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Field of the invention

The present invention concerns an optimised method for producing wort that affords a significant reduction in thermal-energy consumption as well as a significant reduction in process water consumption through the use of optimum heat exchanges between wort and process water.

5 The production of wort is a necessary step for several industries, particular in the brewing and distilling fields or any other industries relating to the production of extracts. The production of wort according to conventional matters can be done discontinuously (in batches) or continuously and generally comprises the steps of mashing (OP 1), filtration of the mash (OP 2), preheating (OP 3), boiling (OP 4), clarification (OP 5) and cooling (OP 6 and OP 7) of the wort. The
10 method may optionally comprise a supplementary stripping step (OP 8) situated before or between the clarification (OP 5) and cooling (OP 6 and OP 7) steps. These various manufacturing steps are depicted in figure 1.

Mashing (OP 1) consists of the hydration of cereal flour or other source of starch with process water at a temperature generally lying between 40°C and 65°C. Commonly this temperature is
15 obtained by mixing process water at room temperature and hot process water (65° - 85°C). The hydrated flour, referred to as mash, is then heated gradually in accordance with a defined heating programme in order to convert the starch into fermentable extract. The mash is thus heated to a temperature generally lying between 76° and 85°C before being filtered.

The filtration (OP 2) of the mash separates the soluble part containing the fermentable
20 extract (wort) and the insoluble part (spent grains). The filtration operation also comprises a sparging phase during which the soluble extract contained in the spent grains is recovered. Commonly this phase is performed by introducing into the filter (filter press or lauter tun) hot process water (78° - 85°C) which is enriched with extract during its contact with the spent grains and the said enriched hot process water being incorporated in the wort

25 Preheating (OP 3) heats the recovered wort from its collecting temperature (76° - 85°C) to the local boiling point (100°C at sea level).

The main objectives of boiling (OP 4) the wort for a given period, generally from 60 to 90 minutes, are sterilisation of the wort, coagulation of the proteins (trub), isomerisation of the hops and elimination of undesirable volatile compounds. In traditional boiling vessels, the wort is boiled by
30 alternating “calm” boiling periods and “vigorous” boiling periods.

Clarification (OP 5) of the boiled wort separates the soluble part containing the fermentable extract and the insoluble part (trub) formed during boiling.

Cooling (OP 6 and 7) of the wort from its clarification temperature to the fermentation temperature, generally between 5° and 20°C, is an operation that is usually performed in a heat
35 exchanger supplied on one side with the hot wort that is cooled, and on other side by process water at ambient or cooled temperature, which is commonly heated to a temperature of 78° to 85°C. This

operation may optionally be supplemented by additional cooling of the wort (OP 7) by means of a heat-transfer fluid, depending on the required wort temperature.

The hot process water (78° - 85°C) produced during the cooling of the wort is usually stored in a buffer tank to be later incorporated during the mashing (OP 1) and filtration (OP 2)

operations, as well as for rinsings after transfers from vessel to vessel. Nevertheless, the quantity of hot process water thus produced is normally distinctly excessive, by approximately 150%, in comparison with a quantity of process water required for the production of wort. This situation therefore normally leads to production surpluses of hot process water, which represents for the producer a waste of water and energy.

Wort production requires several heating and cooling steps that are great consumers of water and energy. For the purpose of reducing the operating costs, several energy recovery methods have been developed in the past and concern mainly the step of boiling the wort, which is one of the steps most generating energy. Several of these energy recovery methods are detailed for example in the EBC Manual of Good Practice (vol 9, 2002, Wort boiling and clarification, §4.6).

One of the most usual methods is of the Pfaduko (Pfannen Dunst Kondensator) type; it consists of an exchange of heat by condensation of the steam produced during boiling (OP 4) and in general requires the use of steam condensers placed at the chimney of the boiling vessel. The energy is transmitted via a heat exchanger supplied on the one hand with the steam from the boiling vessel that condenses, and secondly with a heat-transfer fluid that is usually softened or osmosed water. The heat-transfer fluid is subsequently stored in one or more tanks used as energy vessels (or EST, standing for energy storage tank). The heat-transfer fluid at low temperature, normally around 78° to 85°C, is thus taken off in the bottom of the energy storage tank, heated via the steam condenser to a temperature normally lying between 97° and 99°C and reintroduced into the top of the energy storage tank.

The energy storage tank is thus “charged” during the wort boiling operation.

Then this energy is restored to the product during the wort preheating operation (OP 3). The energy is transmitted via a heat exchanger supplied on one side with the filtered wort, which is heated to a temperature close to its boiling point, and on the other side with the heat-transfer fluid that circulates in a closed loop on the energy storage tank with stratification. The heat-transfer fluid at high temperature, generally around 97° to 99°C, is thus taken off in the top of the energy storage tank and optionally superheated by means of steam, then transfers its heat to the wort in the wort preheater and is reintroduced into the bottom of the energy storage tank at a temperature normally lying between 78° and 85°C.

The energy storage tank is thus “discharged” during the wort preheating operation (OP 3).

Circulation of the heat-transfer fluid thus follows a heating and cooling cycle enabling energy to be transferred and recovered.

This device for recovering energy in a closed loop by means of a heat-transfer fluid makes it possible to reduce the thermal energy consumption necessary for producing wort by approximately 25%. Nevertheless this device in no way reduces the surplus production of hot process water.

5 Some manufacturers have recently developed energy recovery solutions making it possible, apart from the recovery of heat at the boiling vessel mentioned previously, to recover additional heat at the cooling of the wort. Such an improvement is described in the application WO 2011/76 410. For this purpose, in addition to being heated during the boiling operation (OP 4), the heat-transfer fluid is also heated during the wort cooling operation (OP 6).

10 The energy is therefore captured during the cooling of the wort via a heat exchanger supplied on the one hand with the hot wort that cools from a temperature of 98°-99°C to a temperature of 79°-82°C, and on the other hand with a heat-transfer fluid that travels in a closed loop on a stratified energy storage tank. The heat-transfer fluid, at low temperature (normally 78°-85°C), is thus taken off from the bottom of the energy storage tank, heated by the wort cooler to a temperature normally of 95°-
15 96°C and reintroduced into the top of the energy storage tank.

 The energy storage tank is thus “charged” during the wort cooling operation.

 The energy necessary for the preheating (OP 3) of the wort already being covered by the energy recovered during the boiling operation (OP 4), this new quantity of energy must be used at other operation steps of the production.

20 One possibility is to use this energy in order to heat the mash during the mashing operation (OP 1), through a heat exchanger of the double wall type.

 This supplementary device for recovering energy in a closed loop by a heat-transfer fluid would according to its inventor make it possible to further reduce the consumption of heat energy necessary for manufacturing the wort. However, this device has the following drawbacks:

25 • A difficulty in effective energy storage, since, because of the increase in the number of operations during which this energy is consumed (preheating (OP 3) of the wort from 78°-85°C to 97°-99°C on the one hand, heating of the mash (OP 1) in several successive steps from 40°C-65°C to 76°-78°C on the other hand), the heat-transfer fluid is reintroduced into the energy storage tank at variable temperatures, which disturbs the stratification principle and makes it more complex (the need
30 to re-inject at many levels).

 • A difficulty in transmitting energy between the heat-transfer fluid and the product at the mashing level. Given the nature of the product (mash) which firstly contains particles in suspension, which does not allow the use of simple plate-type heat exchangers as with the wort, and secondly is a product deemed sensitive to shearing and oxidation forces, which makes the heating of this product
35 tricky. It is therefore difficult to combine both multiple heating possibilities and preservation of the quality of the product.

One of the drawbacks of Pfaduko methods is that they require the supply of a large quantity of heating energy during the step of boiling the wort (OP 4) in order to recover sufficient energy after the condensation of the steam.

Another drawback of these methods is that they generally produce an excess of hot water that is not sufficiently reprocessed and very often lost.

Some little used technologies in the brewing world combine the boiling (OP 4) and stripping (OP 8) steps. For example, the international application WO 95/26 395 describes a method for manufacturing wort comprising a continuous boiling step and a stripping step. However, these technologies have at the present time not encountered a clear success since, from a purely energetic point of view, they do not have any marked advantage compared with the systems comprising a Pfaduko.

There therefore exists a need for an energy recovery method that does not have the drawbacks mentioned above, while allowing a recovery of energy that is at least as effective as existing methods and requiring only a small consumption of water.

The inventors have thus developed a novel method that meets these criteria. In particular, one of the objects of the present invention is to optimise the thermal efficiency of the wort production. A second object of the invention consists of reducing the consumption of process water necessary for the method as well as considerably reducing the surplus production of hot process water.

Figures

Figure 1: figure 1 depicts an outline diagram of the method for manufacturing cold brewing wort comprising the operations of mashing (OP 1), filtration (OP 2); preheating (OP 3); boiling (OP 4); clarification (OP 5) and cooling (OP 6 and OP 7). The hot process water formed during the cooling of the wort (OP 6) is recovered in a hot process water tank at a temperature generally lying between 78° and 85°C and is used as mashing water during the mashing (OP 1) and sparging water for sparging the cake during filtration (OP 2).

Figure 2: figure 2 is an outline diagram of the wort manufacturing process comprising the same manufacturing steps as those mentioned in figure 1. The method comprises an energy recovery system of the Pfaduko type between the preheating (OP 3) and boiling (OP 4) steps.

Figure 3: figure 3 is an outline diagram of the wort manufacturing process comprising the manufacturing steps of figure 1. The method comprises an energy recovery system according to the invention.

The thermal energy of the cooling of the wort (OP 6) and the optional stripping step (OP 8) is recovered in a hot process water tank at a temperature of between 90° and 99°C. The process water preheats the wort (OP 3) and is then used as mashing water during the mashing (OP 1) and as sparging water for sparging the cake during filtration (OP 2).

Figure 4: outline diagram of a conventional wort manufacturing method comprising the operations mentioned in figure 1. The diagram indicates the detailed energy balance of each operation.

The values are expressed in megajoules per hectolitre of wort at 15°P (extracts expressed as a% by weight of soluble matter).

Figure 5: diagram detailing the energy balance of a method with Pfaduko. The values are expressed in megajoules per hectolitre of wort at 15°P.

Figure 6: diagram detailing the energy balance of a method according to the invention. The values are expressed in megajoules per hectolitre of wort at 15°P.

Figure 7: outline diagram of a conventional wort manufacturing method comprising the operations mentioned in figure 1. The diagram indicates the detailed process water consumption balance. The values are expressed in kg per hectolitre of wort at 15°P.

Figure 8: diagram detailing the process water balance of a method with Pfaduko. The values are expressed in kg per hectolitre of wort at 15°P.

Figure 9: detail describing the process water balance of the method according the invention. The values are expressed in kg per hectolitre of wort at 15°P.

Figure 10: outline diagram detailing the process water balance of the method according to the invention (figure 9) comprising an additional step of cooling the hot process water before implementing into the mashing process (OP 1).

Description of the invention

The present applies to the methods for producing wort comprising the steps of mashing (OP 1), filtration of the mash (OP 2) preheating (OP 3), boiling (OP 4) or formation (OP 4) and stripping (OP 8), clarification (OP 5) and cooling (OP 6) of the wort.

The method according to the invention reduces the consumption of energy and water, hereinafter referred to as process water, which is used in an open loop, that is to say it is subsequently consumed by incorporation in the product. Unlike a heat-transfer fluid, this process water is therefore not water that is softened or osmosed for the purpose of being subjected to circulation and is not used for energy transfer in a closed loop that consists of a heating and cooling circuit. The process water according to the invention is used in counterflow to the production chain, which makes it possible successively to cool (OP 6) and preheat (OP 3) the wort. The process water used will next be stored with a view to being incorporated in the product as mashing and/or sparging water during the sparging of the filtration cake.

The method according to the invention comprises the following operations:

a. Cooling (OP 6) of the wort, with process water, the temperature of the process water at the discharge from the exchanger is above 90°C, preferably between 90° and 97°C and preferentially between 95° and 97°C,

b. The process water produced at step (a) is stored, at a storage temperature above 90°C, the temperature is advantageously between 96° and 99°C.

c. Optionally the method may comprise a step of superheating of the process water to a temperature slightly above its boiling point, preferably between 103° and 105°C.

d. The hot process water obtained at steps (b) or (c) is used for the preheating (OP 3) of the wort, advantageously the wort is preheated to a temperature of between 96° and 99°C.

e. the process water produced after cooling at (d) is stored with a view to be incorporated in the product as mashing water for the mashing operations (OP 1) and sparging water for sparging the filtration cake (OP 2).

According to one embodiment of the invention, the process water that is used for cooling the wort can be cooled from its original temperature (that is to say normally the ambient temperature of the production site, to a temperature slightly below the required temperature of the cooled wort, generally between 7° and 20°C. This cooling is carried out by a second exchanger or in a second stage of the same exchanger using a refrigerating fluid such as glycol water, alcohol water or any other suitable refrigerating liquid. The temperature of the process water after cooling is preferably between 2° and 15°C.

During step (a), the process water is used for cooling (OP 6) the wort. This exchange is carried optimally in order to obtain a minimum temperature difference of around 3°C between the wort entering and the water leaving the exchanger. According to one embodiment of the invention, the heat exchange can be carried out by at least one heat exchanger that, in a first step, cools the wort from a temperature of between 96° and 99°C to a temperature of around 30°C and then, during a second step, cools the wort to a temperature of between 5° and 20°C by means of a refrigerating solution such as a solution comprising glycol. According to one embodiment of the invention, the first step of cooling wort can be carried out partially before and after clarification of the wort in two separate heat exchangers. For example, the first exchanger reduces the temperature of the wort from 99°C to 85°C before clarification, and a second exchanger reduces the temperature of the wort from 85°C to 30°C.

During the step of cooling (OP 6) the wort, the energy accumulated by the product during production is entirely recovered by the process water by heat transfer. It is preferable for the process water to reach a high temperature of around 90° and 97°C at the discharge from the exchanger, unlike the conventional method where the process water is produced at a lower temperature of between 78° and 85°C.

According to one embodiment of the invention, the method may comprise a step of stripping (OP 8) the wort carried out before the cooling operation. The stripping eliminates certain undesirable volatile compounds such as certain aldehydes and dimethylsulfide (DMS), which form during the boiling step.

The stripping consists of a gravity flow of wort in a column equipped with a specific flow device, with a view to maximising the evaporation surface area, optionally in the opposite direction to a flow of steam or other gas, with a view to effectively eliminating the volatile compounds. In the case of injection of steam in counterflow, a degree of injection of steam equivalent to an evaporation rate of 0.5% is preferable.

The stripping device comprises a stripping column in which clean steam is injected and takes away the volatiles. An alternative to steam stripping consists of a step or stripping by hot air that also eliminates the volatile compounds in a satisfactory manner.

When the stripping (OP 8) is done by clean steam, the process water obtained at (a) can be heated in an optional step by condensation of the water vapours produced by the stripping (OP 8). This supplementary heating is carried out by at least one steam condenser making it possible to increase the temperature of the process water to a temperature of between 96° and 99°C.

When the stripping (OP 8) is done by air, the operation does not make it possible to recover energy.

Which in no way modifies the global energy balance of the method. However, for this embodiment, the process water would then be stored at a temperature slightly below 99°C, around 90° to 95°C.

By comparison with the conventional boiling method, a method comprising the steps of formation and stripping according to the invention would thus reduce the consumption of steam from 4%, which corresponds to the degree of evaporation of a modern boiling vessel, to a rate of 1-1.5%, that is to say a saving of around 60% to 70% on this step. Furthermore, since the volatile compounds are eliminated from the wort just before the cooling step, there is no longer any formation of new volatile compounds. In this way the method makes it possible to obtain a wort of superior quality.

During step (b), the hot process water produced at step (a) is stored in a buffer tank. Since it is process water, this water will be produced and consumed continuously. The reservoir therefore does not require any stratification.

Optional step (c) consists of a superheating of the hot water stored at (b) from its storage temperature, approximately 99°C, to a temperature slightly above the temperature at which the user wishes to heat his wort for the so-called formation operation. According to a preferred embodiment, the process water temperature is between 103° and 105°C for a site situated at sea level. This heating can be carried out with steam or superheated water.

The formation step (OP 4) corresponds to a conventional boiling step and is carried out for a period of 60 to 90 minutes. However, it differs therefrom in that a minimum quantity of energy is used to keep the wort at its boiling point, that is to say at a temperature of approximately 100°C. Unlike the Pfaduko methods, it is not necessary to heat the wort in excess or to recover this excess energy in the form of hot water.

The formation operation (OP 4) affords sterilisation of the wort, formation of the trub and, where applicable, isomerisation of the hops. Because of the absence of recovery of energy in the form of steam at this stage, it is preferably to carry out heating equivalent to an evaporation rate of approximately 1%.

During step (d), the hot water stored at (b) is used for preheating (OP 3) the wort during the transfer between the buffer tank and the formation/boiling vessel. This exchange is carried out

optimally in order to obtain a minimum temperature difference between the wort entering and the water leaving the exchanger. The temperature of the water is advantageously between 78° and 85°C at the discharge from the exchanger.

During step (e), the hot water produced at (d) is stored in a buffer tank. This water will be used as mashing water for producing the wort during the mashing operations (OP 1) and/or as sparging water for sparging the filtration cake (OP 2). Unlike conventional methods, the process water therefore does not circulate in a closed heating and cooling cycle.

Moreover, during mashing (OP 1) and filtration (OP 2) operations, the quantity of process water incorporated in the mashing is reduced compared with the conventional methods or ones using a Pfaduko, as described in WO 2011/76 410, since the product will not be as concentrated by evaporation during the boiling/formation.

According to a preferred embodiment, as presented in figure 10, the method can be supplemented by a device for cooling the processed water, which may for example be a dry, wet or hybrid cooling tower, or any other cooling device. According to this device, part of the hot process water stored in the buffer tank after the preheating step (OP 3) is cooled to the mashing temperature, that is to say to a temperature of 40° to 65°C, or is used either directly or stored with a view to subsequent use thereof for mashing. It is thus possible to cancel out the surplus production of hot process water, thus achieving a global water saving of around 30% in the brewhouse.

The energy necessary for the preheating (OP 3) of the wort being provided by the hot process water obtained after cooling (OP 6) of the wort, it is therefore no longer necessary to recover energy during the boiling step (OP 4) according to the Pfaduko methods.

The method according to the invention thus reduces the consumption of energy necessary for the formation step of the wort and improves the global energy balance of the wort production.

Moreover, the method according to the invention recovers hot water solely at the step of cooling (OP 6) the wort and the circulation of water follows an open loop. This makes it possible in particular to avoid the problems encountered by the use of a stratified EST.

Replacement of the wort boiling operation (OP 4) with a combination of formation (OP 4) and stripping (OP 8) operations enables the brewing industry to obtain a wort with a quality at least equal to that obtained according to conventional boiling (OP 4), the stripping (OP 8) eliminating the sulphured compounds including DMS and certain aldehydes, while remarkably reducing the total energy necessary for the wort production.

According to the invention, this energy optimisation comprises a formation step (OP 4) that does not give rise to strong evaporation of water and a stripping step (OP 8), which distinguishes it from the conventional methods with or without Pfaduko. The method according to the invention reduces the process water consumption and also substantially reduces the losses of water by evaporation.

The method developed thus makes it possible to achieve a significant saving in water and energy and makes it possible to replace the formation (OP 4) and stripping (OP 8) technologies from a new perspective.

According to another embodiment, the device can advantageously be equipped with energy recovery equipment of the Pfaduko type at the formation vessel.

The advantages of the method according to the invention are disclosed in the following examples.

EXAMPLES

EXAMPLE 1

Tables I-III and the diagrams in figures 4-6 illustrate the energy balances of a wort manufacturing line according to a conventional method, a method with Pfaduko and the method according to the invention. These various energy balances were established on the basis of assumptions according to which the recipe is a recipe with 100% malt, the mashing step is carried out according to an infusion method and the mashing-in temperature is 55°C. Moreover, account has been taken of a loss of water by evaporation during the boiling operation (OP 4) of 4% for the conventional methods or with Pfaduko. For the method according to the invention account was taken of a loss of water of 1% by evaporation during the formation operation (OP 4) and 0.5% during stripping (OP 8).

On the basis of these initial conditions, it is found that the invention affords a global energy reduction of around 50% compared with a conventional method and 35% compared with a method with Pfaduko.

EXAMPLE 2

Figures 7 to 10 illustrate the water consumption balances of wort manufacturing lines according to a conventional method (figure 7), a method comprising a Pfaduko (figure 8) and a method according to the invention (figures 9 and 10) on the basis of the assumptions of example 1.

It is found that the quantity of processed water necessary for manufacturing wort can be significantly reduced in comparison with the conventional methods or with Pfaduko. These methods require a total quantity of process water of 143.4 kg of water/hectolitre of wort (1.434 kg/l) according to the conventional method or with Pfaduko as against 117.7 kg water/hectolitre of wort (1.177 kg/l) according to the invention. This quantity of water can be further reduced to 102.1 kg of water/hectolitre of wort (1.021 kg/l) if a supplementary cooling step is implemented before mashing (OP 1).

Energy flow by wort manufacturing methods (expressed in megajoules/Hl of wort at 15°Plato)

Method	Conventional					Pfaduko					Invention				
Conditions	4% loss by evaporation during boiling					4% loss by evaporation during boiling					1% loss by evaporation during formation and 0.5% loss by evaporation during stripping				
Steps/ Energy	Addition	Recov- ered	Loss	Total		Addition	Recov- ered	Loss	Total		Addition	Recov- ered	Loss	Total	
Mashing	12.1 (5.9+6.2)	0	0	12.1		12.1 (5.9+6.2)	0	0	12.1		11.4 (5.5+5.9)	0	0	11.4	
Filtration	12.1+13.2	0	3.9	21.4		12.1+13.2	0	3.9	21.4		11.4+3.2	0	3.9	20.7	
Preheating	21.4+ 10.2	0	0	31.6		21.4+3.2+6.9	0	0	31.6		20.7+3.1+6.7	0	0	30.5	
Boiling	31.6+10.0	0	11.4	30.2		31.6+10.0	6.9	4.5	30.2		30.5+2.4	0	2.7	30.2	
Stripping	0	0	0			0	0	0			1.2	1.2	0	30.2	
Cooling	30.2	27.9	9.6	-7.3		30.2	27.9	9.6	-7.3		30.2	27.9	9.6	-7.3	

Recovery of energy per wort manufacturing method (expressed in megajoules/Hl of wort at 15°Plato):

Method	Con- ven- tional	Pfaduko			Invention		
Balance	Total recov- ered	Reuse	Loss	Total recovered	Reuse	Loss	Loss
EST	0	0	0	6.9	6.9	0	0
Hot water tank 1	0	0	0	0	0	0	0
Hot water tank 2	27.9	19.1(5.9+13.2)	8.8	27.9	19.1 (5.9+13.2)	8.8	3.6

Total thermal energy balance (expressed in megajoules/Hl of wort at 15°Plato):

Method	Conventional	Pfaduko	Invention
Thermal energy balance	26.4	19.4	12.6

Patentkrav

1. Fremstillingsproces for urt med reduceret forbrug af termisk energi og procesvand omfattende bryggetrinnene blanding (OP 1), filtrering af mæsken (OP 2), foropvarmning (OP 3), kogning (OP 4) eller omdannelse (OP 4) og stripning (OP 8), klaring (OP 5) og afkøling (OP 6) af urten,
5 **kendetegnet ved, at:**
 - a. efter afkøling (OP 6) af urten med procesvand er procesvandets temperatur ved udløbet fra varmeveksleren højere end 90 °C,
 - b. procesvandet fra trin (a) lagres,
 - c. procesvandet lagret i trin (b) bruges til at foropvarme (OP 3) urten
 - 10 d. procesvandet frembragt i (c) gemmes og anvendes som mæskevand ved blandingstrinnet (OP 1) og/eller som vaskevand ved vask af filterkagen (OP 2).
2. Fremstillingsproces for urt ifølge krav 1 **kendetegnet ved, at** den omfatter et supplerende trin til opvarmning af procesvandet opnået efter trin (a).
15
3. Fremstillingsproces for urt ifølge det foregående krav **kendetegnet ved, at** den yderligere opvarmning udføres ved varmeveksling under dampstripning (OP 8).
4. Fremstillingsproces for urt ifølge et af de foregående krav **kendetegnet ved, at**
20 fremgangsmåden omfatter en overhedning af procesvand, der er lagret i trin (b), til en temperatur på mellem 103 °C og 105 °C.
5. Fremstillingsproces for urt ifølge et af de foregående krav **kendetegnet ved, at** under trin (a), har procesvandet, der kommer fra varmeveksleren, en temperatur på mellem 95 °C og 99 °C.
25
6. Fremstillingsproces for urt ifølge et af de foregående krav **kendetegnet ved, at** under trin (b) bliver procesvandet lagret ved en temperatur på mellem 95 °C og 99 °C.
7. Fremstillingsproces for urt ifølge et af de foregående krav **kendetegnet ved, at** under trin (c)
30 har procesvandet, der kommer fra varmeveksleren, en temperatur på mellem 78 °C og 85 °C.
8. Fremstillingsproces for urt ifølge et af de foregående krav **kendetegnet ved, at** procesvandet, der er lagret i trin (d), anvendes som mæskevand og som vaskevand til filterkagen.
- 35 9. Fremstillingsproces for urt ifølge et af de foregående krav **kendetegnet ved, at** fremgangsmåden omfatter et trin til afkøling af procesvand, der er lagret i (d), til en temperatur mellem 40 °C og 65 °C.

10. Fremstillingsproces for urt ifølge et af de foregående krav **kendetegnet ved, at** den første afkøling af urt sker delvist før og efter klaringen (OP5) af urt fra 99 °C til 85 °C før afklaringen og fra 85 °C til 30 °C efter klaringen.

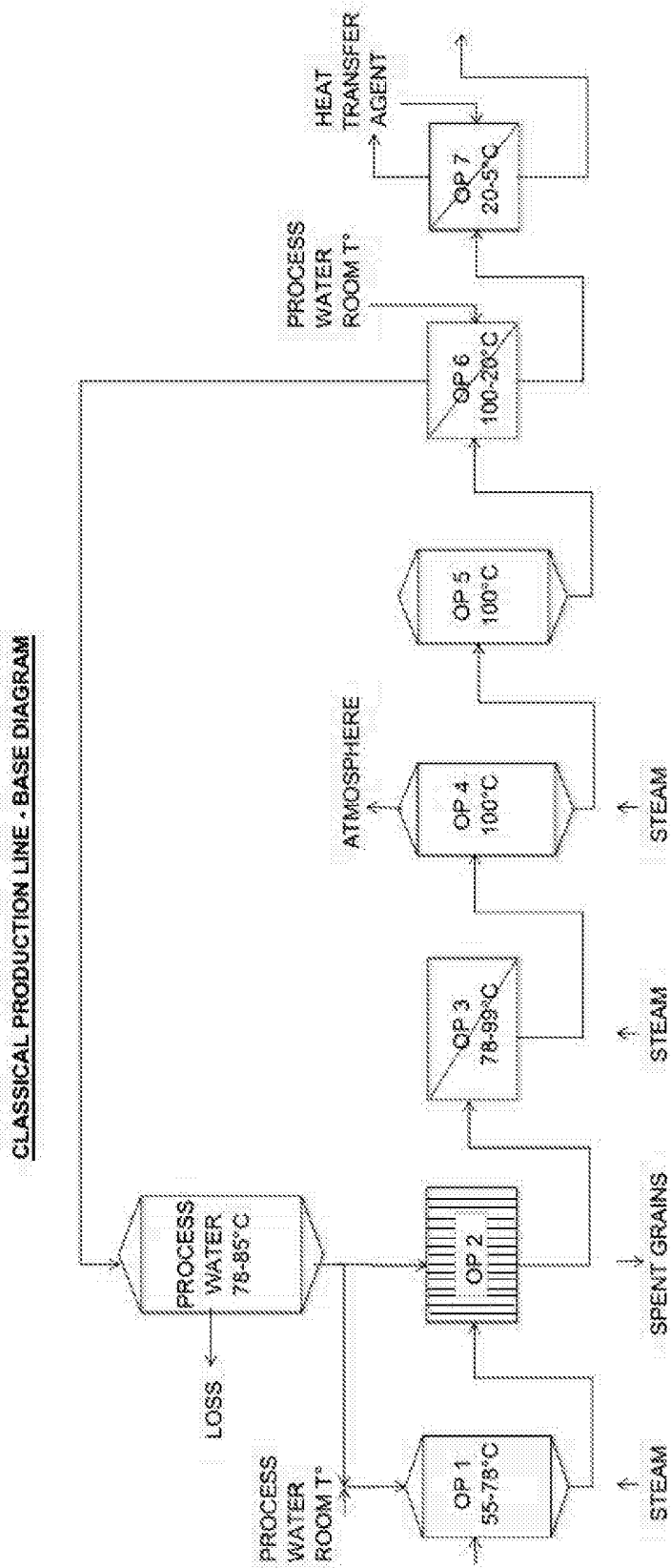
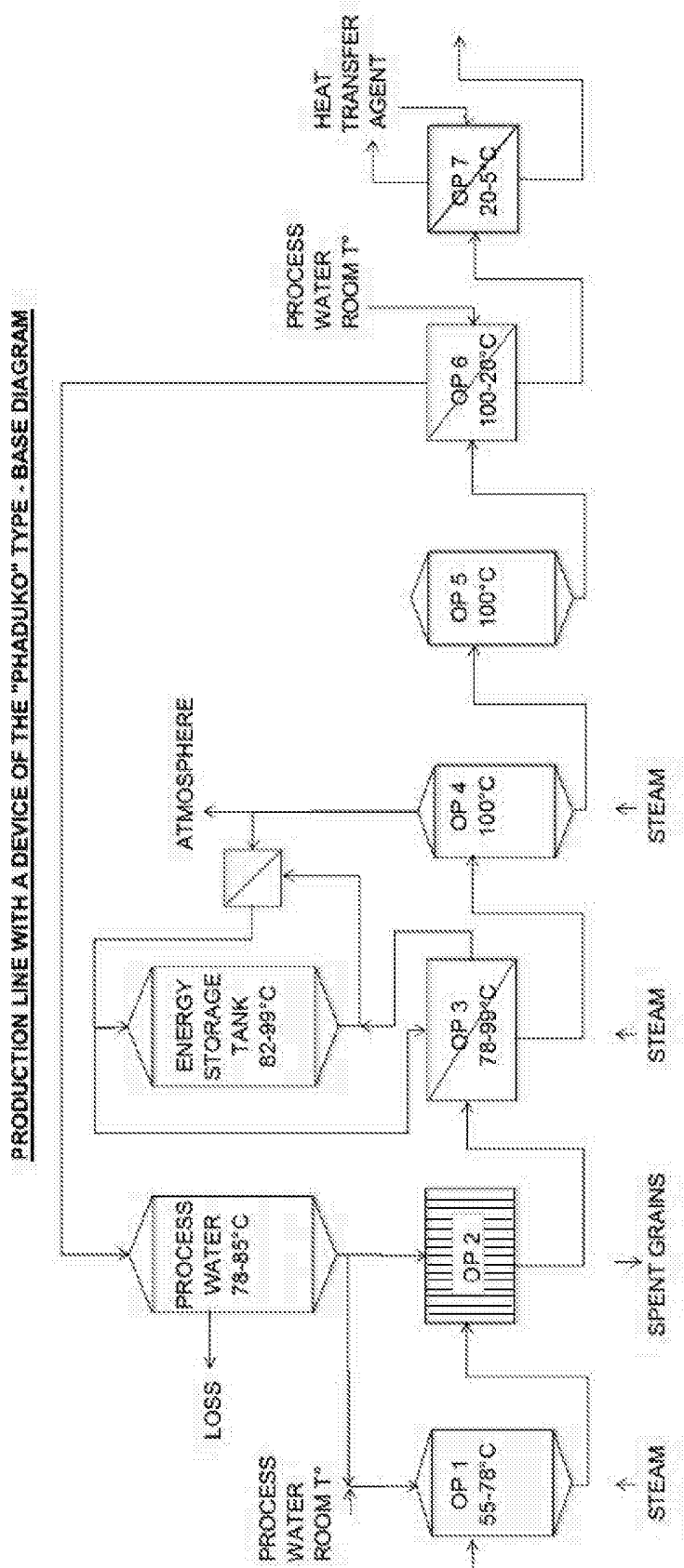


Fig. 1

Fig. 2



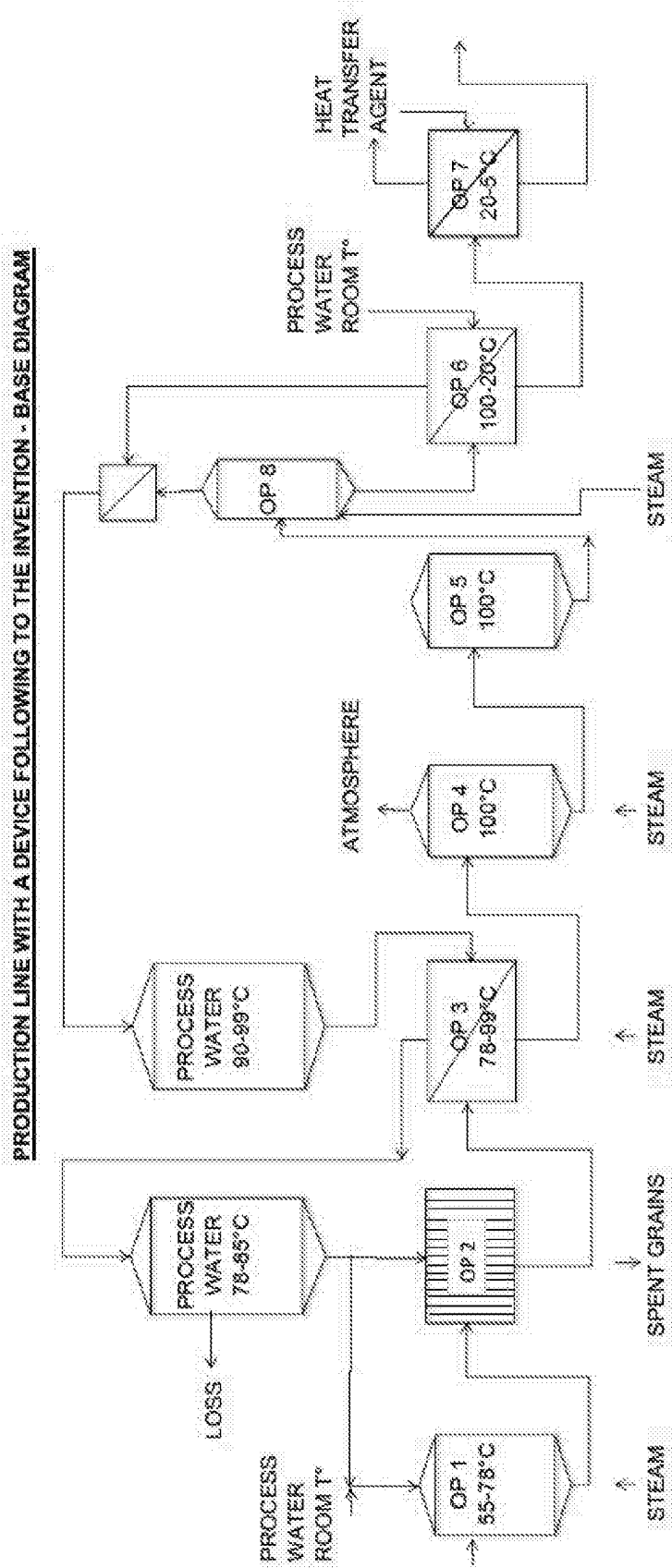
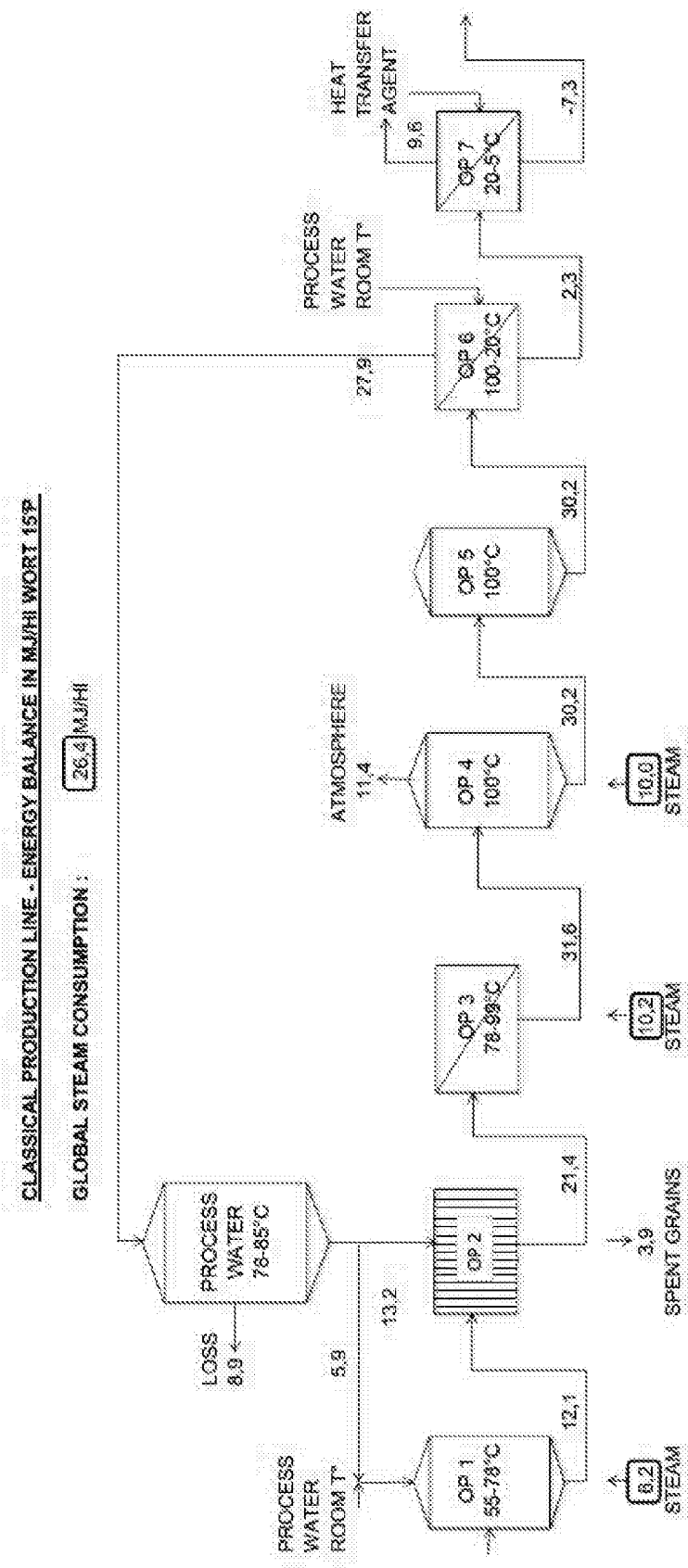


Fig. 3

Fig. 4



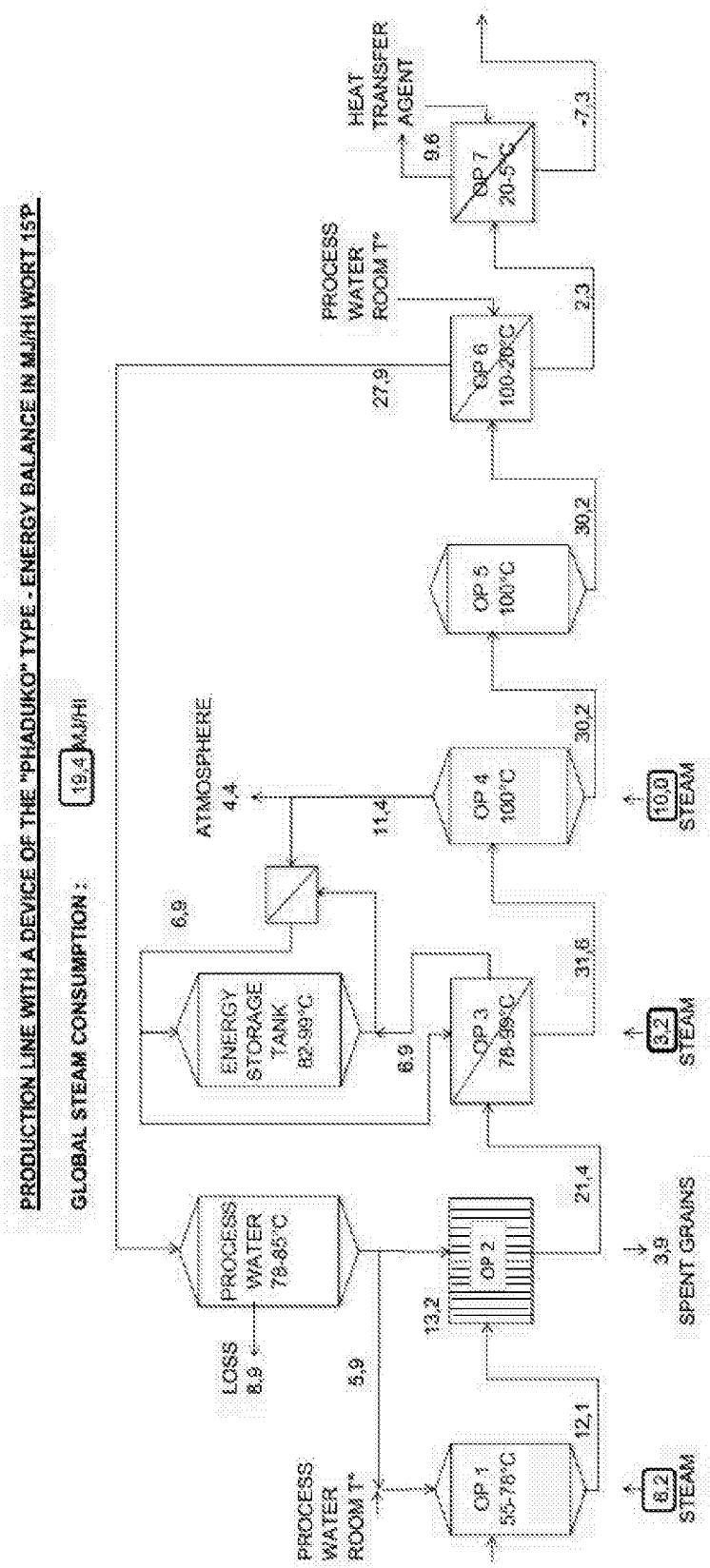
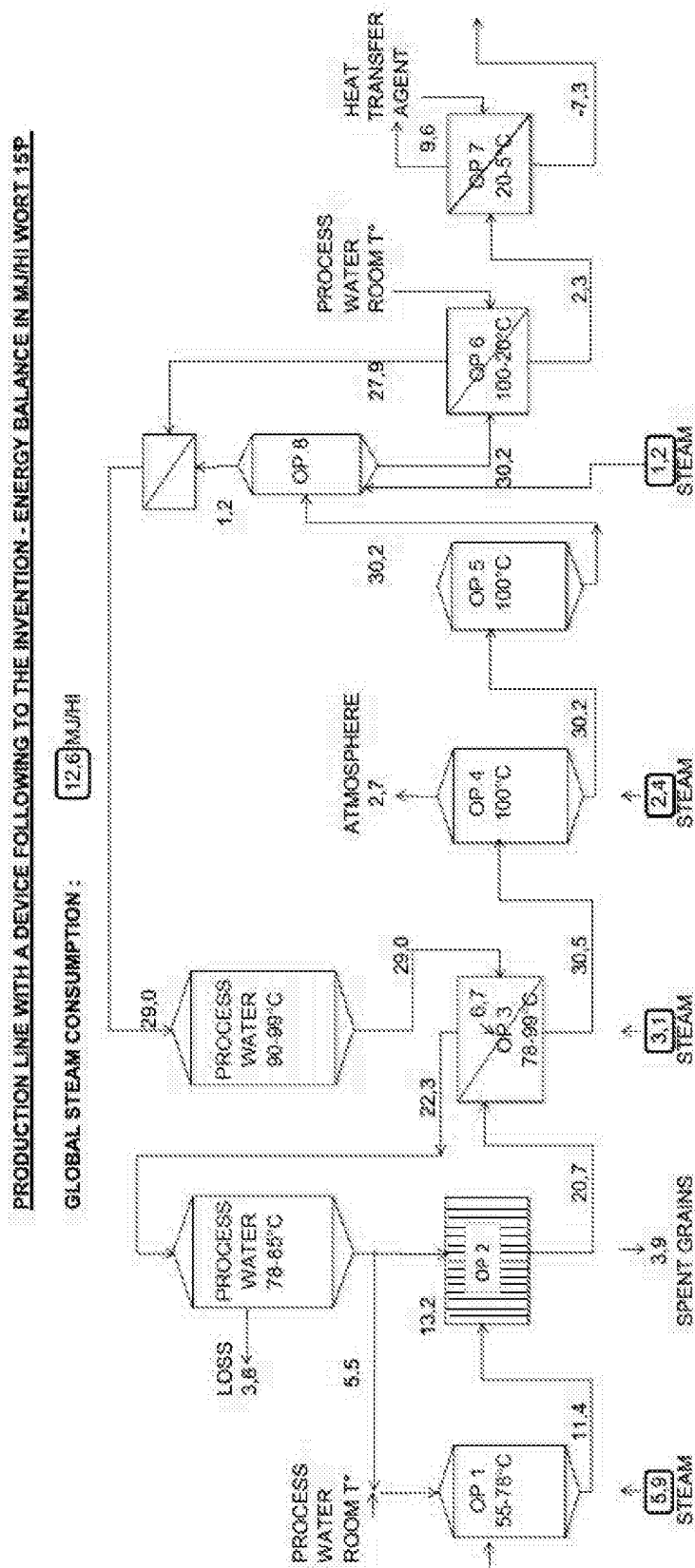


Fig. 5

Fig. 6



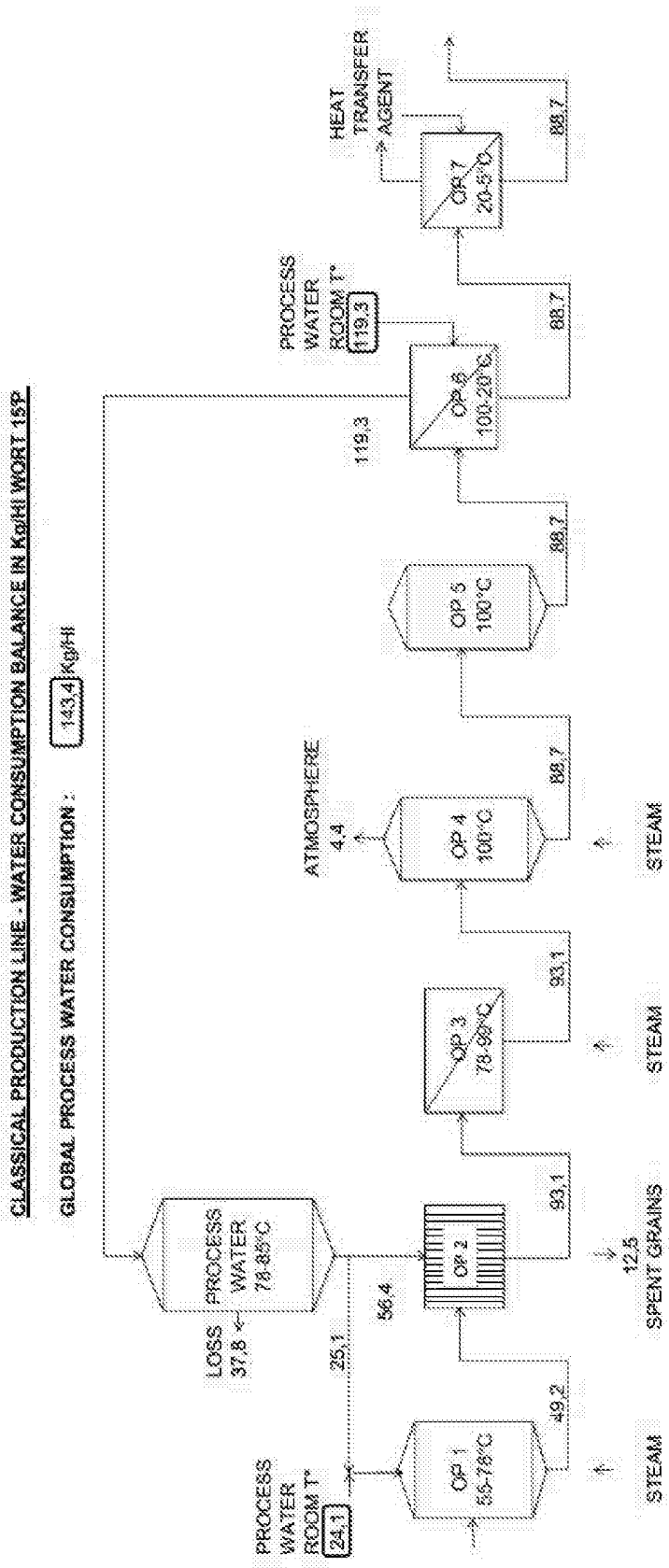
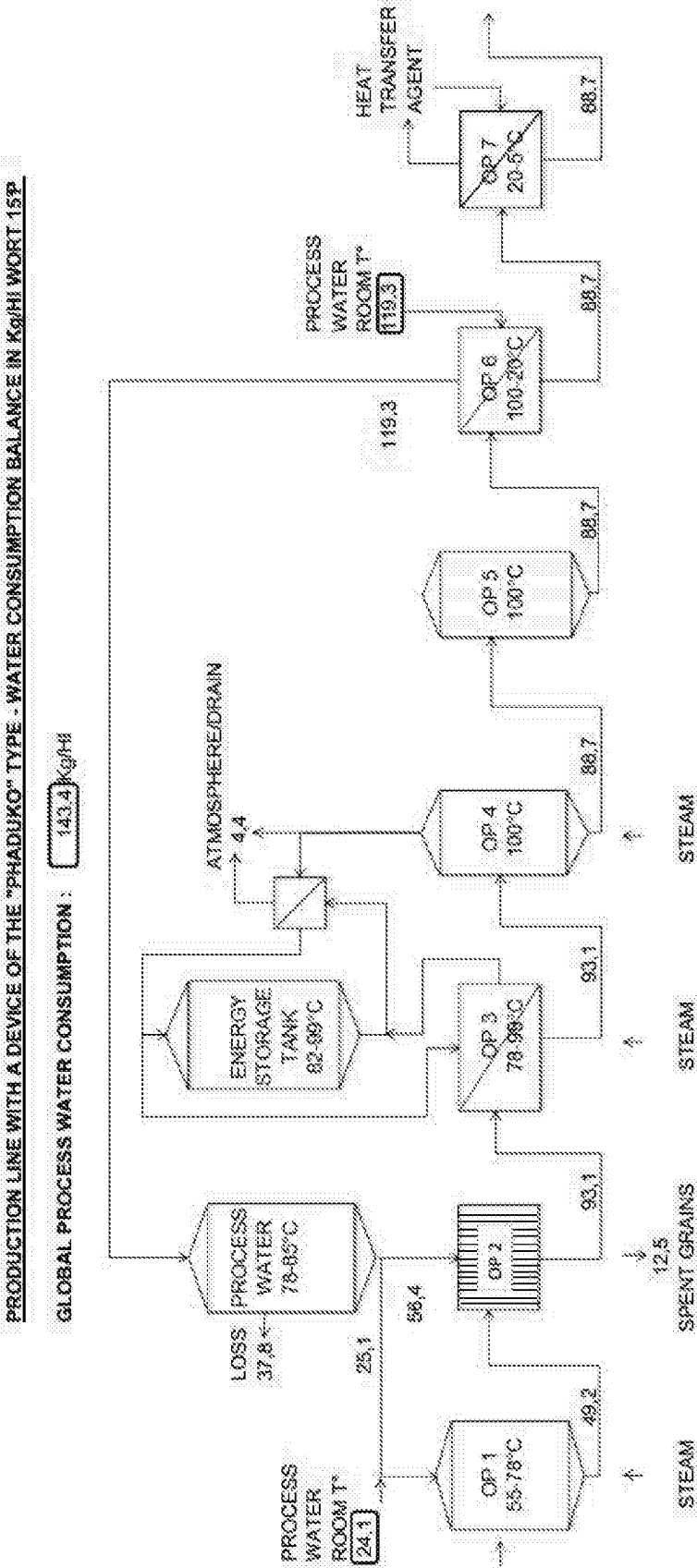


Fig. 7

Fig. 8



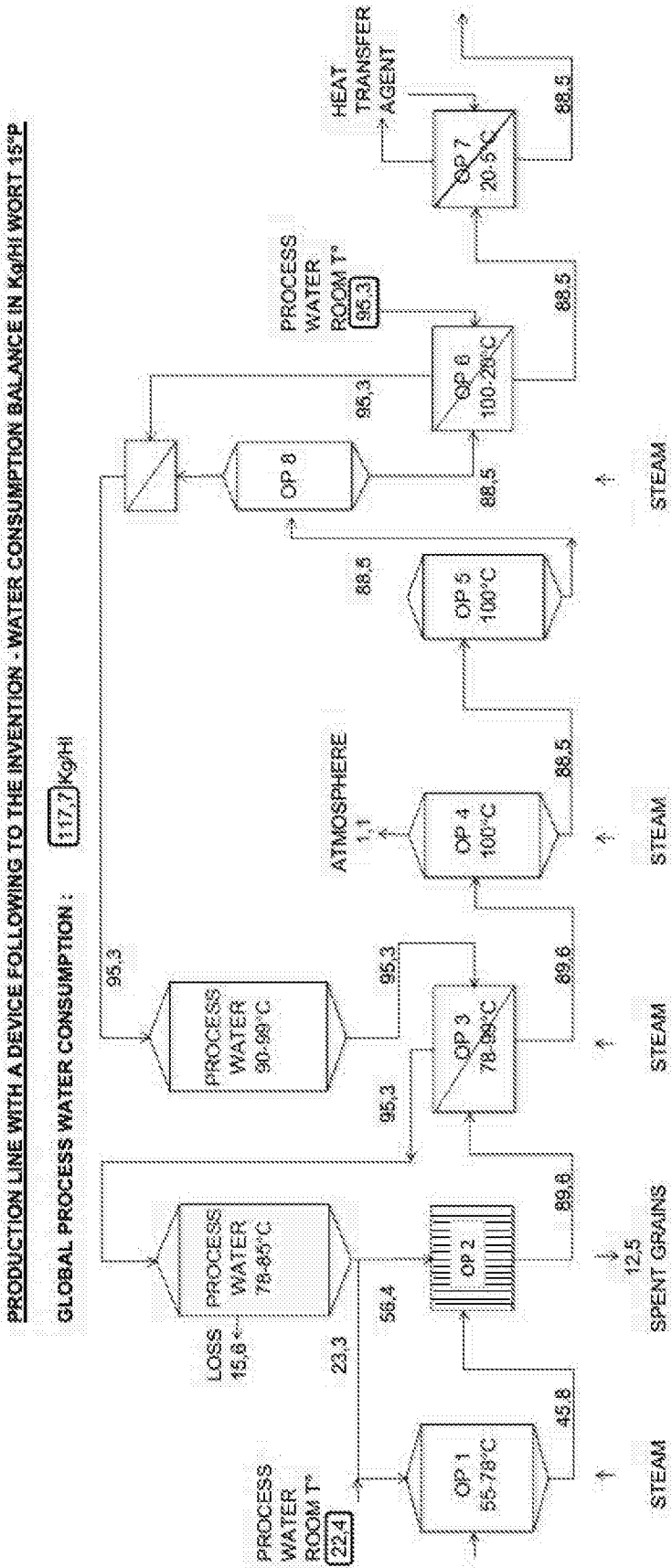


Fig. 9

Fig. 10

