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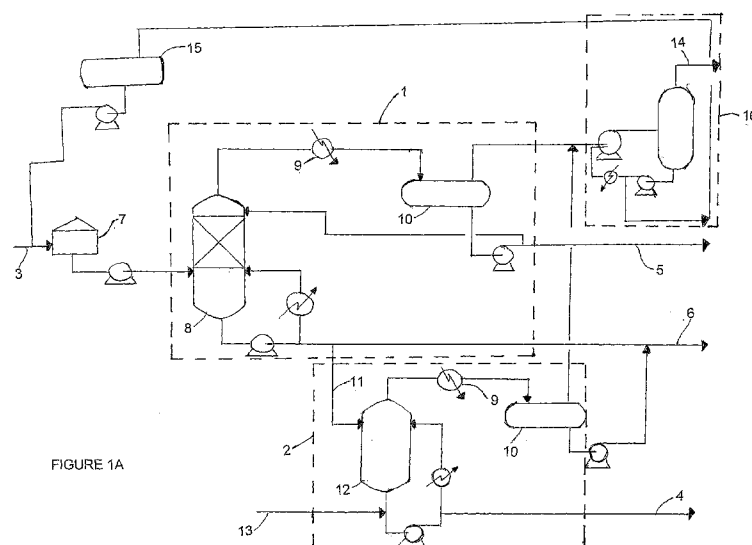
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(54) Title: METHOD FOR REGENERATION AND RECLAMATION OF MONO ETHYLENE GLYCOL USING A VACUUM SLIP STREAM



(57) Abstract: The present invention discloses a novel method for regeneration and reclamation of Mono Ethylene Glycol (MEG).

## METHOD FOR REGENERATION AND RECLAMATION OF MONO ETHYLENE GLYCOL USING A VACUUM SLIP STREAM

## FIELD OF INVENTION

5 The present invention relates to a method for regeneration and reclamation of Mono Ethylene Glycol.

## BACKGROUND OF INVENTION

10 Hydrate inhibitors such as Mono Ethylene Glycol (MEG) are used in hydrocarbon gas and/or condensate pipelines e.g. in gas fields, to absorb moisture and prevent hydrate forming in the pipeline. Typically the MEG is injected into the upstream end of the pipeline and is separated from the hydrocarbon flow at downstream end. The separated MEG (approximately 50 % MEG, 50 % water), denoted as rich MEG, carries the absorbed water. This rich MEG is re-concentrated by a water removal process to produce "lean MEG" (approximately 90 % MEG, 10 %water) for re-use. The MEG is also contaminated with other components from the well and  
15 the pipeline. Pipeline corrosion products, scale and other contaminants such as hydrocarbons, salts from formation water or production chemicals are present, and those impurities are fully or partially removed in the reclamation process.

20 In WO 2007/073204 A1 a process and a plant is described for regeneration of glycol from a mixture comprising glycol , water and salts, the salts comprising carbonate and/or bicarbonate ions. The mixture is flash distilled to obtain a salt- free solution of glycol and water. This solution is condensed and distilled to obtain glycol with reduced water content. The salts are concentrated in the vacuum boiler and removed from a sub-stream taken out of a return circuit to the vacuum boiler.

25 US 2005/0072663 disclose a method of regenerating a glycol solution containing water, hydrocarbons and salts. The glycol solution is expanded in a drum, then distilled in a column. The concentrated glycol collected at the level of a reboiler is placed under vacuum to vaporize the water and to precipitate the salts. The salts are separated from the glycol in a separation device. The concentrated glycol feed of the salts is stored in capacity.

30 In industry two main types of systems are commonly used for MEG reclamation and re-concentration: the Full Stream concept and the Slip Stream concept. These two concepts are schematically shown in figures 2A and 2B respectively. WO 2007/073204 and US 2005/0072663 referred to above are specific examples of these two main systems respectively.

35 By re-concentration is meant concentrating the rich MEG to lean MEG, and by reclamation is meant removing contaminants as salts and corrosion products. By Slip Stream as used herein is meant that the MEG is only partly reclaimed.

In the Full Stream concept all the rich MEG (C) first enters the reclamation part (A), wherein all the rich MEG is evaporated by vacuum boiling and all the salts (D) are removed in a single step. The evaporated rich MEG is then re-concentrated (B) to lean MEG (F) downstream the reclamation part by means of distillation under vacuum. Water (E) is distilled off in the re-concentration process. The Full Stream is suited for production with high solids load but has limitation with respect to capacities. This is resulting in parallel process trains for handling of larger volumes. The process is also highly energy demanding as both MEG and water needs to be evaporated.

10 In the Slip Stream concept the rich MEG (C') is first re-concentrated (B') to lean MEG (F') in the re-concentration part (B') by distillation at atmospheric pressure. In the re-concentration process water (E') is distilled off. Downstream the re-concentration a slip stream from the lean MEG is sent to reclamation part (A') for salt (D') removal. This means that in the slip stream concept the MEG is only partly reclaimed. The total salt concentration in the lean MEG loop must however be kept under a certain max level which is acceptable for the subsea processing. The reclamation part is again performed by means of vacuum boiling. The Slip Stream can be built in larger capacities per process train and it is more energy effective, especially if the reclamation part can be off line during the low salt production period.

The MEG reclamation and re-concentration are energy demanding processes and reducing the energy consumption would lead to large savings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic illustration of an embodiment of the present invention.

25 Figure 1A is a schematic illustration of an embodiment of the present invention.

Figure 2A is schematically showing state of the art Full Stream concept, and Figure 2B shows the Slip Stream concepts.

Figure 3 is a table showing the electrical power consumption (work) in the real case simulation in the Example.

30 Figure 4 is a table showing the heating medium consumption in the real case simulation in the Example.

35 Figure 5 is a table showing the cooling medium consumption in the real case simulation in the Example.

## DETAILED DESCRIPTION OF THE INVENTION

The present invention concerns a method for re-concentration and reclamation of Mono Ethylene Glycol comprising the steps of

a) re-concentrating the rich MEG to lean MEG by water boiling; and

5 b) reclaiming a part of the lean MEG,

wherein both the re-concentration and the reclamation step is performed at conditions below atmospheric pressure. The re-concentration and reclaiming steps are performed in separate units and the step of re-concentration of rich MEG to lean MEG is carried out at a temperature below the evaporation temperature of pure MEG. Salts are removed from part of the lean MEG, the Slip Stream, in a reclamation unit. The temperature in step a) is below the evaporation temperature of pure MEG at said pressure.

10 In the present invention water is evaporated at a pressure below atmospheric pressure and at a temperature below the evaporation temperature of MEG at said pressure. The operating temperatures in both step a) and b) are below the degeneration temperature of MEG.

The concept according to the invention provides an energy effective system for large capacities. In the Full Stream the whole inlet stream, rich MEG, is evaporated under vacuum. This is a process with high energy demand as the total inlet flow, i.e. water and MEG, has to be evaporated. In the Slip Stream concept the whole inlet stream, rich MEG, is re-concentrated by atmospheric water boiling; i.e. only water, not MEG, is boiled off from the main stream. However since the boiling is done at atmospheric pressure, i.e. at higher pressure than in Full Stream, the boiling temperature of the liquid is higher then in Full Stream and the energy savings by boiling off water only may be relatively small.

20 In the method according to the present invention the full rich MEG (3) stream is first re-concentrated (1) to lean MEG (6) in that water (5) is boiled off. The re-concentration unit is connected to vacuum and the boil off is performed at conditions below atmospheric pressure. When water is boiled off under vacuum the boiling temperature is lowered and the energy needed for boil off of water is considerable reduced. This will allow the building of high capacity trains with very low energy demand as only the water is boiled off at low pressure and temperature.

35 A part of the re-concentrated lean MEG, the Slip Stream, is then sent to the reclamation unit (2) for removal of salts (4). The reclamation unit is connected to vacuum and the reclamation is performed by vacuum boiling. The amount of lean MEG sent as Slip Stream part to the reclamation unit is regulated such that the salt concentration in the full lean MEG stream is kept below a certain maximum level which is acceptable for subsea processing.

The re-concentration and reclamation parts may be connected to separate or common vacuum systems.

In periods of low salt production when salt concentration in the full lean MEG stream leaving the re-concentration unit is below the certain maximum level which is acceptable for subsea processing, the reclamation unit may be off line. The energy savings is even more considerable when the reclamation unit is put off line.

The acceptable salt concentration for subsea processing varies from system to system, but would be about 50 g/L maximum, but varies for each case. Acceptable salt concentrations varies in a range from 0 g/L to a maximum of 20-30g/L or as high as 40-50 g/L depending on the system.

Figure 1A illustrates a particular embodiment of the present invention wherein the rich MEG (3) stream is first re-concentrated to lean MEG (6) in a re-concentration unit (1) where water (5) is boiled off under vacuum. The re-concentration unit is connected to vacuum and the boil off is performed at conditions below atmospheric pressure.

A part of the re-concentrated lean MEG, the Slip Stream (11), is then sent to the reclamation unit (2) for removal of salts (4). The reclamation unit is connected to vacuum and the reclamation is performed by vacuum boiling.

In this particular embodiment of the invention re-concentration (1) and reclamation (2) share the vacuum system (16).

Reference numbers in figure 1A refers to the following components;

- |    |                                        |
|----|----------------------------------------|
| 1  | Re-concentration unit                  |
| 2  | Reclamation unit                       |
| 3  | Rich MEG stream                        |
| 25 | 4 Salt removal                         |
|    | 5 Produced water                       |
|    | 6 Lean MEG stream                      |
|    | 7 Storage tank                         |
|    | 8 Distillation column                  |
| 30 | 9 Condensers                           |
|    | 10 Vacuum receivers                    |
|    | 11 Lean MEG Slip Stream to reclamation |
|    | 12 Flash separator                     |
|    | 13 MEG return stream                   |
| 35 | 14 Off gas                             |
|    | 15 Drain vessel                        |
|    | 16 Liquid ring vacuum system           |

## EXAMPLE:

- 5 An example was made for a system with rich MEG flow 32 m<sup>3</sup>/h, regenerating and reclaiming MEG in
- A) Full Stream concept
  - B) Slip Stream Concept (with 25 % Slip Stream Reclaimer, re-concentration at atmospheric pressure, reclamation under vacuum)
  - 10 C) Vacuum Slip Stream Concept (with 25 % Slip Stream Reclaimer, both the Re-concentration and reclamation done under vacuum)

15 The tables in figures 3, 4 and 5 are base on real case simulations, looking at electrical power consumption (work), heating medium consumption and cooling medium consumption.

20 With respect to C) above the re-concentration process (1) is typically performed at a pressure of 15-20 kPa absolute and an operating temperatures are typically in the range of 84-91 °C for the re-concentrated (lean) MEG and 51-58 °C for the separated water phase.

25

## CLAIMS

1. Method for re-concentration and reclamation of Mono Ethylene Glycol comprising the steps of
  - a) re-concentrating the rich MEG to lean MEG by water boiling; and
  - b) reclaiming a part of the lean MEG,characterized in that both the re-concentration and the reclamation step is performed at conditions below atmospheric pressure.
2. Method according to claim 1, characterized in that the temperature in step a) is below the evaporation temperature of pure MEG at said pressure.
3. Method according to any one of claims 1 to 2, characterized in that when the re-concentration is done in a re-boiler or similar followed by a distillation column or similar, both operating at conditions below atmospheric pressure.
4. Method according to any one of claims 1 to 3, characterized in that when the reclamation is done in a slip stream, then the reclamation is performed at conditions below atmospheric pressure.
5. Method according to any one of claims 1 to 4, characterized in that the reclamation slip stream is off line when the salt concentration is acceptable for the subsea processing.
6. Method according to any one of claims 1 to 5, characterized in that the reclamation and re-concentration parts are connected to separate vacuum systems.
7. Method according to any one of claims 1 to 5, characterized in that the reclamation and re-concentration parts are connected to a common vacuum system.

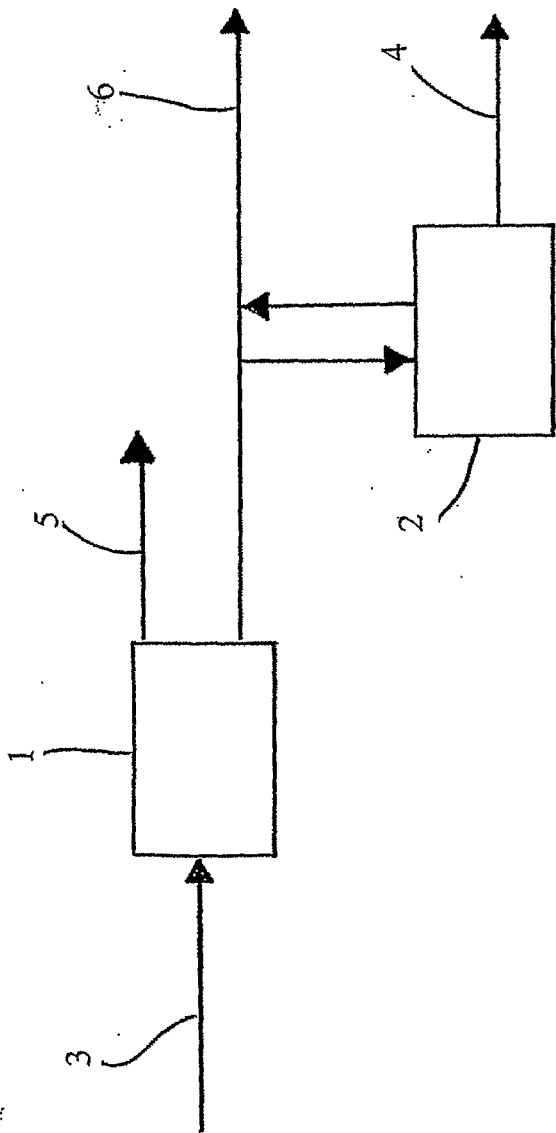


FIGURE 1

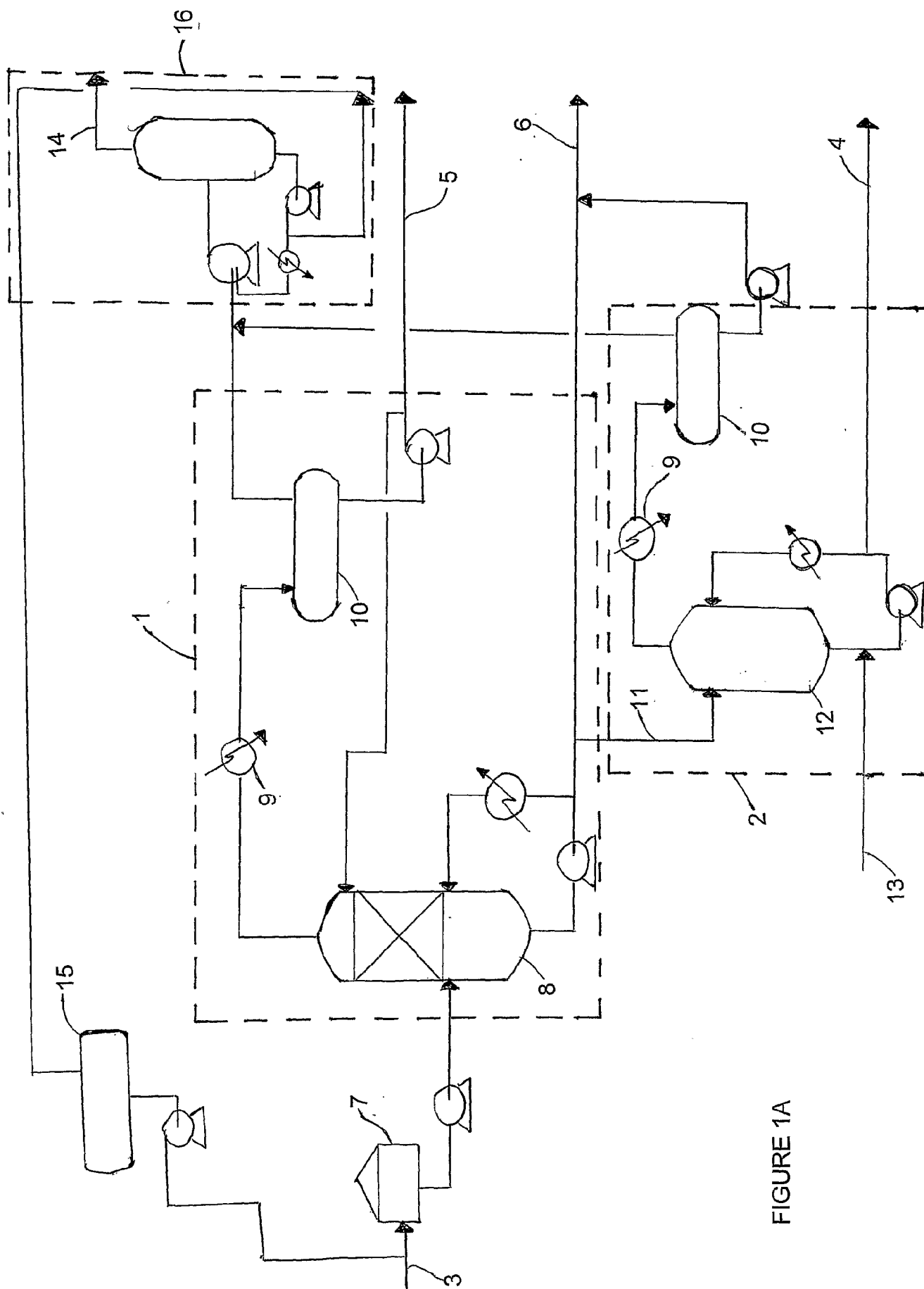


FIGURE 1A

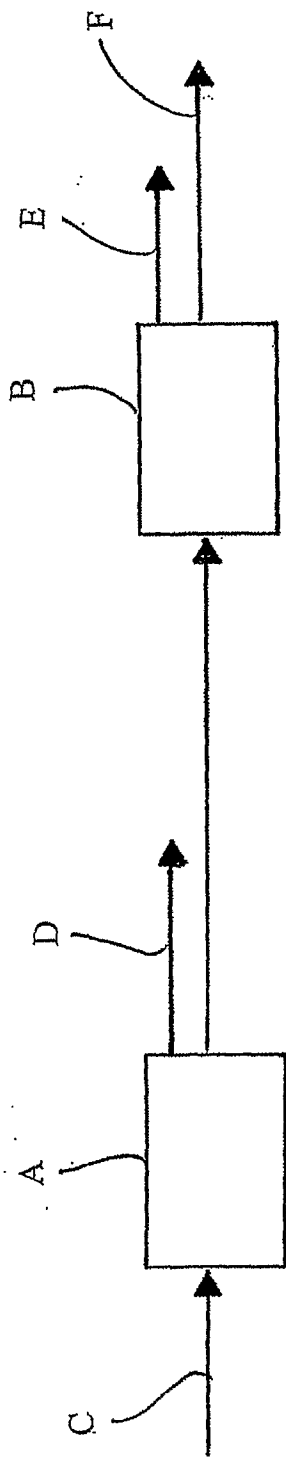


FIGURE 2A

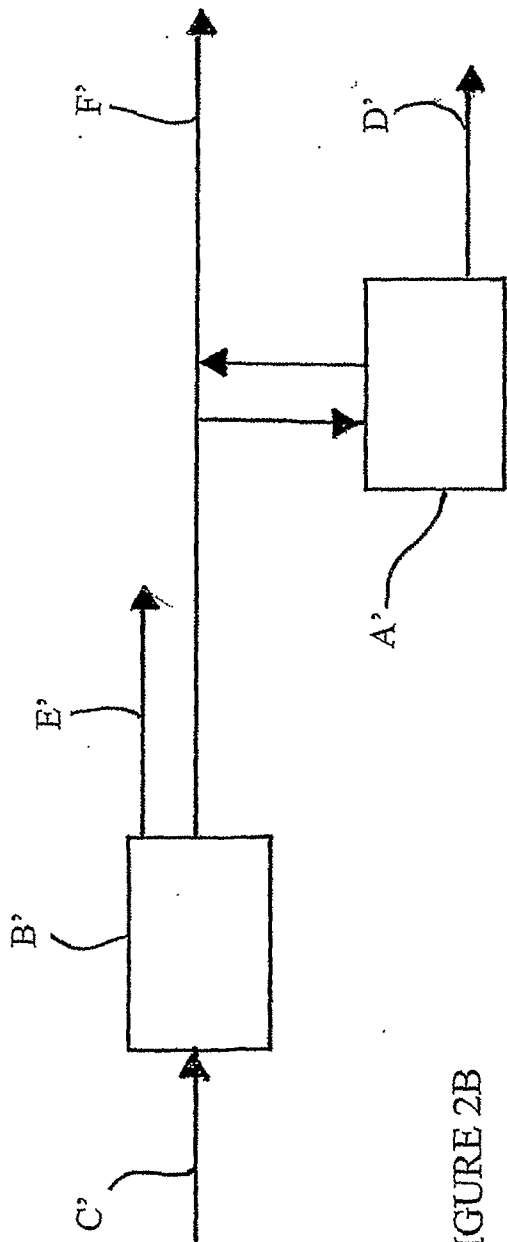


FIGURE 2B

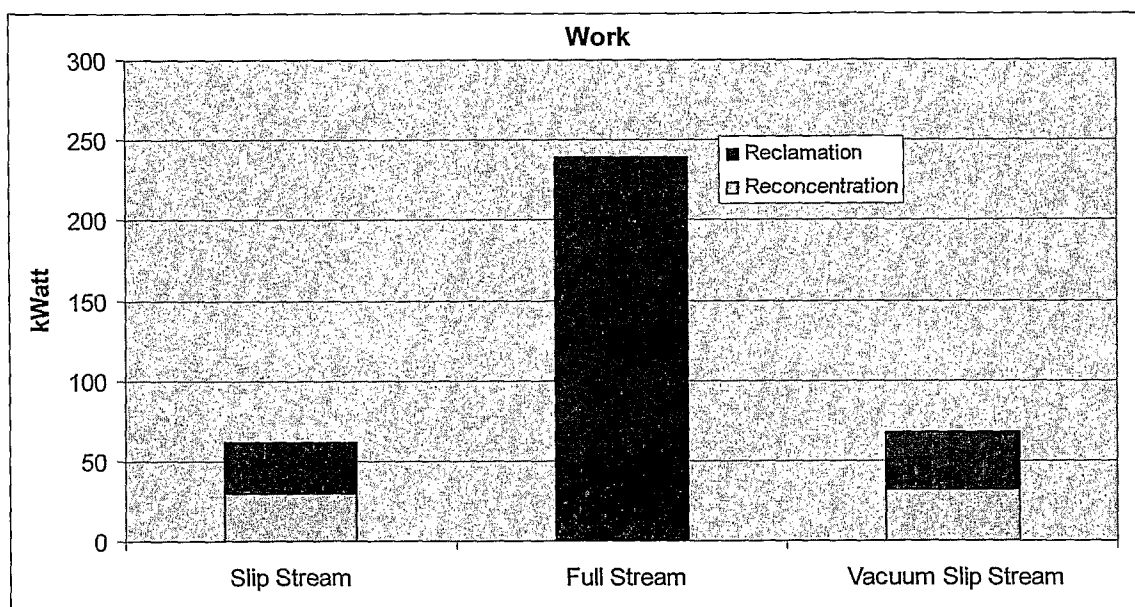


FIGURE 3

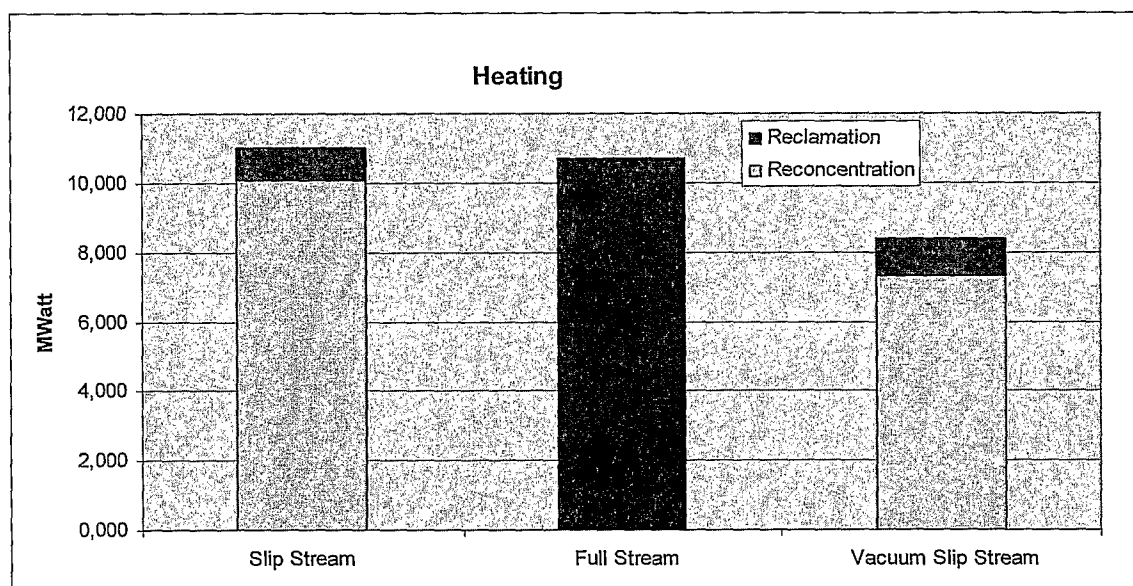


FIGURE 4

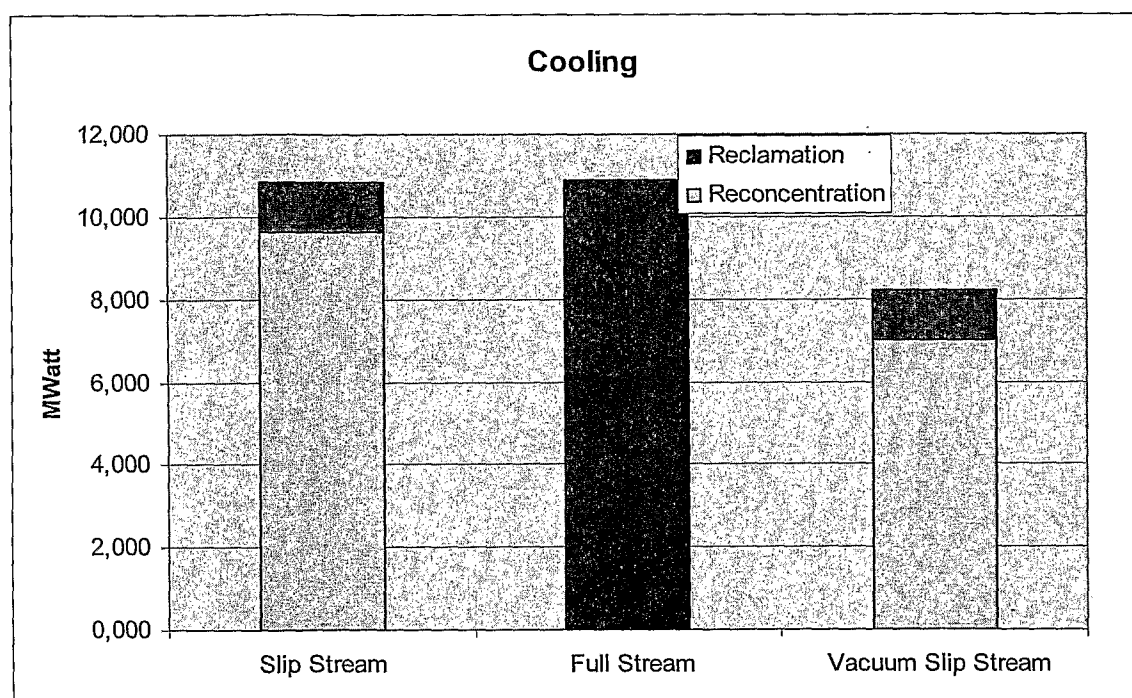


FIGURE 5

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/N02010/000006

## A. CLASSIFICATION OF SUBJECT MATTER

INV. C07C29/86  
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
C07C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, CHEM ABS Data, WPI Data, BEILSTEIN Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                    | Relevant to claim No. |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | US 2005/072663 A1 (LABORIE GERALDINE [FR]<br>ET AL) 7 April 2005 (2005-04-07)<br>cited in the application<br>abstract<br>paragraph [0043] - paragraph [0044]<br>----- | 1-7                   |

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

### \* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/N02010/000006

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
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