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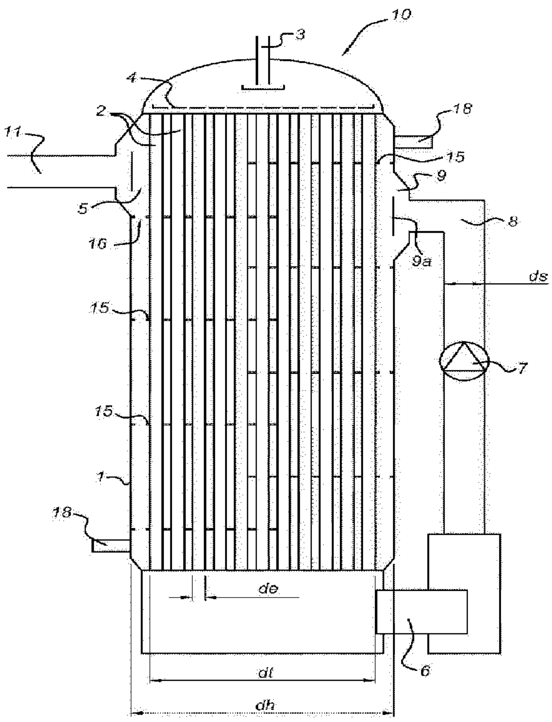
(54) **Evaporator system.**

(57) Evaporator system of the mechanical vapor recompression type, which has a housing (1) and evaporator tubes (2) positioned parallel to each other. A product inlet (3) in fluid communication with a distribution element (4) is connected to the evaporator tubes (2), and a secondary fluid channel (5) is formed between the inside surface of the housing (1) and the external surfaces of the evaporator tubes (2). A vapor liquid separator (6) is positioned at a bottom side of the evaporator tubes (2) and the secondary fluid channel (5). A compressor (7) is in fluid communication with a vapor outlet of the vapor liquid separator (6), and a second fluid transport tube (8) is connected to an inlet (9) of the secondary fluid channel (5). Each evaporator tube (2) of the plurality of evaporator tubes has an inner diameter (de) of at least 50 mm.



Dit octrooi is verleend ongeacht het bijgevoegde resultaat van het onderzoek naar de stand van de techniek en schriftelijke opinie. Het octrooischrift komt overeen met de oorspronkelijk ingediende stukken.

NL C 2006776

Evaporator system

Field of the invention

The present invention relates to an evaporator system of the mechanical vapor recompression type. More in particular, the present invention relates to an evaporator system comprising a housing and a plurality of evaporator tubes positioned parallel to each other, a product inlet in fluid communication with a distribution element connected to the plurality of evaporator tubes, a secondary fluid channel being formed between the inside surface of the housing and the external surfaces of the plurality of evaporator tubes, a vapor liquid separator positioned at a bottom side of the plurality of evaporator tubes and the secondary fluid channel, a compressor in fluid communication with a vapor outlet of the vapor liquid separator, and a second fluid transport tube connected to the compressor and an inlet of the secondary fluid channel.

Prior art

International patent publication WO2010/079148 discloses a thermo-siphon evaporator for heat exchange between fluids, comprising a plurality of parallel positioned hollow tubes for forming a flow path for a first fluid.

European patent publication EP-A-1 767 257 discloses an installation for the treatment of liquid, comprising an evaporator of the Mechanical Vapor Recompression (MVR) type with a primary evaporator and a compressor means.

Summary of the invention

The present invention seeks to provide an improved evaporator system having a higher efficiency than present day evaporator systems.

According to the present invention, an evaporator system according to the preamble defined above is provided, wherein each evaporator tube 2 of the plurality of evaporator tubes has an inner diameter of at least 50 mm. This will reduce the pressure drop in the evaporator system considerably, thus enhancing the efficiency of the evaporator system.

In a further embodiment, the second fluid transport tube has an inner diameter of at least 900 mm, e.g. 1000 mm. This will reduce the pressure drop in another part of the evaporator system, again resulting in an increased efficiency.

The distance between two adjacent evaporator tubes is at least 1.4 times the diameter of the evaporator tube in an even further embodiment. Again this will result in less resistance and consequently a lower pressure drop in the evaporator system.

In an even further embodiment, the housing has an internal diameter which is larger than the combined diameter of the plurality of parallel positioned evaporator tubes. As a result more volume is available for the flow of steam, again resulting in a lower pressure drop in the evaporator system, and an increased efficiency.

A plurality of horizontally oriented baffles are provided in the housing in a further embodiment, each structurally supporting at least a part of the plurality of evaporator tubes. The baffles are positioned partially overlapping seen in a longitudinal direction of the housing in a further embodiment, as a result of which a meandering flow path is created. The baffles are provided with passageways in an area between the evaporator tubes and the housing in a further embodiment, reducing the pressure drop even more. In a further embodiment the baffles are provided with secondary passageways in an area between adjacent evaporator tubes, as a result of which the resistance for the steam flow may be even further reduced.

In an embodiment, the baffles are provided at a decreasing distance from each other at an increasing distance from the inlet. As a result, a more efficient steam path is created in the evaporator system.

In one specific embodiment, the housing has a height corresponding substantially to a length of the evaporator tubes, wherein the inlet part is positioned in a top part of the housing. As alternative embodiments, the housing has a height corresponding substantially to a length of the evaporator tubes, wherein the inlet part is positioned at between 1/3 and 2/3 of the height of the housing, e.g. half way the height of the housing. Circulation of steam within the housing is then improved.

In a further embodiment, the housing comprises an air release pipe in a top part and/or a bottom part of the housing. This allows to let out air entrapped in the evaporator system, thus further enhancing the efficiency in operation of the evaporator system.

The evaporator tubes are made of lean duplex steel in a further embodiment, which provides sufficient strength and rigidity for application in long tubes in an evaporator system.

In an even further embodiment, the evaporator system further comprises a feedback channel for collecting the first fluid in bottom side of the housing and re-introducing the first fluid in the distribution element. Using multi-pass techniques can increase efficiency of the evaporator system reaching high degrees of condensed product.

The present invention further relates to a combination of at least two evaporator systems according to any one of the present invention embodiments, wherein the at least two evaporator systems are connected in a series configuration.

Short description of drawings

The present invention will be discussed in more detail below, using a number of exemplary embodiments, with reference to the attached drawings, in which

Fig. 1 shows a cross sectional view of a single evaporator tube as used in the present invention embodiments;

Fig. 2 shows a cross sectional view of an evaporator system wherein multiple embodiments of the present invention are implemented;

Fig. 3 shows a cross sectional view of a further embodiment of the evaporator system of the present invention.

Detailed description of exemplary embodiments

Evaporator systems are widely used in many applications, e.g. the drying of whey, a by-product of cheese making. Introduction of mechanical vapor recompression (MVR) types of evaporator systems has increased efficiency of the water extraction process by re-using heat efficiently using a mechanical compressor.

The evaporator systems have been improved in efficiency over the years, but still present day implementations of evaporator systems seem to function sub-optimal. It has been surprisingly found that pressure differences in the evaporator system (which is the driving force for circulation of the fluid to be treated and other fluids used in the evaporator system) are present in parts of the system where they would not be expected, or that pressure difference in certain parts are higher than expected.

In Fig. 1, a simplified cross sectional view is shown of an evaporator tube 2 as used in an MVR type evaporator system (using a plurality of evaporator tubes 2 positioned substantially parallel to each other, see below for further constructional details). The evaporator tube 2 provides a limitation of a product/vapor side 2a inside the evaporator tube 2 and a steam side 2b outside the evaporator tube 2. The product to be subjected to the evaporation process (feed 20, e.g. a fluid product, e.g. whey or concentrated whey) is entered into the system, and is distributed over a number of evaporator tubes 2 using a distribution element 4 (in the embodiment shown additionally provided with optional vapor tubes 4a). The product flows downward in the evaporator tube 2 as a film along the inner surface of the evaporator tube 2. The evaporator tube material is heated from the outside surface by the steam input 24 on the steam side 2b. This causes parts of the fluid to evaporate, and due to the pressure difference the vapor flows downward. At the bottom of the evaporator tube 2, in the product/vapor side 2a, the processed part of the product ('concentrate' 21) can be collected (e.g. using a simple outlet structure at the bottom side), and also the evaporated components ('vapor' 22) can be extracted (and re-used in the MVR system as steam). Part of the steam in the steam side will condensate on the outer surface of the evaporator tube 2, and can also be collected at the bottom part of the steam side part 2b ('condensate' 23).

The efficiency of this evaporation process is depending on a number of factors. The vapor flows downward in the evaporator tube 2 because of the pressure difference. The higher the vapor speed, the higher the pressure difference will be ($dP \sim v^2$). The pressure difference in saturated vapor is also directly related to the temperature difference, according to well known steam tables).

In an exemplary existing MVR system, the vapor speed is ~25m/s in a bottom part of the evaporator tubes and the measured pressure difference (between top (pos. Tp0) and bottom (pos. Tp1) of evaporator tube 2, see also Fig. 2) is 15 mbar, which corresponds to a temperature difference of 1.5°C. So if T_{p1} = 60°C, then T_{p0} = 61.5°C. If the steam temperature T_s=65°C the average temperature difference between the steam and the product is only 4.2°C instead of 5°C, which results in an efficiency loss of 15%.

According to the present invention embodiments improvements are provided in this part of the MVR type of evaporator system, but also in other parts, as will be explained with reference to the schematic view of an MVR type of evaporator system 10 shown in Fig. 2. As a result of at least some of the inventive modifications to the evaporator system of the current invention, the vapor speed is reduced to less than 25 m/s, preferable less than 20 m/s, more preferably between 15 – 20 m/s, preferably 10-15 m/s. This leads to less temperature differences in the vapor tubes 2 of between 0,05 and 0,2 °C.

In general, the MVR type evaporator system comprises a housing 1 accommodating a plurality of evaporator tubes 2 positioned substantially parallel to each other. The product to be processed (a fluid, such as whey) is introduced through a product inlet 3 in fluid communication with a distribution element 4 connected to the plurality of evaporator tubes 2. As a result, the product to be processed is distributed over the plurality of evaporator tubes 2 using the distribution element 4, e.g. in the form of a perforated or punched plate.

A secondary fluid channel 5 is formed between the inside surface of the housing 1 and the external surfaces of the plurality of evaporator tubes 2, allowing the use of e.g. steam to heat up the evaporator tubes 2. A vapor liquid separator 6 is positioned at a bottom side of the plurality of evaporator tubes 2 and the secondary fluid channel 5, and a compressor 7 is in fluid communication with a vapor outlet of the vapor liquid separator 6. A second fluid transport tube 8 is connected to the compressor 7 and an inlet 9 of the secondary fluid channel 5.

A steam inlet 11 may be provided separately to allow an initiation of the evaporator process by allowing hot steam to be introduced into the housing 1. The steam heats up the evaporator tubes 2, and as a result, vapor is formed and flows downward in the evaporator tubes 2 (i.e. in the product/vapor side 2a as shown in Fig. 1). The vapor and concentrate originating from the inside of the evaporator tubes is collected at the bottom side of the housing 1, and separated by the vapor liquid separator 6. The vapor is then compressed using compressor 7, i.e. energy is added to the vapor. The compressed (and thus again heated vapor) is re-introduced into housing 1 using the second fluid transport tube 8 and inlet 9 (i.e. at the steam side 2b indicated in Fig. 1).

In order to improve the efficiency of the evaporator system 1, a number of technical improvements have been implemented in parts of the system. These features can be implemented individually, in combination of some of the features, or in combination of all features.

In known evaporator systems, tubes are used for the evaporator tubes 2 having standardized dimensions, e.g. 38 mm (inner diameter). In order to reduce the pressure drop in the product/vapor side 2a (i.e. the inside of the plurality of evaporator tubes 2) of the evaporator system 1, in one embodiment of the present invention each evaporator tube 2 of the plurality of evaporator tubes has an inner diameter de (see Fig. 2) of at least 50 mm. For example the inner diameter of evaporator tube 2 is between 50 -95mm, more preferably between 55-95mm, or between 65-95mm, e.g. between 65-80mm. In a further exemplary embodiment, the inner diameter of the evaporator tube 2 is between 80 and 95 mm. In order to provide sufficient contact surface for evaporation this will increase the total diameter dt of the plurality of evaporator tubes 2 (at same number of tubes 2, possibly even requiring a larger number of tubes 20. Although using larger diameter tubes 2 is associated with higher cost for the entire evaporator system 1, the gain in efficiency and resulting lower energy consumption of the evaporator system 1 will offset the increased cost rapidly during actual operation.

In a further embodiment, the pressure drop in the steam side 2b of the evaporator system 1 is reduced, e.g. in one embodiment wherein the second fluid transport tube 8 has an inner diameter ds of at least 900 mm, e.g. 1000 mm (for a vapor-flow of 20.000 kg/hr). This will reduce the vapor speed in the second fluid transport tube 8 e.g. from 80-100 m/s to about 60 m/s. E.g. at 25000kg/hr steam the tube 8 has a diameter of 800mm as standard, resulting in a vapor speed of 93 m/s at 63˚C. Changing the diameter of the tube 8 to 1000mm will then result in a vapor speed of 60 m/s at 63˚C.

In addition or as an alternative the reduction in vapor speed can be achieved using control to lower the vapor transport or to lower the capacity, e.g. of the compressor 7.

In an even further embodiment, the heart to heart distance between two adjacent evaporator tubes 2 is at least 1.4 times the diameter de of the evaporator tube 2, e.g. at least 70 mm (note that in existing MVR designs, the heart to heart distance between pipes is about 1.2-1.3 times the tube diameter. In a further embodiment, the shortest distance between two adjacent evaporator tubes is between 15-40 mm. This will also decrease the resistance experienced by the steam in the steam side 2b of the evaporator system 1, as a result of which heat will be transferred to the product on the inner surface of the plurality of evaporator tubes 2 more efficiently.

In an evaporator system 10 for actual use, a large number of evaporator tubes 2 are present. In view of the cost factor, commercially available (standard) tubes 2 may be used having specific standardized dimensions, e.g. having a tube wall thickness of 1, 1.2 or 1.25 mm (depending on diameter of the evaporator tube 2).

The plurality of evaporator tubes 2 are positioned substantially in parallel to each other, e.g. using horizontally oriented structures 15, e.g. in the form of baffle plates. The combination of evaporator tubes 2 has a total diameter dt as indicated in Fig. 2. In one embodiment, the housing 1 has an internal diameter dh which is larger than the combined or total diameter dt of the plurality of parallel positioned evaporator tubes 2, e.g. at least 5% larger, or even at least 10% larger. As a result, more space is created for the steam flow in the evaporator system 1, which effectively reduces the pressure drop in the steam side 2b of the evaporator system 1 and thus increases efficiency.

In order to allow the steam to be in contact with the outside surface of the evaporator tubes 2 in an efficient manner, a plurality of horizontally oriented baffles 15 are provided in the housing 1 in a further embodiment, each structurally supporting at least a part of the plurality of evaporator tubes 2. The baffles 15 are positioned partially overlapping seen in a longitudinal direction of the housing in a further embodiment, providing a meander pattern for the steam.

Further measures can be taken to increase efficiency, e.g. by using by-pass features in the steam side 2b of the housing 1. In one embodiment, this is accomplished by having the baffles 15 provided with passageways 16 in an area between the evaporator tubes 2 and the housing 1. This additional space for the steam will result in a lower pressure loss, and hence an increased efficiency. In an even further embodiment, the baffles 15 are additionally or alternatively provided with secondary passageways in an area between adjacent evaporator tubes 2. In theory, this will result in a reduction of the temperature difference in the evaporator tube of a further 0.5°C, making the evaporator system 10 even more energy efficient.

To even further improve the efficiency of the evaporator system 1, the baffles are provided at a decreasing distance from each other at an increasing distance from the inlet 9 (i.e. in the upward direction of the evaporator system 10 above inlet 9 and in downward direction below inlet 9) in a further embodiment. E.g. starting from a mutual distance of about 1.5m at inlet 9 of the housing closing up to about 1.0m or even less at the top part of the housing (resp. bottom of the housing). This provides more and smaller meanders at the parts of the housing 1 further away from inlet 9, forcing the steam in more meanders and higher speed in the housing where the lowest steam flow will be. Purpose of these smaller distances is to push the entrapped air to the top resp. bottom of the evaporator and to effectively remove it from the system, e.g. using air release pipes 18 In the embodiments shown, an air release pipe 18 is provided in both the top part and bottom part of the housing 1, as an alternative embodiment, only a single air release pipe 18 may be provided.

In the present invention embodiments of the evaporator system 10, evaporator tubes 2 are used of which the length depends on the actual use of the evaporator system. Depending on the operational parameters of the evaporator system 10 (vapor speed, temperature difference of vapor/product over the evaporator tube 2, the length is e.g. more than 8m (even up to a length of 20m).

The efficiency improvement is achieved in an embodiment wherein the housing has a height corresponding substantially to a length of the evaporator tubes 2, and wherein the inlet part 9 is positioned in a top part of the housing 1. The steam is thus introduced at one end of the housing 1, and is forced downward throughout the housing 1.

In an even further, alternative embodiment, the housing 1 has a height corresponding substantially to a length of the evaporator tubes 2, and the inlet part 9 is positioned at about 1/2 of the height of the housing 1 (more general positioned between 1/3 and 2/3 of the total height). E.g. when the total height of the evaporator system 1 is about 20 meter, the inlet part 9 in this embodiment is provided at about 10 meter above the bottom part of the evaporator system. This is just above the compressor 7, which is usually at about 3-4 meter above the bottom of the evaporator system 1 (for reasons of accessibility and relation to the vapor liquid separator 6). As a result, the tubing 8 from compressor 7 to the inlet part 9 is shorter, and thus more efficient. Additional effect is that the steam spreads throughout the interior of the housing 1 (i.e. steam side 2b) in a more efficient manner, as it is able to go both upward and downward in almost equal amounts.

To further enhance the flow of steam throughout the interior of housing 1, the inlet part 9 is provided with a guiding plate 9a in a further embodiment. The guiding plate 9a may be present at the connecting side of the second fluid transport tube 8 in the inlet part 9. In a further embodiment, the inlet part 9 is provided as a vapor inlet surrounding a part of the circumference of the housing or even the entire circumference, and the guiding plate 9a may be provided as part of the inlet part 9 (e.g. in the form of a part of a cylinder).

A further possible improvement in efficiency can be obtained by a further embodiment, wherein the housing 1 comprises an air release pipe 18 in the top part of the housing 1. In the evaporator system 1, air can be trapped. As air is a bad heat conducting medium, and in addition will not condense under operating conditions of the evaporator, entrapped air will result in a loss of efficiency. By having an air release pipe 18 installed, air entrapped can be removed efficiently.

The possible air entrapped in the steam side 2b of the evaporator side 2b is heavier than the steam provided at the inlet 9. In order to ensure that entrapped air in forced upward to the air release valve 18, the speed of the steam should be sufficiently high. This can be controlled by the compressor 7, but is also dependent on the path of the steam in the housing 1, which is e.g. determined by the orientation and position of the baffle plates 15.

The features allowing to reduce the pressure drop in the product/vapor side 2a and the steam side 2b of the of the evaporator system 10 are e.g. arranged to provide a maximum pressure drop related to the capacity of the compressor 7 (in the steam side 2b of the evaporator system). E.g. the maximum pressure drop in the entire product/vapor side 2a and steam side 2b is limited to 5% of the pressure increase the compressor 7 can provide. The pressure drop in the entire product/vapor side 2a and steam side 2b is the total of the pressure drops in the evaporator tubes 2 (including inflow and outflow losses), the tubes downstream and upstream (second fluid transport tube 8) of the compressor 7, the inlet part 9 including optional guiding plate 9a, and the lower parts of the evaporator system 10 including the vapor liquid separator 6.

The evaporator tubes 2 of the present invention embodiments are made preferably of 304 or 316L stainless steel , more preferably lean duplex steel). This type of steel allows to have a similar rigidity and constructional strength in the evaporator tubes 2 using a smaller thickness, while still preserving good heat transfer characteristics. In general, four main types of duplex steels are usable, lean duplex, standard duplex, super duplex and hyper duplex. The differences between these types are the chemical analysis and their mechanical and corrosion properties. Their similarities are that they all have a ferritic solidification and that the austenite formation starts at app. 1.420 ˚C, at app. 800 ˚C the austenite formation is finalized. The fact that the duplex steels have two crystal structures results in a combination of desirable properties that is beneficial to the user of the steel. The ferrite basically gives high strength and resistance to SCC (Stress Corrosion Cracking), the austenite gives ductility and general corrosion resistance. In choosing duplex in a construction it is often possible to reduce plate thickness due to the higher strength and thereby reduce weight of the construction. Lean duplex steel has a low Ni content, and combines high strength with good fatigue resistance, very good weldability (when using the right technique), good corrosion resistance and high energy absorption.

In an even further embodiment, the evaporator system 10 further comprises a feedback channel for collecting the first fluid in a bottom side of the housing 1 and re-introducing the first fluid in the distribution element 4. A fluid to be processed can then undergo multiple passes (e.g. 4 pass evaporation cycle), effectively reaching a higher degree of evaporation.

An exemplary embodiment is shown schematically in Fig. 3, where like numerals indicate like elements of the embodiment of Fig. 2. In order to prevent forward and backward mixing of the product, the product collector elements in the bottom part 22 and the distribution element 4 in the top of the housing are adapted. Furthermore, the product inlet 3 is split in two parts 3a and 3b, wherein the untreated product is introduced in part 3a, and the once processed product in part 3b. The distribution element 4 is split in two halves 4a, 4b by a dividing wall 20 (which can run all the way through to the top of the evaporator tubes 2). In the bottom part 22 of the housing 1, a bottom dividing wall 21 is positioned (e.g. suspended from a bottom plate holding the evaporator tubes 2). The bottom dividing wall 21 is provided with an opening 19, e.g. by putting a part of the bottom dividing wall 21 askew (e.g. at between 20 and 30 °, in order to obtain a good separation of the product. The opening 19 is furthermore adapted to allow to obtain a speed of the vapor of less than 60 m/s.

The present invention embodiments of the evaporator system 1 (using MVR type of recompression) can be applied as a combination of at least two evaporator systems 10 according to any one of the present invention embodiments, wherein the at least two evaporator systems 10 are connected in a series configuration. Very high evaporation rates can be achieved in such a multi stage evaporator system combination, e.g. from 6% dry solids to as high as 60% dry solids, for e.g. whey. Using all MVR type of evaporator systems 1 instead of TVR (thermal vapor recompression) types of evaporator systems or a mix of MVR and TVR evaporator systems will lower the total power consumption during operation.

The present evaporation system 10 can also be applied for processing of other products, such as milk, permeate, vegetable juices, delactosed cheese whey, sugar melasses, domestic or industrial waste water, spent culture broth, potato cut water (potato starch and protein recovery waste water), brewery/distillery effluents, paper industry waste water.

The present invention embodiments have been described above with reference to a number of exemplary embodiments as shown in the drawings. Modifications and alternative implementations of some parts or elements are possible, and are included in the scope of protection as defined in the appended claims.

CONCLUSIES

1. Verdampingssysteem van het mechanische damprecompressietype, omvattende een behuizing (1) en een veelvoud van verdamperbuizen (2) die parallel aan elkaar gepositioneerd zijn,
een productinvoer (3) die in vloeistofverbinding staat met een distributie-element (4) dat verbonden is met het veelvoud van verdamperbuizen (2),
een secundair vloeistofkanaal (5) dat gevormd is tussen het binnenoppervlak van de behuizing (1) en het externe opperlvak van het veelvoud van verdamperbuizen (2),
een damp-vloeistofscheider (6) die gepositioneerd is aan een onderzijde van het veelvoud van verdamperbuizen (2) en het secundaire vloeistofkanaal (5),
een compressor (7) die in vloeistofverbinding staat met een dampuitlaat van de damp-vloeistofscheider (6),
en een tweede vloeistoftransportbuis (8) die verbonden is met de compressor en een invoer (9) van het secundaire vloeistofkanaal channel (5),
waarbij elke verdamperbuis (2) van het veelvoud van verdamperbuizen een binnendoorsnee heeft van ten minste 50 mm.

2. Verdampingssysteem volgens conclusie 1, waarbij de tweede vloeistoftransportbuis (8) een binnendoorsnee (ds) heeft van ten minste 900 mm, bijvoorbeeld 1000 mm.

3. Verdampingssysteem volgens conclusie 1 of 2, waarbij de afstand tussen twee naast elkaar liggende verdamperbuizen (2) ten minste 1.4 maal de doorsnee (de) van de verdamperbuis (2) is.

4. Verdampingssysteem volgens conclusie 1, 2 of 3, waarbij de behuizing (1) een binnendoorsnee (dh) heeft die groter is dan de gecombineerde doorsnee (dt) van het veelvoud van parallel gepositioneerde verdamperbuizen (2).

5. Verdampingssysteem volgens een van de conclusies 1-5, waarbij een veelvoud van horizontaal georiënteerde schotten (15) zijn voorzien in de behuizing (1), die elk structureel ten minste een deel van het veelvoud van verdamperbuizen (2) ondersteunt.

6. Verdampingssysteem volgens conclusie 5, waarbij de schotten (15) gedeeltelijk overlappend zijn geplaatst gezien in de lengterichting van de behuizing (1).

7. Verdampingssysteem volgens conclusie 5 of 6, waarbij de schotten (15) zijn voorzien van doorgangen (16) in een gebied tussen de verdamperbuizen (2) en de behuizing (1).

8. Verdampingssysteem volgens conclusie 5, 6, of 7, waarbij de schotten (15) zijn voorzien van secundaire doorgangen in een gebied tussen naast elkaar liggende verdamperbuizen (2).

9. Verdampingssysteem volgens een van de conclusies 5-8, waarbij de schotten (15) zijn voorzien met een afnemende afstand tot elkaar bij een toenemende afstand vanaf de invoer (9).

10. Verdampingssysteem volgens een van de conclusies 1-9, waarbij de behuizing (1) een hoogte heeft die in hoofdzaak overeenkomt met een lengte van de verdamperbuizen (2), waarbij de invoer (9) is gepositioneerd in een bovenste gedeelte van de behuizing (1).

11. Verdampingssysteem volgens een van de conclusies 1-9, waarbij de behuizing (1) een hoogte heeft die in hoofdzaak overeenkomt met een lengte van de verdamperbuizen (2), waarbij de invoer (9) is gepositioneerd tussen 1/3 en 2/3 van de hoogte van de behuizing (1).

12. Verdampingssysteem volgens een van de conclusies 1-11, waarbij de behuizing (1) een ontluchtingspijp (18) omvat in een bovenste gedeelte en/of een onderste gedeelte van de behuizing (1).

13. Verdampingssysteem volgens een van de conclusies 1-12, waarbij de verdamperbuizen (2) zijn gemaakt van arm duplex staal (lean duplex steel).

14. Verdampingssysteem volgens een van de conclusies 1-13, verder omvattende een terugvoerkanaal voor het verzamelen van de eerste vloeistof in een onderste gedeelte van de behuizing (1) en het opnieuw invoeren van de eerste vloeistof in het distributie-element (4).

15. Combinatie van ten minste twee verdampingssystemen volgens een van de conclusies 1-14, waarbij de ten minste twee verdampingssystemen in serie verbonden zijn.

Fig. 1

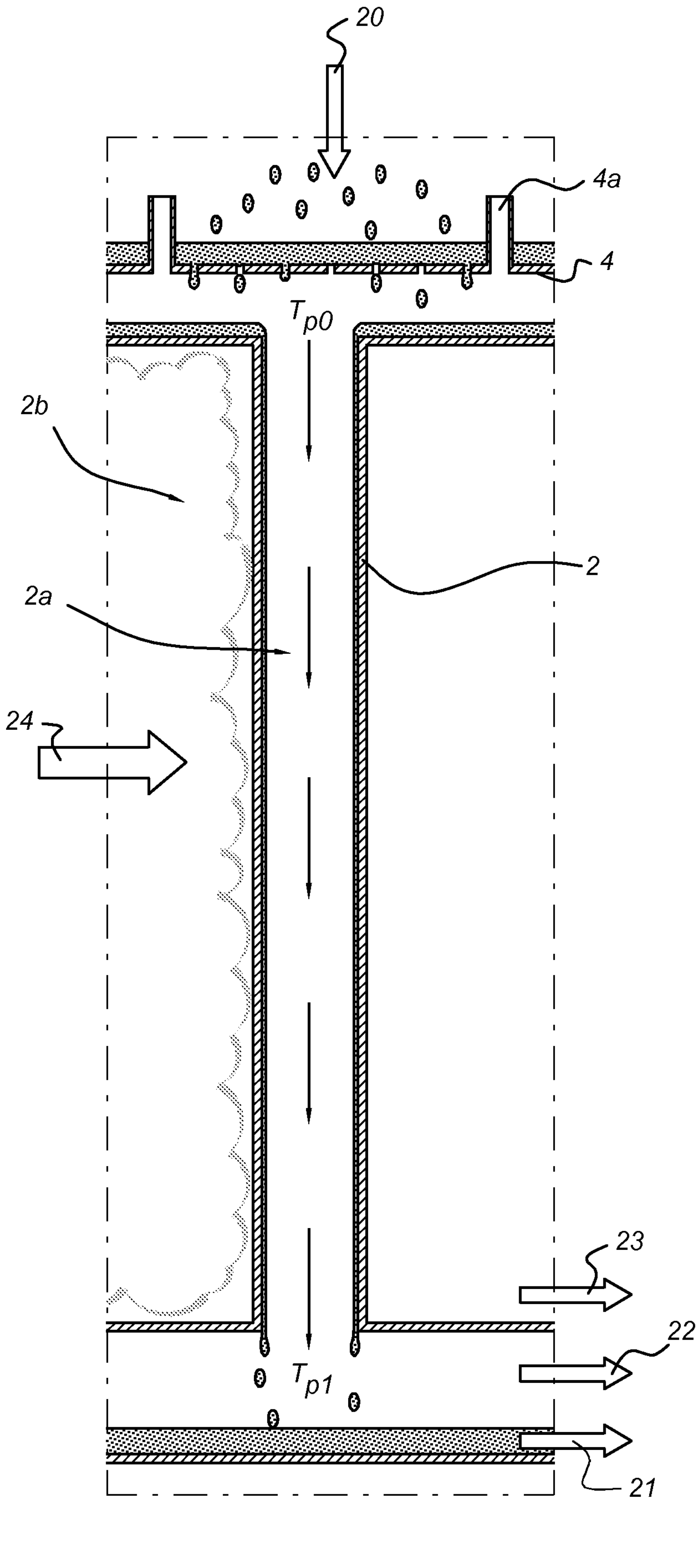


Fig. 2

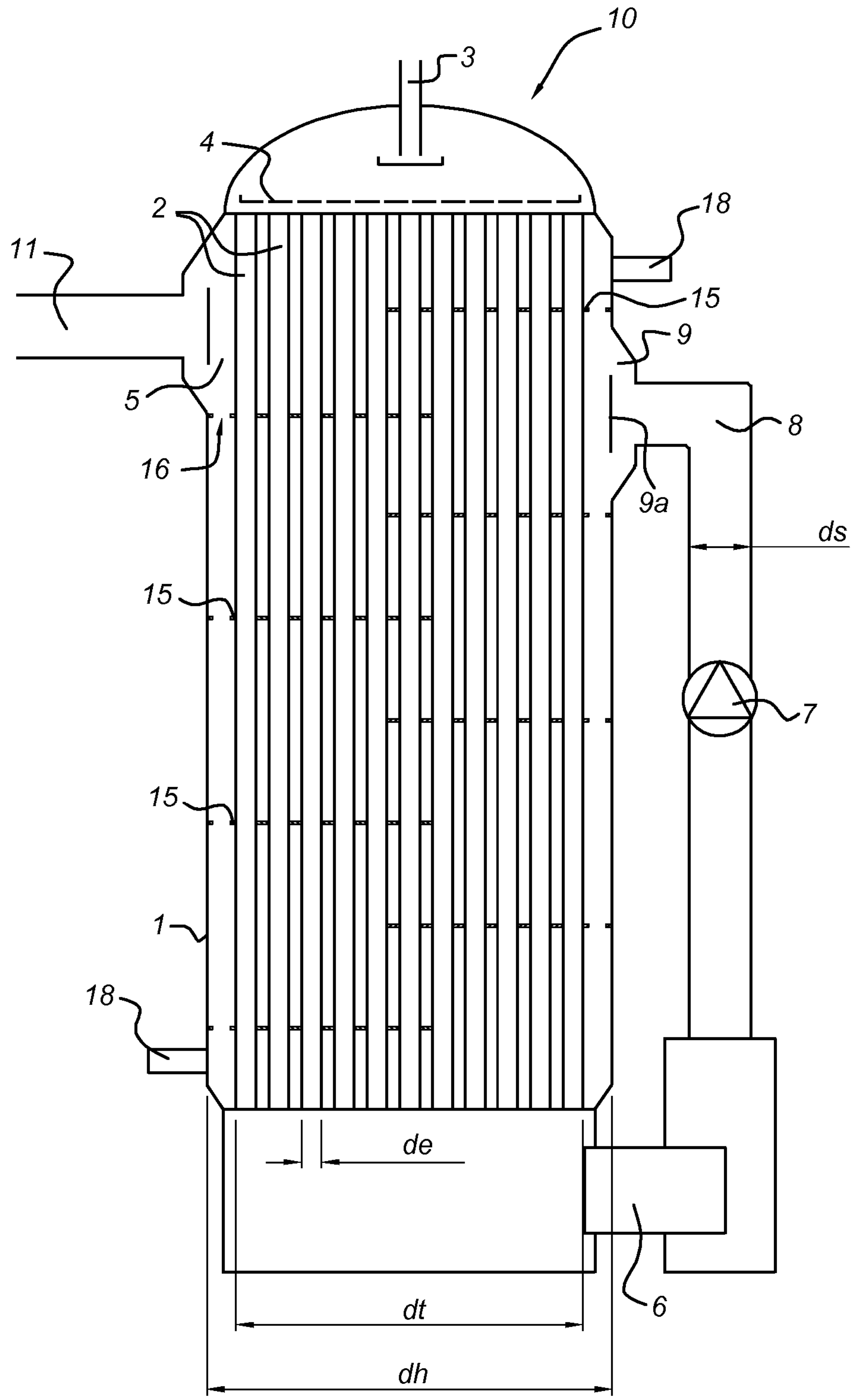
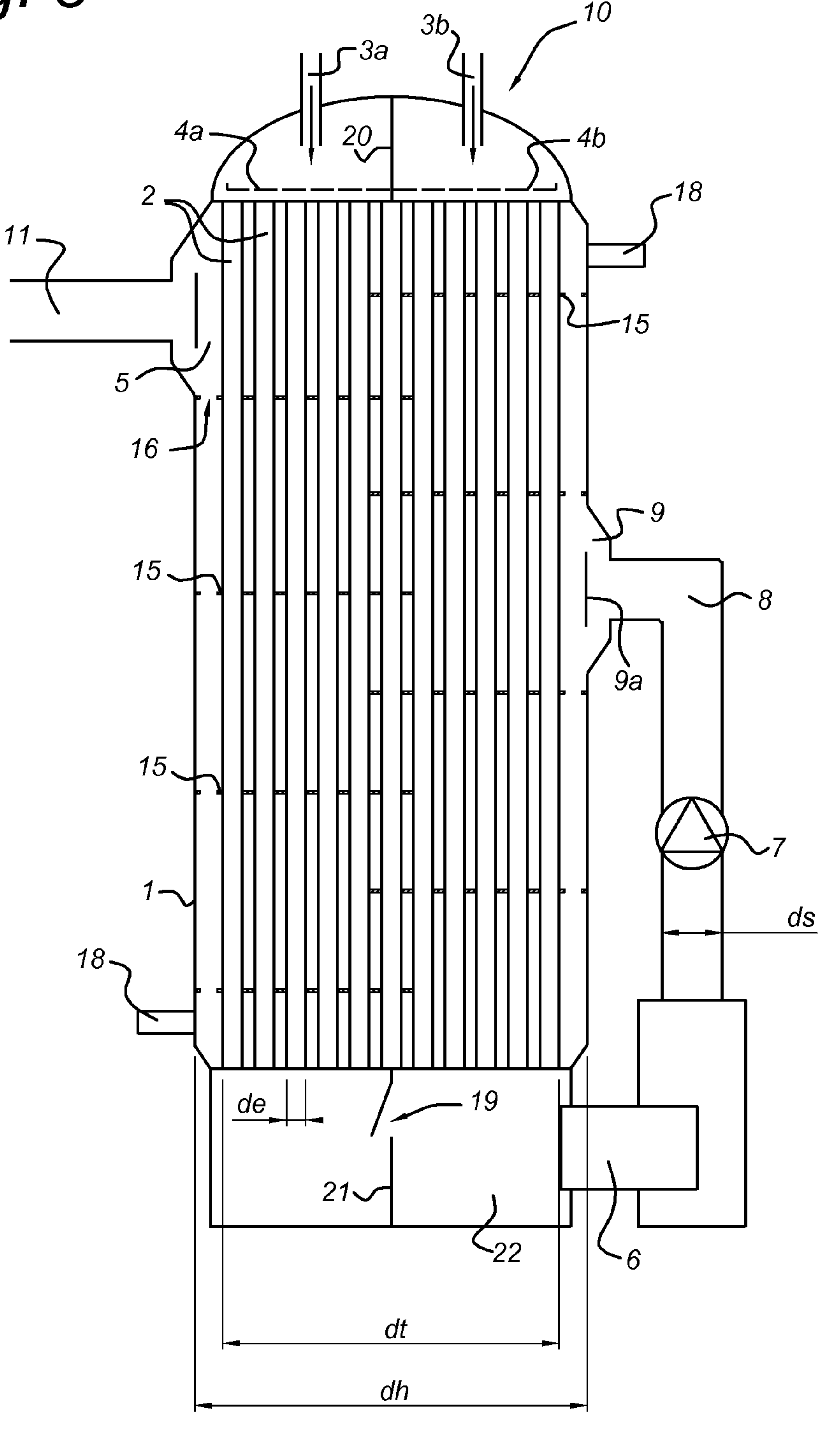


Fig. 3



SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	**KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE** **P6034482NL**
Nederlands aanvraag nr. **2006776**	Indieningsdatum **13-05-2011**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Friesland Brands B.V.**	
Datum van het verzoek voor een onderzoek van internationaal type **16-07-2011**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN56521**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

B01D1/06;B01D1/28

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**B01D**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III.	☐	**GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV.	☐	**GEBREK AAN EENHEID VAN UITVINDING**	(opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2006776

A. CLASSIFICATIE VAN HET ONDERWERP
INV. B01D1/06 B01D1/28
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
B01D

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)

EPO-Internal

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	GB 1 458 492 A (SIR SOC ITALIANA RESINE SPA) 15 december 1976 (1976-12-15) * bladzijde 2, regel 103 - bladzijde 3, regel 56; conclusies 1,3; figuren 2-4 * -----	1-14
X	US 3 244 601 A (ERNST DIEDRICH GUNTHER) 5 april 1966 (1966-04-05) * kolom 3, regels 8-30; conclusies 6,7; figuren 1,3 * -----	1
X	GB 967 929 A (GEN ELECTRIC) 26 augustus 1964 (1964-08-26) * bladzijde 2, regel 52 - bladzijde 3, regel 47; conclusie 9; figuren 1,8 * * bladzijde 5, regels 71-79 * -----	1,14,15
	-/--	

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
18 januari 2012	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Weber, Christian

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ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2006776

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
A	US 3 846 254 A (SEPHTON H) 5 november 1974 (1974-11-05) * kolom 8, regel 22 - kolom 9, regel 8; figuur 3; voorbeelden 1-6 * -----	1-15
A	US 4 235 281 A (FITCH ROBERT E [US] ET AL) 25 november 1980 (1980-11-25) * kolom 5, regel 37 - kolom 6, regel 44; conclusie 1; figuur 1 * -----	1-15
A	EP 0 159 885 A2 (COURTAULDS PLC [GB]) 30 oktober 1985 (1985-10-30) * samenvatting; conclusies 1,7; figuur 1 * -----	1-15

1

Formulier PCT/ISA/201 (vervolg tweede blad) (Januari 2004)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek

NL 2006776

In het rapport genoemd octrooigeschrift		Datum van publicatie	Overeenkomend(e) geschrift(en)			Datum van publicatie
GB 1458492	A	15-12-1976	AU	474313	B2	15-07-1976
			AU	7925575	A	15-07-1976
			GB	1458492	A	15-12-1976
			IT	1009381	B	10-12-1976
			JP	967880	C	31-08-1979
			JP	50133169	A	22-10-1975
			JP	53047223	B	19-12-1978
			MT	P776	A	24-08-1975
			US	3997408	A	14-12-1976
US 3244601	A	05-04-1966	GEEN			
GB 967929	A	26-08-1964	CH	411955	A	30-04-1966
			DE	1266241	B	11-04-1968
			GB	967929	A	26-08-1964
			NL	267249	A	18-01-2012
			SE	303723	B	02-09-1968
			US	3099607	A	30-07-1963
US 3846254	A	05-11-1974	GEEN			
US 4235281	A	25-11-1980	GEEN			
EP 0159885	A2	30-10-1985	DE	3574565	D1	11-01-1990
			EP	0159885	A2	30-10-1985

Agentschap NL
Ministerie van Economische Zaken, Landbouw en Innovatie

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN56521	13.05.2011		NL2006776

International Patent Classification (IPC)
INV. B01D1/06 B01D1/28

Applicant
Friesland Brands B.V.

This opinion contains indications relating to the following items:

- ☒ Box No. I — Basis of the opinion
- ☐ Box No. II — Priority
- ☐ Box No. III — Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV — Lack of unity of invention
- ☒ Box No. V — Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI — Certain documents cited
- ☐ Box No. VII — Certain defects in the application
- ☐ Box No. VIII — Certain observations on the application

Examiner
Weber, Christian

WRITTEN OPINION	Application number NL2006776

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	2-11, 13, 15
	No:	Claims	1, 12, 14
Inventive step	Yes:	Claims	
	No:	Claims	1-15
Industrial applicability	Yes:	Claims	1-15
	No:	Claims	

2. Citations and explanations

   see separate sheet

Re Item V

Reference is made to the following documents:

D1 GB 1 458 492 A (SIR SOC ITALIANA RESINE SPA) 15 december 1976 (1976-12-15)

D2 US 3 244 601 A (ERNST DIEDRICH GUNTHER) 5 april 1966 (1966-04-05)

D3 GB 967 929 A (GEN ELECTRIC) 26 augustus 1964 (1964-08-26)

1.CLARITY

Claims are not clear.

Claim 1 defines the channel (5) as a liquid channel and the conduit (8) as a liquid conduit. Apart from the fact that an apparatus should not be defined by process features (aggregation state of medium), it is to be expected that most of the medium would be a vapor phase.

It is further remarked that "vloeistof verbinding" is not the correct translation of a fluid connection as fluid can be both a liquid or gas phase.

Additionally, the description and figures relate to an evaporator with <u>vertical</u> tubes. The subject-matter claimed is broader than the scope described.

Hence claim 1 and referenced claims are not clear.

It is further remarked that claim 3 does not specify whether the factor 1,4 relates to the internal or external diameter of the evaporator tubes.

Also in claim 10,11 the "in <u>hoofdzaak</u> overeenkomt" is vague and leaves the reader in doubt of the exact meaning of such a definition.

2.INDEPENDENT CLAIM 1

The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

Document D1 discloses (fig.2-4, page 2 line 103 - page 3 line 56, claim 1):

An evaporator of mechanical vapor compression type comprising

-a housing (10,12) and multiple vertical evaporator tubes (40) positioned in parallel configuration,

-an inlet (106,142,70,70A) for the feed that is in fluid connection with a distributor (52,54) connected with said tubes inner side,

-a space (42) within said housing and surrounding said tubes,

-a gas-liquid separator (26) below said tubes and connected to the inner side of said tubes,

-a compressor (102) in fluid connection with the vapor outlet (via demister 104) of said gas-liquid separator,

-a connection (elbow 106) of said compressor to said space within said housing and,

-each said evaporator tube has preferably a diameter of 50-100 mm (page 3 line 50-51).

Document D2 discloses (fig.1,3, column 3 line 8-30, claim 6,7):

An evaporator of mechanical vapor compression type comprising

-a housing (40) and multiple vertical evaporator tubes (42) positioned in parallel configuration,

-an inlet (56) for the feed that is in fluid connection with a distributor connected with said tubes inner side,

-a space (48) within said housing and surrounding said tubes,

-a gas-liquid separator (60) below said tubes and connected to the inner side of said tubes,

-a compressor (34 shown in fig. 1) in fluid connection with the vapor outlet (32,64) of said gas-liquid separator,

-a connection (16,50) of said compressor to said space within said housing and,

-each said evaporator tube has a diameter of 2,5-6 inch corresponding with 63,5-152,4 mm (claim 6,7).

Document D3 discloses (fig.1,8, page 2 line 52 - page 3 line 47, claim 9):

An evaporator suitable for using mechanical vapor compression comprising

-a housing (2) and multiple vertical evaporator tubes (4) positioned in parallel configuration,

-an inlet (18) for the feed that is in fluid connection with a distributor (13,20) connected with said tubes inner side,

-a space (5) within said housing and surrounding said tubes,

-a gas-liquid separator (15) below said tubes and connected to the inner side of said tubes,

-a compressor (27) that is optionally connected with the vapor outlet of said gas-liquid separator (page 2 line 107-114),

-a connection (6) of said compressor to said space within said housing and,

-each said evaporator tube has a diameter varying from 1-4 inches corresponding with 25,4-101,6 mm (see fig.8 and page 5 line 71-79).

Hence, claim 1 is not new.

3.DEPENDENT CLAIMS

Dependent claims 2-15 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/or inventive step.

-claim 2-4: The sufficient large size of both the compressor outlet conduit and the space surrounding the tubes is merely one of several straightforward possibilities from which the skilled person would select, in relation to the size of the tubes, without the exercise of inventive skill, in order to avoid a too high pressure drop.

-claim 5-9: The positioning of baffles that both support the tubes and create a meandering flow of the vapor phase around the tubes is a commonly applied technique in the field of heat exchangers in order to especially enhance heat exchange efficiency. The positioning and size of the baffles with possible perforations are merely one of several straightforward possibilities that would not require the skilled person to exercise an inventive step.

-claim 10: When designing an evaporator one would not normally add more space than necessary to the evaporator; an upper portion has to accommodate the distribution of the feed and a separator at the bottom is needed for the gas liquid separation. When tubes are relatively long it would be implicit that the major portion of the evaporator is occupied by the heat exchange surface (the tube bundle).

-claim 11: The introduction of compressed vapor into the space surrounding the tubes it would be obvious that a too high or too low introduction thereof should be avoided in order to obtain a good distribution.

-claim 12: D1 (fig.2,3, claim 3) discloses a (vacuum) suction tube (64,66) for the incondensables.

-claim 13: It is a common practice to utilise an anti-corrosion material (e.g. lean duplex steel).

-claim 14: Both D1 (fig.2 line 154) and D3 (fig.1 line 18) show the possibility to reintroduce the liquid collected in the sump.

-claim 15: It is a commonly known possibility to use evaporators in series when further purification is to be achieved (e.g. D3 fig.7).