

LIQUID/GAS SEPARATOR

The present invention relates to a method and apparatus for separating liquid contained in a liquid/gas mixture.

Gas extracted from a well is commonly contaminated by liquid which has to be removed. Drying facilities are conventionally provided at the production site to perform this removal. However, space on the production site is at a premium. Further, any breakdown or maintenance which causes the separator to be out of use may reduce the capacity of the site.

According to the present invention a liquid/gas separator comprises a pipe section having an inlet, in use, connected to an upstream part of a liquid/gas supply pipe and an outlet, in use, connected to a downstream part of the supply pipe; the pipe section containing a first drain for draining liquid which has undergone preliminary separation; a plurality of fixed vanes downstream of the first drain arranged, in use, to swirl the liquid/gas mixture to cause further separation; and a second drain downstream of the vanes to separate the liquid which has undergone the further separation; wherein, in use, gas which is substantially free of liquid leaves the separator through the outlet.

The separator of the present invention being housed within a pipe section can be fitted into a conventional supply pipe. The space needed for the separator is therefore minimal. The separator need have no moving parts and therefore has excellent reliability and needs little maintenance.

The vanes may be arranged in any configuration which causes the liquid/gas mixture to swirl. The best separation is provided by two sets of vanes, a radially outer and a radially inner set, arranged in parallel which are each symmetrically disposed around the axis of the pipe section. ~~The vanes are inclined in the direction of the~~

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flow of the liquid/gas mixture and are circumferentially inclined. The radially outer set of vanes preferably comprises more vanes than the radially inner set of vanes. Also, the radially outer set of vanes are preferably inclined at a steeper angle with respect to the axis of the pipe.

The inlet of the pipe section is preferably flared in the direction of flow of the liquid/gas mixture. This causes the mixture to undergo the preliminary separation.

To improve the drainage of the liquid from the separator, a third drain may be provided adjacent to the vanes.

The drains preferably lead into a common tank. Advantageously, means are provided to monitor and control the level of liquid in the tank.

More than one of the above described separators may be provided in series further to improve the drying process.

An example of a separator constructed in accordance with the present invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is an axial section through the pipe and the tank;

Figure 2 is an axial section through the vanes;

Figure 3 is a front elevation of the vanes;

Figure 4 is a section taken along line IV - IV in Figure 2;

Figure 5 is a section taken along line V - V in Figure 2;

Figure 6 is a section taken along line VI - VI in Figure 2;

Figure 7 is a section taken along line VII - VII in Figure 2.

The separator is housed in a pipe section 1 which is fitted between an upstream part 2 and a downstream part 3 of a liquid/gas supply pipe.



A concentric expander 4 and a concentric reducer 5 join the upstream end and the downstream end respectively of the pipe section 1 to the liquid/gas supply pipe.

Two diffusers 6, 7 are sealed to the inner wall of the pipe section 1 adjacent upstream and downstream ends respectively of the pipe section 1. Each diffuser comprises an annular plate 10 sealed to the wall of the pipe section 1 and a tubular sleeve 11 extending upstream from the inner edge of the annular plate. This leaves a gap 12 at the radially central region of the pipe. Thus a trap is formed by the annular plate 10 and tubular sleeve 11 to trap liquid flowing at the radially outer part of the pipe section 1. Drains 8, 9 are provided adjacent to the tubular sleeves 11 of the respective diffusers 6, 7.

A combined swirler/diffuser 13 is provided between the diffusers 6, 7 and is associated with a third drain 14. The swirler comprises a radially inner 15 and a radially outer 16 set of vanes shown in figures 2 to 7. The radially inner set of vanes 15 consists of eight vanes which are forwardly inclined with respect to the axis of the pipe section 1. The radially outer set of vanes 16 consists of sixteen vanes which are forwardly inclined with respect to the axis of the pipe at a steeper angle than the vanes of the radially inner set 15. A conical deflector is provided at the upstream end of the swirler to direct the liquid/gas mixture flowing adjacent to the axis of the pipe towards the vanes 15, 16. An inner sleeve 18 provides a flow path for liquid/gas mixture leaving the radially inner set of vanes 15. An outer sleeve 19 and an annular plate 20 which is sealed to the wall of pipe section 1 to provide a diffuser similar to the two previously described diffusers 6, 7.

The three drains 8, 9, 14 lead to a common liquid tank 21 which is provided with a sight level gauge 22. A network of pipes 23 is provided for the removal of liquid from the tank 21.



In use, the liquid/gas mixture flowing in the supply pipe enters the separator through expander 4. The expansion of the mixture results in a small decrease of its velocity which allows some natural separation of the liquid from the gas to take place. The liquid particles which separate out are typically 10-15 μm in diameter. These fall out of the gas phase towards the outer wall of the separator and are trapped by the diffuser 6. The trapped liquid is caused to flow under gravity around the outside of the sleeve 11 and subsequently to drain through drain 8. The gas phase being lighter than the liquid phase keeps to the centre of the pipe and passes through the gap 12 in the diffuser 6.

As the partially separated mixture progresses along the pipe section, some further natural separation takes place and liquid separating at this time is trapped by the diffuser 19, 20 of the combined swirler/diffuser 13 and is drained through the drain 14.

The rest of the mixture encounters the two sets of vanes 15, 16 and is caused to swirl. The mixture travelling closer to the axis of the pipe will flow between the radially inner vanes 15, possibly after having been deflected by the conical deflector 17 and will flow through the inner sleeve 18. The mixture flowing further from the axis of the pipe section 1 which flows inside outer sleeve 19 passes between the vanes 16 and leaves the swirler/diffuser 13 through the hole in the annular plate 20. Thus the swirler 13 creates a variable swirl which causes coagulated droplets to be thrown towards the outer wall of the pipe section 1. The liquid which is separated in this way is trapped by diffuser 7 and drains through the drain 9.

The dried gas, now up to 98% dry, passes through the reducer 5 and returns to the downstream end 3 of the supply pipe.

The level of liquid in the tank 21, which has drained through the drains 8, 9, 14 is monitored by sight level

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gauge 22 and its level is maintained by liquid take of
pipes 23 controlled by choke valves.

CLAIMS

1. A liquid/gas separator comprising a pipe section (1) having an inlet, in use, connected to an upstream part (2) of a liquid/gas supply pipe and an outlet, in use, connected to a downstream part (3) of the supply pipe; the pipe section containing a first drain (8) for draining liquid which has undergone preliminary separation; a plurality of fixed vanes (15,16) downstream of the first drain arranged, in use, to swirl the liquid/gas mixture to cause further separation; and a second drain (9) downstream of the vanes to separate the liquid which has undergone the further separation; wherein, in use, gas which is substantially free of liquid leaves the separator through the outlet.
2. A separator according to claim 1, wherein the fixed vanes comprise two sets of vanes, a radially outer (16) and a radially inner (15) set, arranged in parallel which are each symmetrically disposed around the axis of the pipe section.
3. A separator according to claim 1 or claim 2, wherein the radially outer set of vanes (16) comprises more vanes than the radially inner set of vanes (15).
4. A separator according to any one of the preceeding claims, wherein the vanes (15,16) are inclined in the direction of the flow of the liquid/gas mixture and are circumferentially inclined.
5. A separator according to claim 4 when dependent on claim 2 or claim 3, wherein the radially outer set of vanes (16) are inclined at a steeper angle than the inner set of vanes (15) with respect to the axis of the pipe.



6. A separator according to any one of the preceding claims, wherein the inlet of the pipe section is flared in the direction of flow of the liquid/gas mixture.
- 5 7. A separator according to any one of the preceding claims, wherein a third drain (14) is provided adjacent to the vanes (15,16).
- 10 8. A separator according to any one of the preceding claims, wherein the drains (8,9,14) lead into a common tank (21).
- 15 9. A separator according to claim 8, wherein means (22,23) are provided to monitor and control the level of liquid in the tank.
10. A system for separating liquid and gas comprising more than one separator, according to any one of the preceding claims, connected in series.