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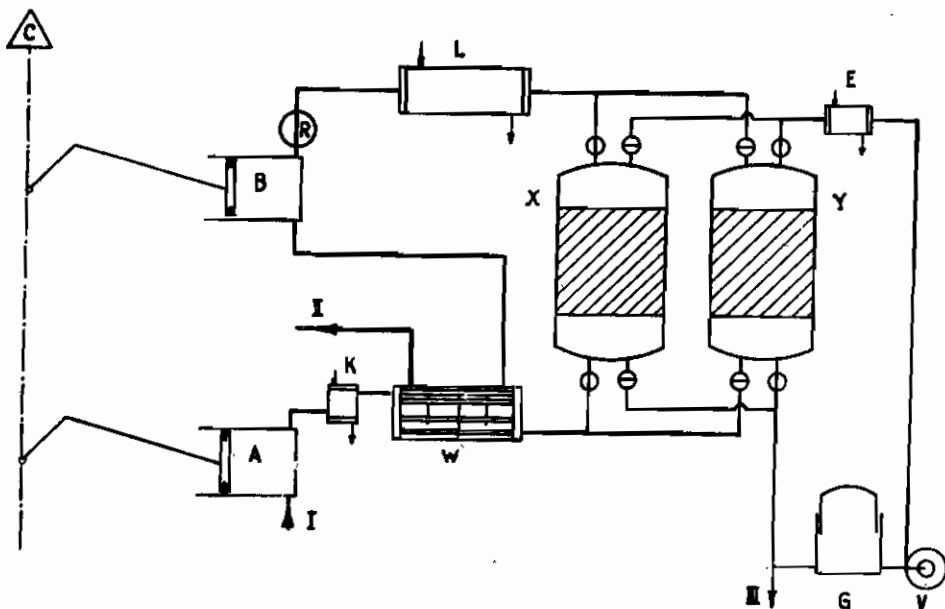
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PROCESS OF ABSORBING GASES AND VAPORS

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# ALIEN PROPERTY CUSTODIAN

## PROCESS OF ADSORBING GASES AND VAPORS

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The present invention relates to a process of adsorbing gases and vapors.

Spacious plants are necessary for selecting relatively small amounts of gas out of large quantities by adsorption by way of active carbon or silica gel, for instance for obtaining 2 per cent of ethylene from coke oven gas, without decomposing the main portion of the gases; in consequence thereof said plants only work with relatively large losses of energy. The adsorption of higher amounts of gases by a cooling process is not only rather uneconomical with regard to the costs of energy, but it also requires prolonged change-over-periods. If, on the other hand, the main gas portion which often comprises 98 per cent of the total gas portion is not required in the compressed state, the application of pressure for improving the adsorption would afford unreasonably high compression costs.

Now I have found that the afore-named drawbacks may be avoided by separating gases and vapors under pressure and at a low temperature within a cold gas machine, particularly by compressing the gaseous mixture, cooling it, thereby utilizing the temperature drop between the compressed initial mixture and the expanded gas, leading the cooled and compressed gas into adsorbers containing active carbon or silica gel, then causing the non-adsorbed components leaving the adsorbers to be cooled and expanded, thus supplying the low aforementioned temperature for cooling the initial mixture. According to the invention the coupling of the adsorbers with a cold gas system (cf. Schüle, "Technische Thermodynamik," 4th edition, volume 1, pages 171 et seq.) does not only allow a cooling in a simple manner of the gas and vapor entering the plant, but enables, by using an expansion engine, the cooling of the apparatus in a very simple and favorable manner from an economical point of view, while a large portion of the costs due to compression are recovered.

The invention is diagrammatically illustrated by way of example in the accompanying drawing.

The quantity of gas to be treated enters the plant through conduit I and is compressed by compressor A for instance to 4 atmospheres above atmospheric pressure. The heat of compression is eliminated by cooling water in condenser K. The total quantity of gas then enters a heat-exchanger W where it is cooled in counter-current to the gas discharged from the expansion engine. The cooled and compressed gas is then passed to the adsorber X which is charged for instance with active carbon. In said part of the

device the heavy hydrocarbons are adsorbed. Owing to the pressure applied and the low temperature the quantities of gases adsorbed are by far greater than in the usual adsorption plants. The gas freed from heavy constituents, for instance coke oven gas freed from ethylene and other heavy hydrocarbons, is cooled, if necessary, by the heat of adsorption in a water cooler L to which it is passed and then expanded to about normal pressure in an expansion device B. As the expansion is effected adiabatically a considerable temperature drop in the expanded gas is produced. The low temperature is utilized for the adsorption process by conducting the quantity of leaving gas through the heat exchanger W in counter-current to the compressed initial gas and causing it to leave the apparatus at II. Since more work is consumed by compressor A than is furnished by expansion device B, both devices are suitably coupled and provided with an electromotor or another power engine C so that the missing output is recovered. If very large portions of gas are treated or if an excess of heat of any part of the apparatus exists it may be advisable to use the three machines A, B and C as turbo-compressors or turbines and interconnected by suitable couplings.

After the adsorber X has been completely charged the main current of gas is changed-over by hand or automatically to the discharged adsorber Y and the heavy hydrocarbons which have been separated are expelled from X. This operation may be performed first by an expansion of the adsorber X to a gasometer G. If it is intended to remove further quantities, heavy hydrocarbons already obtained may be removed from the gasometer, for instance with a blast V, and moderately heated in a heating device E; the adsorber cooled by the expansion is thus heated until the discharge is complete. The stage of operating thus described is illustrated in the drawing by the second adsorbing device Y which must be actuated in alternation with the body X. In many cases it will be advisable to use a third adsorber which after the removal of the ethylene is cold-blasted with the cooled gas (II) leaving the apparatus.

The ethylene thus obtained and the heavy hydrocarbons are eliminated from the apparatus at III; they may be introduced into a plant of liquefaction. For saving the step of compression it may, therefore, be possible first to cause a compression of the pressure between the adsorber and the liquefaction plant, while initially avoiding the gasometer G.

There are still to be mentioned some further known steps which may serve as a simplification of the process. If readily condensing or freezing constituents are contained in the gas arriving, such as water, naphthalene or the like, two regenerators filled with accumulated material will be mounted in an alternating system instead of the main heat exchanger W. Furthermore it may be useful for the same reasons to install at different parts of the plant separators which may be changed-over, driers or the like. Finally the heating device E may be heated with waste heat coming from any part of the apparatus or from the additional driving machine C.

Finally it may in some cases be advisable to have the expansion machine B expanded on a pressure higher than the suction pressure, for instance for obtaining a pressure necessary for feeding a long distance gas pipe system or for carrying out any other subsequent process. According to the size of the plant and the operating conditions chosen compressor A, expansion machine B and additional power engine C may be piston engines, turbo-engines with mechanical, hydraulic or electric intermediate gears, C may be a steam engine, an electro-motor or a gas power engine.

When comparing it with the steaming method usual in the adsorption technic, the process of the present invention involves the advantage of saving steam and, above all, of excellently protecting the adsorbing agent, especially active carbon. The number of the adsorption bodies required can in general be reduced. The present process may be useful for the decomposition of coke oven gas or the like as well as for the separation of small percentages of reacted gases or vapors from mixtures obtained in catalytic processes using a circulating gas.

The economical value of the present process essentially depends on the fact not to produce any unnecessarily low temperatures by the application of unnecessarily high pressures. It has, therefore, to be endeavoured to adjust a low operating pressure in the cycle, while the temperature of the cooling water utilized in the cooler is likewise low. This is performed according to the invention by the application of a means known in the art and regulating the filling, said means being mounted at the expansion machine and being illustrated in the drawing by R. The fluctuations of the temperature of the cooling water occurring during the prolonged operations could be regulated by hand. But in the course of an operation fluctuations in the cold cycle likewise occur which depend on the fact that either the heat exchanger was just thawed off or a heated adsorber was changed-over. These fluctuations of temperature, too, may suitably be compensated by a temporary alteration of the operating pressure. The regulation of filling the expansion machine will, therefore, have to be made dependent on the temperature of the gas

introduced after having passed the heat exchanger and before the adsorption sets in, the operation being performed in such a manner that pari passu with the decreasing temperature of the gas which may be parallel with the decreasing temperature of the cooling water, the pressure is decreased, in other words the filling is increased and vice versa.

Many of the components to be obtained and present only in traces, such as ethylene, propylene and others are so intimately adsorbed by the adsorbing agent that, on merely expanding the charged body, the adsorbed, heavy constituents are set free not at once, but only after a prolonged time. Therefore, it will be suitable in such cases to effect the expansion of the charged body which has been taken out of the pressure cycle not by the way of the gasometer for the substances to be obtained, as large portions of inert gases, for instance methane or hydrogen, would dilute the substances obtained and impair the further treatment. After having been taken out of the pressure cycle the charged adsorber will, therefore, be expanded into the gas leaving the plant which is not under pressure and has been freed from the heavy constituents. Only after the expansion pure heated gas or a gas enriched with heavy constituents is blown from the gasometer through the adsorber in order to discharge it entirely. If the removed substances constitute mixture, for instance ethylene and propylene or "Gasol," i. e. a mixture of heavy hydrocarbons, it may often be preferable to use heated pure ethylene for discharging the adsorbing agent and to expel in the manner to a large extent the heavier components. In such a case that gas will be used for the removal which is the least adsorbed at the increased removal temperature and above all tends the least to undesired phenomena, such as polymerization on the adsorbing agent and others. For a careful treatment of the adsorbing agent it may furthermore be suitable once to steam it in known manner after each thirtieth or fiftieth discharge so as to remove entirely the residual charge with agents injuring the adsorption.

The present process enables to separate 1.5 per cent of ethylene from illuminating gas; the application of the entire quantity of gas according to the present invention shows surprising results. By means of mechanically readily attainable pressures, for instance 4 atmospheres above atmospheric pressure, and suitable active carbons selective for ethylene there may be obtained such quantities of gases adsorbed as amount to ten times the normal quantities. The discharge thus becomes economical and simple, since in the case of components of small percentages to be obtained and the small additional charges the energies of loss on changing become too large in the usual processes.

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