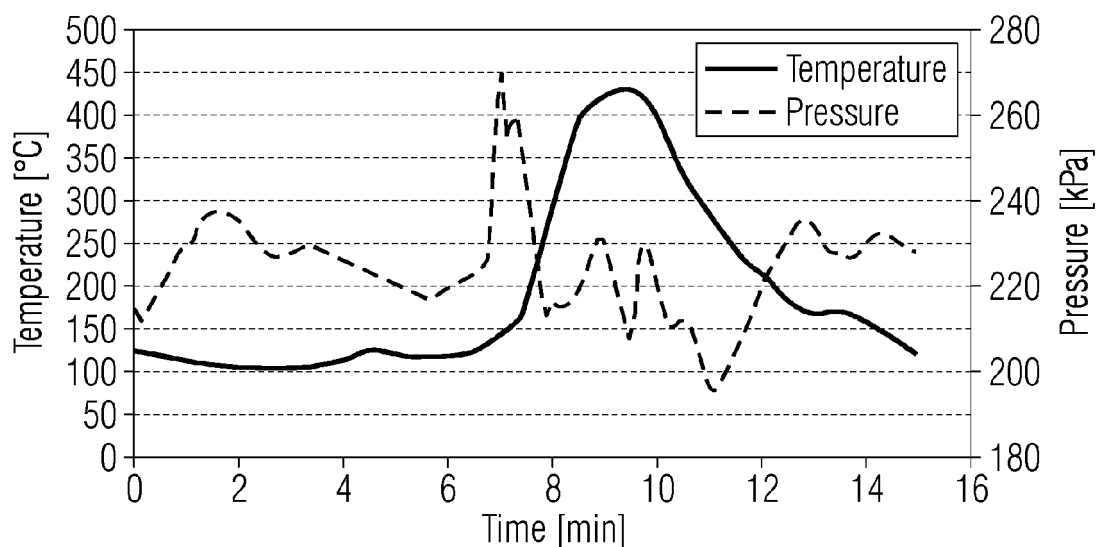
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(54) **Method and device for decreasing the temperature of blast furnace gas temperature peaks**

(57) The present invention provides a method for decreasing the temperature of blast-furnace gas temperature peaks, which method is characterized in that the pressure of the blast-furnace gas is being measured continuously, and injection of water into the blast-furnace gas is triggered off when a threshold value for the pressure is exceeded.

It also comprises a device for performing the method, with means for measuring the pressure of a blast furnace's blast-furnace gas, and with means for injection of water into the blast furnace's blast-furnace gas, which device is characterized in that it comprises means for triggering off the means for injection of water based on a signal of the means for measuring the pressure.

**FIG 2****EP 2 574 873 A1**

## Description

### Technical Field

**[0001]** The present invention relates to a method and a device for decreasing the temperature of blast-furnace gas temperature peaks.

### Background

**[0002]** During production of pig iron in a blast furnace peaks of temperature of the blast furnace gas can occur. Such peaks of temperature, which can reach up to 1300°C, can be caused by several kinds of events in the blast furnace.

**[0003]** For example, occurrence of peaks of temperature of the blast furnace gas is facilitated when grain sizes of the blast furnace burden segregate during charging of the blast furnace. At the angle of repose of the burden coarse grain of the burden rolls towards the centre of the blast furnace, while fine grain stays near the wall of the blast furnace shaft. The more coarse grain is present in a region of the blast furnace, the more flow-channels are available for gas streaming upwards through this region- accordingly, in those regions upstreaming gas meets less resistance and streams faster. With diminishing resistance exerted by the burden in regions in the blast furnace - for example the central region of the blast furnace - the velocity of flow of the gas may increase so much that the burden is hardly able to assimilate heat from the gas. Depending on its type of construction, hot blast is blown into a blast furnace under a pressure of up to  $5 \cdot 10^5$  Pa (g). In case a plurality of flow-cannels in the burden are available to the gas, only a small amount of heat is withdrawn from the gas during its journey through the burden, and hardly any pressure drop occurs - in such a case blast-furnace gas may exit the burden with a temperature of more than 600°C, usually 1000°C or more than 1000°C, this blast-furnace gas being under a pressure much increased compared to normal operation of the blast furnace, which leads to opening of the bleeder valves at the top of the furnace.

**[0004]** Another situation which leads to peaks of temperature of the blast furnace gas is collapsing of bridges of melting ore burden which have been formed during descending of the blast furnace's burden.

**[0005]** While the devices for diverting and for treating of the blast-furnace gas which accompany a blast furnace are mainly designed to cope with temperature and pressure occurring during normal operation of the blast furnace, in case of a peak of temperature and pressure of the blast-furnace gas these parameters are above the levels of normal operation. The high temperature of the blast-furnace gas in case of a peak may lead to overheating of the blast furnace's upper parts and of the devices for diverting and for treating - e.g. purifying - of the blast-furnace gas. In addition, the permitted maximum pressure in the blast furnace system may be exceeded

by the pressure peak, necessitating to relieve pressure by a means for relieving pressure - which is called bleeder -, into the atmosphere. This results in pollution of the atmosphere, especially by carbon monoxide and dust.

**[0006]** In order to diminish effects of peaks of temperature of the blast furnace gas, it is well known to monitor the temperature in the so called off-takes, through which blast-furnace gas is diverted from the blast furnace. The so called burden-spray, which is allocated in the area of the blast furnace's throat, is activated as soon as a preset value for the temperature of the blast-furnace gas is exceeded. The burden-spray injects water into the space in the area of the blast furnace's throat. The temperature of the blast furnace gas is decreased due to evaporation of the injected water, thereby diminishing the danger of overheating of the upper areas of the blast furnace and of the accompanying devices for diverting and for treating the blast furnace gas. Unfavourably, a portion of the injected amount of water wets the burden and is not available for efficient and rapid cooling of the blast furnace gas. In addition, monitoring of the temperature in the off-takes in conjunction with inherent retardation of temperature measurements leads to a somewhat delayed activation of the burden-spray. Therefore, the high temperature of the peak perpetuates for some time, the devices for diverting and for treating of the blast-furnace gas having to master such temperatures. Hence, in systems with temperature-monitoring based detection of peaks of temperature of the blast furnace gas a certain temperature tolerance has to be provided for the blast-furnaces upper parts and the devices for diverting and for treating of the blast-furnace gas.

### Summary of the invention

#### Technical problem

**[0007]** It is the object of the present invention to provide a method and device for decreasing the temperature of blast furnace gas temperature peaks, which avoid the disadvantages of off-take temperature-monitoring based temperature peak detection.

#### Solution to problem

**[0008]** This is achieved by a method for decreasing the temperature of blast-furnace gas temperature peaks, characterized in that the pressure of the blast-furnace gas is being measured continuously, and injection of water into the blast-furnace gas is triggered off when a threshold value for the pressure is exceeded.

#### Advantageous effects of invention

**[0009]** It has been found by the inventors that a distinctive rise of temperature caused by events leading to temperature peaks occurs after a distinctive rise in pres-

sure of the blast furnace gas.

**[0010]** Measuring of the pressure of the blast-furnace gas according to the invention permits diagnosing development of a slip at an early stage before a distinctive rise of temperature occurs. When a threshold value for the pressure is exceeded injection of water into the blast-furnace gas is triggered off. Hence, actions for decreasing temperature and smoothing temperature peaks are taken earlier when compared to off-take temperature-monitoring based slip detection.

**[0011]** The pressure of blast-furnace gas during normal operation depends on the type of construction and on the blast furnace's mode of operation. Consequently, in each case a different threshold value is characteristic for the development of a slip. Therefore, the threshold value for the pressure of the blast-furnace gas is set by the blast furnace's operator according to the conditions in the respective blast furnace.

**[0012]** Advantageously, injection of water is carried out in the area of the blast furnace's throat. Thereby the exposition of blast furnace parts to the hot blast furnace gas at the temperature of the peak is kept small.

**[0013]** According to one embodiment of the invention, the pressure of the blast-furnace gas is being measured in the off-takes through which blast-furnace gas is diverted from the blast furnace.

**[0014]** According to another embodiment of the invention the pressure of the blast-furnace gas is being measured upstream of the off-takes in the direction of flow of the blast furnace gas. Thereby, earlier detection of a peak of temperature is possible. The direction of flow of the blast furnace gas is from the burden to the off-takes. For example, the pressure of the blast-furnace gas may be measured in the area of the blast furnace's furnace throat.

**[0015]** A further object of the invention is a device for performing the method according to the invention, with means for measuring the pressure of a blast furnace's blast-furnace gas, and with means for injection of water into the blast furnace's blast-furnace gas, characterized in that it comprises means for triggering off the means for injection of water based on a signal of the means for measuring the pressure.

**[0016]** Thereby injection of water can be triggered off when a threshold value for pressure is exceeded.

**[0017]** According to a preferred embodiment the means for measuring the pressure comprises probes in the off-takes through which blast-furnace gas is diverted from the blast furnace.

**[0018]** According to a preferred embodiment, the means for measuring the pressure comprises probes in the area of the blast furnace's furnace throat.

**[0019]** Advantageously, the means for injection of water comprises injection nozzles in the area of the blast furnace's throat. Thereby the exposition of blast furnace parts to the hot blast furnace gas at the temperature of the temperature peak exiting the burden is kept small.

**[0020]** Preferably, the nozzles belong to one or several of the nozzle-types in the group

- spillback nozzle,
- twin fluid nozzle,
- spiral nozzle.

**[0021]** Using such nozzles for burden spray injection of water in combination with the inventive continuous measuring of the pressure of the blast-furnace gas to avoid blast-furnace gas temperature peaks increases the efficiency of the water injection. Those nozzles produce smaller water droplets which evaporate before reaching the blast furnace burden, hence wetting of the burden will be minimized or avoided. Compared to burden spray injection of water droplets with larger droplet diameter which wets the burden - i.e. burden spray injection of water in which not all of the injected water is evaporated and thereby not available for cooling the temperature peak - the same cooling effect can be achieved with less injected water. Furthermore, the unfavourable effects of wetting the burden are minimized or avoided.

**[0022]** Spillback nozzles and twin fluid nozzles are especially preferred due to the fine water droplets which can be produced. Twin fluid nozzles are especially favourable since due to the water's atomisation with gas like compressed air or nitrogen the amount of water injected per time unit can be changed very quickly, which allows to react quickly when conditions in the blast furnace gas change. Hence, too little or too much cooling of the blast furnace gas can be avoided.

**[0023]** The nozzles belonging to one or several of the nozzle-types in the group

- spillback nozzle,
- twin fluid nozzle,
- spiral nozzle

preferably are nozzles producing droplets with a diameter  $d_{90}$  equal to or smaller than  $1000\text{ }\mu\text{m}$ . A typical spiral nozzle has a  $d_{90}$  of about  $1000\text{ }\mu\text{m}$ ; a typical spillback nozzle has a  $d_{90}$  of about  $600\text{ }\mu\text{m}$ ; a typical twin fluid nozzle has a  $d_{90}$  of about  $150\text{--}200\text{ }\mu\text{m}$ .

**[0024]** The invention is explained based on the following schematic exemplary drawings.

Figure 1 shows a schematic view of a device according to an embodiment of the invention.

Figure 2 shows the development of temperature and pressure of blast furnace gas when peaks of temperature of the blast furnace gas occur.

**[0025]** Blast furnace 1 is filled with burden 2. Blast-furnace gas, depicted by arrows, is diverted from the blast furnace 1 by several lines of off-take 3. Means for injection of water 4 are provided in the area of the blast furnace's furnace throat 5, in this case a twin fluid nozzle which produces droplets with a  $d_{90}$  of  $200\text{ }\mu\text{m}$ . Means

for measuring the pressure 6 of the blast-furnace gas are provided at four different positions in the several lines of off-take 3 and in the blast furnace throat 5. A means for triggering off 7 the means for injection of water 4 based on a signal of the means for measuring the pressure 6 is connected to both the means for injection of water 4 and the means for measuring the pressure 6. The connection may be physical, e.g. by wire, or non-physical, e.g. by wireless signals. A device for treating of the blast-furnace gas 8 is also shown, in this case a dedusting device.

[0026] Figure 2 shows typical pressure and temperature readings for blast furnace gas, a peak of temperature of more than 300°C is preceded by a peak in pressure of more than 250kPa(g) by about 60 seconds.

#### Reference sign list

#### [0027]

- |   |   |    |
|---|---|----|
| 1 | Blast furnace   | 5  |
| 2 | Burden  | 10 |
| 3 | Line of off-take  | 15 |
| 4 | Means for injection of water                                  | 20 |
| 5 | blast furnace's furnace throat                                | 25 |
| 6 | Means for measuring the pressure of the blast-furnace gas     | 30 |
| 7 | means for triggering off (the means for injection of water 4) | 35 |
| 8 | device for treating of the blast-furnace gas                  |    |

#### Claims

- |    |  |    |
|----|--|----|
| 1. | Method for decreasing the temperature of blast-furnace gas temperature peaks, <b>characterized in that</b> the pressure of the blast-furnace gas is being measured continuously, and injection of water into the blast-furnace gas is triggered off when a threshold value for the pressure is exceeded. | 40 |
| 2. | Method according to claim 1, <b>characterized in that</b> injection of water is carried out in the area of the blast furnace's furnace throat.   | 45 |
| 3. | Method according to claim 1 or 2, <b>characterized in that</b> the pressure of the blast-furnace gas is being measured in the off-takes through which blast-furnace gas is diverted from the blast furnace.  | 50 |
| 4. | Method according to any one of claims 1 to 3, <b>char-</b>   | 55 |

**acterized in that** the pressure of the blast-furnace gas is being measured upstream of the off-takes in the direction of flow of the blast furnace gas.

- |    |   |  |
|----|---|--|
| 5. | Device for performing the method according to claims 1 to 4, with means for measuring the pressure of a blast furnace's (1) blast-furnace gas, and with means for injection of water (4) into the blast furnace's (1) blast-furnace gas, <b>characterized in that</b> it comprises means for triggering off (7) the means for injection of water (4) based on a signal of the means for measuring the pressure (6). |  |
| 6. | Device according to claim 5, <b>characterized in that</b> the means for measuring the pressure (6) comprises probes in the off-take (3) through which blast-furnace gas is diverted from the blast furnace (1).   |  |
| 7. | Device to any one of claims 5 or 6, <b>characterized in that</b> the means for measuring the pressure (6) comprises probes in the area of the blast furnace's furnace throat (5).   |  |
| 8. | Device according to any one of claims 5 to 7, <b>characterized in that</b> the means for injection of water (4) comprises injection nozzles in the area of the blast furnace's (1) furnace throat (5).  |  |
| 9. | Device according to claim 8, <b>characterized in that</b> the nozzles belong to one or several of the nozzle-types in the group   |  |
|    | - spillback nozzle,   |  |
|    | - twin fluid nozzle,  |  |
|    | - spiral nozzle.  |  |

FIG 1

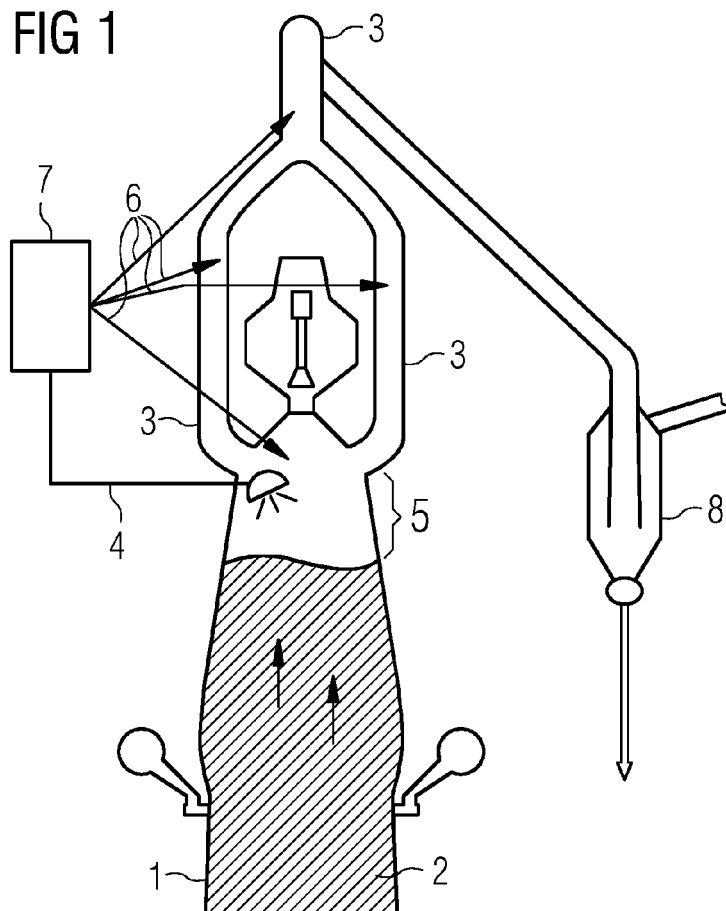
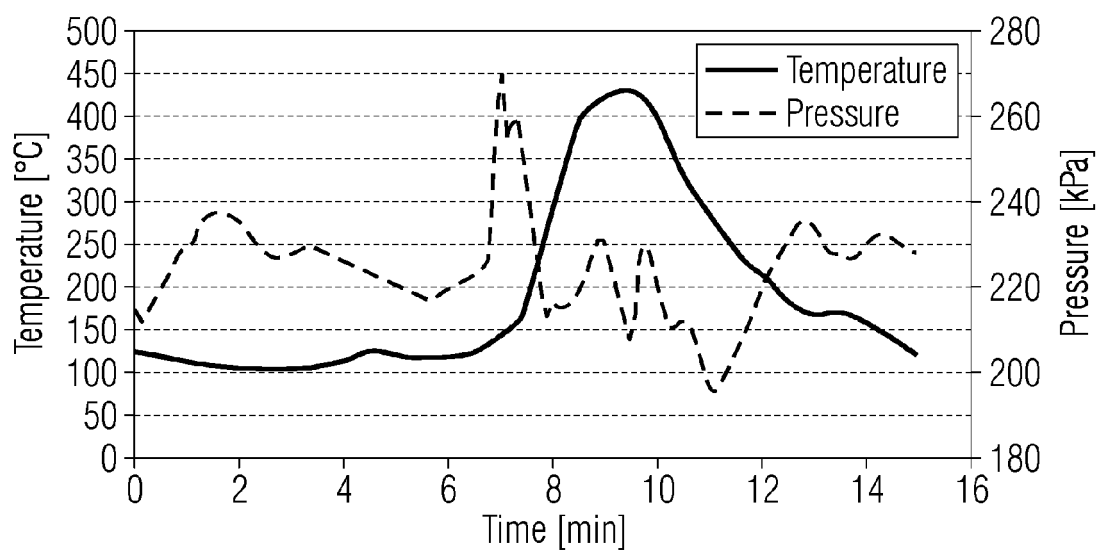


FIG 2





## EUROPEAN SEARCH REPORT

Application Number  
EP 11 18 3103

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 2 April 2012	Examiner Gavriliu, Alexandru
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (F04C01)



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Place of search Munich		Date of completion of the search 2 April 2012	Examiner Gavriliu, Alexandru
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... &amp; : member of the same patent family, corresponding document</p>			

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**ANNEX TO THE EUROPEAN SEARCH REPORT  
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