

[54] GAS-LIQUID SEPARATOR

[75] Inventor: Neely E. Lowrie, Tulsa, Okla.

[73] Assignee: Combustion Engineering, Inc., New York, N.Y.

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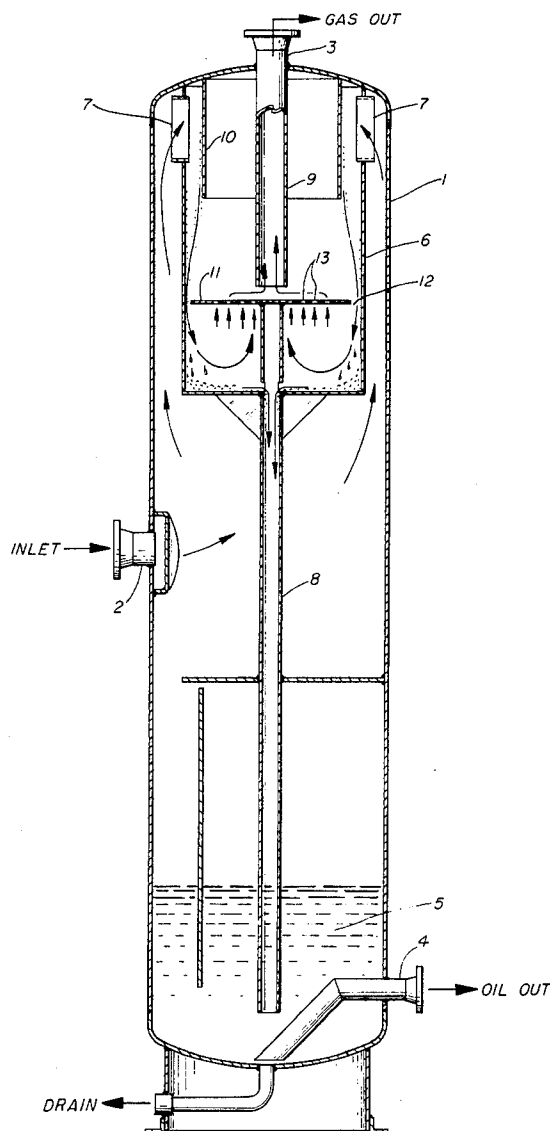
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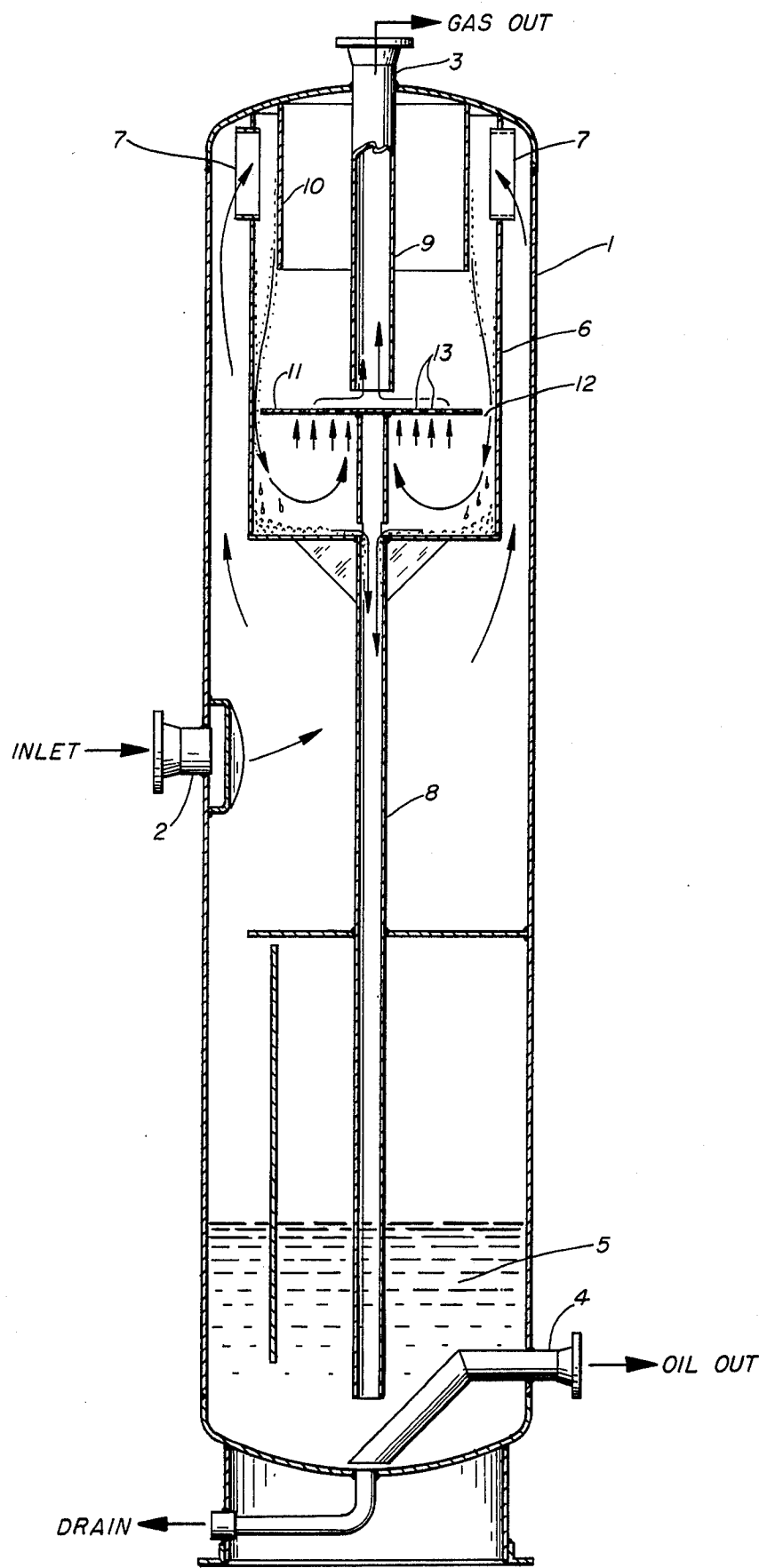
Primary Examiner—Frank W. Lutter
Assistant Examiner—David L. Lacey
Attorney, Agent, or Firm—Arthur L. Wade

[57] ABSTRACT

A vertical, cylindrical vessel which has a cylindrical compartment mounted coaxially in its upper portion. A mixture of liquid and gas is flowed into the compartment and tangential to the inside wall. A cylindrical baffle in the top of the compartment receives liquid imparted on the upper surface of the compartment and the cylindrical baffle. A horizontal perforated plate within the compartment provides a passage between the edge of the plate and the internal wall of the compartment. Through this passage, the liquid falling from the cylindrical baffle is carried by a portion of the separated gas. Beneath the plate, the two fluids disengage, the gas being diverted upward, through the perforated plate, to join the bulk of the separated gas and pass from the vessel through a discharge.

3 Claims, 1 Drawing Figure





GAS-LIQUID SEPARATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to control of the flow of liquid and gas after their separation by centrifugal force to maintain their separation. More specifically, liquid initially separated from a mixture of liquid and gas is transferred from surface to surface so it is drawn off separately from the gas and not reentrained.

2. Description of the Prior Art

There are, of course, many configurations of baffles mounted in vessels to promote separation of liquid and gas mixtures passed through the vessels. The vessels are usually cylindrical because it is generally simple and relatively inexpensive to manufacture this form. When the fluids are under pressure, they may be extended vertically or horizontally.

One of the most effective techniques of separation is to cause the impact of the liquid of the mixture upon a baffle surface and then flow the liquid along this surface to a lower collection from which it can be drawn from the vessel in separation. To bring about liquid impact, mixtures have been given a circular flow path to generate centrifugal force upon the liquid which will force the liquid into baffle contact. Generally, centrifugal force has been generated in vertical vessels in which vertical baffles are mounted. However, in at least one part of these flow paths there is developed a maximum likelihood of reentrainment of the liquid by the gas. Where the liquid collected on a baffle disengages therefrom and falls to a lower collection of the liquid, a direction must be given the separated gas which will obviate reentrainment.

SUMMARY OF THE INVENTION

A principal object of the invention is to direct a portion of separated gas so it will carry liquid disengaged from a baffle to the liquid discharge from the vessel while isolated from the main flow of separated gas as it flows to its discharge from the vessel.

Another object is to disengage the carrier separated gas portion from the disengaged liquid and direct this gas portion to the gas discharge of the vessel.

The present invention is embodied in a vertical, cylindrical vessel which has a cylindrical compartment mounted coaxially in its upper portion. A mixture of liquid and gas is flowed into the compartment and tangential to the inside wall. A cylindrical baffle depends from the top of the compartment to receive liquid imparted on the upper surface of the compartment and the cylindrical baffle. A horizontal plate divides the compartment below the axial exit of the gas, providing a passage between the edge of the plate and the internal wall of the compartment. Through this passage, the liquid falling from the cylindrical baffle is carried by a portion of the separated gas. Beneath the plate, two fluids disengage, the gas being diverted upward, through holes in the plate, to join the bulk of the separated gas and pass from the vessel through a single discharge.

Other objects, advantages and features of this invention will become apparent to one skilled in the art upon consideration of the written specification, appended claims, and attached drawings, wherein;

The drawing is a sectioned front elevation of a separator vessel in which the present invention is embodied.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawing, a vertical, cylindrical shell 1 is shown, sectioned to disclose the flow path of fluids into, therethrough and therefrom. A mixture of liquid and gas flows into the shell 1 through inlet 2. After the mixture has been separated, the gas discharges from outlet 3. The liquid discharges from outlet 4.

There is a wide variation in the ratio of gas and liquid quantities which are brought to shell 1 in a mixture. In the products of oil and gas wells, the liquids may be so large a portion of the mixture that much of such liquid readily separates, or falls out, as free liquid in this first crude step of the process. This free liquid readily and quickly falls to collection 5 in the bottom of shell 1.

The free liquid falls downward. The gas and entrained liquid flows upward. It is the separation of the gas and entrained liquid of the upward flowing mixture that is the principal object of the present invention. The structures of the prior art to extract the entrained liquid from the gas have been termed "mist extractors."

The mist extractor may separate relatively little liquid from the gas flowing through the separator after disengagement from the free liquid. Relative to the quantity of free liquid. Still, it is an important quantity of liquid and in many cases must be reduced, extracted, from the gas which is finally discharged through outlet 3. For separators through which oil and gas flow, there has developed a valid general statement. The quantity of liquid entrained ranges from five to ten gallons per million standard cubic feet of gas. It is reasonable to expect the liquid to be reduced by the mist extractor to about 0.1 gallon/MMSCF in the form of very small liquid particles.

To bring about this result, extraction of the liquid from the gas must be made. Then, as the separated liquid and gas flow toward their respective outlets, the liquid must be protected against reentrainment by the gas.

The invention provides, within shell 1, a cylindrical compartment 6. This compartment is, itself, a vertically extended cylindrical vessel. It is attached to the upper wall of shell 1. It is spaced from the internal wall of shell 1 and has a series of openings, or nozzles, 7 through which the mixture of fluids flows tangential to the cylindrical, inside wall of compartment 6. The nozzles 7 are shaped to give this tangential fluid flow, spinning a great deal of the fluids on the internal wall of 6 in a downward spiral with an angle to the horizontal of about 45°.

The centrifugal forces on the fluids generate a low pressure at the axis of the compartment 6. The axis, then, is an excellent exit locus for the gas. But how do you prevent the liquid from being carried over to the exit with the gas? The prior art has presumed to do the job by simply providing distance between the gas exit conduit at the axis and the liquid hopefully centrifugal to the wall. However, at certain rates of mixture flow through the structure, some of the liquid on the wall have traveled, not downward with the bulk of the liquid, but upward. The flow path for this liquid has extended upward to the top of whatever compartment is provided for the centrifuge action. The flow path has extended from the top of the compartment to the low pressure at the axis. The flow path has then extended down this axis, on whatever structure is located there,

until the gas exit was reached. This liquid has then carried over with the gas, reentrained by the gas.

Model testing has finally outlined this weakness in the prior art. Although it was obvious that a barrier was needed to obviate liquid reaching the gas outlet, the broad solution offered by this invention simply did not become apparent for years.

Of course this amount of carry over varies with many factors. The obvious factors are the ratio of liquid to gas in the mixture and the quantity of mixture relative to the size of vessel and its inlet and outlets. There are certainly ranges of these factors which would negate the importance of the specific quantity of liquid carry over. But there are many ranges desired, or required, within which the prior art arrangement is inadequate to keep the carry over of liquid with the gas below or at specified levels. It is to the problem of these latter ranges this invention is addressed. It is to the control of liquid carry over in the gas discharged that this invention is directed.

A prominent element in embodiment of the present invention is baffle 10. Essentially baffle 10 is no more than a cylinder, open at the bottom, mounted on the head of shell 1 or whatever forms the top of compartment 6. However, the size and placement of this structure are important in obtaining the results desired.

The area of the cross-section of the annulus between the internal wall of compartment 6 and the outside of cylindrical baffle 10 must be not less than the total area of the cross-sections of nozzles 7. If this area is made less than the nozzle area, the pressure drop will increase and raise the flow rate of the fluids. The liquids spinning on and falling from the surface of cylinder 10 will have two important forces acting upon them as gravity causes their descent. The low pressure at the conduit 9, which is at the axis of 10, 6 and 1, will be a force drawing the liquid into reentrainment by the gas flowing up conduit 9. The centrifugal force on the liquid will tend to spin it outward, toward the internal wall of compartment 6. Obviously it is desired to overcome the force of the low pressure and use a portion of the gas to carry the liquid to the bottom of compartment 6.

Horizontal plate 11 is mounted beneath the lower end of conduit 9. The edge of this plate is spaced from the walls of compartment 6 to form a passage 12. Through this passage 12 all the liquid which spirals down the inside wall of compartment 6 and the liquid disengaged from baffle 10 is to flow. Once below plate 11, the liquid flows down conduit 8 to join collection 5.

Flowing the bulk of the liquid, centrifuged to the wall of compartment 6, through passage 12 is no trick. The liquid is on the wall. It is spiralling down, but adhering to the wall, it has no obstruction in its path to prevent entry into passage 12. It is that portion of the liquid which has climbed up the wall, flowed toward the axis and flowed down the outside of cylinder 10 which generates the problem. How do you get it to jump from the lower edge of cylinder 10 to passage 12?

We are considering an old problem. In all these centrifugal mist extractors, some part of the liquid forced to the wall does not follow the neat little path provided to the bottom of the compartment where it can be drained away. Some wall climbing has taken place and when it does the low, axial pressure is sitting there waiting to sweep it up into the gas outlet.

Providing cylinder 10 has a good start on the solution. Rather than flow to the axis of the compartment, the liquid was provided a path downward, well away from the axis. But at some point disengagement from the surface of 10 must be brought about. Then the forces on the falling liquid must then result in a transport of the liquid to passage 12 where they will join the main body of liquid below plate 11.

The present invention provides a small portion of the gas itself as this required means of transportation. A flow path for less than 25% of the total gas is provided by proper sizing of plate 11 to form passage 12 large enough for sufficient gas to sweep the falling liquid from the lower edge of cylinder 10 and direct it to passage 12.

Next, holes 13 are sized and spaced to complete the flow path of this transporting gas. After the gas has swept the liquid through passage 12 it exits up through holes 13. To reach holes 13 it must change direction drastically. In changing direction abruptly and drastically, the gas becomes disengaged from the heavier liquid it has swept to this lower portion of the compartment 6. So freed of its burden, the gas flows up through holes 13 to the bulk of the gas drawn out conduit 9. The disengaged liquid joins the bulk of the liquid in the bottom of compartment 6 and flows out conduit 8.

From the foregoing, it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and inherent to the apparatus.

It will be understood that certain features and sub-combinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the invention.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted in an illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. A separator for liquid and gas, including,
 - a cylindrical vessel mounted vertically,
 - an inlet in the vessel wall through which a mixture of liquid and gas is directed,
 - a cylindrical compartment mounted in the upper portion of the vessel and having a plurality of tangential inlet openings through its vertical wall and near the top of the compartment through which gas and entrained liquid is directed to flow tangential to the surface of the vertical internal wall of the compartment,
 - a cylindrical baffle mounted concentric to the vertical internal compartment wall and extending downward from the top of the compartment and spaced from the plurality of openings into the compartment so as to form a flow path for liquids of the mixture, the liquids flowing downward in the compartment and disengaging from the lower edge of the baffle,
 - an outlet for gas from the cylindrical compartment located coaxial with the compartment to remove the gas flowing vertically upward,
 - a circular plate mounted horizontally below the baffle and the gas outlet and spaced from the internal wall of the compartment and having holes through

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which gas of the mixture flows from beneath the plate to the outlet for gas, and
an outlet for liquid of the mixture from the compartment below the plate and in the lower portion of the compartment, whereby the liquid disengaging from the lower edge of the baffle is carried by a portion of the gas through the space between the edge of the circular plate and internal wall of the compartment to the lower portion of the compartment and the gas portion then disengages from the liquid as the gas flows up through the plate holes and through the gas outlet.

2. The separator of claim 1 in which,
the cylindrical baffle is mounted and sized to form an

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annulus with compartment walls which has a cross-section not less than the total of the areas of the cross-sections of the plurality of openings near the top of the cylindrical compartment.

whereby the liquid in its flow path on the walls of the annulus spirals downward at an angle of substantially 45° to the horizontal.

3. The separator of claim 2 in which,
the circular plate is sized to form a passage between the edge of the plate and the internal wall of the compartment through which gas in the order of less than 25 percent of the total flows in carrying liquid below the plate for discharge.

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