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STABILIZER CONTROL

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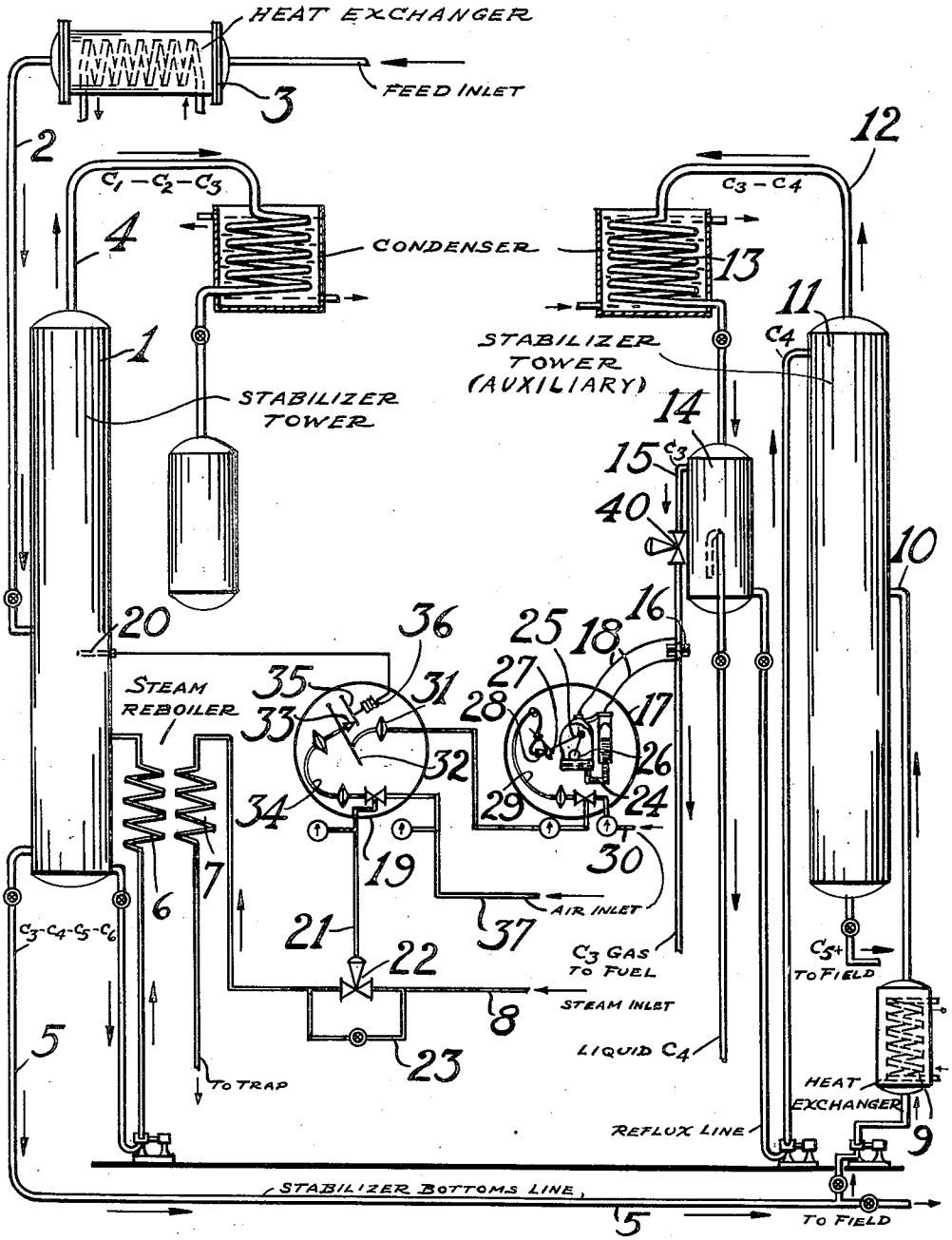

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STABILIZER CONTROL

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4 Claims. (Cl. 196—11)

This invention relates to a method and means for controlling the composition of the bottoms product of a stabilizer tower which is, as is known, a distillation tower employed to remove undesired light ends from a hydrocarbon mixture. This invention is applicable to the treatment of any stock, from a crude to any intermediate fraction thereof. In order to illustrate the essential features of this process, however, it will be described particularly with reference to that type of stabilizer tower known in the art as a depropanizer which is employed for separating propane and lighter hydrocarbons from a cracked distillate, the bottoms of which will consist of hydrocarbons, the lightest member of which is a butane.

In the practical operation of a depropanizer, considerable difficulty is encountered in keeping the concentration of propane in the bottoms at a minimum. This difficulty is largely attributable to variations in temperature and partial pressure in the stabilizer tower. It is customary to analyze the bottoms for propane content to determine what changes in the conditions in the stabilizer tower may be necessary. This method of control leaves much to be desired because by the time the analysis of the sample of bottoms is completed and the determination of the required changes in the conditions which resulted in that sample are made, those conditions oftentimes will have changed quite radically whereby the determinations made from the analysis of the sample become inapplicable.

The main object of this invention is to provide a process of operating a stabilizer tower in which the content of undesirable hydrocarbons (propane in a depropanizer) can be set at a minimum and can be maintained at that minimum by using any change in the content thereof to bring into operation controlling means for the temperature of the stabilizer tower and to provide an apparatus in which the temperature of the stabilizer tower can be so controlled.

It is a further object of this invention to provide a process in which only a portion of the stabilizer bottoms is employed for the operation of the temperature control means and in which the content of undesirable hydrocarbons in the bottoms is greatly magnified in the portion used for temperature control. The advantage of this mode of procedure is that the more highly the content of undesirable hydrocarbons in the bottoms is magnified in the portion of the bottoms used for temperature control, the more sensitive will be the temperature control and the more accurate will be the control of the content of undesired hydrocarbons in the bottoms.

Further objects and advantages of this invention will appear from the following detailed description of the accompanying drawing, the only figure of which is a diagrammatic elevation of one type of apparatus in which the improved process can be carried out.

Referring to the drawing in detail, numeral 1 represents a stabilizer tower of conventional design to which the feed stock is introduced through feed line 2 after passing through heat exchanger 3 and from which overhead, consisting in a depropanizer mainly of C_1, C_2, and C_3 hydrocarbons, is taken off through line 4 and passed to a condenser, and the bottoms, consisting in a depropanizer mainly of C_4, C_5, C_6 and heavier hydrocarbons together with small amounts of C_3 hydrocarbons, is taken off through line 5. The stabilizer tower is also provided with the conventional steam reboiler by means of which the temperature to which the bottom stock is heated is controlled by passing part of the stock out of the tower through a coil 6 which is arranged in heat exchange relation with steam coil 7 fed by steam line 8.

According to this invention, a portion of the stabilizer bottoms from the outlet line 5 is passed through heat exchanger 9 and through line 10 into a pentane stabilizer tower 11 maintained at a temperature suitable for causing C_3 and C_4 hydrocarbons to pass off as overhead and the higher hydrocarbons to pass off as bottoms. The overhead is passed through line 12, through condenser 13 maintained at the temperature necessary to condense C_4 hydrocarbons, and into a chamber 14 where the C_4 hydrocarbons are deposited and from which the C_3 hydrocarbons pass off as overhead through line 15 of fixed capacity.

Line 15 is provided with a diaphragm valve or any other conventional type of pressure regulating valve 40, the purpose of which is to maintain the system under any selected pressure. The advantage accruing from the use of this pressure regulating valve is that by maintaining chamber 14 under pressure the amount of water condensation necessary to effect a clear cut separation of propane and butane vapors can be easily regulated. This pressure regulating valve plays no part in our novel method of control except to build up a pressure in the system when it is started and to maintain that pressure in the customary manner.

Arranged in the line 15 is an orifice plate 16

which forms part of a rate of flow controller 17 of conventional design which is connected to line 15 by the usual small bore gas tubes 18 on either side of the orifice plate 16.

The rate of flow controller 17 is hooked up with a temperature controller 19, also of conventional design, which, in turn, is connected to the thermometer bulb 20 in stabilizer tower 1 and, through line 21, to a diaphragm valve 22 in steam line 8 which latter is provided with a by-pass 23 around said diaphragm valve.

Although the two control devices are of conventional design, they are operatively connected for the purpose of this invention in a manner not hitherto usual. As in the usual rate of flow controller, each of tubes 18 is connected to one of the legs of a U-tube 24 containing mercury or any other suitable liquid. One leg of the U-tube is enlarged and has pivoted therein a bell crank 25, one arm of which carries a float 26, the position of which is controlled by the level of liquid in the enlarged leg of the U-tube and the other arm of which presses against a flap valve 27 which, in turn, is mounted to move relative to a nozzle 28 on a bleeder line 29 branched off from a main air line 30.

Ordinarily, air line 30 is connected to a diaphragm valve which controls the rate of flow in the line to which the tubes 18 are connected, whereby any change in the rate of flow of fluid through said line is reflected in the liquid levels in the two legs of the U-tube and in the amount of air expelled through the bleeder line 29. In the present case, however, the air line 30 is connected to a bellows 31 in the temperature control device. This bellows which is attached to one end of arm 32, which in turn is pivoted at its other end to a fixed point adjusts the position of said arm 32 to which is connected the nozzle 33 of a bleeder line 34. The bellows 31 adjusts the position of arm 32 by expanding and contracting with a change of fluid pressure in line 30. The flap valve 35, which operates in conjunction with the nozzle 33 to control the amount of air expelled through the bleeder line, and which is pivoted to a fixed point at its upper end is actuated by the movement of the expansion coil 36 connected to the thermometer 20 and to said flap valve. The air line 37 in the temperature controller is connected to the diaphragm valve 22 in the steam line 8 as before described. Thus, instead of the position of the nozzle 33 of the temperature controller being set by hand in the conventional manner, it is set by the pressure of air in the air line 30 which in turn is regulated by the flow of gas in the line 15.

In the operation of this system the parts are set so that the stabilizing tower will operate at a selected temperature, at which a certain percentage of propane will remain in the bottoms. Any change in the flow of propane through line 15 will change the pressure in line 30, which in turn regulates the position at nozzle 33, as described above. An increase in the flow of propane in line 15 will close nozzle 28 and increase the pressure in line 30, causing nozzle 33 to be moved away from valve 35. An increase in temperature in the stabilizing tower as measured at 20 causes element 36 to tend to close valve 35. The pressure in line 21 depends upon the relative positions of nozzle 33 and valve 35. An increase in pressure in line 21, caused by a closing of nozzle 33, tends to cause valve 22 to close, thereby reducing the flow of heating medium to the steam re-boiler. Since the relative positions of nozzle 33 and flap valve 35 are governed both by the content of propane in the bottoms of the stabilizer and the temperature of the stabilizer as measured at 20, it follows that a change in either of these factors is reflected in the flow of heating medium to the re-boiler.

The system described above could be so adjusted that any flow of propane whatsoever in the line 15 would cause an increase in the feed of steam through steam line 8 and a consequent increase in the temperature of the stabilizer tower 1. It is preferred, however, to set the system so as to permit a minimum flow of propane through the line 15 so that in the event that the temperature in the stabilizer tower becomes so high as to tend to send off C_4 hydrocarbons as overhead, the flow of steam in the line 8 will be reduced with a consequent reduction in temperature of the tower 1.

For the sake of illustration, let it be assumed that the temperature in tower 11 is so adjusted as to cause 30% of the feed to that tower to pass off as overhead. All the propane in the feed will be contained in the overhead. Consequently, if the bottoms from the stabilizer tower 1 contain 1% of propane, the overhead from tower 11 will contain about 3% of propane. It follows that any increase or decrease in the concentration of propane in the bottoms from stabilizer tower 1 is reflected three-fold in the flow of gas through line 15 and in the control devices.

In addition to controlling the propane content of the stabilizer bottoms from stabilizer tower 1, this method of control also affords a positive means of regulating the pressure on the second stabilizer tower 11. If no gas were released from the second stabilizer tower 11, i. e. all the overhead vapor from tower 11 being condensed in condenser 13, the pressure control of this tower would depend on the temperature of the distillate in chamber 14, which, in turn, depends on the cooling water temperature. In order to avoid the pressure fluctuations due to changes in water temperature, it is necessary to regulate the water going to the condensers of the second stabilizer 11 or install a pressure regulator in the vapor line 12 from the stabilizer tower 11, unless the above method of control is used.

It is to be understood that this invention is not restricted to the precise arrangement of procedural details described above but can be practiced by the utilization of any means for measuring and controlling the undesired hydrocarbons in the bottoms and utilizing these hydrocarbons to bring into operation means for controlling the temperature in the stabilizer tower.

The nature and objects of this invention and a specific embodiment thereof, which are to be taken as illustrative rather than limitative, having been described, what is claimed as new and useful and is desired to be secured by Letters Patent is:

1. A process for controlling the composition of the bottoms of a stabilizing tower, which comprises regulating the temperature conditions of the stabilizing tower to retain in the bottoms a certain percentage of the highest boiling substance desired in the overhead, removing the bottoms from the stabilizing tower, separating said highest boiling substance from a selected portion of said bottoms, passing said highest boiling portion through a passage of fixed capacity, causing the rate of flow of said highest boiling portion through said passage to be directly proportional to the volume of said highest boiling portion in

said bottoms, and controlling the temperature in the stabilizer tower by the rate of flow of said highest boiling substance through said passage.

2. A stabilizing plant comprising a stabilizer tower, means for regulating the conditions in said tower so as to retain in the bottoms a certain percentage of the highest boiling substance desired in the overhead, means for removing the bottoms from said tower, means for separating said substance from a selected portion of said bottoms, a passage of fixed capacity through which said separated substance must pass, whereby the rate of flow of said substance through said passage varies with the volume of said substance and means operated in accordance with the rate of flow of said substance through said passage for controlling the temperature of the stabilizer tower.

3. A stabilizing plant comprising a stabilizer tower, means for regulating conditions in said tower so as to retain in the bottoms a certain percentage of the highest boiling substance desired in the overhead, means for removing the bottoms from said tower, means for removing said highest boiling substance from a selected portion of said bottoms, a passage of fixed capacity through which said highest boiling substance must pass upon being removed from said bottoms, whereby the rate of flow of said substance through said passage, is directly proportional to the volume of said substance in said bottoms, means for heating the bottoms in the stabilizer tower, means for controlling said heating means operated by the pressure of a stream of gas and means operated in accordance with the rate of flow of said highest boiling substance for regulating the pressure of said stream of gas.

4. A stabilizing plant according to claim 2 in which the means operated by the rate of flow of the highest boiling substance for controlling the temperature of the stabilizer tower comprises a steam reboiler, a feed line for steam to said reboiler, a diaphragm valve in said feed line, means for conducting a stream of air against said diaphragm valve for regulating its position, means comprising a bleeder line provided with an exhaust nozzle for controlling the pressure of said stream of air, means operated by a second stream of air for regulating the amount of air expelled through said nozzle, means comprising a bleeder line provided with exhaust nozzle for regulating the pressure of said second stream of air and means operated in accordance with the rate of flow of said highest boiling substance for controlling the amount of air given off by said second exhaust nozzle.

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