Claims

1. Ethylene plant, comprising

- a cracking furnace for converting a hydrocarbon feedstock into a cracked gas stream;
- a separation section configured to provide at least an ethylene-enriched product stream, a hydrogen-enriched fuel stream and a methane-enriched fuel stream from the cracked gas stream;
- a passage way for feeding at least part of the hydrogen-enriched fuel from the separation section to a burner of the cracking furnace and/or a passage way for feeding at least part of the hydrogen-enriched fuel from the separation section to a burner of a waste heat recovery boiler of a combined cycle gas turbine power plant(CCGT);
- a methane storage configured for storing methane-enriched fuel and a passage way for feeding at least part of the methane-enriched fuel from the separation section to the storage;
- the CCGT, comprising a gas turbine – the gas turbine comprising a combustor - and a passage way for feeding at least part of the methane-enriched fuel from the storage to the combustor of the gas turbine of the CCGT, which CCGT is configured to generate electric power and/or to generate high pressure steam to drive a steam turbine forming part of a steam generation circuit of the ethylene plant; and
- an electric power connection configured to provide part of the power for operating the plant, which is a connection to an electric power system to produce electric power from a renewable source.

2. Ethylene plant according to claim 1, wherein

the methane storage is configured for storing liquefied methane-enriched fuel, obtained directly from the separation section or after liquefying a gaseous methane-enriched fuel stream from the separation section, and

the passage way for feeding at least part of the methane-enriched fuel from the storage to the combustor of the gas turbine of the CCGT is configured to feed liquefied methane-enriched fuel to the combustor of the gas turbine of the CCGT via an evaporator unit configured to convert at least part of the liquefied methane-enriched fuel into a gaseous methane-enriched fuel.

3. Ethylene plant according to claim 1 or 2, wherein the separation section is further configured to separate a gaseous methane-enriched fuel stream from the cracked gas, the plant further comprising at least one of:

- a passage way for feeding part of the gaseous methane-enriched fuel from the separation section to the burner of the cracking furnace; and
- a passage way for feeding part of the gaseous methane-enriched fuel from the separation section to the burner of the waste heat recovery boiler of the CCGT.

4. Ethylene plant according to any of the preceding claims, wherein the passage way for feeding part of the methane-enriched fuel is configured for feeding liquefied methane-enriched fuel from the storage to the burner of the cracking furnace.

5. Ethylene plant according to any of the preceding claims, wherein the storage is configured for storing liquified methane-enriched fuel and the plant comprises a passage way for feeding part of the liquefied methane-enriched fuel from the storage to the burner of the waste heat recovery boiler of the CCGT via an evaporator unit configured to convert at least part of the liquefied methane-enriched fuel into a gaseous methane-enriched fuel.

6. Ethylene plant according to any of the preceding claims, comprising a controlling system configured to compensate for fluctuations in the electric power provided via the renewable electric power connection, wherein a fuel flow rate and/or pressure in one or more of said passage ways is regulated, in response to the fluctuations thereby increasing electric power output of the CCGT when electric power provided by said electric power connection decreases or is expected to decrease and electric power output of the CCGT when electric power provided by said electric power connection increases or is expected to increase.

7. Ethylene plant according to any of the preceding claims, wherein the electrical power system comprises a power system selected from the group consisting of wind power systems, solar energy systems, hydropower systems, geothermal energy systems, osmotic power systems, systems configured to generate electricity from biomass and systems configured to generate electricity from a bio-renewable fuel, e.g. bio-ethanol or biodiesel.

8. Ethylene plant according to any of the preceding claims, comprising an electrolyzer, wherein the electric power connection is connected to the electrolyzer, which electrolyzer is configured to use at least part of the electric power from the renewable source and optionally to use at least part of the electric power generated by the CCGT to

generate hydrogen by electrolysis, and further comprising a passage way for feeding generated hydrogen from the electrolyzer to the burner of the cracking furnace and/or a passage way for feeding generated hydrogen from the electrolyzer to the burner of the waste heat recovery boiler of the CCGT.

9. Ethylene plant according to any of the preceding claims, wherein the electric power system configured to produce electric power from a renewable source is an integrated part of the ethylene plant or an integrated part of an industrial complex of which the ethylene plant is a part and/or wherein the electric power system is connected to the ethylene plant via an external electricity grid.

10. Ethylene plant according to claim 9, wherein both said electric power system configured to produce electric power from a renewable source and the CCGT have an electric connection to an internal grid of the ethylene plant or industrial complex of which the ethylene plant is a part and wherein the ethylene plant further has an electric connection which electric connection is configured to allow receiving electric power from the power plant providing renewable electric power and to allow the supply of surplus power outside the ethylene plant, e.g. to another facility outside the ethylene plant within the same industrial complex or to the external electric grid.

11. Ethylene plant according to any of the preceding claims, having an ethylene plant steam generation circuit and a power plant circuit,

the ethylene plant steam generation circuit comprising

- said cracking furnace, wherein the cracking furnace is configured to generate high pressure steam from boiler feed water;
- a steam turbine configured to be driven by said high pressure steam;
- a process compressor configured to be driven by the steam turbine;
- a condenser configured to condense at least part of the high pressure steam;
- a pump configured to pump the condensed steam to the cracking furnace as boiler feed water;

the power plant circuit comprising the waste heat recovery boiler configured to recover heat as high pressure steam,

wherein the system further comprises a first connection between the ethylene plant steam generation circuit and the power plant circuit configured to lead at least part of the high pressure steam from the waste heat recovery boiler to the at least one steam turbine of the ethylene plant steam generation circuit to drive said at least one steam turbine.

12. Ethylene plant having an ethylene plant steam generation circuit and a power plant circuit according to claim 11, wherein the ethylene plant steam generation circuit includes a process compressor which is configured to be driven directly by the gas turbine of the power plant circuit.

13. Ethylene plant having an ethylene plant steam generation circuit and a power plant circuit according to any of the preceding claims 11-12, wherein the power plant circuit further includes at least one steam turbine and at least one generator, wherein the circuit is configured to provide at least part of the high pressure steam from the waste heat recovery boiler to the at least one steam turbine of the power plant circuit, wherein the at least one steam turbine is configured to drive the at least one generator for generating power.

14. Ethylene plant having an ethylene plant steam generation circuit and a power plant circuit according to claim 13, wherein the power plant circuit further includes a condenser configured to condense at least part of the high pressure steam, and a pump configured to pump said condensed steam as boiler feed water back to the waste heat recovery boiler.

15. Ethylene plant according to any of the preceding claims, wherein the plant comprises a machine, such as a compressor, configured to be driven by electric power from the CCGT and/or by electric power from the electric power system configured to produce electric power from a renewable source.

16. Ethylene plant according to any of the preceding claims, wherein the cracking furnace is a high efficiency cracking furnace.

17. Ethylene plant according to claim 16, wherein the ethylene plant has an integrated ethylene and power plant system and the high efficiency cracking furnace includes a radiant section, a convection section and a cooling section, wherein the cooling section includes at least one transfer line exchanger configured to preheat feedstock before entry into the radiant section, and wherein the convection section comprises a boiler coil configured to generate saturated steam from flue gas, said boiler coil being preferably located in a bottom part of the convection section.

18. Ethylene plant according to claim 17, wherein the ethylene plant has an integrated ethylene and power plant system and the high efficiency cracking furnace includes a radiant section, a convection section and a cooling section, wherein the cooling section includes at least one transfer line exchanger configured to preheat feedstock before

entry into the radiant section, and wherein the convection section comprises a second high temperature coil configured to preheat feedstock after exit of the feedstock from the transfer line exchanger and before entry into the radiant section, said second high temperature coil being preferably located in a bottom part of the convection section.

19 Ethylene plant according to any of the preceding claims, wherein said cracking furnace is a fired cracking furnace.

20. Ethylene plant according to any of the preceding claims, wherein said cracking furnace is a rotodynamic pyrolysis reactor and wherein the plant comprises said passage way for feeding at least part of the hydrogen-enriched fuel from the separation section to said burner of said waste heat recovery boiler of said combined cycle gas turbine power plant.

21. Ethylene plant according to any of the preceding claims, wherein said cracking furnace is an electrically heated cracking furnace and wherein the plant comprises said passage way for feeding at least part of the hydrogen-enriched fuel from the separation section to said burner of said waste heat recovery boiler of said combined cycle gas turbine power plant.

22. Ethylene plant according to any of the preceding claims, comprising a plurality of cracking furnaces selected from the group consisting of fired cracking furnaces, rotodynamic pyrolysis reactors and electrically heated cracking furnaces.

23. Process for producing ethylene from a hydrocarbon feed, comprising

- cracking the hydrocarbon in a cracking furnace of an ethylene plant according to any of the preceding claims to produce a cracked hydrocarbon-containing gas, comprising ethylene, hydrogen and methane;
- separating at least part of the cracked hydrocarbon-containing gas at least into an ethylene-enriched product, a hydrogen-enriched fuel and a methane-enriched fuel;
- feeding at least part of the hydrogen-enriched fuel from the separation section to a burner of the cracking furnace and/or feeding at least part of the hydrogen-enriched fuel from the separation section to a burner of a waste heat recovery boiler of a combined cycle gas turbine power plant(CCGT);
- feeding at least part of the methane-enriched fuel, obtained directly from the separation section as a liquid or after liquefying a gaseous methane-enriched fuel stream from the separation section, to a methane storage;

- feeding at least part of the methane-enriched fuel from the storage to the combustor of the CCGT wherein said methane-enriched fuel from the storage is vaporized before it is fed into the combustor; and
- subjecting the vaporized methane-enriched fuel fed to the combustor of the CCGT, to combustion in the CCGT, thereby generating electric power and/or thereby generating high pressure steam for driving a steam turbine forming part of a steam generation circuit of the ethylene plant,

wherein at least a part of the power is electric power produced from a renewable source.

24. Process according to claim 23, wherein from the cracked gas further a gaseous methane-enriched stream is obtained and at least a part of the gaseous methane-enriched fuel is fed from the separation section to the burner of the cracking furnace without having been subjected to a liquefying step and/or at least a part of the gaseous methane-enriched fuel is fed from the separation section to the burner of the waste heat recovery boiler of the CCGT without having been subjected to a liquefying step,

wherein a part of the liquefied methane-enriched fuel is fed from the methane storage to the burner of the cracking furnace, said methane-enriched fuel from the storage having been vaporized before it is fed into the burner as a gas.

25. Process according to claim 24, wherein at least a part of the liquefied methane-enriched fuel is fed from the methane storage to the burner of the cracking furnace and/or to the burner of the waste heat recovery boiler of the CCGT, said methane-enriched fuel from the storage having been vaporized before it is fed into the burner as a gas.

26. Process according claim 23, 24 or 25, wherein fluctuations in the electric power produced from the renewable source provided via the electric power connection are compensated for by increasing the electric power output of the CCGT when electric power provided by said electric power connection decreases or is expected to decrease and decreasing electric power output of the CCGT when electric power provided by said electric power connection increases or is expected to increase.

27. Process according to any of the claims 23-26, wherein water is electrolyzed to produce hydrogen by an electrolyzer as part of the ethylene plant using an electric power connection providing renewable electric power that is connected to the electrolyzer, and wherein at least part of the renewable electric power and optionally at least part of the electric power generated by the CCGT is used by the electrolyzer to generate said hydrogen by electrolysis and at least part of the generated hydrogen is fed from the electrolyzer to the

burner of the cracking furnace and/or the burner of a waste heat recovery boiler of the CCGT.

28. Process according to any of the claims 23-27, wherein the cracking furnace is a rotodynamic pyrolysis reactor or an electrically heated cracking reactor and at least part of the hydrogen-enriched fuel is fed from the separation section to said burner of said waste heat recovery boiler of said combined cycle gas turbine power plant.

29 Process according to any of the claims 23-28, wherein the cracking furnace is a fired cracking furnace comprising a firebox wherein one or more burners are present combusting fuel.

30. Use of an ethylene plant according to any of the claims 1-22 for the temporary storage of renewable power.

31. Use of an ethylene plant according to any of the claims 1-22 for the indirect conversion of hydrogen to methane-rich gas.