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VAPOR PRESSURE MONITORING

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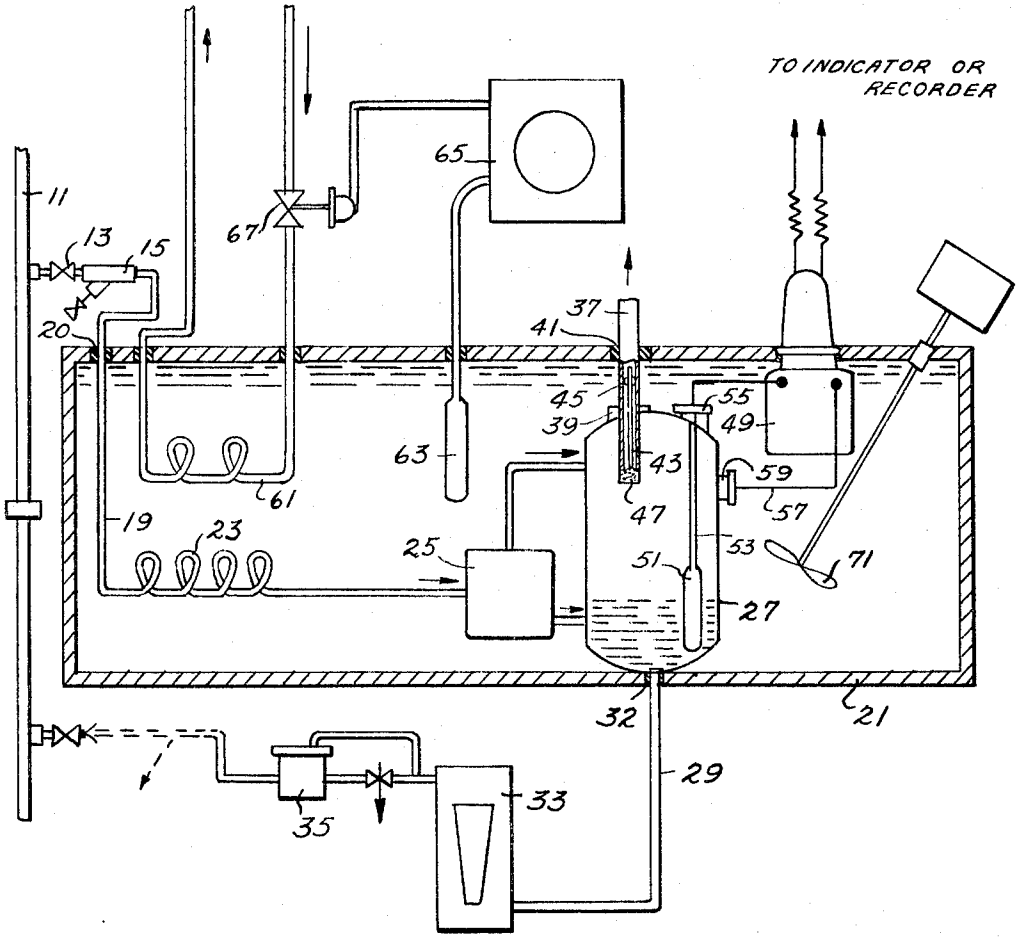

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VAPOR PRESSURE MONITORING

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This invention relates to vapor pressure detecting, and more particularly to the monitoring of the vapor pressure of a stream of material such as commercial liquified propane gas.

It is well known that the value of certain materials may be enhanced over and above their product values when such materials are blended with other materials. For example, in the manufacture of commercial propane, controlled amounts of ethane may be added to the propane LPG (liquified petroleum gas) to increase the vapor pressure of the propane, which is normally 186 p.s.i.a. at 100° F. The vapor pressure of the commercial propane may be increased in this manner to the maximum permitted by ASTM standards, which is 210 p.s.i.g. at 100° F. as defined by ASTM–D1267–55, "Vapor Pressure of Liquified Petroleum Gases."

One of the problems which arises in connection with the upgrading of the value of material such as ethane in the manner pointed out above is the requirement for the careful control of the amounts of such material which are added to the blending materials. Heretofore it has been common practice to meet this control problem and to maintain constant the consistituency of the blend by means of laboratory testing of vapor pressure. By means of instruments such as disclosed here the blending product is continuously sampled and vapor pressure readings are taken of the samples. Variations in the sample vapor pressure indicates variations in the blend constituency and modifications in the blend are made accordingly. The present invention provides an improved method and means for providing the monitoring required for blending operations such as those described above.

In accordance with the present invention, a stream of liquid propane is sampled and a pool is formed with the sample in a measuring chamber. The sampling of the stream of propane is continuous so that new propane from the stream is continuously added to the pool. Propane is also continuously removed from the pool and returned to the main propane stream so that the pool is part of a continuously flowing sample stream. The measuring chamber is immersed in an oil bath maintained at 100° F. and the propane flows through a heat exchanger in this bath before being added to the pool. A standard liquid comprising a blend of propane and ethane is selected to have a vapor pressure of just below 210 p.s.i.g. at 100° F., which vapor pressure is the target value desired in the main stream of commercial propane. The standard liquid is placed in a closed container, which is immersed in the pool of propane forming part of the sample stream of propane. A differential vapor pressure detector, which is also immersed in the oil bath maintained at 100° F., is connected to detect any difference in pressure between the closed container containing the standard liquid and the measuring chamber containing the pool of liquid propane forming part of the sample stream of propane. The fact that the standard liquid is in a container immersed in the sample stream of propane ensures that the temperature of the standard liquid is precisely the same as the temperature of the sample stream. The oil bath maintained at 100° F. keeps both the standard liquid and the pool in the sample stream as close as possible to 100° F. Because

of this combination of features, more accurate monitoring of the vapor pressure of the liquid stream is obtained than can be obtained with the systems of the prior art. The fact that the differential vapor pressure detector is also immersed in the oil bath further increases the accuracy of the monitoring. The measuring chamber is vented with a capillary tube to permit non-condensibles to escape from the measuring chamber. This capillary tube is essential when the liquid being monitored is a mixture.

Accordingly, a principal object of the present invention is to provide an improved system for monitoring the vapor pressure of liquids.

Another object of this invention is to provide a more accurate system for monitoring the vapor pressure of liquids.

A further object of this invention is to provide a more accurate apparatus for monitoring the vapor pressure of liquids.

A still further object of this invention is to provide a more accurate method for monitoring the vapor pressure of liquids.

A still further object of this invention is to provide an improved system for monitoring the vapor pressure of liquid propane.

Further objects and advantages of the present invention will become readily apparent as the following detailed description of the invention unfolds and when taken in conjunction with the single figure of the drawings which schematically illustrates the apparatus and method of the present invention.

As shown in the drawings, the commercial propane, the vapor pressure of which is to be monitored, flows through a line **11**. A sample of the propane is tapped from the line **11** and flows through a valve **13** and then through a strainer **15**. From the strainer **15** the sample of the propane flows through a line **19** which passes into a tank **21** through a seal **20**. Within the tank **21** the line carrying the sample of propane is surrounded by an oil bath which is maintained at a controlled temperature. Within the oil bath in the tank **21**, the sample of propane passes from the line **19** through a coil **23**, where the sample is heated to the temperature of the oil bath. After passing through the coil **23**, the propane sample flows to a valve **25** which is also immersed in the oil bath within the tank **21**. The valve **25** admits a controlled amount of the propane sample to a measuring chamber **27**, which is also immersed in the oil bath within the tank **21**. The valve **25** permits just enough of the sample to flow into the chamber **27** to maintain the chamber **27** 20% full of liquid propane. Within the chamber **27**, the vapor and liquid propane approach an equilibrium. Liquid is withdrawn from the chamber **27** from the bottom through a line **29**, which passes out through the wall of the tank **21** through a seal **32**. The propane withdrawn through the line **29** flows through a flow rate indicator **33** and then through a flow regulator **35**. From the flow regulator **35** the propane flows back to the line **11** at a suitable point. The flow regulator **35** maintains the rate of propane flow out of the chamber **27** through the line **29** constant. A vent tube **37** passes through the top of the chamber **27** in a seal **39** and through the top of the tank **21** in a seal **41**. A capillary tube **43** is centrally mounted in the tube **37** by means of a seal **45** which surrounds the capillary tube **43** and completely seals off the space between the capillary tube **43** and the vent tube **37** so that the top of the chamber **27** is open to the vent tube **37** only through the capillary tube **43**. The vent tube **37** leads to atmosphere or to a flare line. The capillary tube **43** permits a very small amount of vapor to be continuously

released from the top of the chamber **27**. This operation serves to purge traces of non-condensibles which otherwise would accumulate within the chamber **27**. A screen **47** may be used to cover the bottom of the vent tube **37** to prevent the capillary tube **43** from clogging. A differential pressure measuring transmitter **49** is also mounted within the tank **21** and immersed in the oil bath. A closed container comprising a bulb **51** is immersed in the pool of propane liquid within the chamber **27**. A line **53** transmits the vapor pressure within the bulb **51** to the transmitter **49**. The line **53** passes through the wall of the chamber **27** at the top thereof in a seal **55**. The pressure transmitter **49** also has an input line **57** which transmits an applied input pressure to the transmitter **49**. The transmitter **49** produces an output signal representing the difference in the pressure transmitted to the unit **49** through the line **57** and the pressure in the bulb **51** transmitted to the unit **49** through the line **53**. In the system of the present invention the line **57** leads into the upper part of the chamber **27** through a seal **59** and senses the vapor pressure in the upper part of the chamber **27**. Thus the differential transmitter **49** will produce an output signal representing the difference in the vapor pressure within the bulb **51** and the vapor pressure within the chamber **27**. The bulb **51** is permanently filled with a standard fluid, which is a standard propane and ethane blend, the vapor pressure of which is selected to be at the desired target value of the propane being monitored flowing through the line **11**. This target value, as pointed out above, is slightly below 210 p.s.i.g. at 100° F. If the vapor pressure of the sample propane liquid flowing through the chamber **27** from the line **11** is above or below this desired target value, it will be indicated by the output signal from the unit **49**.

The oil bath within the tank **21** is maintained at a constant temperature, which in the specific embodiment of the present invention is 100° F. by means of a coil of tubing **61**. The temperature of the oil within the tank **21** is sensed by means of a bulb **63** which transmits a signal representing the temperature to a control unit **65**. In response to the temperature sensed by the bulb **63** the control unit **65** positions a valve **67** which controls the amount of heating fluid flowing through the tubing coil **61**. When the temperature sensed by the bulb **63** starts to drop below 100° F., the control unit **65**, in response thereto, opens the valve **67** a little wider, permitting more heating fluid to flow through the coil **61**, thus causing the temperature of the oil within the tank **21** to be raised again back to 100° F. Likewise, when the temperature of the oil bath in the tank **21** starts to rise above 100° F., the control unit **65**, in response thereto, moves the valve **67** towards its closed position to reduce the amount of heating fluid flowing through the coil **61** to bring the temperature of the oil in the tank **21** back to 100° F. The oil in the tank **21** is continuously circulated by means of a propeller **71** to maintain a uniform temperature throughout the oil bath. The oil bath thus keeps the pool of liquid propane formed in the measuring chamber **27** and the standard liquid in the bulb **51** as close as possible to 100° F., the temperature at which the target value of vapor pressure is measured. Because the bulb **51** is immersed in the pool of liquid propane in the chamber **27**, any slight variation in the temperature of the pool will cause the same change in the temperature of the standard liquid in the bulb **51**. Such small variations in temperature of the pool in the measuring chamber **27** will not cause errors in the output signal from the transmitter **49** since the changes in vapor pressure caused by such variation in temperature will occur in both the pool and in the standard liquid. Thus the transmitter **49** will very accurately detect any variation in the vapor pressure of the propane stream in the line **11** from the target value. This accuracy is further augmented because the transmitter **49** itself is immersed in the oil bath.

Alternative arrangements for providing a constant temperature for the system may be employed. For example, the bath may be heated electrically and the liquid propane stream itself may be used to provide a bath which is closely controlled in a known manner to have a relatively constant temperature. These and many other modifications may be made to the above described specific embodiment of the invention without departing from the spirit and scope of the invention, which is defined in the appended claims.

What is claimed is:

1. An apparatus for continuously determining vapor pressure of liquids comprising a measuring chamber, a closed container suitable for containing a standard fluid within said measuring chamber, means to continuously introduce liquid into said chamber, remove such liquid from said chamber, and maintain a pool of such liquid in said chamber immersing said closed container, means to detect any pressure differential between said container and said chamber, and means to provide a constant temperature bath immersing said measuring chamber.

2. An apparatus for continuously detecting vapor pressure of liquids comprising a measuring chamber, a closed container suitable for containing a standard fluid within said measuring chamber, means to continuously introduce liquid into said chamber, remove such liquid from said chamber, and maintain a pool of such liquid in said chamber immersing said closed container, means to detect any pressure differential between said chamber and said container, and means to maintain the pool of liquid in said chamber at a constant temperature.

3. An apparatus for continuously detecting vapor pressure of liquids comprising a measuring chamber, a closed container suitable for containing a standard fluid in said measuring chamber, means to continuously introduce liquid into said chamber, remove such liquid from said chamber, and maintain a pool of such liquid in said chamber immersing said closed container, means to detect any pressure differential between said chamber and said container, and a capillary tube venting said chamber above the pool of liquid in said chamber.

4. An apparatus for continuously detecting vapor pressure of liquids comprising a measuring chamber, a closed container suitable for containing a standard fluid in said measuring chamber, means to continuously introduce liquid into said chamber, remove such liquid from said chamber and maintain a pool of such liquid in said chamber immersing said closed container, means to detect any pressure differential between said chamber and said container, a capillary tube venting said chamber above the pool of liquid in said chamber, and means to provide a constant temperature bath immersing said measuring chamber.

5. An apparatus for continuously detecting vapor pressure of liquids comprising a measuring chamber, means to continuously introduce liquid into said chamber, remove such liquid from said chamber, and maintain a pool of such liquid in said chamber, a closed container suitable for containing a standard fluid, a differential pressure detector connected to detect any pressure differential between said container and said measuring chamber, and means to provide a constant temperature bath immersing said chamber, surrounding said container, and immersing said differential pressure detector.

6. An apparatus for detectiing vapor pressure of liquids comprising a measuring chamber, a closed container suitable for containing a standard fluid within said measuring chamber, means to continuously introduce liquid into said chamber, remove such liquid from said chamber, and maintain a pool of such liquid in said chamber immersing said closed container, a differential pressure detector connected to detect any pressure differential between said chamber and said container, and a constant temperature bath immersing said measuring chamber and said differential pressure detector.

7. A method of detecting any variation in the vapor pressure of a stream of liquid from a target value comprising the steps of placing a standard liquid having substantially the same composition as said stream and having a vapor pressure at said target value in a closed container, forming a pool with said stream of liquid, immersing said closed container with the said standard liquid therein in said pool, continuously introducing liquid from said stream into said pool, continuously removing liquid from said pool, and detecting any vapor pressure differential between the liquid in said pool and in said closed container.

8. A method of detecting any variation in the vapor pressure of a stream of liquid from a target value at a predetermined temperature comprising the steps of placing a standard liquid having substantially the same composition as said stream and having a vapor pressure at said target value in a closed container, forming a pool of liquid with said stream of liquid, maintaining the temperature of said pool at said predetermined temperature,

immersing said closed container with the standard liquid therein in said pool, continuously introducing liquid from said stream into said pool, continuously removing liquid from said pool, and detecting any vapor pressure differential between the liquid in said pool and in said closed container.

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