SHIP WITH A CARBON DIOXIDE CAPTURE SYSTEM

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Background art

Slow steaming has become the main stream of shipping for the reduction of fuel, cost and emissions. Additionally LNG may be used as fuel is recommended for cost savings and GHG emission reduction. However, methane is not completely burned in a slow running ship engine.

WO 2017042163 A1 - A method and plant for capturing CO2 from a CO2 containing exhaust gas, where the exhaust gas is compressed and thereafter cooled before the exhaust gas is introduced into an absorber, where the exhaust gas is brought in counter-current flow with an aqueous CO2 absorbent solution, to give a lean exhaust gas that is withdrawn from the absorber , reheated against incoming compressed exhaust gas, and thereafter expanded and released into the atmosphere, where the aqueous CO2 absorbent solution is an aqueous potassium carbonate solution, and that the steam and CO2 withdrawn from the regenerator is cooled in a direct contact cooler by counter-current flow of cooling water, to generate a gaseous flow of cooled CO2 and steam that is withdrawn for compression and drying of the CO2, and a liquid flow of cooling water and condensed steam that is withdrawn and flashed, to give a cooled liquid phase that is recycled as cooling water for the direct contact cooler for the withdrawn CO2 and steam, and a gaseous phase that is compressed and thus heated, and introduced into the regenerator as stripping steam.

WO 2019172772 A1 - A method and a plant for capturing CO2 from an incoming flue gas. The flue gas can be exhaust gas from coal and gas fired power plants, cement factories or refineries. The incoming exhaust gas is cooled, mixed with air and compressed, and thereafter introduced into a combustion chamber together with gas and/or liquid fuel. Part of the combustion is achieved by separate burners

with cooling/combustion air feed with a volume equal to the volume of CO2 captured. Said burners will elevate the temperature in the combustion chamber allowing combustion of exhaust gas with low oxygen content. CO2 is captured at high partial pressure before expansion by the gas turbine to produce power and generate steam in the heat recovery unit. The gas turbine will operate with high
efficiency close to design parameters with respect to inlet temperature, pressure and flow.

Brief Figure captions

The invention is illustrated in the attached drawings.

Fig. 1 is a simplified vertical section sketch of an embodiment of the invention. Relevant approximate temperatures and pressures are indicated in the drawings.

Fig. 2 is a simplified plan view of a stern of a vessel with an embodiment of the invention. Arrangement drawing CO2 and Nox capture Slow running diesel engine NCR; 11216 KW.
90 000 CBM Class LPG Carrier.
Karbon CCS Ltd. 21.12.2020. (KB)

Brief Summary of the invention

The invention is defined in the attached claims.
The invention is a ship with a flue gas Carbon Dioxide capture and storage plant,
said ship comprising
- a main engine (1) such as a slow running Diesel or gas driven engine (1) arranged for providing a flue gas (FG),
- an exhaust block and bleed valve unit (2) for said flue gas (FG) arranged in an exhaust funnel;
- an exhaust fan (3) is arranged after said exhaust block and bleed valve unit (2),
- whereupon a self-cleaning filter (4) is arranged before,
- a flue gas heat exchanger (6) with a thermal fluid exit (5) arranged for feeding a re-boiler (22), said flue gas heat exchanger (6) arranged for cooling said flue gas (FG),
- a flue gas cooler (7) is arranged thereafter for cooled flue gas (FG), with vapour drain, and arranged for further cooling flue gas (FG),

- a compressor (9) is then arranged for compressing said further cooled flue gas (FG) up to acompressed flue gas (CFG),said compressor (9) being common-axial with a expander (10), said expander (10) arranged for expanding resulting CO2-reduced flue gas (CRFG),
- a high pressure shell of a HTHE (14) is arranged after said compressor (9) and said high pressure shell of said HTHE (14) is further connected to a high pressure shell of a combustion chamber (13) also arranged for said compressed flue gas (CFG),
- said combustion chamber (13) enveloped by a perforated inner wall arranged for receiving said compressed flue gas (CFG),
- said combustion chamber (13) comprising a fuel feed (11) and a pre-mix gas burner (12) arranged for afterburning said compressed flue gas (CFG) and also arranged to burn out remaining methane from said slow running Diesel engine,
- wherein the combustion chamber (13) is arranged to result in hot afterburned compressed flue gas (ACFG) thus enriched in CO2,
- said afterburned compressed flue gas (ACFG) is arranged to be heat exchanged in said HTHE (14) with returning resulting CO2-reduced flue gas (CRFG), which is arranged to heat CO2-reduced flue gas (CRFG) and further leading said heated CO2-educed flue gas (CRFG) to said expander (10),
- wherein said HTHE (14) cools said afterburned compressed flue gas (ACFG),
- said HTHE (14) is further connected to an SCR (16) arranged for reducing a NOx content of said cooled afterburned compressed flue gas (ACFG),
- a LTHE (17) is arranged for further cooling of said afterburned compressed flue gas (ACFG),
    - said LTHE (17) arranged for heat exchanging with said cooled returning resulting CO2-reduced flue gas (CRFG) which shall go to said HTHE (14),
- a condenser (18) arranged for further cooling of said cooled, afterburned compressed flue gas (ACFG),
- and further arranged for conducting said cooled afterburned compressed flue gas (ACFG) sent through one or more CO2-absorber columns (20) arranged for exchanging CO2 into a K2CO3/water solution and forming CO2-reduced flue gas (CRFG) and further arranged to returned said CRFG via a re-humidifier (19),through said LTHE (17) and further via said HTHE (14) and to said expander (10) which is arranged for generating electrical energy at generator (8);

- said CO2-absorber (20) arranged for leading said CO2-enriched absorber solution to a CO2-stripper (21) and further arranged for exporting CO2 to a CO2-compressor (26) to a CO2- export line (28) to onboard CO2 pressure storage tanks,

- wherein a re-boiler (22) is arranged for heating said CO2-stripper (21) circulating said thermal fluid from said exit (5) and further arranged for returning cooled CO2-lean absorber fluid to a pump arranged for feeding an absorbent (K2CO3/water) heat exchanger (23) back to the top of said absorber columns (20).

The invention is a method for Carbon Dioxide capture and storage plant onboard a ship, the method comprising the steps of;

- providing a flue gas (FG) by running a main engine (1) such as a slow running Diesel or gas driven engine (1),
- leading said flue gas (FG) through an exhaust block and bleed valve unit (2) in an exhaust funnel;
- and through an exhaust fan (3) after said exhaust block and bleed valve unit (2),
- and through a self-cleaning filter (4),
- and further through a flue gas heat exchanger (6) with a thermal fluid exit (5) feeding a re-boiler (22), said flue gas heat exchanger (6) cooling said flue gas (FG),
- further cooling said cooled flue gas (FG) in a flue gas cooler (7), with vapour drain,,
- said further cooled flue (FG) in a compressor (9) compressing it up to a compressed flue gas (CFG), said compressor (9) being common-axial with a expander (10), said expander (10) arranged for expanding resulting CO2-reduced flue gas (CRFG),
- said compressed flue gas (CFG) feed into a high pressure shell of a HTHE (14), wherein said high pressure shell of said HTHE (14) is further fluid connected to a high pressure shell of a combustion chamber (13),
- feeding said compressed flue gas (CFG) through a perforated inner wall enveloping said combustion chamber (13),
- afterburning said compressed flue gas (CFG) in said combustion chamber (13) using a fuel feed (11) and a pre-mix gas burner (12) ,which also burns out remaining methane from said slow running Diesel engine,
- thus resulting in hot afterburned compressed flue gas (ACFG) thus enriched in CO2,
- heat exchanging said afterburned compressed flue gas (ACFG)in said HTHE (14) producing

returning resulting CO2-reduced flue gas (CRFG), thus heating CO2-reduced flue gas (CRFG) and further leading said heated CO2-educed flue gas (CRFG)to said expander (10),

- wherein said HTHE (14) cools said afterburned compressed flue gas (ACFG),
- then subsequently reducing a NOx content of said cooled afterburned compressed flue gas (ACFG) in an SCR (16) connected from said HTHE (14),
- further cooling of said afterburned compressed flue gas (ACFG) in a LTHE (17),heat exchanging said afterburned compressed flue gas (AFCG) with said cooled returning resulting CO2-reduced flue gas (CRFG) which is conducted to said HTHE (14),
- further cooling of said cooled, afterburned compressed flue gas (ACFG) in a condenser (18),
- and conducting said cooled afterburned compressed flue gas (ACFG) through one or more CO2-absorber columns (20) exchanging CO2 into a K2CO3/water solution and forming CO2-reduced flue gas (CRFG) and further returning said CRFG via a re-humidifier (19), through said LTHE (17) and further via said HTHE (14) and to said expander (10) and generating electrical energy at generator (8) connected to said expander (10);
- leading said CO2-enriched absorber solution from said CO2-absorber (20) to a CO2-stripper (21) and exporting CO2 to a CO2-compressor (26) to a CO2-export line (28) to onboard CO2 pressure storage tanks,
- heating said CO2-stripper (21) using a a re-boiler (22), circulating said thermal fluid from said exit (5) and further returning cooled CO2-lean absorber fluid to a pump feeding an absorbent (K2CO3/water) heat exchanger (23) back to the top of said absorber columns (20).

Description of embodiments of the invention

The invention provides a ship with a flue gas Carbon Dioxide capture and storage plant.

The invention provides a ship with a flue gas Carbon Dioxide capture and storage plant, said ship comprising

- a main engine (1) such as a slow running Diesel or gas driven engine (1) arranged for providing a flue gas (FG),
- an exhaust block and bleed valve unit (2) for said flue gas (FG) arranged in an exhaust funnel;
- an exhaust fan (3) is arranged after said exhaust block and bleed valve unit (2),
- whereupon a self-cleaning filter (4) is arranged before,

- a flue gas heat exchanger (6) with a thermal fluid exit (5) arranged for feeding a re-boiler (22), said flue gas heat exchanger (6) arranged for cooling said flue gas (FG),
- a flue gas cooler (7) is arranged thereafter for cooled flue gas (FG), with vapour drain, and arranged for further cooling flue gas (FG),
- a compressor (9) is then arranged for compressing said further cooled flue gas (FG) up to a compressed flue gas (CFG),said compressor (9) being common-axial with a expander (10), said expander (10) arranged for expanding resulting CO2-reduced flue gas (CRFG),
- a high pressure shell of a HTHE (14) is arranged after said compressor (9) and said high pressure shell of said HTHE (14) is further connected to a high pressure shell of a combustion chamber (13) also arranged for said compressed flue gas (CFG),
- said combustion chamber (13) enveloped by a perforated inner wall arranged for receiving said compressed flue gas (CFG),
- said combustion chamber (13) comprising a fuel feed (11) and a pre-mix gas burner (12) arranged for afterburning said compressed flue gas (CFG) and also arranged to burn out remaining methane from said slow running Diesel engine,
- wherein the combustion chamber (13) is arranged to result in hot afterburned compressed flue gas (ACFG) thus enriched in CO2,
- said afterburned compressed flue gas (ACFG) is arranged to be heat exchanged in said HTHE (14) with returning resulting CO2-reduced flue gas (CRFG), which is arranged to heat CO2-reduced flue gas (CRFG) and further leading said heated CO2-educed flue gas (CRFG) to said expander (10),
- wherein said HTHE (14) cools said afterburned compressed flue gas (ACFG),
- said HTHE (14) is further connected to an SCR (16) arranged for reducing a NOx content of said cooled afterburned compressed flue gas (ACFG),
- a LTHE (17) is arranged for further cooling of said afterburned compressed flue gas (ACFG),
    - said LTHE (17) arranged for heat exchanging with said cooled returning resulting CO2-reduced flue gas (CRFG) which shall go to said HTHE (14),
- a condenser (18) arranged for further cooling of said cooled, afterburned compressed flue gas (ACFG),

and further arranged for conducting said cooled afterburned compressed flue gas (ACFG) sent through one or more CO2-absorber columns (20) arranged for exchanging CO2 into a K2CO3/water solution and forming CO2-reduced flue gas (CRFG) and further arranged to

returned said CRFG via a re-humidifier (19),through said LTHE (17) and further via said HTHE (14) and to said expander (10) which is arranged for generating electrical energy atgenerator (8);
- said CO2-absorber (20) arranged for leading said CO2-enriched absorber solution to a CO2-stripper (21) and further arranged for exporting CO2 to a CO2-compressor (26) to a CO2-export line (28) to onboard CO2 pressure storage tanks,
- wherein a re-boiler (22) is arranged for heating said CO2-stripper (21) circulating said thermal fluid from said exit (5) and further arranged for returning cooled CO2-lean absorber fluid to a pump arranged for feeding an absorbent (K2CO3/water) heat exchanger (23) back to the top of said absorber columns (20).

The invention provides a method for Carbon Dioxide capture and storage plant onboard a ship, the method comprising the steps of;

- providing a flue gas (FG) by running a main engine (1) such as a slow running Diesel or gas driven engine (1),
- leading said flue gas (FG) through an exhaust block and bleed valve unit (2) in an exhaust funnel;
- and through an exhaust fan (3) after said exhaust block and bleed valve unit (2),
- and through a self-cleaning filter (4),
- and further through a flue gas heat exchanger (6) with a thermal fluid exit (5) feeding a re-boiler (22), said flue gas heat exchanger (6) cooling said flue gas (FG),
- further cooling said cooled flue gas (FG) in a flue gas cooler (7), with vapour drain,,
- said further cooled flue (FG) in a compressor (9) compressing it up to a compressed flue gas (CFG), said compressor (9) being common-axial with a expander (10), said expander (10) arranged for expanding resulting CO2-reduced flue gas (CRFG),
- said compressed flue gas (CFG) feed into a high pressure shell of a HTHE (14), wherein said high pressure shell of said HTHE (14) is further fluid connected to a high pressure shell of a combustion chamber (13),
- feeding said compressed flue gas (CFG) through a perforated inner wall enveloping said combustion chamber (13),
- afterburning said compressed flue gas (CFG) in said combustion chamber (13) using a fuel feed (11) and a pre-mix gas burner (12) ,which also burns out remaining methane from said slow running Diesel engine,
- thus resulting in hot afterburned compressed flue gas (ACFG) thus enriched in CO2,

- heat exchanging said afterburned compressed flue gas (ACFG)in said HTHE (14) producing returning resulting CO2-reduced flue gas (CRFG), thus heating CO2-reduced flue gas (CRFG) and further leading said heated CO2-educed flue gas (CRFG)to said expander (10),
- wherein said HTHE (14) cools said afterburned compressed flue gas (ACFG),
- then subsequently reducing a NOx content of said cooled afterburned compressed flue gas (ACFG) in an SCR (16) connected from said HTHE (14),
- further cooling of said afterburned compressed flue gas (ACFG) in a LTHE (17),heat exchanging said afterburned compressed flue gas (AFCG) with said cooled returning resulting CO2-reduced flue gas (CRFG) which is conducted to said HTHE (14),
- further cooling of said cooled, afterburned compressed flue gas (ACFG) in a condenser (18),
- and conducting said cooled afterburned compressed flue gas (ACFG) through one or more CO2-absorber columns (20) exchanging CO2 into a K2CO3/water solution and forming CO2-reduced flue gas (CRFG) and further returning said CRFG via a re-humidifier (19), through said LTHE (17) and further via said HTHE (14) and to said expander (10) and generating electrical energy at generator (8) connected to said expander (10);
- leading said CO2-enriched absorber solution from said CO2-absorber (20) to a CO2-stripper (21) and exporting CO2 to a CO2-compressor (26) to a CO2-export line (28) to onboard CO2 pressure storage tanks,
- heating said CO2-stripper (21) using a a re-boiler (22), circulating said thermal fluid from said exit (5) and further returning cooled CO2-lean absorber fluid to a pump feeding an absorbent (K2CO3/water) heat exchanger (23) back to the top of said absorber columns (20).

The ship comprises a number of technical features illustrated in the attached drawings Fig. 1 and Fig. 2.

A main engine (1) such as a slow running engine (1) such as a Diesel engine or a gas driven engine (1) provides flue gas (FG). The flue gas from the main engine (1) holds a temperature e.g. 345° Celsius and may be led through a turbo charger (TC), if such a turbo charger is required, down to a temperature e.g. 202° Celsius.

The flue gas (FG) is led to an exhaust block and bleed valve unit (2).
The flue gas is led through an exhaust fan (3), if such exhaust fan is required, and through an optional self-cleaning filter (4).

The flue gas (FG) is then led through a flue gas heat exchanger (6) with a thermal fluid exit (5) @ e.g. 160° Celsius to a re-boiler (22), said flue gas heat exchanger (6) arranged for cooling said flue gas (FG).

The so cooled flue gas (FG) is further led through a flue gas cooler (7) with vapour drain, providing further cooled flue gas (FG) of e.g. 30 Celsius.

The cooled flue gas (FG) is then led into a compressor (9) compressing it up to a compressed flue gas (CFG) of e.g. 12 Bar and e.g. 355 Celsius.
The compressor (9) is optionally a turbine compressor of a converted gas turbine, which compressor (9) is common-axial with a turbine expander (10), said expander (10) for expanding resulting CO2-reduced flue gas (CRFG), which is the resulting flue gas to be released from the ship. It is relatively easy to convert such a turbine.

The compressed flue gas (CFG) led into a high pressure shell of a HTHE (14) and further to a connected high pressure shell of a combustion chamber (13). Thus the high pressure shell is not subject to excess, structure destructive temperatures.

The combustion chamber (13) is enveloped by a perforated inner wall for receiving said compressed flue gas (CFG), said perforated inner wall enveloped by said relatively cooler high pressure shell.

The combustion chamber (13) is provided with a fuel feed (11) and a pre-mix gas burner (12) for afterburning said compressed flue gas (CFG). Advantageously, In this combustion chamber the afterburning process of said CFG also burns out remaining methane from said slow running Diesel engine.

The afterburning process results in hot afterburned compressed flue gas (ACFG) thus enriched in CO2, e.g. of 600 Celsius.

The afterburned compressed flue gas (ACFG) is heat exchanged in said HTHE - high temperature heat exchanger (14) with returning resulting CO2-reduced flue gas (CRFG), which CO2-reduced flue gas (CRFG) as suchshall be heated to e.g. 550 Celsius to go to said turbine expander (10).

In the HTHE the afterburned compressed flue gas (ACFG) is cooled to e.g. 350 Celsius.

The cooled, afterburned compressed flue gas (ACFG) is run through an SCR - selective catalytic reduction (16) e.g. 30 m^3 reducing its NOx content. SCR reduces NO and NO2 to N2 gas and water. The Urea/water solution tank (15) e.g. 90 m^3, is connected to the SCR (16) with a pipe through a pump.

The afterburned, compressed flue gas (ACFG) is further cooled through a Low-temperature heat exhanger LTHE (17). The LTHE (17) heat exchanges with said cool, e.g. 140 Celsius returning resulting CO2-reduced flue gas (CRFG) to e.g. 300 Celsius which shall go further back to said HTHE (14).

The cooled, afterburned compressed flue gas (ACFG) is further cooled in a condenser (18) to e.g. 136 Celsius.
The cooled afterburned compressed flue gas (ACFG) is sent through one or more CO2-absorber columns (20) exchanging CO2 into a K2CO3/water solution, forming CO2-reduced flue gas (CRFG) which is returned at e.g. 94 Celsius via a re-humidifier (19), via at e.g. 140 Celsius through said LTHE (17) and further at e.g. 300 Celsius via said HTHE (14) to about 550 Celsius and to said expander (10). We may generate electrical energy at generator (8).

The CO2-absorber (20) leads said CO2-enriched absorber solution to a CO2-stripper (21) operating at e.g. 1 Bar and exports CO2 through CO2 gas pipe (27) to a CO2-compressor (26), which is driven by a electric motor (25), to a CO2-export line (28) to onboard CO2 pressurized storage tanks.

The CO2-stripper (21) is heated by means of a re-boiler (22) circulating thermal fluid from said exit (5) and returning cooled CO2-lean absorber fluid to a pump and an absorbent (K2CO3/water) heat exchanger (23) back to the top of said absorber columns (20) for

renewed absorption of CO2.

After combustion in the main engine (1), the flue gas (Oxygen content abt.14,8 %) will be directed to and burned in the combustion chamber (13)/ boiler under pressure.

Components list

1	Slow running marine Diesel engine, e.g. 11216 kW with exhaust gas flow 28.3 kg/s
2	Exhaust block with bleed valves
3	exhaust fan
4	Self-cleaning filter
5	Thermic fluid exit to re-boiler (22)
6	Flue gas heat exchanger
7	Flue gas cooler with vapour drain
8	Electric generator / start engine
9	Flue gas compressor
10	Flue gas expander [opt. on common axle]
11	Fuel feed to burner (12)
12	Pre-mix gas burner (e.g. Siemens HR3)
13	Combustion chamber with inner perforated shall and outer pressure shell, exhaust cooled)
14	High Pressure High Temperature HPHT heat exchanger
15	SCR liquid solution storage tank, such as urea / water
16	SCR selective catalytic reduction unit
17	Low Temperature Heat Exchanger gas/gas
18	Condenser
19	Re-humidifier
20	Absorption columns at pressure, operating at e.g. between 11 and 12 Bar
21	CO2-stripper op. at e.g. 1 Bar

22	Re-boiler receiving thermic fluid from exit (5) of flue gas heat exchanger (6)
23	Absorbent (K2CO3 / water) heat exhanger
24	Absorbent fluid pipes
25	Electric motor
26	CO2-compressor
27	CO2 gas pipe
28	CO2 liquid pipe to storage tanks
29	Thermic fluid expansion tank
30	Cooling water pump
31	Switchboard and control room.

Embodiments of the invention

With the present invention the functionality and operation of a slow running Main Engine (1) will be improved, especially under low load operation. After combustion in the main engine (1), the flue gas (Oxygen content abt.14,8 %) will be directed to and burned in a combustion chamber (13) under pressure.

The afterburner combustion chamber (13) has two main functions, firstly, to generate heat for the CO2 capture system`s Re- boiler (22), said afterburner heats up the CO2-reduced flue gas (CRFG) in the HTHE (14) to about 550 Celsius before the CO2-reduced flue gas enters the expander (10) to generate electrical energy at generator (8), such as the electrical energy produced is used to heat up said re-boiler (22) through an electrical heating element in said re-boiler (22), which heats the CO2-stripper (21), and secondly, to burn out residual Methane. A significant problem of a slow running marine diesel engine is that it has functional “Dead Space” in the cylinder and parts of the piston. Consequently, incomplete combustion of Methane can hardly be avoided without additional combustion.

Further, the capacity of the re-boiler (22) can be increased in order to comply with energy required for cargo tank heating and energy for the cargo pumps (El or steam driven)

Additional combustion of the flue gas in the afterburner combustion chamber (13) / boiler

will secure full burn out of the Methane. This is achieved by long reaction time in the combustion chamber, at a temperature well above Methane self - ignition temperature.

Claims

1. A ship with a flue gas Carbon Dioxide capture and storage plant,
said ship comprising
- a main engine (1) such as a slow running Diesel or gas driven engine (1) arranged for providing a flue gas (FG),
- an exhaust block and bleed valve unit (2) for said flue gas (FG) arranged in an exhaust funnel;
- an exhaust fan (3) is arranged after said exhaust block and bleed valve unit (2),
- whereupon a self-cleaning filter (4) is arranged before,
- a flue gas heat exchanger (6) with a thermal fluid exit (5) arranged for feeding a re-boiler (22), said flue gas heat exchanger (6) arranged for cooling said flue gas (FG),
- a flue gas cooler (7) is arranged thereafter for cooled flue gas (FG), with vapour drain, and arranged for further cooling flue gas (FG),
- a compressor (9) is then arranged for compressing said further cooled flue gas (FG) up to a compressed flue gas (CFG),said compressor (9) being common-axial with a expander (10), said expander (10) arranged for expanding resulting CO2-reduced flue gas (CRFG),
- a high pressure shell of a HTHE (14) is arranged after said compressor (9) and said high pressure shell of said HTHE (14) is further connected to a high pressure shell of a combustion chamber (13) also arranged for said compressed flue gas (CFG),
- said combustion chamber (13) enveloped by a perforated inner wall arranged for receiving said compressed flue gas (CFG),
- said combustion chamber (13) comprising a fuel feed (11) and a pre-mix gas burner (12) arranged for afterburning said compressed flue gas (CFG) and also arranged to burn out remaining methane from said slow running Diesel engine,
- wherein the combustion chamber (13) is arranged to result in hot afterburned compressed flue gas (ACFG) thus enriched in CO2,
- said afterburned compressed flue gas (ACFG) is arranged to be heat exchanged in said HTHE (14) with returning resulting CO2-reduced flue gas (CRFG), which is arranged to heat CO2-reduced flue gas (CRFG) and further leading said heated CO2-educed flue gas (CRFG) to said expander (10),
- wherein said HTHE (14) cools said afterburned compressed flue gas (ACFG),

- said HTHE (14) is further connected to an SCR (16) arranged for reducing a NOx content of said cooled afterburned compressed flue gas (ACFG),
- a LTHE (17) is arranged for further cooling of said afterburned compressed flue gas (ACFG),
    - said LTHE (17) arranged for heat exchanging with said cooled returning resulting CO2-reduced flue gas (CRFG) which shall go to said HTHE (14),
- a condenser (18) arranged for further cooling of said cooled, afterburned compressed flue gas (ACFG),
- and further arranged for conducting said cooled afterburned compressed flue gas (ACFG) sent through one or more CO2-absorber columns (20) arranged for exchanging CO2 into a K2CO3/water solution and forming CO2-reduced flue gas (CRFG) and further arranged to returned said CRFG via a re-humidifier (19),through said LTHE (17) and further via said HTHE (14) and to said expander (10) which is arranged for generating electrical energy at generator (8);
- said CO2-absorber (20) arranged for leading said CO2-enriched absorber solution to a CO2-stripper (21) and further arranged for exporting CO2 to a CO2-compressor (26) to a CO2-export line (28) to onboard CO2 pressure storage tanks,
- wherein a re-boiler (22) is arranged for heating said CO2-stripper (21) circulating said thermal fluid from said exit (5) and further arranged for returning cooled CO2-lean absorber fluid to a pump arranged for feeding an absorbent (K2CO3/water) heat exchanger (23) back to the top of said absorber columns (20).

2. The flue gas Carbon Dioxide capture and storage plant according to claim 1, wherein said expander (10) generates energy at generator (8), arranged to supply said re-boiler (22) with electrical energy through a power cable to an electrical heating element in said re-boiler (22).

3. The flue gas Carbon Dioxide capture and storage plant according to claim 1 or 2, wherein said re-boiler (22) is arranged to supply energy required for cargo tank heating and energy for cargo pumps.

4. A method for Carbon Dioxide capture and storage plant onboard a ship, the method comprising the steps of;

- providing a flue gas (FG) by running a main engine (1) such as a slow running Diesel or gas driven engine (1),
- leading said flue gas (FG) through an exhaust block and bleed valve unit (2) in an exhaust funnel;
- and through an exhaust fan (3) after said exhaust block and bleed valve unit (2),
- and through a self-cleaning filter (4),
- and further through a flue gas heat exchanger (6) with a thermal fluid exit (5) feeding a re-boiler (22), said flue gas heat exchanger (6) cooling said flue gas (FG),
- further cooling said cooled flue gas (FG) in a flue gas cooler (7), with vapour drain,,
- said further cooled flue (FG) in a compressor (9) compressing it up to a compressed flue gas (CFG), said compressor (9) being common-axial with a expander (10), said expander (10) arranged for expanding resulting CO2-reduced flue gas (CRFG),
- said compressed flue gas (CFG) feed into a high pressure shell of a HTHE (14) , wherein said high pressure shell of said HTHE (14) is further fluid connected to a high pressure shell of a combustion chamber (13),
- feeding said compressed flue gas (CFG) through a perforated inner wall enveloping said combustion chamber (13),
- afterburning said compressed flue gas (CFG) in said combustion chamber (13) using a fuel feed (11) and a pre-mix gas burner (12) ,which also burns out remaining methane from said slow running Diesel engine,
- thus resulting in hot afterburned compressed flue gas (ACFG) thus enriched in CO2,
- heat exchanging said afterburned compressed flue gas (ACFG)in said HTHE (14) producing returning resulting CO2-reduced flue gas (CRFG), thus heating CO2-reduced flue gas (CRFG) and further leading said heated CO2-educed flue gas (CRFG)to said expander (10),
- wherein said HTHE (14) cools said afterburned compressed flue gas (ACFG),
- then subsequently reducing a NOx content of said cooled afterburned compressed flue gas (ACFG) in an SCR (16) connected from said HTHE (14),
- further cooling of said afterburned compressed flue gas (ACFG) in a LTHE (17),heat exchanging said afterburned compressed flue gas (AFCG) with said cooled returning resulting CO2-reduced flue gas (CRFG) which is conducted to said HTHE (14),
- further cooling of said cooled, afterburned compressed flue gas (ACFG) in a condenser (18),

- and conducting said cooled afterburned compressed flue gas (ACFG) through one or more CO2-absorber columns (20) exchanging CO2 into a K2CO3/water solution and forming CO2-reduced flue gas (CRFG) and further returning said CRFG via a re-humidifier (19), through said LTHE (17) and further via said HTHE (14) and to said expander (10) and generating electrical energy at generator (8) connected to said expander (10);
- leading said CO2-enriched absorber solution from said CO2-absorber (20) to a CO2-stripper (21) and exporting CO2 to a CO2-compressor (26) to a CO2-export line (28) to onboard CO2 pressure storage tanks,
- heating said CO2-stripper (21) using a a re-boiler (22), circulating said thermal fluid from said exit (5) and further returning cooled CO2-lean absorber fluid to a pump feeding an absorbent (K2CO3/water) heat exchanger (23) back to the top of said absorber columns (20).

5. The method according to claim 4, wherein said afterburner heats up the CO2-reduced flue gas (CRFG) in the HTHE (14) before the CO2-reduced flue gas enters the expander (10) to generate electrical energy at generator (8), such as the electrical energy produced is used to heat up said re-boiler (22) through an electrical heating element in said re-boiler (22).