Title: STRUCTURAL CONFIGURATION AND METHOD FOR ENVIRONMENTALLY SAFE WASTE AND BIOMASS PROCESSING TO INCREASE THE EFFICIENCY OF ENERGY AND HEAT GENERATION

Abstract: The present invention relates to the method and structural configuration for environmentally safe waste and biomass processing to increase the efficiency of energy and heat generation. In the structural configuration of the invention solid municipal and industrial waste as well as biomass are loaded and milled and afterwards they are subject to pyrolysis and gasification. The produced pyrolysis gas is cooled, cleaned and carbon dioxide is captured from it. Pyrolysis gas is compressed and accumulated together with syngas and they are used for electric power and heat generation and this generated electric power and heat is supplied to external consumers. During pyrolysis and gasification, melting occurs and basalt-like slag is produced which is processed and used for production of a heat-insulation material or granulated slag. Additional electric power is further generated from the heat occurred as a result of pyrolysis gas cooling. Carbon dioxide captured from exhaust gases occurred as a result of electric power and heat generation, is compressed and accumulated together with carbon dioxide recovered from pyrolysis gas and, after distribution and dosing, first, it is sent to plasma torches as plasma-forming gas, second, it is used for production of marketable products using carbon dioxide for external consumers, third, it is fed as a nutrient to cultivate algae; herewith, seed material is loaded and algae is cultivated using heat source and carbon dioxide and thus algae biodiesel and biomass production is provided. Produced biodiesel is cleaned, accumulated and used for generation of electric power and heat. Biomass extraction
is returned to the beginning of the process, algae biomass and oil received as a result of liquid biofuel production are supplied to external consumers as marketable products. In addition, for the purpose of processing waste range expansion, coal dust is loaded simultaneously at the beginning of the process afterwards syngas is generated using heat then it is compressed and together with pyrolysis gas it is accumulated and used for generation of electric power and heat.
AMENDED CLAIMS

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1. Structural configuration of environmentally safe waste and biomass processing to increase the efficiency of electric power and heat generation which comprises a plasma waste and biomass processing unit (54) comprising the first solid municipal and industrial waste treatment input (1) and the second biomass treatment input (2) which are also the first and second inputs for waste and biomass loading and shredding system (3); plasma waste and biomass processing unit (54) also comprises, at least, one plasma converter (4), one pyrolysis gas cleaning system (6), first compression system (8), and the first gasholder (9); at least, one output of the waste loading and shredding system (3) is connected to the first input of, at least, one plasma converter (4); the second output of, at least, one plasma converter (4) is connected to the input of a basalt-like slag processing unit (13); output of the first compression system (8) is connected to the first input of the first gasholder (9); output of the first gasholder (9) is also the second output of the plasma waste and biomass processing unit (54) which is connected to the second input of a dual-fuel regulator (25) of the steam & gas turbine unit (56) which is also the second input of the steam & gas turbine unit (56); the first output of a heat recovery hot water generator (5) is also the first heat output (A) of the plasma waste and biomass processing unit (54) which is connected to the third input of a steam & gas turbine unit (56) which is also the third input of a heat recovery steam generator (32) of the steam & gas turbine unit (56); steam & gas turbine unit (56) comprises, at least, one gas turbine (26) comprising a compressor (27), dual-fuel combustion chamber (28), and turbine (29); in addition, it comprises, at least, one electrical generator (30), at least, one heat recovery steam generator (32), steam turbine (34), second electrical generator (35), water treatment system (33), and, at least, one exhaust stack (38); compressor (27) output is connected to the third input of a dual-fuel combustion chamber (28); the first input of a dual-fuel combustion chamber (28) is connected to the first output of a fuel regulator (25) and the second output of the fuel regulator (25) is connected to the second input of the dual-fuel combustion chamber (28); dual-fuel combustion chamber (28) output is connected to the turbine (29) input; the first output of the turbine (29) is connected to the first electrical generator (30) which output is also the first connection output for external power consumers (31A) in the configuration; the second turbine (29) output is connected to the first input of a heat recovery steam generator (32); the second input of a heat recovery steam generator (32) is connected to the water treatment system (33); the first output of a heat recovery steam generator (32) connected to the first output of a steam turbine (34) is also the third connection output for external heat consumers (36) in the configuration; the second output of the heat recovery steam generator (32) is connected to the steam turbine (34) input; second output of the steam turbine (34) is connected to the input of the second electrical generator (35) which output is also the second connection output for external power consumers (31B) in the configuration; output of the exhaust stack (38) is connected to the input of a process control and monitoring unit (57) having two-way communications with other units in the configuration and consisting of a process control and monitoring system (39) and, at least, one environmental emission control system (40); in the basalt-like slag processing unit (13) comprises the liquid slag unloading system (46) which input is connected the second output of a plasma
converter (4) of the plasma waste and biomass processing unit (54); output of the liquid slag unloading system (46) is connected through the fiber forming system (47) to the input of a fiber-precipitation system (48); one output of the fiber-precipitation system (48) is connected to the heat-insulation material forming system (50) and another output is connected to the input of a non-fiber particle collecting and granulating system (49); output of the heat-insulation material forming system (50) is also the heat-insulation material output (51) in the configuration; output of the non-fiber particle collecting and granulating system (49) is also the granulated slag output (53) in the configuration or to the input of the liquid slag unloading system (46) of the basalt-like slag processing unit (13) is connected the second output of a plasma converter (4) of the plasma waste and biomass processing unit (54); output of the liquid slag unloading system (46) is connected to the slag collecting and granulating system (52); output of the slag collecting and granulating system (52) is also the granulated slag output (53) in the configuration is characterized in that the first output of, at least, one plasma converter (4) of the plasma waste and biomass processing unit (54) is connected to the input of a heat recovery hot water generator (5); output of the heat recovery hot water generator (5) is connected through pyrolysis gas cleaning system (6) to the input of the first carbon dioxide capture system (7); the first output of the first carbon dioxide capture system (7) is connected to the input of the first compression system (8); the second output of the first carbon dioxide capture system (7) is connected through the second compression system (10) to, at least, one of the inputs of the second gasholder (11); output of the second gasholder (11) is connected to the input of a carbon dioxide distribution and dosing system (12); the first output of a carbon dioxide distribution and dosing system (12) is connected to the second input of a plasma converter (4); the second output of the carbon dioxide distribution and dosing system (12) is also the third output of a plasma waste and biomass processing unit (54) which is connected to the input of a carbon dioxide marketable product production unit (58); output of the carbon dioxide marketable product production unit (12) is also the carbon dioxide marketable product output (D) in the configuration; the third output of a carbon dioxide distribution and dosing system (12) is also the fourth output of a plasma waste and biomass processing unit (54) which is connected to the first input of the algae biodiesel and biomass production unit (55); the second input of the algae biodiesel and biomass production unit (55) is connected to the third connection output (36) of a steam & gas turbine unit (56) and the second input of a coal syngas generator unit (59); the third output of the algae biodiesel and biomass production unit (55) is connected to the first input of a steam & gas turbine unit (56); the first input of, at least, one dual-fuel regulator (25) of the steam & gas turbine unit (56) is connected to the output of a gas turbine fuel preparation system (24) which input is also the first input of the steam & gas turbine unit (56); the third output of a heat recovery steam generator (32) of a steam & gas turbine unit (56) is connected to the input of the second carbon dioxide capture system (37); the first output of the second carbon dioxide capture system (37) is connected to the input of, at least, one exhaust stack (38); the second output of the second carbon dioxide capture system (37) is also the fourth output of a steam & gas turbine unit (56) which is connected to the fourth input of a plasma waste and biomass processing unit (54) which is also the input of the third compression system (14) which output is connected to, at least, one of the inputs of the second gasholder (11); the third input of a plasma waste and
biomass processing unit (54) is also the input of the fourth compression system (15) which is connected to the output of a coal syngas generator unit (59) comprising a coal dust treatment input (41); output of the fourth compression system (15), in its turn, is connected to, at least, one of the inputs of the first gasholder (9).

2. Structural configuration as set forth in claim 1 is characterized in that the algae biodiesel and biomass production unit (55) comprises of the first heat exchanger (17), photo-bioreactor (16), separator (18), press (19), centrifuge (20), algae biodiesel production unit (21), algae biodiesel cleaning system (22), and algae biodiesel storage (23) which first input is also the first input of a photo-bioreactor (16); the second photo-bioreactor (16) input is connected to the output of the first heat exchanger (17) which input is also the second input of the algae biodiesel and biomass production unit (55) which is connected to the third connection output for external heat consumers (36) and the second input of a coal syngas generator unit (59); photo-bioreactor (16) output is connected through the separator (18) with the press (19) input which first output is also the first algae biomass marketable product output (B) of the algae biodiesel and biomass production unit (55) which is connected the second input of a plasma waste and biomass processing unit (54); the second press (19) output is connected to the centrifuge (20) input which first output is also the second algae oil marketable product output (C) of the algae biodiesel and biomass production unit (55); the second centrifuge (20) output is connected through the algae biodiesel production unit (21) and algae biodiesel cleaning system (22) with the algae biodiesel storage (23) input; output of the algae biodiesel storage (23) is also the third output of the algae biodiesel and biomass production unit (55) which is connected to the input of, at least, one gas turbine fuel preparation system (24) of a steam & gas turbine unit (56).

3. Structural configuration as set forth in claims 1 and 2 is characterized in that the coal syngas generator unit (59) comprises the first coal dust treatment input (41) which is also the input of a coal dust loading system (42), output of the coal dust loading system (42) is connected to the first input of a coal syngas generator (44) and its output is connected to the input of a syngas cleaning system (45), which output is also the output of a coal syngas generator unit (59), the second input of a coal syngas generator unit (44) is connected to the output of the second heat exchanger (43) which input is also the second input of a coal syngas generator unit (59) and it is connected to the third connection output for external heat consumers (36).

4. Method for environmentally safe waste and biomass processing to increases the efficiency of electric power and heat generation during which waste and biomass are loaded and milled and afterwards they are subject to pyrolysis and gasification; produced pyrolysis gas is cooled, cleaned and carbon dioxide is captured from it; cleaned pyrolysis gas is compressed and accumulated together with syngas; and they are used for electric power and heat generation; this generated electric power and heat are supplied to external consumers; from heat occurred during pyrolysis gas cooling, additional electric energy is generated, in its turn; during pyrolysis and gasification melting occurs and basalt-like slag is formed which is processed and used for production of a heat-insulation material or granulated slag which is characterized in that carbon dioxide captured from the exhaust gases occurred as a result of electric
energy and heat generation, is compressed, and accumulated together with carbon dioxide captured from pyrolysis gas and after distribution and dosing, first, it is sent to plasma torches as plasma-forming gas, second, it is used for production of carbon dioxide marketable products for external consumers, third, it is fed as nutrient to cultivate algae, herewith, seed material is loaded and algae is cultivated using heat source and carbon dioxide and algae biodiesel and biomass production is provided; produced biodiesel is cleaned, accumulated and used simultaneously with cleaned pyrolysis gas to generate electric power and heat and biomass extraction is returned to the beginning of the process; biomass and algae oil produced during liquid biofuel production is supplied to the external consumers; in addition, to expand the range of processing waste, coal dust is loaded simultaneously at the beginning of the process, syngas is generated using heat then it is compressed and together with cleaned pyrolysis gas it is accumulated and used for generation of electric power and heat.  

5. Method as set forth in claim 4 of the preferred embodiment is characterized in that pyrolysis gas at the plasma converter (4) output is heated up to 1200-1450°C and thus, additional time of high-temperature effect on pyrolysis gas is achieved which prevents it from cooling during transfer in a gas duct to the heat recovery hot water generator (5) and eliminates spontaneous formation of furans and dioxins. 

6. Method as set forth in claims 4 or 5 of another preferred embodiment is characterized in that to increase the calorific value of pyrolysis gas and, consequently, expand the amount of electric power and heat generated and decrease emission of carbon dioxide into the atmosphere, the processes of algae cultivation in an enclosed space and production of biomass and liquid biofuel from algae are introduced into the process of waste and biomass processing; during algae cultivation, prepared algal seed material is loaded in the photo-bioreactor (16) filled with fresh water which chemical composition provides max algae growth rate, thus, providing efficient photosynthesis; during their growth in photo-bioreactor (16) under a certain shock algae start separating at a growing rate accumulating maximum quantity of oleaginous fluid in their mass from which fuel of high quality is produced. 

7. Method as set forth in any of claim 4 to 6 of the third preferred embodiment is characterized in that the produced diesel fuel is cleaned from the water, and it is accumulated to provide a continuous supply under set flow and pressure parameters and simultaneously with cleaned pyrolysis gas it is fed to the dual-fuel combustion chamber (28) of a gas turbine (26); biomass extraction after producing liquid biofuel is milled and fed in required quantity to the plasma converter (4) and part of algae biomass and oil produced received as a result of liquid biofuel production, is supplied to external consumers. 

8. Method as set forth in any of claims 4 to 7 of the fourth preferred embodiment is characterized in that the process of coal waste processing is introduced to expand the range of waste processing; for this coal waste is fed as coal dust to the coal syngas generator unit (59) where it is gasified during an autonomous process (autonomous process means both operation in parallel with generation of pyrolysis gas in the plasma waste and biomass processing unit (54) and autonomous operation); syngas generated at the output of a coal syngas generator unit (59) is compressed and accumulated together with cleaned pyrolysis gas and their mixture is fed to the dual-fuel combustion chamber (28) of a gas turbine (26) as a
fuel; steam from the heat recovery steam generator (32) of a gas turbine (26) or steam turbine (34) is used for syngas generation.