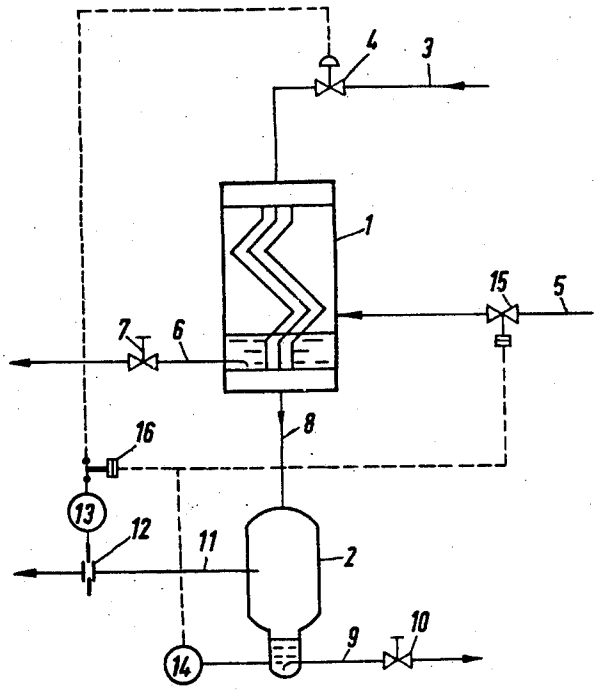
April 7, 1964 F. RANKE 3,127,751

PROCESS AND APPARATUS FOR THE VAPORIZATION OF LIQUID

Filed July 20, 1961




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3,127,751

Patented Apr. 7, 1964



3,127,751

# PROCESS AND APPARATUS FOR THE VAPORIZATION OF LIQUID

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Filed July 20, 1961, Ser. No. 125,595
Claims priority, application Germany July 20, 1960
5 Claims. (Cl. 62—52)

The present invention relates to the vaporization of low boiling point liquids containing high boiling point mixtures down to a residual liquid, more particularly, to a method and apparatus for the vaporization of liquid oxygen containing hydrocarbons down to a small quantity of residual liquid by passing the oxygen in heat exchange relationship with a gas whereby the gas is condensed.

The oxygen which is obtained through the rectification of air contains high boiling point mixtures, in particular hydrocarbons. When the liquid oxygen is vaporized, the resulting enrichment of these high boiling point mixtures presents a danger of explosion.

It has been known to eliminate this risk by evaporating the liquid oxygen to such a degree that the concentration of the hydrocarbons in the residual liquid is less than the explosion limit. In general, this quantity of residual liquid is less than 1% and usually from 0.5 to 1% of the quantity of liquid which is to be evaporated. In known processes the residual liquid is separated from the gases emerging from the vaporizer. The residual liquid is then either discharged or purified in absorbers.

The supply of the liquid oxygen into the vaporizer can be so adjusted that it exceeds the quantity which is to be vaporized by the amount of the residual liquid. As a result, this residual liquid will continuously accumulate in the separator.

This method has the disadvantage that relatively small variations in the supplied and/or vaporized substance produces considerable variations in the amount of the residual liquid which is formed and also the quantity of the liquid which is collected in the separator. Accordingly, either too much residual liquid is separated or the liquid is evaporated over a prolonged period up to dryness.

There is another disadvantage in this known method. The pipes of the vaporizer which are arranged in parallel are supplied with varying amounts of the liquid because of the irregular distribution of the supplied liquid oxygen. In those pipes which are constantly supplied with less liquid, the liquid is evaporated to dryness and accordingly, a particularly high amount of hydrocarbons will accumulate.

It is therefore the principal object of this invention to provide a novel and improved method and apparatus for the vaporization of low boiling point liquids containing higher boiling point mixtures down to a small quantity of residual liquid.

It is another object of this invention to obtain in the present method and apparatus an automatic adjustment of the level of residual liquid so as to continuously obtain a complete scavenging of the evaporator.

In the present invention the vaporizer runs in two distinct operating periods. In the first operating period the vaporizing efficiency is considerably greater than corresponds to the supply of liquid which is to be vaporized. As a result, no residual liquid will accumulate during this operating period even if there are fluctuations in the operating conditions.

In the second operating period the vaporizing efficiency of the vaporizer is considerably less than correpsonds to the supplied quantity of liquid to be vaporized. Accordingly, a considerable quantity of residual liquid will accumulate within a short period of time. As a further



result all of the vaporizer pipes will be effectively scavenged. Normally, the first operating period will have a greater duration of time than the second operating period.

The first operating period can be obtained by supplying the evaporator with considerably less liquid oxygen than the evaporator can evaporate. The change-over of the evaporator from the first operating period to the second operating period may be accomplished in several different ways. One possibility comprises maintaining constant the quantity of gas effecting the vaporization but supplying more liquid in the second operating period so that a larger portion of the liquid passes through the vaporator without being vaporized.

A second method of changing over from the first operating period to the second operating period comprises maintaining constant the supply of liquid but to interrupt or to considerably reduce the supply of the gas which evaporates the liquid.

Valves are provided in both the gas and liquid supply lines with the valves being operated by means of a time switch. The time switch is adjusted to operate intermittently so that the duration of the second operating period can be adjusted. By increasing or reducing the second operating period the quantity of residual liquid accumulating can either be increased or decreased.

Other advantages and objects of the present invention will be apparent upon reference to the accompanying description when taken in conjunction with the single drawing.

The drawing is a schematic diagram showing the various components utilized together with the evaporator and separator in order to carry out the method of this invention.

The apparatus of this invention comprises an evaporator **1** which has, in cross-section, a plurality of parallel tubes or pipes. There is a separator **2**.

A liquid oxygen supply line **3** having a control valve **4** is connected to the top of the evaporator **1**.

A gas supply line **5** introduces nitrogen into the central portion of the evaporator **1**. A conduit **6** having a valve **7** drains off liquid nitrogen from the evaporator **1** and may possibly be connected to a rectifying column. A line **8** connects the bottom of the evaporator **1** with the separator **2**. A line **9** having a control valve **10** therein is connected with the bottom of the separator **2** wherein the residual liquid accumulates. A line **11** draws off gaseous oxygen from the separator **2** and has a measuring device **12** which is connected to a flow controller **13**. The flow controller maintains the vaporized quantity of oxygen constant at a desired quantity by adjusting the control valve **4**. In order that the supplied quantity of liquid oxygen is not exposed to any variations, during the first operating period and accordingly remains below the vaporizing efficiency, it is appropriate to adjust the valve **4** to automatically act as a function of the flow of liquid oxygen therethrough.

A control valve **15** is provided in the gas supply line **5** and is connected to a time switch **16**.

In the method of this invention, which can be carried out with the apparatus as described above, the liquid oxygen which is to be vaporized flows into the evaporator **1** through the supply line **3**. Gaseous nitrogen is introduced into the evaporator through the gas supply line **5**. The nitrogen is brought into heat exchanging relationship with the oxygen and condenses. The liquid nitrogen is then drained off through the line **6**.

The mixture of liquid and gaseous oxygen or only gaseous oxygen which is formed in the evaporator **1** then flows through the line **8** into the separator **2**. The residual liquid accumulates in the bottom of the separator **2** and is continuously drawn off through the line **9**.

The gaseous oxygen is tapped from the separator **2**

through the line **11** and flows through the measuring device **12** of the flow controller **13**.

The liquid level controller **14** can be adjusted to a predetermined minimum or maximum liquid level in the accumulator **2**. When the minimum liquid level occurs as a result of the continuous draining of the liquid through the line **9** the valve **15** will be automatically closed. Thus, the evaporator **1** will no longer be supplied with gas and the liquid oxygen entering the evaporator through the line **3** will pass therethrough without being vaporized. Accordingly, this liquid oxygen will scavenge all of the pipes in the evaporator.

When the predetermined maximum liquid level occurs in the separator **2**, the valve **15** will open and the entire quantity of liquid oxygen supplied through the control valve **4** will be completely vaporized.

Switch **16** simultaneously opens and closes with the respective opening and closing of the valve **15**. As a result, the control valve **4** is maintained in its adjusted position for the short duration of time during which the reduced flow of gas passes through the flowmeter **12**.

Thus, the combination of controlling devices, one which acts as a function of time and the other acting as a function of the liquid level, can be so coordinated that the change-over to the second operating period is effected by a periodically operating time switch closing the valve **15**; and the change-over to the first operating period is accomplished as a function of the maximum level of the accumulated residual liquid by opening the valve **15** whereby the time switch period covers both the second operating period and the succeeding first operating period.

The present invention has been specifically described in conjunction with the vaporizing of oxygen containing hydrocarbons. However, this process has other uses such as in the vaporization of liquefied hydrocarbons containing nitric oxide.

The apparatus as described above can be operated as a component in an installation for the decomposition of air. In such an installation the gaseous oxygen escaping from the vaporizer leaves the installation while absorbing heat in the mass of the regenerators. Therefore, the change-over from the first operating period to the second operating period and vice versa can be readily controlled by the same mechanism which produces the periodic reversing of the regenerators. Ordinarily, when the regenerators are reversed, there is a time lag during which there is no discharge of gaseous oxygen from the regenerators, thus resulting in a shock on the rectifier and also a temporary upset in the equilibrium steady state conditions of the column. It is, therefore, a preferred embodiment of this invention to operate the vaporizer in such a way as to reduce or eliminate this shock to the air separation system.

This is done by changing over to the second operating period of the vaporizer (build-up of residual liquid oxygen in the separator) by interrupting the flow of the gaseous heating medium to the vaporizer simultaneously with the change-over of the regenerators. In this manner the flow of gaseous oxygen from the separator to the regenerators is reduced simultaneously with the temporary stoppage of the discharge of oxygen from the regenerators, thus reducing or eliminating a buildup of back pressure to the rectifier.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions, and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.



What is claimed as this invention is:

1. A process for the continuous vaporization of low boiling point liquid substance containing higher boiling point mixtures down to a residual liquid, and comprising the steps of passing a gas in heat exchange relationship to the low boiling point substance so that the gas is condensed thereby, and periodically interrupting the supply of gas to the substance to form residual liquid, the moment of interruption being a function of the level of the residual liquid so that the substance is periodically vaporized.

2. A process for the continuous vaporization of low boiling point liquid substance containing higher boiling point mixtures down to a residual liquid, and comprising the steps of passing a gas in heat exchange relationship to the low boiling point substance so that the gas is condensed thereby, and periodically interrupting the supply of gas to the substance so that the substance is periodically vaporized, resuming the flow of gas when a predetermined quantity of residual liquid has accumulated.

3. A process for the continuous vaporization of liquid oxygen containing hydrocarbons down to a residual liquid, and comprising the steps of regulating the quantity of the liquid oxygen which is to be vaporized, passing nitrogen in heat exchange relationship to the liquid oxygen so that the nitrogen is condensed thereby, intermittently forming a residual liquid from the oxygen emerging from the heat exchanging step, and regulating the supply of nitrogen as a function of the residual liquid level.

4. An apparatus for the continuous vaporization of low boiling point liquid substance containing higher boiling point mixtures down to a residual level, and comprising a vaporizer, a separator connected to said vaporizer and having a gas exhaust conduit, a supply line connected to said vaporizer for introducing the liquid substance therein, valve means in said liquid substance supply line, a second supply line connected to said vaporizer to supply a gas for vaporizing the liquid substance, second valve means in said gas supply line, a flow regulator in said gas exhaust conduit and actuating said first valve means in response to the flow of gas therethrough, and means at said separator for closing said second valve means when the residual liquid in the separator reaches a minimum level and for opening said second valve means when the residual liquid reaches a maximum level.

5. A process for the continuous vaporization of low boiling point liquid substance containing higher boiling point mixtures down to a residual liquid in a low temperature rectification installation equipped with groups of alternating regenerators located in the feedstream flowing to the rectifier and in the line conveying the low boiling liquid substance and comprising the steps of passing a gas in indirect heat exchange relationship to the low boiling point substance in a heat exchange zone so that the gas is condensed thereby, and periodically interrupting the supply of gas to the heat exchange zone simultaneously with the change-over of said regenerators so that the substance is periodically vaporized and periodically remains liquid.

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