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(54) Title: A PROCESS AND A DEVICE FOR GENERATING LOW PRESSURE SUPERHEATED STEAM

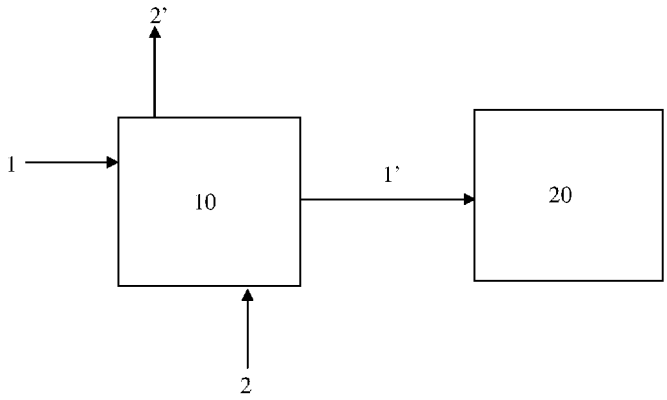


Figure 1

(57) Abstract: The present disclosure relates to a process and a device for generating low pressure superheated steam. The device is defined by a mantle and a plurality of tubes disposed within the mantle. The device has a control valve for automatically controlling the flow of a second stream through the plurality of tubes for controlled transfer of heat from the second stream to the first stream to superheat the first stream and generate low pressure superheated steam. The process comprises feeding the first stream and the second stream to the mantle and the plurality of tubes respectively. Transfer of heat from the second stream to the first stream is permitted to generate low pressure superheated steam from the mantle. Due to this, the consumption of the second stream is reduced as compared to that required during the utilization of sensible heat of the second stream, for generating low pressure superheated steam.

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A PROCESS AND A DEVICE FOR GENERATING LOW PRESSURE SUPERHEATED STEAM

FIELD

The present disclosure relates to the field of chemical engineering. Particularly, the present disclosure relates to a process and a device for generating low pressure superheated steam.

DEFINITIONS

As used in the present disclosure, the following terms are generally intended to have the meaning as set forth below, except to the extent that the context in which they are used indicate otherwise.

Sensible heat is heat exchanged by a system or a fluid that changes the temperature of the system or fluid.

Latent heat is the amount of heat absorbed or released by a fluid undergoing a change of state, at a constant temperature and pressure.

Down gradation of steam refers to sudden change, particularly sudden drop, in the temperature of steam.

BACKGROUND

Steam is introduced into process equipment such as crude distillation units, vacuum distillation units, diesel strippers, heavy atmospheric gas oil (HAGO) strippers, and the like, to reduce the partial pressure of hydrocarbons contained in the process equipment, thereby facilitating the separation of hydrocarbons. Particularly, the steam used as a stripping agent or medium in the crude distillation units, vacuum distillation units, diesel strippers, heavy atmospheric gas oil (HAGO) strippers, and the like comprises approximately 73% medium pressure steam and 27% low pressure steam, in the case of mixing the low pressure steam and medium pressure steam for superheating.

Steam also acts a mass transport medium, and it facilitates in pulling out unwanted contaminants from the process fluid. Moreover, depending upon the requirement, high

pressure (HP), medium pressure (MP) and low pressure (LP) grades of steam are used. The use of the LP steam is based on following factors:

1. it is the cheapest form of steam;
2. excess availability at the point of application; and
3. if the MP steam is not available free/excess, it would be used as a substitute for the MP steam to cater the requirement of the process requirement, thereby reducing the consumption of the MP steam.

Particularly, there is a need to superheat the steam so as to prevent the condensation of the steam. Slug of condensate in stripping steam will upset stripping trays in a column. Apart from the possible mechanical upset, the stripping efficiency of the steam is reduced if the steam is wet, since the moisture content of the steam would vaporize, due to which the sensible heat of the steam from the side-product will be wasted, thereby resulting in sub-cooling of the steam and reducing its flash point below specification.

Therefore, the steam should at least be "freed" from the condensate. The stripping effect depends on the amount of steam injected, and the stripping efficiency depends on the correct degree of superheating of the stripping steam.

Conventionally, the low pressure superheated steam may be generated by mixing the medium pressure steam with the low pressure steam or by superheating in heater coils. However, there are certain drawbacks associated with the conventional process such as:

- in the case of mixing the MP steam with the LP steam, the amount of the medium pressure steam consumed for the generation of the low pressure superheated steam is significantly more; and it results in down gradation of the medium pressure steam (i.e., the heat content of the medium is not utilized efficiently); and
- in the case of superheating, steam coils need to be installed in heaters. Due to this, the amount of energy available or required for heating the process fluid will be reduced, thereby resulting in the substitution of process coils by steam coils.

There is, therefore, felt a need for an alternative to generate low pressure superheated steam that obviates the above mentioned drawbacks.

OBJECTS

Some of the objects of the present disclosure, which at least one embodiment herein satisfies, are as follows.

It is an object of the present disclosure to ameliorate one or more problems of the prior art or to at least provide a useful alternative.

An object of the present disclosure is to provide a process and a device for generating low pressure superheated steam.

Another object of the present disclosure is to provide a process and a device for reducing the consumption of medium pressure steam.

Still another object of the present disclosure is to provide a process and a device for reducing down gradation of medium pressure steam.

Other objects and advantages of the present disclosure will be more apparent from the following description, which is not intended to limit the scope of the present disclosure.

SUMMARY

The present disclosure provides a process for generating low pressure superheated steam. The process comprises feeding a first stream to a mantle of a device at a temperature in the range of 130°C to 150°C. A second stream is simultaneously fed to a plurality of tubes of the device at a temperature in the range of 200°C to 250°C. Transfer of heat from the second stream to the first stream is permitted in the device to generate low pressure superheated steam from the mantle. The temperature of low pressure superheated steam can be in the range of 180°C to 215°C.

The flow-rate of the second stream is lower than the flow-rate of the first stream. The second stream can be fed to the plurality of tubes at a flow-rate in the range of 1 TPH to 1.5 TPH; and the first steam can be fed to the mantle at a flow-rate in the range of 27 TPH to 35 TPH.

The present disclosure also provides a device for generating low pressure superheated steam. The device is defined by a mantle and a plurality of tubes disposed within the mantle. The mantle is configured to receive a first stream; and the plurality of tubes are configured to receive a second stream.

The device has a control valve for automatically controlling the flow of the second stream through the plurality of tubes for controlled transfer of heat from the second stream to the first stream to superheat the first stream and generate low pressure superheated steam.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWING

A process and a device for generating low pressure superheated steam will now be described with the help of the accompanying drawing, in which:

Figure 1 depicts a flow-diagram for generating low pressure superheated steam and utilizing low pressure superheated steam in different process equipment in accordance with the present disclosure.

Table illustrates a list of the following reference numerals:

Components	**Reference numeral**
Device	10
First stream	1
Second stream	2
Residual stream	2’
Low pressure superheated steam	1’
Process equipment	20

DETAILED DESCRIPTION

Conventionally, sensible heat of medium pressure steam can be utilized for generating low pressure superheated steam. However, there are certain drawbacks associated with the

conventional process such as the consumption of the medium pressure steam for the generation of the low pressure superheated steam is significantly high, down gradation of the medium pressure steam (i.e., the heat content of the medium pressure steam is not utilized efficiently), and the conventional process is not energy efficient.

The present disclosure, therefore, envisages a process and a device for generating low pressure superheated steam, so as to obviate the above mentioned drawbacks.

The device and the process for generating low pressure superheated steam are described with reference to **Figure 1**.

In one aspect of the present disclosure, the device (10) is defined by a mantle and a plurality of tubes disposed within the mantle. The mantle is configured to receive a first stream; and the plurality of tubes are configured to receive a second stream. The device has a control valve for automatically controlling the flow of the second stream through the plurality of tubes for controlled transfer of heat from the second stream to the first stream to superheat the first stream and generate low pressure superheated steam.

Particularly, the plurality of tubes is in heat exchange relationship with the mantle to facilitate heat transfer between the first stream (1) and the second stream (2). Typically, the first stream (1) is low pressure steam and the second stream (2) is medium pressure steam.

In another aspect of the present disclosure, the process is described in the steps provided herein below.

The first stream (1) is fed to the mantle at a temperature 130°C to 150°C; and simultaneously the second stream (2) is fed to the plurality of tubes at a temperature in the range of 200°C to 250°C. Transfer of heat from the second stream (2) to the first stream (1) is permitted in the device to generate low pressure superheated steam from the mantle. The temperature of low pressure superheated steam is in the range of 180°C to 215°C.

The flow-rate of the second stream (2) fed to the plurality of tubes is lower than the flow-rate of the first stream (1) fed to the mantle.

The flow-rate of the first stream (1) is in the range of 27 TPH to 35 TPH; and the flow-rate of the second stream (2) is in the range of 1 TPH to 1.5 TPH.

In accordance with the present disclosure, the latent heat of the second stream (2) is utilized to heat the first stream (1) and generate low pressure superheated steam (1'), thereby reducing the consumption of the second stream (2) by 95 percent of the total amount of the second stream (2) required for generating low pressure superheated steam (1') using the conventional process; and reducing the down gradation of the second stream (2) to approximately 95 percent.

Particularly, while generating low pressure superheated steam (1'), the heat content in the second stream (2) is reduced, thereby condensing the second stream (2) to form a residual stream (2'). The second stream (2) leaving the plurality of tubes is in the form of the residual stream (2').

Low pressure superheated steam (1') can be utilized in different process equipment (20) such as crude distillation units, vacuum distillation units, diesel strippers, heavy atmospheric gas oil (HAGO) strippers, and the like, to reduce the partial pressure of hydrocarbons and facilitate the separation of lighter hydrocarbons contained in the process equipment (20).

The present disclosure is further described in light of the following laboratory experiments which are set forth for illustration purpose only and not to be construed for limiting the scope of the disclosure. The following laboratory experiments can be scaled up to industrial/commercial scale and the results obtained can be extrapolated to industrial scale.

Experiments 1 to 4:

Different experiments were carried out by varying the temperature and flow-rate of the first stream (1) and the second stream (2) passing through the mantle and the plurality of tubes respectively. The experimental details are summarized in the table provided herein below.

Table:

Expt. Nos	**Parameters**	**First stream**	**Second stream**	**Low pressure superheated steam**	**% reduction in down gradation of second steam**
1	Temp (°C)	147	200.5	180	95
	Flow-rate (TPH)	27	1	27	

2	Temp (°C)	140	210	180	92
	Flow-rate (TPH)	27	1.5	27	
3	Temp (°C)	135	205	185	92
	Flow-rate (TPH)	25	1.4	25	
4	Temp (°C)	150	220	185	95
	Flow-rate (TPH)	35	1.3	35	

Conclusion:

From the above table, it is evident that by passing the first stream and the second stream through the mantle and the plurality of tubes respectively, particularly by utilizing the latent heat of the second stream, low pressure superheated steam is generated. From the above table, it is also evident that, by utilizing the latent heat of the second stream, down gradation of the second stream is reduced.

TECHNICAL ADVANCES AND ECONOMICAL SIGNIFICANCE

The present disclosure described herein above has several technical advantages including, but not limited to, the realization of a process and a device that:

- is capable of generating low pressure superheated steam by utilizing the latent heat of the second stream;
- is capable of reducing the amount of the second stream required for generating low pressure superheated steam;
- is capable of avoiding the use of the second stream as a low grade heat option to provide the additional temperature to the first stream, wherein the first stream with increased temperature can suffice the requirement;
- is economical and energy efficient; and
- is capable of reducing the carbon emission and in turn reduces green footprint.

The disclosure has been described with reference to the accompanying embodiments which do not limit the scope and ambit of the disclosure. The description provided is purely by way of example and illustration.

The embodiments herein and the various features and advantageous details thereof are explained with reference to the non-limiting embodiments in the following description. Descriptions of well-known components and processing techniques are omitted so as to not unnecessarily obscure the embodiments herein.

The foregoing description of the specific embodiments so fully revealed the general nature of the embodiments herein that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments herein have been described in terms of preferred embodiments, those skilled in the art will recognize that the embodiments herein can be practiced with modification within the spirit and scope of the embodiments as described herein.

CLAIMS:

1. A process for generating low pressure superheated steam, said process comprising the following steps:
    a) feeding a first stream to a mantle of a device at a temperature in the range of 130°C to 150°C;
    b) simultaneously feeding a second stream to a plurality of tubes of said device at a temperature in the range of 200°C to 250°C; and
    c) permitting transfer of heat from said second stream to said first stream in said device to generate low pressure superheated steam from said mantle.
2. The process as claimed in claim 1, wherein the flow-rate of said second stream is lower than the flow-rate of said first stream.
3. The process as claimed in claim 2, wherein said second stream is fed to said plurality of tubes at a flow-rate in the range of 1 TPH to 1.5 TPH.
4. The process as claimed in claim 2, wherein said first steam is fed to said mantle at a flow-rate in the range of 27 TPH to 35 TPH.
5. The process as claimed in claim 1, wherein the temperature of low pressure superheated steam is in the range of 180°C to 215°C.
6. A device for generating low pressure superheated steam, defined by a mantle and a plurality of tubes disposed within said mantle, wherein said mantle is configured to receive a first stream; and said plurality of tubes are configured to receive a second stream, and said device has a control valve for automatically controlling the flow of said second stream through said plurality of tubes for controlled transfer of heat from said second stream to said first stream to superheat said first stream and generate low pressure superheated steam.

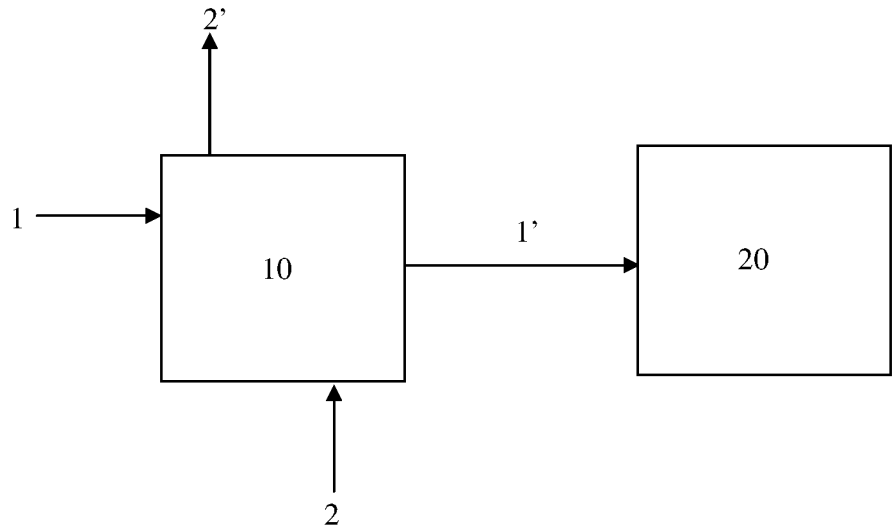


Figure 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2017/055232

A. CLASSIFICATION OF SUBJECT MATTER
F22G1/00 Version=2017.01

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)

F22G1/00

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 practicable, search terms used)

Patseer, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US20070245736 A1, (EASTMAN CHEMICAL CO),7 January 2009, (Paragraphs [0001],[0007],[0037],[0062]-[0065];Claims 1,2,13;Figures 1-5)	1,5
Y	(Paragraphs [0001],[0007],[0037],[0062]-[0065];Claims 1,2,13;Figures 1-5)	2-4,6
Y	US 20150276210 A1,(TOKUDEN CO., LTD.), 1 October 2015, (Abstract; Paragraphs [0008],[0036];Claim 1,Figures 1-4)	2-4,6

☐ 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 application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT
Information on patent family members

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Citation	Pub.Date	Family	Pub.Date
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