a liquid outlet port located at a lower end of the vessel body, and a gas vent port located at an upper end of the vessel body, the secondary separator having an inlet port which is connected to the gas vent port of the primary separator such that gas leaving the vessel body of the primary separator via the gas vent port of the primary separator enters the secondary separator via the inlet port of the secondary separator, a gas outlet port, and a liquid outlet port which is connected to the interior of the vessel body of the primary separator via a liquid return line.

The primary separator preferably includes a plurality of baffles which are located in the vessel body below the inlet port so that liquid entering the vessel body via the inlet port flows over the baffles as it descends down the vessel body.

The inlet of the primary separator may be provided with a primary diverter assembly which splits the incoming fluid into a lower density stream which is predominantly gas with entrained solids and liquids, and a higher density liquid stream which is predominantly liquid with entrained gas and solids.

The inlet of the primary separator is located in an upper region of the vessel body.

The primary separator may be further provided with a liquid seal which is connected to the liquid outlet port. The liquid seal may comprise a generally U-shaped pipe.

The primary separator may be provided with a liquid level sensing system which is operable to provide an indication of the surface level of liquid collected in the bottom of the vessel body. The liquid level sensing system may comprise a generally vertical pipe, the bottom of which is connected to the interior of the vessel body by means of a port in a lower portion of the vessel body, and a liquid level sensor which is mounted on the vertical pipe

and is operable to provide an indication of the liquid level in the vertical pipe. The liquid level sensing system may comprise a radar level sensor.

The drilling system may further include a shaker and / or centrifuge / degasser system through which all fluid flows before entering the drilling fluid reservoir.

The drilling system may also include an overboard diversion line which extends from the returns line to a discharge point where riser fluid may be discharged relatively safely. An overboard diverter valve may be provided in the overboard diversion line, the overboard diverter valve being operable to either permit or substantially prevent flow of fluid along the overboard diversion line.

A further overboard diversion line may extend from the liquid seal to a further discharge point wherein fluid from the primary separator may be discharged relatively safely. A further overboard discharge valve may be provided in the further overboard diversion line, the further overboard discharge valve being operable to either permit or substantially prevent flow of fluid along the further overboard diversion line.

The returns line may also be connected directly to the drilling fluid reservoir via a main diverter flow line, the main diverter flow line including a diverter valve which is operable to either permit or substantially prevent flow of fluid from the returns line directly to the drilling fluid reservoir.

The drilling system may further include a rig choke and kill manifold which is connected to a wellbore annulus below the subsea BOP via a well control choke line, the choke and kill manifold being, in turn, connected to the inlet of the primary separator via a choke valve which is operable to either permit or substantially prevent flow of fluid from the choke and kill manifold to the inlet of the primary separator.

We provide a drilling system including a separator apparatus for degassing drilling fluid, a riser which extends between a subsea blowout preventer mounted on a wellhead at the top of a wellbore, and a diverter which has a returns port which is connected to

A further overboard diversion line may extend from the liquid seal to a further discharge point wherein fluid from the primary separator may be discharged relatively safely. A further overboard discharge valve may be provided in the further overboard diversion line, the further overboard discharge valve being operable to either permit or substantially prevent flow of fluid along the further overboard diversion line.

The returns line may also be connected directly to the drilling fluid reservoir via a main diverter flow line, the main diverter flow line including a diverter valve which is operable to either permit or substantially prevent flow of fluid from the returns line directly to the drilling fluid reservoir.

We provide a method of operating a drilling system including a separator comprising a vessel body having an inlet port, a liquid outlet port located at a lower end of the vessel body, a liquid level control valve operable to control or prevent flow of fluid out of the vessel body through the liquid outlet port, a gas vent port located at an upper end of the vessel body, and a liquid level sensing system which is operable to provide an output representing the surface level of liquid collected in the bottom of the vessel body, the method including closing the liquid level control valve and monitoring the output from the liquid level sensing system to determine the rate of change in liquid level in the vessel body over time, and using this to monitor the flow rate of fluid into the vessel body over time to determine the flow rate trend over time.

The method may further include using the liquid level control valve automatically to regulate the liquid level in the separator when a hazardous flow rate trend is detected. One example may be during a flow check (a known industry well control procedure) where the liquid level sensing system can decipher between flow from the release of trapped pressure or wellbore breathing as opposed to a hazardous source such as gas, underbalance or the mud pumps and/or riser booster pumps inappropriately left on. The release of

Claims

1. An apparatus for degassing drilling fluid comprising a primary separator and a secondary separator, the primary separator comprising a vessel body having an inlet port, a liquid outlet port located at a lower end of the vessel body, and a gas vent port located at an upper end of the vessel body, the secondary separator having an inlet port which is connected to the gas vent port of the primary separator such that gas leaving the vessel body of the primary separator via the gas vent port of the primary separator enters the secondary separator via the inlet port of the secondary separator, a gas outlet port, and a liquid outlet port which is connected to the interior of the vessel body of the primary separator via a liquid return line.

2. An apparatus according to claim 1 wherein the inlet port of the secondary separator is connected exclusively to the gas vent port of the primary separator.

3. An apparatus according to claim 1 or 2 wherein the liquid outlet port of the second separator is directly connected to the interior of the vessel body of the primary separator via a liquid return line.

4. An apparatus according to claim 1, 2 or 3 wherein the primary separator includes a plurality of baffles which are located in the vessel body below the inlet port so that liquid entering the vessel body via the inlet port flows over the baffles as it descends down the vessel body.

5. An apparatus according to any preceding claim wherein the inlet of the primary separator is provided with a primary diverter assembly which splits the incoming fluid into a lower density stream which is predominantly gas with entrained solids and liquids, and a higher density liquid stream which is predominantly liquid with entrained gas and solids.

6. An apparatus according to any preceding claim wherein the inlet of the primary separator is located in an upper region of the vessel body.

7. An apparatus according to any preceding claim wherein the primary separator is further provided with a liquid seal which is connected to the liquid outlet port.

8. An apparatus according to claim 7 wherein the liquid seal comprises a generally U-shaped pipe.

9. An apparatus according to any preceding claim wherein the primary separator is provided with a liquid level sensing system which is operable to provide an indication of the surface level of liquid collected in the bottom of the vessel body.

10. An apparatus according to claim 8 wherein the liquid level sensing system comprises a generally vertical pipe, the bottom of which is connected to the interior of the vessel body by means of a port in a lower portion of the vessel body, and a liquid level sensor which is mounted on the vertical pipe and is operable to provide an indication of the liquid level in the vertical pipe.

11. An apparatus according to claim 9 or 10 wherein the liquid level sensing system comprises a radar level sensor.

12. An apparatus according to any preceding claim wherein the secondary separator comprises a cyclone separator which has a housing which is configured to divert the flow of a gas stream entering the housing via the inlet of the cyclone separator so that it flows in a generally circular flow path around a vortex chamber within the housing.

13. An apparatus according to claim 12 wherein the cyclone separator includes at least one deflector vane which extends from the housing into the interior of the housing.

14. An apparatus according to claim 12 or 13 wherein the inlet and gas outlet port of the cyclone separator are arranged along a longitudinal axis of the secondary separator, whilst the liquid outlet port is provided in a portion of the housing which extends generally parallel to the longitudinal axis of the secondary separator.

15. An apparatus according to claim 12, 13 or 14 wherein the housing of the cyclone separator encloses a space with a generally circular transverse cross-section.

16. An apparatus according to any preceding claim wherein the liquid return line extends down the interior of the vessel body to end at a point in the lowermost portion of the vessel body.

17. A drilling system including an apparatus for degassing drilling fluid according to any one of claims 1 to 16 wherein the drilling system includes a riser which extends between an subsea blowout preventer mounted on a wellhead at the top of a wellbore, and a diverter which has a returns port which is connected to the inlet of the primary separator via a returns line, the returns line containing a diversion flow valve which is operable to permit or substantially prevent flow of fluid from the returns line to the primary separator.

18. A drilling system according to claim 17 further comprising a drilling fluid reservoir, wherein the liquid outlet port of the primary separator is connected to the drilling fluid reservoir via a liquid seal.

19. A drilling system according to claim 17 or 18 wherein a liquid level control valve is provided in a line between the liquid seal and the drilling fluid reservoir, the liquid level control valve being operable to stop, or restrict to a variable extent, flow of fluid from the liquid outlet of the primary separator to the drilling fluid reservoir.

20. A drilling system according to claim 17, 18, or 19 wherein the drilling system further includes a shaker and / or centrifuge / degasser system through which all fluid flows before entering the drilling fluid reservoir.

21. A drilling system according to any one of claims 17 to 20 wherein the drilling system also includes an overboard diversion line which extends from the returns line to a discharge point where riser fluid may be discharged relatively safely.

22. A drilling system according to claim 21 wherein an overboard diverter valve is provided in the overboard diversion line, the overboard diverter valve being operable to either permit or substantially prevent flow of fluid along the overboard diversion line.

23. A drilling system according to any one of claims 17 to 22 wherein a further overboard diversion line extends from the liquid seal to a further discharge point wherein fluid from the primary separator may be discharged relatively safely.

24. A drilling system according to claim 23 wherein a further overboard discharge valve is provided in the further overboard diversion line, the further overboard discharge valve being operable to either permit or substantially prevent flow of fluid along the further overboard diversion line.

25. A drilling system according to any one of claims 17 to 24 wherein the returns line is also connected to the drilling fluid reservoir via a main diverter flow line, the main diverter flow line including a diverter valve which is operable to either permit or substantially prevent flow of fluid from the returns line to the drilling fluid reservoir.

26. A drilling system according to any one of claims 17 to 25 wherein the drilling system further includes a rig choke and kill manifold which is connected to a wellbore annulus below the subsea BOP via a well control choke line, the

choke and kill manifold being, in turn, connected to the inlet of the primary separator via a choke valve which is operable to either permit or substantially prevent flow of fluid from the choke and kill manifold to the inlet of the primary separator.

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