Claims

1. A process for utilizing carbonaceous materials, in which in a first process stage the carbonaceous materials are supplied and pyrolysed, wherein pyrolysis coke and pyrolysis gas are formed; in a second process stage, the pyrolysis coke from the first process stage is gasified at a temperature above 850 °C, wherein synthesis gas is formed, and slag and other residues are removed; and in a third process stage, the synthesis gas from the second process stage is converted by Fischer-Tropsch synthesis or liquid-phase methanol synthesis into hydrocarbons or methanol, which are discharged; wherein the three process stages form a closed cycle, surplus gas from the third process stage is passed as recycle gas into the first process stage, the pyrolysis gas of the first process stage is passed into the second process stage, in the second process stage oxygen and/or process steam is blown into a fire bed formed by the pyrolysis coke, while the pyrolysis gas is blown into the gas phase above said fire bed, spatially separated from the point of entry of the oxygen, where they are cracked and broken down, pyrolysis coke and pyrolysis gas remaining in the second process stage for at least 2 seconds, and synthesis gas from the second process stage is conducted into the third process stage.

2. The process according to claim 1, wherein hydrogen is supplied, preferably in the third process stage.

3. The process according to claim 1 or 2, wherein carbon dioxide is supplied, preferably in the first process stage or second process stage.

4. The process according to any one of the preceding claims, wherein there is a pressure drop along the cycle.

5. The process according to any one of the preceding claims, wherein the heat energy for the pyrolysis reactions in the first process stage is provided in part or completely by returning a part of the hot synthesis gas from the second process stage into the first process stage, and/or by partial oxidation of the carbonaceous starting material and the resultant pyrolysis coke.

6. The process according to any one of the preceding claims, wherein the first process stage is carried out at a temperature between 300 and 800 °C, preferably between 450 and 700 °C, and particularly preferably between 500 and 600 °C.

7. The process according to any one of the preceding claims, wherein for the gasification reaction in the second process stage oxygen and/or steam and/or carbon dioxide is used as gasification agent.

8. The process according to any one of the preceding claims, wherein, in the second process stage, the thermal energy required for the gasification reaction is supplied in part or completely from outside, for example by heating devices and/or heat exchangers; and/or is generated by oxidizing a part of the pyrolysis coke with an oxidizing agent, in particular oxygen.

9. The process according to any one of the preceding claims, wherein the second process stage is carried out at a temperature between 600 and 1600 °C, preferably between 700 and 1400 °C, and particularly preferably between 850 and 1000 °C.

10. The process according to any one of the preceding claims, wherein the first process stage and/or the second process stage is carried out at a pressure between 1 and 60 bar, preferably between 5 and 25 bar, and particularly preferably between 10 and 15 bar.

11. The process according to any one of the preceding claims, wherein the first process stage and the second process stage are carried out in the same pressure reactor.

12. The process according to any one of the preceding claims, wherein electrical and/or mechanical energy is generated by oxidation of the hydrocarbons and other solid, liquid, and/or gaseous products of the third process stage, to an oxidation gas essentially consisting of carbon dioxide and water.

13. The process according to claim 12, wherein pure oxygen is used as oxidizing agent.

14. The process according to claim 12 or 13, wherein water is condensed out and/or separated from the oxidation gases.

15. The process according to any one of claims 12 to 14, wherein at least a part of the oxidation gases is fed back into the first process stage and/or the second process stage and/or the third process stage of the utilization process.

16. The process according to any one of claims 1 to 15, wherein electrical and/or mechanical energy is generated by cooling the synthesis gas in a heat exchanger,

wherein superheated steam and/or another hot gas are formed, from which electrical and/or mechanical energy is generated using a heat engine, preferably a steam turbine.

17. A facility for utilizing carbonaceous materials, with a utilization installation including a utilization unit with a first subunit for carrying out a pyrolysis of the carbonaceous materials to form pyrolysis coke and pyrolysis gas; a second subunit for carrying out a gasification of the pyrolysis coke in a fire bed, at a temperature above 850 °C, to form synthesis gas and residues; and a third subunit for carrying out a conversion of the synthesis gas into hydrocarbons or methanol, by carrying out a Fischer-Tropsch synthesis or a liquid-phase methanol synthesis, wherein all three subunits of the utilization unit are pressure-tightly closed and form an essentially closed cycle; a transport pipe for the pyrolysis gas connects the first subunit pressure-tightly to the second subunit, such that the point of entry of the pyrolysis gas into the second subunit is above the fire bed of the pyrolysis coke; a means blowing oxygen into the fire bed is provide, spatially separated from the point of entry of the pyrolysis gas; a transport pipe for the synthesis gas connects the second subunit pressure-tightly to the third subunit; and a transport pipe for the recycle gas connects the third subunit pressure-tightly to the first subunit.

18. The facility according to claim 17, wherein at least one compressor is arranged along at least one of said transport pipes of the utilization unit.

19. The facility according to claim 17 or 18, wherein the subunits of the utilization unit each include one or more pressure reactors.

20. The facility according to any one of claims 17 to 19, wherein the first subunit and the second subunit of the utilization unit include a shared pressure reactor.

21. The facility according to any one of claims 17 to 20, wherein the third subunit of the utilization unit includes a Fischer-Tropsch synthesis stage, and/or a liquid-phase methanol synthesis stage.

22. The facility according to any one of claims 17 to 21, wherein an energy installation is arranged for generating electrical and/or mechanical energy and/or thermal energy by using hydrocarbons and/or other products from the utilization installation as fuels.

23. The facility according to claim 22, wherein the energy installation is provided with a drive device for generating electrical and/or mechanical energy from the fuels,

wherein said drive device obtains the energy necessary for operation from the oxidation of the fuels to an oxidation gas essentially consisting of carbon dioxide and water, and includes a device for the compression and/or condensation of the oxidation gas.

24. The facility according to claim 23, wherein the drive device of the energy installation can be operated with pure oxygen as the oxidizing agent.

25. The facility according to claim 23 or 24, wherein the drive device of the energy installation includes a heat exchanger for cooling down the oxidation gas stream, upstream and/or downstream of the device for the compression and/or condensation of the oxidation gas.

26. The facility according to any one of claims 23 to 25, wherein the drive device of the energy installation includes a device for condensation and/or separation of water from the oxidation gas.

27. The facility according to any one of claims 23 to 26, wherein the drive device of the energy installation is provided with a storage for collecting the oxidation gas, or the residual gas after compression and/or condensation of the oxidation gas, respectively.

28. The facility according to any one of claims 23 to 27, wherein the drive device of the energy installation is a combustion engine, with at least one combustion chamber for combustion of liquid or gaseous fuel with oxygen, with means for converting the resulting gas pressure or gas volume into mechanical work, with a feed device for introducing oxygen into the combustion chamber, and with a venting device for removing the oxidation gases from the combustion chamber.

29. The facility according to claim 28, wherein the drive device of the energy installation is provided with a feed device for introducing water and/or steam into the combustion chamber, and/or into the oxidation gas stream after exit from the combustion chamber.

30. The facility according to any one of claims 17 to 29, wherein the utilization installation includes an energy unit for generating electrical and/or mechanical energy, with at least one drive device for generating electrical and/or mechanical energy from steam and/or other hot gases that have been generated or superheated in the utilization unit.

31. The facility according to claim 30, wherein the energy unit of the utilization installation includes a drive device for generating electrical and/or mechanical energy from steam or other hot gases that have been generated or superheated in the utilization unit; and in that in the cycle of the utilization unit at least one heat exchanger is provided for heating steam and/or other gases, and/or for generating steam.

32. The facility according to any one of claims 17 to 31, characterized by an installation for the production of hydrogen, and means for supplying the hydrogen into the utilization unit.