

Description

Steam generator

The invention relates to a steam generator having a combustion chamber for generating a working medium by burning a fuel.

In a fossil-fired steam power plant, the energy content of the fuel is converted into a technologically utilizable form of energy. In the process, a hot gas is generated as working medium by burning the fuel, the heat content of which gas is utilized in order to completely or partly evaporate and/or superheat water in an evaporator. The resulting steam is directed to a steam turbine, where it expands and in the process transmits energy to a generator system.

In this case, in particular the fossil energy carriers heating oil, natural gas or even coal are used as the fuel. A common feature of these fuels is that they release carbon dioxide (CO_2) during their combustion. The carbon converted as a result was combined in the fuel for a considerable length of time before the combustion and was thus extracted from the carbon-dioxide balance of the earth's atmosphere. The combustion of these fuels therefore contributes to an increase in the current global CO_2 level. It is also of particular importance, in particular in view of the greenhouse effect caused by this, i.e. continuous warming of the earth's atmosphere, to use regenerable energy carriers or energy carriers having a comparatively short carbon-dioxide cycle, such as biomass for example, during the generation of steam. Although carbon dioxide (CO_2) is likewise emitted to the atmosphere during the combustion of biomass, such as straw for example, the carbon forming the basis of this carbon dioxide was in general incorporated into the biomass only a short time previously,

so the combustion of the biomass results in no significant increase in the average carbon-dioxide level.

Therefore straw as biomass in particular has proven to be an especially attractive fuel for steam generation. In the design of a steam generator for straw as fuel, however, it proves to be problematic that intensified corrosion of the metallic heating areas of the steam generator starts at steam temperatures above about 470 °C on account of materials contained in the straw, such as chlorine and potassium for example. However, in order to be able to operate a steam generator at a sufficiently high efficiency for economical operation, steam temperatures of more than 500 °C are required.

The object of the invention is therefore to specify a steam generator with which, when biomass is used as the fuel, a high efficiency can be achieved without intensified corrosion starting.

This object is achieved according to the invention by a steam generator having a first combustion chamber for generating a working medium by burning a first fuel and having a second combustion chamber for burning a second fuel, which second combustion chamber is connected downstream of the first combustion chamber in the direction of flow of the working medium.

Such a steam generator can be adapted in an especially flexible manner to varying requirements during the use of different fuel types. Only thereby is it ensured that the special requirements during the combustion of biomass for avoiding corrosion on the heating areas of the steam generator can be taken into account while still achieving a

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high temperature level in the steam generator required for a high efficiency.

In an especially advantageous development, coal, in particular bituminous coal, can be fed here as fuel to the first combustion chamber and/or biomass, in particular straw, can be fed as fuel to the second combustion chamber. It is thereby ensured that a steam temperature of, for example, more than 550 °C, which steam temperature is required for a high efficiency, can be achieved in the region of the first combustion chamber, the steam temperature being less than about 470 °C in the region of the second combustion chamber, fired with biomass, to avoid high-temperature corrosion. In this way, the biomass, in particular the straw, can be utilized as main fuel for producing a steam temperature of about 470 °C, the steam-temperature level being raised from about 470 °C to more than 550 °C by the coal firing merely like auxiliary firing.

For an especially high efficiency of the steam generator, during operation thereof the working medium generated in the first combustion chamber serves as combustion air in the second combustion chamber. To this end, the first combustion chamber can expediently be operated with excess air, in particular with an excess-air ratio of the actually supplied air quantity to the air quantity required for stoichiometric combustion of about 2.5. In addition, during operation of the first combustion chamber with excess air, the flue-gas temperature of the working medium can be lowered to about 1050 °C so that ash fusion and resulting contamination of heating areas are avoided.

In order to ensure especially favourable heat transfer during the steam generation, the outer walls of the steam generator expediently contain a number of steam-generator tubes. Depending on operating pressure, the steam generator may in this case be designed as

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a once-through steam generator, as a forced-circulation steam generator or as a natural-circulation steam generator.

5 In order to ensure in an especially reliable manner the high steam-temperature level required for a high efficiency, a number of superheater heating areas are expediently provided. Here, in an especially advantageous development, a first superheater heating area is arranged in the flue-gas region of the second combustion chamber, and a second superheater heating area is arranged in the flue-gas region of the first combustion chamber. Thus the operating parameters of the steam generator can be adapted in an especially flexible manner to the flue-gas temperature level of the first and second combustion chambers.

15 For a further improvement in efficiency, a heat exchanger for preheating air by heat exchange with flue gas generated during the combustion is expediently connected in an air-supply line connected to the first and/or the second combustion chamber.

20 The advantages obtained with the invention consist in particular in the fact that, by connecting the second combustion chamber downstream on the side of the working medium behind the first combustion chamber, it is possible to use biomass as main fuel, but nonetheless a high efficiency of the steam generator is ensured while avoiding high-temperature corrosion on the heating areas. In addition, the use of bituminous coal as auxiliary fuel, in particular compared with alternative auxiliary fuels such as, for example, the pure fuels heating oil or natural gas, ensures economical operation of such a steam generator.

30 An exemplary embodiment of the invention is explained in more detail with reference to a drawing,

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in which the figure shows a steam generator.

The steam generator 1 according to the figure is connected in the water/steam circuit of a steam turbine (not shown) via its feedwater supply 2 and via its steam-side outlet 4. To this end, the feedwater supply 2 is connected via a preheater or economizer 6 to a number of steam-generator tubes 8 which are part of the outer walls 10 of the steam generator 1. The steam-generator tubes 8 are connected on the outlet side to a first high-pressure superheater 12. The latter is connected on the outlet side to a second high-pressure superheater 14, which leads into the steam-side outlet 4 of the steam generator 1.

For a steam turbine having a plurality of pressure stages, a first reheater 16 is additionally arranged in the steam generator 1. This reheater 16 is connected on the inlet side to a steam inlet 18 and on the outlet side to a second reheater 20 which is likewise arranged in the steam generator 1 and leads into a steam outlet 22. Depending on the design of the steam turbine, the steam inlet 18 may be connected for example to the steam outlet of a first or high-pressure part of the steam turbine, and the steam outlet 22 may be connected to the steam inlet of a second or intermediate- or low-pressure part of the steam turbine.

The steam generator 1 contains a first combustion chamber 24 for generating a working medium A by burning a first fuel K. Here, the first fuel K is preferably coal, in particular bituminous coal. Furthermore, the steam generator 1 contains a second combustion chamber 26, arranged or connected downstream of the first combustion chamber 24 in the direction of flow of the working medium A, for burning a second fuel S. Here, the latter is preferably biomass, in particular straw. In this case, the combustion chambers 24 and 26 are arranged in such a way that the second high-pressure superheater 14 and the

second reheater 20 are arranged in the flue-gas region of the first combustion chamber 24 and that the first high-pressure superheater 12 and the first reheater 16 are arranged in the flue-gas duct of the second combustion chamber 26.

An air-supply line 30 connected to the first combustion chamber 24, just like an air-supply line 32 connected to the second combustion chamber 26, is fed from a common air-supply line 34. The air-supply line 34 is connected in the secondary side of a heat exchanger 36. The latter is connected on the primary side in the exhaust-gas flow of exhaust gas or flue gas R generated during the combustion. The heat exchanger 36 therefore serves as air preheater.

During operation of the steam generator 1, bituminous coal is fed as fuel K to the first combustion chamber 24. In order to avoid ash fusion and resulting contamination of heating areas, the combustion of the fuel K is effected in such a way that the temperature of the working medium A, generated during the combustion, in the region of the second high-pressure superheater 14 is about 1050 °C. To this end, the fuel K in the 1st combustion chamber 24 is operated with excess air, in particular at an excess-air ratio of about 2.5. A portion of the heat content of the working medium A is transferred via the steam-generator tubes 8 to a water/steam mixture flowing through the latter. A further portion of the heat content of the working medium A is transferred via the second high-pressure superheater 14 and the second reheater 20 to the steam flowing through them in such a way that the steam temperature to achieve a high efficiency is about 550 °C. The working medium A, thus cooled down to about 550 °C, is then fed as combustion air to the second combustion chamber 26. In this case, the second combustion chamber 26 may be separated from the flue-gas region of the first combustion chamber 24 for straw firing, for example by a grate 36 [sic].

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In addition to the working medium A, biomass, in particular straw, as second fuel S, and if required, via the air-supply line 32, further combustion air are fed to the second combustion chamber 26. The fuel S is burned in the second combustion chamber 26 in such a way that the resulting flue gases - after heat emission to the water/steam mixture carried in the steam-generator tubes 8 - have a temperature of about 850 to 880 °C. At such a temperature, the use of various biomasses as fuel S is possible without excessive contamination of the heating areas occurring due to ash fusion.

A portion of the heat content of the flue gas R is transferred via the first high-pressure superheater 12, the first reheater 16, the steam-generator tubes 8 as well as the economizer 6 to water or steam carried in them. In the process, the steam temperatures do not exceed 470 °C, so high-temperature corrosion of the heating areas does not occur even when biomass is used as second fuel S. The flue gas R cools down in the process to about 350 °C. The remaining portion of the heat content of the flue gas R is transferred via the heat exchanger 36 for the air preheating to the combustion air fed to the first combustion chamber 24 and/or the second combustion chamber 26.

In such a steam generator 1, therefore, the use of biomass, in particular straw, as main fuel for generating steam temperatures up to about 470 °C is possible. In this case, the corrosion of the heating areas is slight, so the steam generator 1 has a particularly long service life. By connecting the first combustion chamber 24 upstream, it is in addition possible to achieve steam temperatures of more than 550 °C, which are especially favourable for a high efficiency.

Patent Claims

1. Steam generator (1) having a first combustion chamber (24) for generating a working medium (A) by burning a first fuel (K) and having a second combustion chamber (26) for burning a second fuel (S), the second combustion chamber (26) being connected downstream of the first combustion chamber (24) in the direction of flow of the working medium (A).
2. Steam generator according to Claim 1, characterized in that coal can be fed as fuel (K) to the first combustion chamber (24).
3. Steam generator according to Claim 1 or 2, characterized in that biomass can be fed as fuel (S) to the second combustion chamber (26).
4. Steam generator according to one of Claims 1 to 3, characterized in that during operation thereof the working medium (A) generated in the first combustion chamber (24) serves as combustion air in the second combustion chamber (26).
5. Steam generator according to one of Claims 1 to 4, characterized in that its outer walls (10) contain a number of steam-generator tubes (8).
6. Steam generator according to one of Claims 1 to 5, characterized in that a number of superheater heating areas (12, 14, 16, 20) are provided in it.

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7. Steam generator according to Claim 6, characterized in that a first superheater heating area (12, 16) is arranged in the flue-gas region of the second combustion chamber (26), and in that a second superheater heating area (14, 20) is arranged in the flue-gas region of the first combustion chamber (24).

8. Steam generator according to one of Claims 1 to 7, characterized in that a heat exchanger (36) for preheating air by heat exchange with flue gas (R) generated during the combustion is arranged in an air-supply line (30, 32, 34) connected to the first and/or to the second combustion chamber (24, 26).

9. Steam generator according to either of Claims 7 and 8, characterized in that the temperature of the steam generated in the first superheater heating area (12, 16) does not exceed a maximum of about 470 °C.

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