A PRE-HEATER FOR AN APPARATUS FOR THE PRODUCTION OF CARBON BLACK

Abstract: A pre-heater for an apparatus for the production of carbon black, is adapted to pre-heat air by heat exchange (1) to a temperature of at least 800°C, comprises an elongated jacket (10) arranged substantially and having a top end and a bottom end, said jacket defining a space, a plurality of tubings (23) arranged inside said space, said tubings having a diameter of 85 to 90 mm, said jacket (10) being provided with an air inlet and an air outlet, for allowing said air to enter and exit said space, a smoke inlet chamber (24) and a smoke collection chamber (27b) for allowing smoke to enter and exit said tubing (23). Said jacket (10) is supported by a suspension means (26) between said top and bottom ends excluding at the top end as such, such that the jacket is allowed to expand upwards above and downwards below said suspension means (26).
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A Pre-Heater for an Apparatus for the Production of Carbon Black

Technical field

[0001] The present invention relates to a pre-heater for an apparatus for the production of carbon black, wherein air to be pre-heated by combustion fumes are adapted to increase the temperature of the air by heat exchange to a temperature of at least 800 °C, comprising an elongated jacket adapted to be arranged substantially vertically and having a top end and a bottom end, said jacket defining a space, a plurality of tubings arranged inside said space, said tubings having a diameter of 85 to 90 mm, said jacket being provided with an air inlet and an air outlet, for allowing said air to enter and exit said space, a smoke inlet chamber and a smoke collection chamber for allowing smoke to enter and exit said tubings.

The invention also relates to an apparatus for the production of carbon black, comprising a burner connected to a fuel or gas source, to a feedstock source and to a combustion reactor, said combustion reactor being connected to said smoke inlet chamber, and a fan delivering air to such a pre-heater.

[0002] Such a pre-heater and such an apparatus for the production of carbon black are known from the prior art discussion of EP-B-0 865 600, figures 1 and 2. The known pre-heater is however disadvantageous, since it is self-supporting on a bottom flange, causing high compressive stresses in the lower part of the shell of the pre-heater. The same relates to the pre-heater of WO 98/54529.

[0003] FR-C-892 762 discloses a heat exchanger having a jacket with vertical tubings inside. The heat exchanger tubings are suspended in the top end thereof for preventing high compressive stresses in the tubings.
[0004] It is generally known to suspend a pre-heater in springs at the top end thereof. However, that kind of suspension cannot absorb horizontal loads, due to heavy wind or earth quakes.

[0005] EP-A-0 246 486 discloses a combustion cooler suspended by support means on the mantle. However, the heat exchanger thereof is neither intended for, nor possible to be used at high temperatures.

Disclosure of the invention

[0006] One object of the present invention is to improve the mechanical stability of the jacket of the pre-heater.

[0007] This has been solved by a pre-heater of the initially defined kind, wherein said jacket is supported by a suspension means between said top end and said bottom end, excluding at the top end as such, such that the jacket is allowed to expand upwards above said suspension means and downwards below said suspension means.

[0008] Hereby, the jacket of the pre-heater will be exposed to less compressive stress, i.e. mechanical instability, such as buckling, is prevented. As a consequence of this, longer pre-heaters can be used, and thus higher temperatures can be allowed in the pre-heater.

[0009] Furthermore, “flag pulling”, i.e. bending of the pre-heater caused by uneven thermal expansion of the jacket, due to plugging of tubes or uneven flow distribution can be absorbed.

[0010] Furthermore, the pre-heater external forces, such as wind and earth quake loads will be absorbed via the suspension means.

[0011] Preferably, said suspension means is arranged above the centre of gravity of the pre-heater. In addition or alternatively, said suspension means is arranged at the upper half of the elongation of the jacket. In particular said
suspension means is arranged substantially a third of the elongation of the jacket from said top end. Hereby is achieved an optimal balance between the centre of gravity and/or the length of the jacket and a desired downward expansion of the pre-heater below the suspension means.

[0012]  Suitably said air inlet is arranged substantially at said top end, said air outlet being arranged substantially at said bottom end, said air being pressurised and conveyed from said air inlet to said air outlet exterior of said tubings.

Preferably, said smoke inlet chamber is arranged substantially at said bottom end, said smoke collection chamber being arranged substantially at said top end, wherein said tubings are adapted to convey smoke from said smoke inlet chamber to said smoke collection chamber. Hereby, a counter flow heat exchange is achieved, wherein the hot gases enter in the bottom of the pre-heater and exit at its top, whereas the air enter in the top and exits at the bottom thereof.

[0013]  Advantageously, an expansion compensator is arranged at said bottom end. Hereby, the downward directed expansion of the pre-heater is absorbed.

[0014]  Preferably, said expansion compensator defines at least a part of said smoke collection chamber. Hereby, a gas tight flexible connection is achieved.

[0015]  Suitably, said expansion compensator comprises a bellows. Alternatively, a pack box may be utilised.

[0016]  In particular, said bellows is metallic and is protected by a refractory lining. Hereby, the metallic bellows is protected from hot process gases. Alternatively a fabric bellows may be utilised.
[0017] Preferably, said suspension means is adapted to be connected to a support means of a supporting structure in such a way that the suspension means is substantially prevented from performing movements.

[0018] Preferably, a lower portion of the pre-heater is provided with a guiding means adapted for guiding the pre-heater to move in a substantially vertical direction. Hereby, the pre-heater is guided in a controlled manner during expansion.

[0019] Suitably, the length of said tubings is within the range of 12 to 20 metres. Hereby, the pre-heater is adapted to produce combustion air, i.e. air to be supplied to the burner, in a temperature range of about 800 – 1000 °C.

[0020] More particular, if the length of said tubings is within the range of 12 to 13 metres, the pre-heater is adapted produce combustion air at a temperature of about 800°C; while a length of said tubings within the range of 14 to 16 metres increases the temperature of the combustion air to about 900 °C; while a length of said tubings within the range of 17 to 20 metres, increases the temperature of the combustion air to about 1 000 °C. Of course, the temperature does not increase in steps.

Brief description of the drawings

[0021] In the following, the invention will be described in further detail with reference to the accompanying drawings, according to which

Figure 1 illustrates schematically an apparatus for the production of carbon black with a pre-heater according to the invention;

Figure 2a is a horizontal cross-section along lines II-II of the pre-heater shown in figure 1;

Figure 2b is a tube sheet for the pre-heater shown in figure 1.
Figure 3 is an enlargement of the expansion compensator shown in figure 1;

Figures 4a and 4b illustrate the expansion compensator in different positions; and

Figures 5A – 5C illustrate the position of a suspension means.

Best mode for carrying out the invention

[0022] Figure 1 shows an apparatus 2 for the production of carbon black, comprising a fan 4 for supply of pressurised air via a pipe 6 to an air inlet 8 of a jacket 10 of a pre-heater 12. The pre-heated air is further distributed through an outlet 13 via a pipe 14 to a burner 16. The burner 16 is furthermore supplied with fuel or gas via a tube 18 and carbon black feedstock, such as thick oil or tar via a tubing 19. The burner is connected to a carbon black reactor 20, in turn connected to a connection part 21, where the fumes created in the reactor rise via an expansion compensator 22 to tubings 23, sealingly connected at their opposite ends, respectively to openings of a tube plate 23a (cf. figure 2b). The connection part 21 and the expansion compensator 22 thus together constitute a smoke collection chamber 24. The tube plates 23 prevent the exhausts from entering the space between the tubings.

[0023] The reactor is furthermore provided with water nozzles 25 for stopping the combustion reaction and for cooling the fumes.

[0024] The pre-heater 12 is intended for increasing the efficiency of the process in the carbon black reactor 22. The higher the reached temperature of the air in the pre-heater 12, the higher the efficiency. However, the higher the temperature in the pre-heater, the more the strength of the material thereof will be affected. An increase of the temperature requires a larger heat exchanging surface, i.e. either a longer or wider pre-heater, in any case resulting in a heavy construction. In turn, this adds to weakening of the
material, in particular of the jacket.

[0025] The outer diameter of the tubings used in pre-heaters for the production of carbon black are generally 85 – 90 mm. Most commonly, an outer diameter of substantially 89 mm is utilised, in particular 88,9 mm. A larger diameter would cause problems with the strength of material of the tube sheets 23a, while tubings of a smaller diameter than 85 mm would cause problems with clogging carbon black.

[0026] When using tubings having a diameter of 85 – 90 mm and a length of 12 to 13 metres, a temperature of the combustion air of about 800°C is obtainable, while with tubings being 14-16 metres, a temperature of the combustion air of about 900°C, and with tubings having a length of 17-20 metres a temperature of the combustion air of about 1 000°C is obtainable.

[0027] In order to compensate for the decrease of the strength of the material of the pre-heater, the jacket is suspended by a suspension means 26, which will be further described in further detail below.

[0028] The smoke led through the tubings 23 are collected in a top cone 27a defining a smoke collection chamber 27b.

[0029] The fumes are led through a pipe 28 to a heat exchanger 30, that cools the fumes e.g. by means of oil or water and further via a tube 32 to a filtering device 34 for collecting the carbon black produced in the reactor 20, and the purified fumes are transported via a not shown plant for further purification of the fumes to a chimney 40.

[0030] In figure 2a is shown a horizontal cross-section along the line Ila-IIa of the pre-heater shown in figure 1. The suspension means 26 comprises four radially extending brackets 42 arranged on the jacket 10. The brackets 42 are supported by a support device 44 comprising four l-bars forming a
square, arranged on a not shown support structure.

[0031] Of course, more or less than four brackets may be used and more or less than four I-bars may be used. Furthermore, other kinds of bars than I-bars may be utilised. Furthermore, an annular bracket about the circumference of the jacket 12 may be used.

[0032] It should be contemplated that the suspension means 26 may be flexible and/or elastic, comprising e.g. compressible or tensile springs, compressible pads or the like. It should however be noted that the suspension means is substantially prevented from movement by the support device 44 and the support structure.

[0033] In figure 3, the expansion compensator 22 is shown in further detail. An upper flange 46 is adapted to be connected to the jacket 10 of the pre-heater 12, whereas a lower flange 48 is adapted to be connected to the connection part 21. The upper flange 46 is connected to an inner sleeve 50 whereas the lower flange 48 is connected to an outer sleeve 52.

[0034] A heat resisting ring 54 is arranged on said inner sleeve 50. A metallic bellows 56 is arranged between the upper and lower flanges 46, 48. The inner sleeve 50 is slidingly arranged in relation to an outer sleeve 52.

[0035] Figures 4A and 4B illustrate how the inner and outer sleeves, 50, 52 constitute a labyrinth sealing 55 protecting the metallic bellows 56 from the hot process gases. A horizontal guiding means 58, comprising at least one protection member 60 and at least one guide member 62, is provided for guiding the jacket 10, such that horizontal movements of the lower end of the jacket 10 are prevented, in turn protecting the bellows 56 from performing substantially other than axial movements.

[0036] In figure 5A is shown how the support means 26 is arranged at different positions above half the longitudinal extension of the jacket. The optimal
position has proven to be at 1/3 from the top of the jacket.

[0037] In figure 5B and 5C are shown how the support means is arranged above the centre of gravity of the pre-heater. In cases where the centre of gravity is very low, the position of the support means may even be under half the longitudinal extension of the jacket.

OPERATION

[0038] During operation, the air from the fan 4 will be pre-heated outside the tubings 23 in the space inside the jacket 10. The pre-heated air is led in the pipe 14 to the burner 16. The more the air is pre-heated the more efficient the carbon black reaction will be, and in turn the lower the energy consumption, i.e. the pre-heater increases the efficiency of the process. In order to produce carbon black, the reaction is performed at imperfect combustion, i.e. at under-stoichiometric combustion.

[0039] The hot gases produced in the carbon black reactor 20 are led through the smoke collection chamber through the pre-heater 12. The hot gases will cause expansion of the pre-heater 12. The suspension means 26 causes the part of the pre-heater above the suspension means 26 to expand upwards, whereas the part of the pre-heater underneath the suspension means 26 will expand downwards. Consequently, the part of the pre-heater underneath the suspension means 26 will not be subjected to compressive forces.

[0040] The downward expansion is further controlled by the guiding means 58.
Claims

1. A pre-heater for an apparatus for the production of carbon black, wherein air to be pre-heated by combustion fumes are adapted to increase the temperature of the air by heat exchange to a temperature of at least 800 °C, comprising
   - an elongated jacket (10) adapted to be arranged substantially vertically and having a top end and a bottom end, said jacket defining a space,
   - a plurality of tubings (23) arranged inside said space, said tubings having a diameter of 85 to 90 mm,
   - said jacket (10) being provided with an air inlet and an air outlet, for allowing said air to enter and exit said space,
   - a smoke inlet chamber (24) and a smoke collection chamber (27b) for allowing smoke to enter and exit said tubings (23),
   characterised in that said jacket (10) is supported by a suspension means (26) between said top end and said bottom end, excluding at the top end as such, such that the jacket is allowed to expand upwards above said suspension means and downwards below said suspension means (26).

2. A pre-heater according to claim 1, wherein said suspension means (26) is arranged above the centre of gravity of the pre-heater.

3. A pre-heater according to claim 1 or 2, wherein said suspension means (26) is arranged at the upper half of the elongation of the jacket.

4. A pre-heater according to any one of claims 1 to 3, wherein said suspension means (26) is arranged substantially a third of the elongation of the jacket from said top end.

5. A pre-heater according to any one of the preceding claims, wherein said air inlet (8) is arranged substantially at said top end, said air outlet (13) being arranged substantially at said bottom end, said air being pressurised and conveyed from said air inlet (8) to said air outlet (13) exterior of said tubings.
6. A pre-heater according to any one of the preceding claims, wherein said smoke inlet chamber (24) is arranged substantially at said bottom end, said smoke collection chamber (27) being arranged substantially at said top end, wherein said tubings are adapted to convey smoke from said smoke inlet chamber (24) to said smoke collection chamber (27).

7. A pre-heater according to any one of the preceding claims, wherein an expansion compensator (22) is arranged at said bottom end.

8. A pre-heater according to claim 7, wherein said expansion compensator (22) defines at least a part of said smoke collection chamber (24).

9. A pre-heater according to claim 7 or 8, wherein said expansion compensator comprises a bellows (56).

10. A pre-heater according to claim 9, wherein said bellows (56) is metallic and is protected by a refractory lining (54).

11. A pre-heater according to claim 9, wherein said suspension means (26) is adapted to be connected to a support means (44) of a supporting structure in such a way that the suspension means (26) is substantially prevented from performing movements.

12. A pre-heater according to any one of the preceding claims, wherein a lower portion of the pre-heater is provided with a guiding means (58) adapted for guiding the pre-heater to move in a substantially vertical direction.

13. A pre-heater according to any one of the preceding claims, wherein the length of said tubings is within the range of 12 to 20 metres, respectively.

14. A pre-heater according to claim 13, wherein the length of said tubings range of 12 – 13 metres, respectively.
15. A pre-heater according to claim 13, wherein the length of said tubings is within the range of 14-16 metres, respectively.

16. A pre-heater according to claim 13, wherein the length of said tubings is within the range of 17-20 metres, respectively.

17. A pre-heater according to any one of the preceding claims, wherein the outer diameter of the tubings is substantially 89 mm.

18. A pre-heater according to any one of the preceding claims, wherein the outer diameter of the tubings is 88.9 mm.

19. An apparatus for the production of carbon black, comprising a burner (16) connected to a fuel or gas source (18), to a feedstock source (19) and to a combustion reactor (20), said combustion reactor being connected to said smoke inlet chamber (24), and a fan (4) delivering air to a pre-heater (12) according to any one of the preceding claims, said air outlet (13) being connected to said burner (16).
# INTERNATIONAL SEARCH REPORT

**International application No**  
PCT/EP2005/055205

## A. CLASSIFICATION OF SUBJECT MATTER

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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)

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

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

EPO-Internal, WPI Data, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

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- **'P'** document published prior to the International filing date but later than the priority date claimed

### Date of actual completion of the International search

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### Date of mailing of the International search report

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