

This invention relates to gas purification, more particularly to the purification of natural gas.

Adsorption processes, widely used in the natural gas supply and transmission industries, have application for the purification of feed gas to natural gas liquefaction plants.

Adsorption is the process by which particular molecules are transferred under certain conditions of temperature and pressure from a fluid medium to the surface of a solid adsorbent material. These materials are characterised by a very large surface area per unit of volume, which can give them a selective and useful adsorption capacity. The adsorption process is reversible when the conditions of temperature and/or pressure are changed so that the material can be regenerated.

In practical application the process utilises two or more fixed beds of adsorbent operated cyclically, one bed adsorbing while the others are in various stages of regeneration.

Adsorption processes have been used in the natural gas supply and transmission industries for a considerable number of years and adsorbents such as activated carbon, alumina and silica gel have been particularly important in gas drying and hydrocarbon recovery applications. The development of synthetic zeolites (molecular sieves) over the last 25 years has extended their applications in gas processing to purification prior to liquefaction, hydrocarbon separation, sulphur removal, and drying.



Molecular sieves are used on natural gas liquefaction (LNG) plants to remove both carbon dioxide (CO₂) and water vapour from the natural gas feed thereby preventing blockages occurring in the heat exchangers in the liquefaction stage.

In the United Kingdom, the early supplies of natural gas came from the Southern Basin of the North Sea where the average concentration of carbon dioxide is about 0.15%. The later supplies from the Northern fields have up to five times as much and thus existing gas purification plants have had to be uprated to accomodate this increase.

The most widely used configuration for gas purification is a two-tower system as depicted in Figure 1 of the accompanying drawings. In this system one tower is on-line whilst the other is being regenerated, for example, by heating to drive off the adsorbed carbon dioxide and water.

A typical form of operation is as follows :-

Whilst tower A is adsorbing, tower B is being regenerated; when breakthrough of tower A is approached the gas is switched to the regenerated tower. This provides a continuous supply of purified gas with adsorption carried out at approximately 25°C with downflowing gas. In the regeneration step the saturated adsorbent is heated using a hot upflowing sidestream of the purified gas to displace the CO₂ and water.

During the initial phase of regeneration the gas is heated to

approximately 300°C. To reduce the regeneration time and save fuel heating is stopped before all of the bed has reached the maximum temperature. The flow of regeneration gas is continuous and transfers heat from the hot section of the bed to the unheated upper section, finally cooling the whole bed to approximately 25°C. Typically, temperatures of approximately 250°C are obtained at the top of the bed using this "thermal pulse" technique.

The effects of using feed gases having high carbon dioxide levels means that the towers have to be regenerated more frequently. Thus for a conventional two-tower system the decrease in on-line time must be matched by a consequential decrease in regeneration if either processing of raw gas is not to be halted or the costs of building and operating additional towers is to be avoided.

The present invention seeks to provide a process and means whereby these economic disadvantages can be avoided.

Thus the present invention provides a process for the removal of carbon dioxide and water by adsorption from a feed gas wherein the feed gas is passed through one of two beds of a molecular sieve, and gas exiting from the bed, in order to regenerate the other bed, is heated and passed through the other bed such that adsorbed carbon dioxide



and water are substantially desorbed therefrom, followed by cooling of the desorbed bed, characterised in that cooling is effected after completion of the desorption stage by passing feed gas which contains carbon dioxide and water through the desorbed bed, the cooling being such that the regenerated bed adsorbs carbon dioxide and water from the feed gas which is effecting the cooling.

By this method of "on-line cooling" with the feed gas, the total length of regeneration time is reduced, i.e. the tower is put into the adsorption mode before all the regeneration heat has been removed.

After the temperature at the top of the bed has reached its peak and all the CO₂ and water have been driven off it can take up to an hour to cool the top of the bed. The essence of on-line cooling is to use the process gas for bed cooling at the same time as it is being purified. The bed rapidly cools well ahead of the adsorption front because of the higher adsorption gas flowrate compared with the regeneration gas flowrate. The provision of a gas cooler at the outlet of the molecular sieve unit may be required to control the inlet temperature to the liquefaction unit to approximately 25°C.

On conventional cycles this technique could reduce the

5

(14)

regeneration time by as much as 30%. On cycles already modified to incorporate the silica gel as described in our copending application No. 8525632 (Serial No. 2181666), low temperature regeneration technique, on-line cooling should reduce the regeneration time by about 10 to 15%.

The cost of the modification is significantly less than the cost of adding a third tower.

CLAIMS

6



1. A process for the removal of carbon dioxide and water by adsorption from a feed gas wherein the feed gas is passed through one of two beds of a molecular sieve, and gas exiting from the bed, in order to regenerate the other bed, is heated and passed through the other bed such that adsorbed carbon dioxide and water are substantially desorbed therefrom, followed by cooling of the desorbed bed, characterised in that cooling is effected after completion of the desorption stage by passing feed gas which contains carbon dioxide and water through the desorbed bed, the cooling being such that the regenerated bed adsorbs carbon dioxide and water from the feed gas which is effecting the cooling.
2. A process as claimed in claim 1, wherein the temperature of the carbon dioxide and water-containing gas exiting the bed is controlled to about 25°C.
3. A process as claimed in claim 1 or claim 2, wherein the feed gas which effects the cooling is passed through the desorbed bed substantially immediately upon completion of the desorption stage.
4. A process as claimed in any of the preceding claims wherein the process employs two or more beds of a molecular sieve.

7



(16)

5. A process for removal of carbon dioxide and water from gases substantially as herein described with reference to the accompanying drawing.
