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(54) Benævnelse: **Energifrembringelsessystem med et kraftvarmeværk og et forgæringsanlæg og fremgangsmåde til energifrembringelse**

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The invention relates to an energy generating system with a cogeneration plant, a fermentation plant, and an electrolysis system which is connected to the fermentation plant via a line.

Such a system is known from WO 2015/120983 A1. In this system, methane gas and water are generated from hydrogen and carbon dioxide in an exothermic process. Another system is known from EP 1 634 946 A1 in which a cogeneration plant and fermentation plant are connected to one another via a line in order to use heat from the cogeneration plant for the fermentation plant. For this purpose, some of the methane gas produced in the fermentation plant is combusted in a combined heat and power unit to generate heat for the biogas plant and electricity for a power supply system. Systems of such kind are highly advantageous, because waste heat with a low energy level is particularly suitable for use in a fermentation plant.

The invention is based on the object of developing an energy generating system of this type further. This object is achieved with an energy generating system having the features of Patent Claim 1. A method for energy generation having the features of Claim 14 shows an advantageous procedure for using the resultant energy particularly well.

Advantageous further developments are the subject of the sub-claims.

According to the invention, the cogeneration plant and the fermentation plant are connected to one another by means of a line in order to use heat from the cogeneration plant for the fermentation plant, and the electrolysis system and the cogeneration plant are connected to one another via a line for gas in order to use oxygen generated during the electrolysis for the cogeneration plant. This makes it possible to improve the efficiency of the energy generating system. Since the electrolysis system and the cogeneration plant are connected to one another via a line for gas, oxygen produced in the electrolysis process can be used for the cogeneration plant.

If the cogeneration plant is a waste incineration plant, a part of the waste can be treated in the fermentation plant, whilst another part is incinerated.

In practice, it has been established that it is advantageous if the fermentation plant is a plant for dry fermentation.

An advantageous embodiment provides that the cogeneration plant and the fermentation plant are also connected to one another directly by means of a power line, in order to use power generated at the cogeneration plant for the fermentation plant. That is to say that part of the power generated using the heater is not fed into a public power grid, but rather is used directly for operating the fermentation plant.

It is particularly advantageous if the electrolysis plant and the fermentation plant are connected to one another by means of a line for heat, in order to use heat generated during the electrolysis for the fermentation plant.

In addition, the electrolysis plant and the fermentation plant may be connected to one another by means of a line for gas, in order to use hydrogen produced during the electrolysis for the fermentation plant. In this case, the hydrogen can be used in the fermentation to increase methane production, in that hydrogen is already supplied during fermentation.

Alternatively or cumulatively, it may be provided that the electrolysis plant and the fermentation plant are connected to one another by means of a line for gas, in order to mix hydrogen produced during the electrolysis, with gas produced during fermentation. Gas refinement is achieved as a result.

Power generated at the cogeneration plant may be used not only for the fermentation, but also for the electrolysis. Therefore, it is suggested that the electrolysis plant and the cogeneration plant be connected to one another directly by means of a power line, in order to use power generated at the cogeneration plant for the electrolysis plant. The power is therefore not initially introduced into a public power grid in order to be used from there for the electrolysis, but rather a direct line between the cogeneration plant and electrolysis plant enables the use of power generated at the cogeneration plant for the electrolysis.

Accordingly, the electrolysis plant and the cogeneration plant may also be connected to one another by means of a line, in order to use steam produced at the cogeneration plant for the electrolysis plant. The line may therefore be a steam or hot-water line for example.

The individual plants where the gas that is to be used in a different plant is produced naturally have a certain gas storage device, in which the gas accumulates. In order to control the gas exchange between the components of the energy generating system and/or to provide the gas for third parties, it is suggested that the energy generating system have a gas storage device which has a volume of more than 50 m^3.

A particular development of the energy generating system provides that it includes a methane-gas production plant, which is connected to the cogeneration plant and/or the fermentation plant by means of lines for carbon dioxide and to the electrolysis plant by means of a line for hydrogen. This makes it possible to integrate a methane-gas production plant into the energy generating system in a particularly advantageous manner.

It is advantageous in this case if the methane-gas production plant is connected to the cogeneration plant and/or to the electrolysis plant by means of a line for heat. As a result, even internally generated heat can be used for the methane-gas production plant.

Accordingly, internally generated power can also be used for the methane-gas production plant if the methane-gas production plant is connected to the cogeneration plant directly by means of a power line, in order to use power generated at the cogeneration plant for the methane-gas production plant.

Accordingly, a method for energy generation with an energy generating system according to any of Claims 1-13 provides for using heat from a cogeneration plant for a fermentation plant, wherein the oxygen from the electrolysis is used for the cogeneration plant.

In this case, it is advantageous if hydrogen from the electrolysis plant is converted to methane using carbon dioxide from dry fermentation.

In order to supply the gas produced during the method for further use in a controlled manner, it is suggested that at least one gas flow created in the energy generating system be stored. This gas flow may be carbon dioxide, hydrogen, oxygen, methane and/or biogas. This makes it possible to control the gas production and the gas consumption in the individual components of the plant more easily, as the storage devices allow a temporal coupling, at least to a limited extent.

Advantageous exemplary embodiments are illustrated in the drawing and are explained in more detail in the following. In the figures:

Figure 1 shows an energy generating system with cogeneration plant, fermentation plant and electrolysis plant,

Figure 2 shows an energy generating system according to Figure 1 having a methane-gas production plant, and

Figure 3 shows an energy generating system according to Figure 2 having gas storage devices.

The energy generating system 1 created in Figure 1 has a waste incineration plant as cogeneration plant 2. This waste incineration plant delivers energy for a fermentation plant 3 which is embodied as a dry fermentation plant. A line 4 is arranged between the cogeneration plant 2 and the fermentation plant 3 for this purpose, so that heat from the cogeneration plant 2 can be used for the fermentation plant 3.

Furthermore, the energy generating system 1 has an electrolysis plant 5, which is connected by means of lines 6 to 10 both to the cogeneration plant 2 and to the fermentation plant 3.

A power line 11 connects the cogeneration plant 2 to the fermentation plant 3 directly in order to use power generated at the cogeneration plant 2 for the fermentation plant 3.

The electrolysis plant 5 and the fermentation plant 3 are connected to one another by means of a line 9 for heat and by means of a line 10 for gas, in order to use heat generated during the electrolysis and hydrogen produced during the electrolysis for the fermentation plant 3. The fermentation plant 3 has a system for dry fermentation 12 and a gas refinement plant 13. This makes it possible also to mix hydrogen produced during the electrolysis in the fermentation plant 3 in the gas refinement plant 13 by means of a line 14 between the electrolysis plant 5 and the fermentation plant 3.

The electrolysis plant and the cogeneration plant 2 are connected to one another by means of a line 6, in order to use steam or heat produced at the cogeneration plant 2 for the electrolysis plant 5. A power line 7 between electrolysis plant 5 and cogeneration plant 2 makes it possible to use power generated at the cogeneration plant 2 directly for the electrolysis plant, and a line 8 for gas between the electrolysis plant 5 and the cogeneration plant 2 makes it possible to use oxygen produced during the electrolysis for the cogeneration plant 2.

This energy generating system 1 is connected to a power grid 16 by means of a power line 15. A line 17 connects the energy generating system 1 to a heating grid 18 and a line 19 connects the fermentation plant 3 to a gas supply 20. This makes it possible to conduct away power via the line 15, to discharge heat via the line 17, and to transport gas out of the energy generating system via the line 19.

A line 21 makes it possible additionally to supply the electrolysis plant 5 with power from the power grid 16. In addition, the gas refinement plant 13 can be supplied with power from the cogeneration plant 2 via a power line 22 and with heat from the cogeneration plant 2 via a line 23.

Figure 2 shows the integration of a methane-gas production plant 24 into the energy generating system 1 shown in Figure 1. In this case, identical components are provided with the same reference numbers. The methane-gas production plant 24 is constructed as a P2G (power to gas) plant and receives CO_2 by means of the line 25 from the cogeneration plant 2 and CO_2 from the gas refinement plant 13 of the fermentation plant 3 by means of the line 26. Using hydrogen supplied by means of the line 27 from the electrolysis plant 5, the methane-gas production plant produces methane which is supplied to the gas supply 20 by means of the line 28. A line 29 provides the methane-gas production plant 24 with heat from the cogeneration plant 2 and a line 30 provides the methane-gas production plant 24 with heat from the electrolysis plant 5.

The gas produced in the methane-gas production plant 24 can either be supplied to the gas supply directly by means of the line 28 or initially supplied to the gas refinement plant 13 by means of a line 31. This gas refinement plant 13 receives biomethane gas by means of the line 32 from the dry fermentation plant 12 with integrated gas treatment.

The line 33 is used as a power line supplying the methane-gas production plant 24 with power from the cogeneration plant 2.

The combination of cogeneration plant 2, dry fermentation plant 12 and electrolysis plant 5 makes it possible to supply the dry fermentation plant 12 and the electrolysis plant 5 with energy from the cogeneration plant. The electrolysis plant 5 consequently improves the efficiency of the cogeneration plant 2 and the dry fermentation plant 12, and it increases the calorific value of the gas produced in the fermentation plant 3. In addition, the electrolysis decouples the circuit from the power grid as a current sink.

The further integration of the methane-gas production plant 24 uses this plant as a CO_2 sink and enables use of the biogenic CO_2 produced in the dry fermentation plant 12 (carbon capture, negative CO_2 balance). In addition, the methane-gas production plant enables further decoupling from the power grid as a hydrogen sink.

Figure 3 shows how the dry fermentation plant 12 is connected to a storage device 34 for biogas and the gas refinement plant 13 is connected to storage devices 35 for CO_2 and 36 for biomethane gas. The electrolysis plant 5 is connected to a storage device 37 for hydrogen and the methane-gas production plant 24 is connected to a storage device 38 for methane gas. These storage devices primarily enable a strengthened decoupling from the power grid 16.

Patentkrav

1. Energifrembringelsessystem (1) med et kraftvarmeværk (2), et forgæringsanlæg (3) og et elektrolyseanlæg (5), som via en ledning (10) står i forbindelse med forgæringsanlægget (3), **kendetegnet ved,** at kraftvarmeværket (2) og forgæringsanlægget (3) er forbundet med hinanden ved hjælp af en ledning (4) med henblik på at udnytte kraftvarmeværkets (2) varme til forgæringsanlægget (3), og at elektrolyseanlægget (5) og kraftvarmeværket (2) står i forbindelse med hinanden via en ledning (8) til gas med henblik på at benytte oxygen, som fremkommer ved elektrolysen, til kraftvarmeværket (2).

2. Energifrembringelsessystem ifølge krav 1, **kendetegnet ved,** at kraftvarmeværket (2) er et affaldsforbrændingsanlæg.

3. Energifrembringelsessystem ifølge et af de foregående krav, **kendetegnet ved,** at forgæringsanlægget (3) omfatter et anlæg til tørforgæring (12).

4. Energifrembringelsessystem ifølge et af de foregående krav, **kendetegnet ved,** at kraftvarmeværket (2) og forgæringsanlægget (3) er forbundet direkte med hinanden via en strømledning for at anvende strøm, som frembringes ved kraftvarmeværket (2), til forgæringsanlægget (3).

5. Energifrembringelsessystem ifølge et af de foregående krav, **kendetegnet ved,** at elektrolyseanlægget (5) og forgæringsanlægget (3) står i forbindelse med hinanden via en ledning (9) til varme med henblik på at anvende varme, som frembringes ved elektrolysen, til forgæringsanlægget (3).

6. Energifrembringelsessystem ifølge et af de foregående krav, **kendetegnet ved,** at elektrolyseanlægget (5) og forgæringsanlægget (3) står i forbindelse med hinanden via en ledning (10) med henblik på at anvende oxygen, som frembringes ved elektrolysen, til forgæringsanlægget (3).

7. Energifrembringelsessystem ifølge et af de foregående krav, **kendetegnet ved,** at elektrolyseanlægget (5) og forgæringsanlægget (3) står i forbindelse med hinanden via en ledning (14) til gas med henblik på at blande oxygen, som frembringes ved elektrolysen i et gasforædlingsanlæg (13), med gas, som frembringes i forgæringsanlægget (3).

8. Energifrembringelsessystem ifølge et af de foregående krav, **kendetegnet ved,** at elektrolyseanlægget (5) og kraftvarmeværket (3) er forbundet direkte med hinanden via en strømledning med henblik på at anvende strøm, som frembringes ved kraftvarmeværket (2), til elektrolyseanlægget (5).

9. Energifrembringelsessystem ifølge et af de foregående krav, **kendetegnet ved,** at elektrolyseanlægget (5) og kraftvarmeværket (2) er forbundet med hinanden via en ledning (6) med henblik på at anvende damp, som frembringes ved kraftvarmeværket (2), til elektrolyseanlægget (5).

10. Energifrembringelsessystem ifølge et af de foregående krav, **kendetegnet ved,** at det har mindst en gasbeholder (34, 35, 36, 37, 38), som har et volumen på mere end 50 m^3.

11. Energifrembringelsessystem ifølge et af de foregående krav, **kendetegnet ved,** at energifrembringelsessystemet (1) har et metanfrembringelsesanlæg (24), som ved hjælp af ledninger (25, 26) til carbondioxid står i forbindelse med kraftvarmeværket (2) og/eller forgæringsanlægget (3) ligesom det også via en ledning (27) til oxygen står i forbindelse med elektrolyseanlægget (5).

12. Energifrembringelsessystem ifølge krav 11, **kendetegnet ved,** at metanfrembringelsesanlægget (24) står i forbindelse med kraftvarmeværket (2) og/eller med elektrolyseanlægget (5) via en ledning (29) til varme.

13. Energifrembringelsessystem ifølge krav 11 eller 12, **kendetegnet ved,** at metanfrembringelsesanlægget (24) står i direkte forbindelse med kraftvarmevær-

ket (2) via en strømledning (33) med henblik på at anvende strøm, som frembringes ved kraftvarmeværket (2), til metanfrembringelsesanlægget (24).

14. Fremgangsmåde til energifrembringelse med et system ifølge et af de foregående krav, ved hvilken et kraftvarmeværks (2) varme anvendes til et forgæringsanlæg (3), **kendetegnet ved,** at et elektrolyseanlægs (5) yderligere varme anvendes til forgæringsanlægget (3), og elektrolyseanlæggets (5) oxygen anvendes til kraftvarmeværket (2).

15. Fremgangsmåde ifølge krav 14, **kendetegnet ved,** at damp, som frembringes ved kraftvarmeværket (2), anvendes til elektrolyseanlægget (5).

16. Fremgangsmåde ifølge krav 14 eller 15, **kendetegnet ved,** at elektrolyseanlæggets (5) hydrogen omdannes med forgæringens carbondioxid til metan.

17. Fremgangsmåde ifølge et af kravene 14 til 16, **kendetegnet ved,** at mindst en gasstrøm, som fremkommer i energifrembringelsessystemet (1), lagres.

18. Fremgangsmåde ifølge et af kravene 14 til 17, **kendetegnet ved,** at produceret og lagret gas tilføres kontrolleret en fortsat anvendelse.

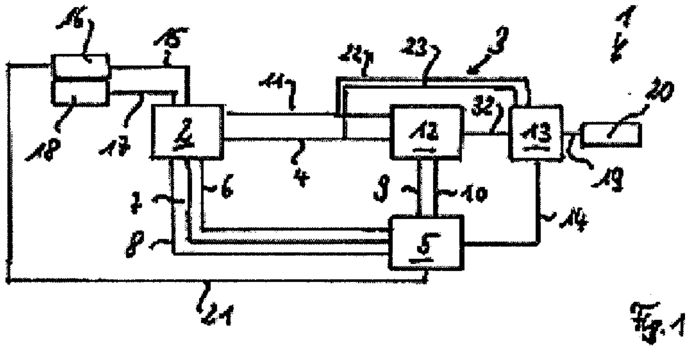

Fig. 1

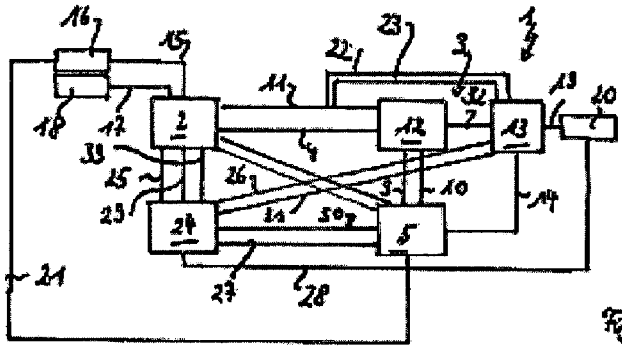

Fig. 2

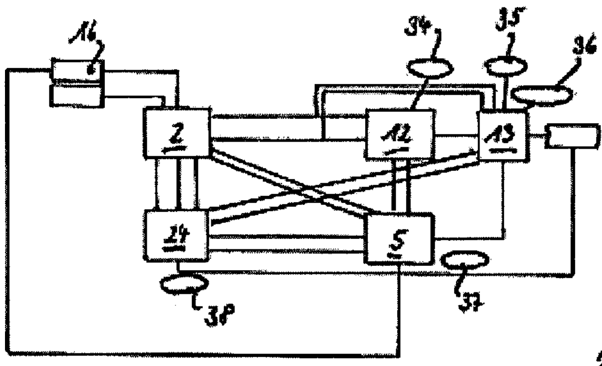

Fig. 3