

Recovery Process for the removal of volatile components from a carrier gas at a pressure higher than atmospheric pressure

Subject

The patent is requested for a Recovery Process for the removal of volatile components from a carrier gas at a pressure higher than atmospheric pressure. In this case the discharge pressure of the vacuum pump will not be sufficient to return the non-condensable gases from the top of the re-absorber back to the inlet of the adsorbers. The alternatives would be to compress the vapours directly at the outlet of the vacuum pump by means of a compressor to adsorption pressure or the compress the vapours from the top of the re-absorber to adsorption pressure, before feeding them back to the inlet of the adsorber.

Both alternatives will introduce difficult control problems due to highly variable throughput, will introduce serious safety risks and will increase the energy consumption.

Process Description

The process for which a patent is applied is based on the well known principle of adsorption on activated carbon and regeneration of the activated carbon by means of vacuum followed by re-absorption of the desorbed components in a suitable absorption liquid.

The specialty of the process described herein is that the gas mixture to be treated is at a pressure higher than the maximum discharge pressure of the vacuum pump. In this case the saturated gas mixture from the top of the re-absorber cannot be returned to the inlet of the adsorber system and is treated in a third adsorber. The function of the three adsorbers switches every cycle in the following manner.

The first adsorber is in adsorption mode at the pressure of the incoming gas mixture, the second adsorber is in regeneration mode under vacuum generated by the vacuum pump and the third adsorber treats the gas mixture from the top of the re-absorber at a pressure less than the maximum pressure that can be generated by the vacuum pump.

After elapse of the cycle time the second adsorber will be re-pressurised to atmospheric pressure with ambient air, the first adsorber will be regenerated by the vacuum pump and the third adsorber will be put in adsorption mode to treat the inlet gas mixture, etc.

5 Each adsorber will sequentially go through an adsorption cycle at inlet pressure, a regeneration cycle at vacuum and a pre-adsorption cycle at near atmospheric pressure.

10 The adsorber in adsorption mode is kept under pressure by means of a back pressure control valve CV1. In case of an inert gas carrier gas the cleaned outlet gas can eventually be reused for blanketing purposes through connection N3 with valve V1 at a pressure near the original adsorption pressure.

15 For example

The gas to be treated enters the system at connection "N1" and flows through line "a", valve "A2", line "k" to the top of adsorber "ADS A". The mixture flows downwards through the activated bed where the volatile components are adsorbed. The cleaned gas leaves the adsorber from the bottom through line "l" and valve "A5". The clean gas can be re-used as inert gas through connection "N3" and valve "V1" or be vented to atmosphere via back pressure control valve "CV1" and vent stack "g".

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25 Meanwhile adsorber "ADS B" is regenerated by pulling vacuum to the adsorber by vacuum pump "V" via line "c", valve "B3" and line "m". The desorbed components are pumped at near atmospheric pressure through line "I" to the re-absorber "ABS". In the re-absorber the components are absorbed in a circulating liquid entering the re-absorber via connection "K1" and returned to storage by circulation pump "P" via connections "K2".

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Inert gas, present in the adsorber, will leave the re-absorber saturated with vapours from the circulated liquid and will return to the top of adsorber "ADS C" through line "b", valve "C1" and line "o". The volatile components in the return flow will be adsorbed in adsorber "ADS C"

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and the carrier gas will leave the adsorber through the bottom connection line "p", valve "C4" and line "d" to the vent stack "g".

During the last few minutes of the regeneration some air from ambient through valve "B7" or inert gas through valve "B6" will be purged over the activated carbon to insure the required emission level during the adsorption phase.

This gas will be evacuated by the vacuum pump, flow through the re-absorber and will be saturated with components from the circulating liquid. This gas will also be treated in adsorber "ADS C" as described above.

At the end of the cycle, valve "B3" will be closed and adsorber "ADS B" will be re-pressurised to near atmospheric pressure through valves "B7" and or "B6".

At the mean time adsorber "ADS C" will be pressurised to adsorption pressure through valves "C6" and or "C5".

After adsorber "ADS B" has reached atmospheric pressure and adsorber "ADS C" has reached adsorption pressure, valve "C2" and valve "C5" are opened, valves "A2" and "A5" are closed, valves "B1" and "B4" are opened and valve "A3" is opened.

The next process cycle has now begun with adsorber "ADS C" in adsorption mode, "ADS B" in pre-adsorption mode and "ADS A" in regeneration mode, etc.

Advantages of the system

- 1) The clean gas from the outlet of the adsorber on line remains at inlet pressure and can easily be used for re-injection into the blanketing system.
- 2) The described system uses less energy than a system using re-compressors.
- 3) A system operating at elevated adsorption pressure requires less activated carbon compared to a system designed for the same volume to be treated, but operated entirely at atmospheric pressure.

Alternatives

- 1) Decompression of the adsorber leaving the adsorption mode (e.g. "ADS A") can be carried out by leading the gas through valve "A1" and line "b" to the adsorber just put in pre-adsorption ("ADS B") mode through valve "B1" until the pressure in "ADS A" is atmospheric. Than close "A1" and open "A3" for regeneration by the vacuum pump.
- 2) As alternative 1), but using a dedicated decompression valves parallel to valve "A1", "B1" and "C1".
- 3) Instead of one vacuum pump a set of parallel vacuum pumps can be used.
- 4) Instead of three adsorbers a multiple set of three adsorbers can be used in parallel.

Claims

1. Recovery process for the removal of volatile components from a carrier gas at a pressure higher than atmospheric pressure based on the principle of adsorption on activated carbon and regeneration of the activated carbon by means of vacuum followed by re-absorption of the desorbed components in a suitable absorption liquid, characterized in that the gas mixture to be treated is at a pressure higher than the maximum discharge pressure of the vacuum pump.