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(54) Purification of effluent liquors.

(57) Aqueous effluent liquors, for example those obtained from the fixed bed gasification of coal with steam and oxygen, may be purified by subjecting said liquor, maintained at elevated pressure, to flash evaporation thereby to produce a vapor product and a liquid residue. The vapor product, comprising steam, may be used as a gasifying agent in, for example, the fixed bed gasification process. A first portion of the liquid residue is subjected to incineration and a second portion is recycled back to the flash evaporation stage.

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Purification of Effluent Liquors

This invention relates to the purification of aqueous effluents and especially to the recovery of aqueous components used in gasification processes, such that they may be reused. More particularly, the invention relates to the recovery and reuse of such components in association with the production of environmentally acceptable by-products.

In, for example, the fixed bed gasification of solid carbonaceous feedstocks such as coal, wherein steam and an oxygen-containing gas eg. air or oxygen per se, are employed as gasifying agents, the product gas may be treated to remove excess steam and inorganic and organic contaminants. This removal process is usually effected by quenching and cooling the synthesis gas thereby causing tars, oils and aqueous liquors to condense out. The condensate may then be further treated to separate the aqueous and non-aqueous components.

The non-aqueous components comprising tars and oils, being carbonaceous in nature, can be returned to the gasifier as a feedstock. Likewise it has been proposed to return the aqueous component either in liquid or vapor form, to supplement the steam being supplied as a gasifying agent.

The present invention provides a process for the steam-oxygen gasification of carbonaceous materials to produce a synthesis gas which is treated to separate out condensible components including an aqueous liquor, which process comprises subjecting said aqueous liquor to flash evaporation at a pressure greater than that at which gasification is effected, to produce a vapor product containing mainly steam and a residual aqueous liquid product, thereafter recycling a portion of said liquid product to the flash evaporation stage, and subjecting a second portion of said liquid product to incineration. The said vapor product is recycled for use in gasification. After mixing with oxygen and, possibly, additional steam, it is made to react with the carbonaceous feed material.

In the flash evaporation stage, the aqueous liquor, at elevated pressure eg. 40 bar, forms two fractions. The first fraction, a vapour fraction, contains steam and some of the more volatile organic components. The second fraction is a liquid residue containing water, dissolved inorganic compounds, such as chlorides, and the remaining organic species. A further fraction of water, as steam, may be recovered from the liquid residue by recycling a portion of it back to the flash evaporator vessel where it is evaporated in the presence of further amounts of the aqueous liquor. Another portion of side stream of the liquid residue may be incinerated to produce solid and gaseous final products.

Within the evaporator loop is provided a recycle pump to bring the pressure of the recycled residue back up to the elevated pressure required for the flash evaporation. It may be convenient to place the recycle pump upstream of the incinerator side stream so that residue is pumped to the incinerator under pressure for flash evaporation within the incinerator.

With liquors derived from the gasification of coal, as the carbonaceous material, it may be preferred to pretreat the aqueous liquor prior to flash evaporation. Thus the liquor may be subjected to steam stripping to remove volatile compounds such as hydrogen sulphide and ammonia, which can be separately processed to give environmentally acceptable products.

The present invention offers the advantage that only a small part of the condensed water from the gasification stage leaves the process. The remainder is recycled in such a way as to reduce the energy and water demands of the process. Thus the quantity of steam or water, which must be rendered fit for discharge to the enviornment, is greatly reduced. The present invention has two advantages over processes in which the recycle of water to the gasifier is made in the liquid phase. Firstly liquid phase recycles result in greatly increased concentrations of involatile solutes, of which the most troublesome is chloride. This is avoided by the vapour phase recycle of the present invention. Secondly, the recycling e of liquids may adversely affect gasifier operation in the main process of coal gasification.

There is likely to be a limit on the amount of water which may be recycled; whereas recycle of steam should be unlimited.

A further advantage of the invention is that it renders more economic the use of an incineration process for the aqueous liquor waste. Incineration processes for aqueous wastes require costly support fuel. The present invention drastically reduces the fuel demand and in certain cases the organic content of the waste for incineration should be sufficient to allow combustion without support fuel. This saving is achieved at a small extra cost, which results from the downgrading of a high pressure steam supply to the pressure and temperature of the vapour recycled to the gasifier. The combination of the invention with an incinerator also has the advantage of reducing to zero the liquid effluent discharged by the process to the environment.

EXAMPLE

The invention will be further described and illustrated with reference to the accompanying drawing which is a schematic representation of a process train employing embodiments of the invention.

As shown in the drawing, the effluent purification process can be applied to the gasification of coal.

Coal 11, steam 12 and oxygen 13 are reacted in a gasifier 1, for example, an ash-slagging gasifer, as described in "The Chemistry of Coal Utilization" (2nd Supplementary Volume), 1981, John Wiley & Son Inc. The steam supply is supplemented by steam 46 obtained from the flash evaporation device 40. Heat for the flash evaporation is provided, for example, by steam supply 49.

Hot product gas 14 is subjected to quenching (in quench 2) and cooling (in gas coolers 3) to produce a gaseous product 21 and a liquid condensate 22. The gaseous product 21 is suitable for use as a synthesis gas, fuel gas or for upgrading to substitute natural gas. The liquid condensate 22 is passed to a process unit, 5, for separation of the non-aqueous portion, 23, which consists of tarry and oily materials. The non-aqueous portion 23 may be recycled to the gasifiers, incinerated or sold. While part of the aqueous condensate may be recycled as stream 24 to the quench, there must remain an aqueous condensate stream 41, requiring treatment as a waste.

This aqueous liquor 41 which may optionally be first subjected to steam stripping, is fed to the flash evaporator vessel (operating at for example 40 bar) 40 via pump 41. Within pump 42 the liquor pressure is raised to, for example, about 100 bar. The liquor is flash evaporated to give a vapor portion 46 which is used as a gasifying agent, and a residual liquor 47. The residual liquor stream 47 is divided into a recycle stream 44 and an incinerator side stream 45. As shown in the drawing all of the residual liquor, even that not required for recycle, passes through the recycle pump 43. Prior to re-injection into the flash evaporator, the recycle liquor 44 must be reheated in heater 48.

In an alternative embodiment, the aqueous liquor 41 may be subjected to steam stripping to remove volatile sulphur compounds prior to flash evaporation. The off-gases comprising hydrogen sulphide and ammonia may be further treated in, for example, a Claus Plant to recover elemental sulphur. For this purpose it will be economical to conbine the off gases with other waste gases produced elswhere on the site, for treatment in a common Claus plant.

A portion 45 of the residual liquor 47 is the only waste remaining for disposal. Thus when the liquor 44 in the recirculation loop contains dissolved solids of a predetermined concentration, a portion 45 is drawn off for disposal, by incineration or otherwise. This waste stream 45 is very small in comparison with the original waste stream 41.

A typical application of the invention is in combination with an ash-slagging gasifier operated at a pressure of 32 bar. The flash evaporation of the liquor should yield vapour at a pressure of 38 bar. For the gasification of a British coal containing, on a dry ash free basis, 0.5% chlorine, the following stream compositions will result.

The stream numbers are those shown in the drawing.

Stream	41 Liquor	45 Liquid Residue	46 Flash Vapour
Temperature °C	70	240	250
Pressure Bar	1	100	38
Flowrate kg/	39000	4875	34125
Composition, weight %			
NH_3, free	0.40	0	0.46
NH_3, combined	1.30	10.40	0
HCl, combined	2.57	20.57	0
Phenols	0.66	4.84	0.06
H_2O	94.48	63.21	98.95
H_2S	0.45	0	0.52
Other components	0.14	0.98	0.01

These results relate to the gasification of 195000 kg/h of coal (on dry ash-free basis).

Claims

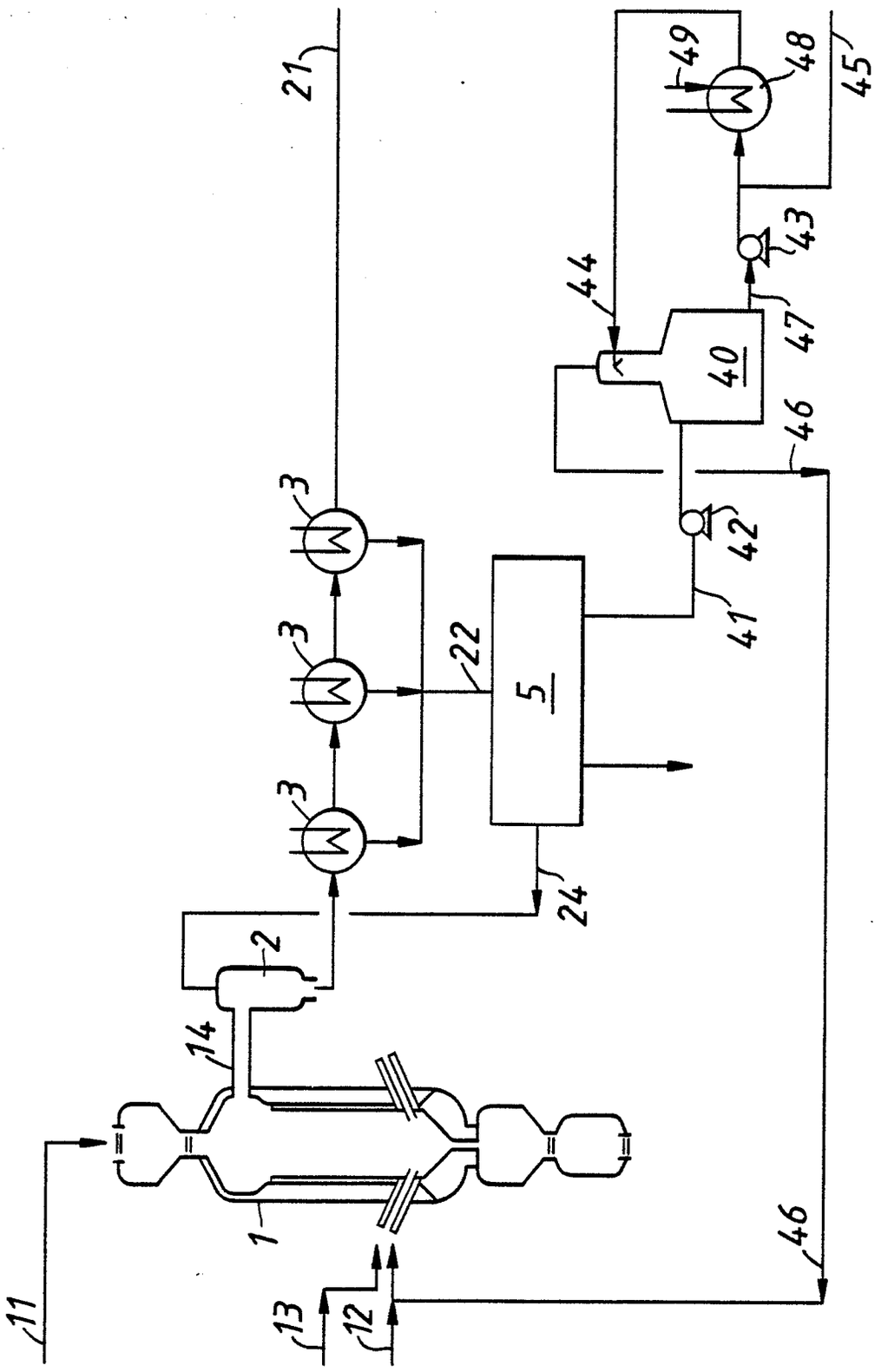
1. A process for the steam-oxygen gasification of carbonaceous materials to produce a synthesis gas and wherein said synthesis gas is treated to separate out condensible components including an aqueous liquor, characterised in that said liquor is subjected to flash evaporation at a pressure greater than that at which gasification is effected, to produce a vapor product comprising steam and a residual liquid product and in that a first portion of said liquid product is recycled to the flash evaporation stage and a second portion is subjected to incineration, and in that the said vapour product is used as a reactant in gasification.

2. A process as claimed in claim 1 wherein said flash evaporation is effected at pressure in the range 10-110 bar.

3. A process as claimed in claim 1, wherein said flash evaporation is effected at temperatures in the range 160 - 320°C.

4. A process as claimed in any one of the preceeding claims wherein said liquor is subjected to stripping (by steam or otherwise) prior to flash evaporation.

5. A process for the gasification of carbonaceous materials according to claim 1 and substantially as hereinbefore described with reference to the accompanying drawings.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