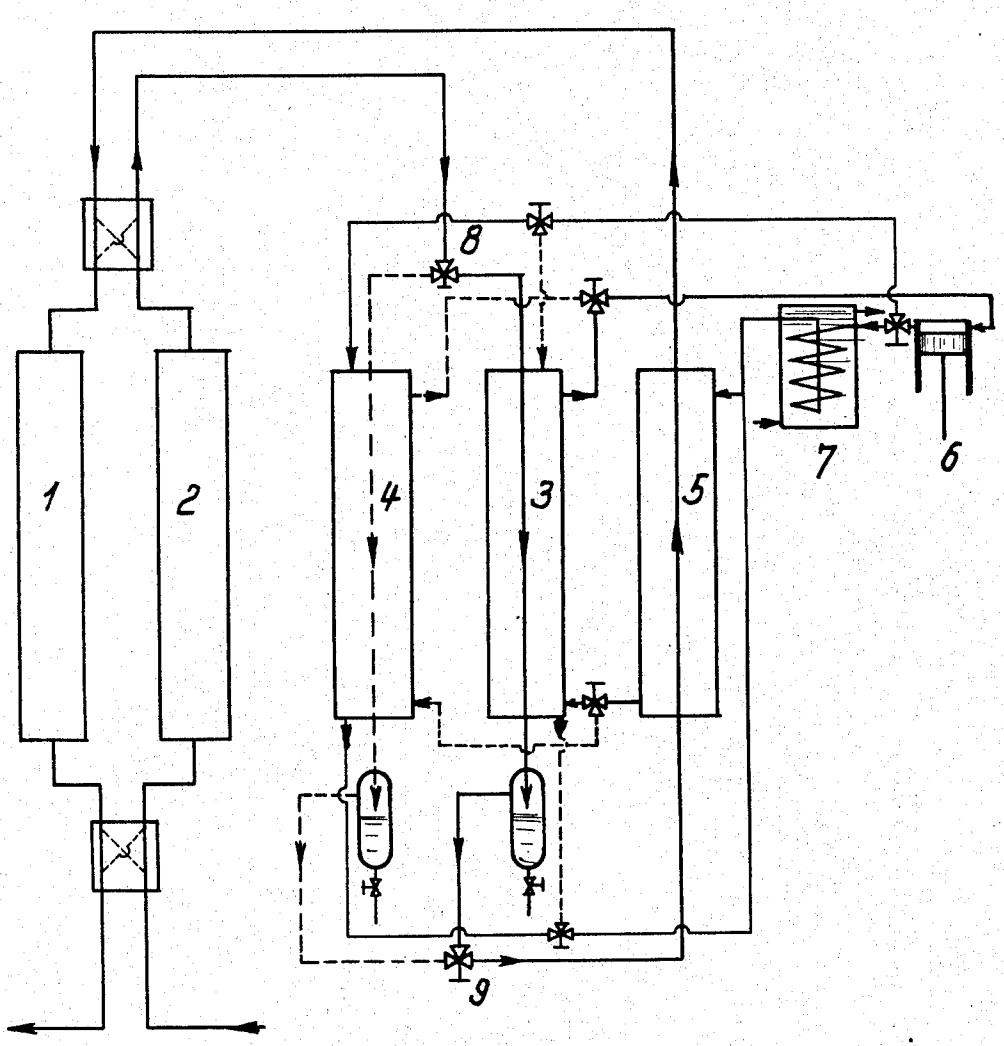
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PROCESS FOR CONDENSING VAPORS FROM GAS MIXTURES

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PROCESS FOR CONDENSING VAPORS FROM GAS MIXTURES

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The present invention relates to a process for separating easily condensable constituents from gas mixtures by cooling and condensation. According to the invention the gases are cooled in periodically changed cold accumulators down to the dew point of the vapors. The further cooling and the condensation of the vapors is performed in separate coolers by means of a refrigerating machine, e. g. a multiple stage ammonia refrigerating machine. The gas escaping from the last cooler has a temperature far below the dew point of the vapors in the fresh gas; it is, therefore, not possible to utilize the cold of this gas completely in the regenerators, as in this case a portion of the vapors to be obtained would be condensed in the cold accumulators and, after reversing, would be carried along by the escaping gas. The cold residual gas, therefore, according to the present invention, is reheated before entering the regenerators up to a sufficiently high temperature to prevent a condensation of the vapors from the fresh gas. An advantageous way of performing this reheating of the residual gas is to bring it into heat exchange with the refrigerant of the refrigerating machine, thus transmitting the cold contained in the residual gas to the refrigerant.

The new process presents important advantages in comparison with the processes used heretofore. By replacing the usual counter-current heat exchangers by the cold accumulators energy is saved as well on account of the smaller loss of pressure of the gases while passing the exchanger as by the higher efficiency of cold recovery, the heat of vaporization being completely transmitted in the regenerators from the incoming to the outgoing gas. Other processes proposing to use regenerators with long periods could not make use of these advantages and diminish the losses of cold.

The invention will be more particularly described as applied to the separation of benzene from coal distillation gases with reference to the accompanying drawing which is a diagrammatic representation of a system of apparatus embodying the invention.

The gas, precooled and freed from the chief quantities of tar and naphthalene, is cooled, in the cold accumulator 2, respectively 1, down to the dew point of the benzene in the gas, for example, at a content of 25 grams per cubic meter down to —18° C. Then the gas enters the cooler 3 of known construction which is cooled by evaporation of carbon dioxide or ammonia; here it is cooled until the benzene is condensed to the extent desired. The cooler in which the benzene is separated, is provided in duplicate in the usual manner (3 and 4 in the drawing). When a certain quantity of benzene is condensed in a cooler the gas flow is reversed to the other cooler by means of valves 8 and 9, and the first cooler is heated to melt off the benzene frozen-out. The flow of the gas and of the refrigerant in the period after reversing coolers 3 and 4 is shown by the dotted lines. This heating is suitably effected by using the cold contained in the cooler so that the cooler serves not as an evaporator, but as a condenser for the refrigerant. The refrigerant flows in one period as shown in the drawing from the compressor 6 through water cooler 7 where it is condensed and is undercooled in the cooler 5 and then evaporated in 3 or 4, respectively, where the benzene is condensed. In order to melt out the benzene condensed in 3 or 4, respectively, after reversing the coolers, a portion of the volatile refrigerant, leaving compressor 6, is condensed in this cooler and then added to the portion of the refrigerant liquefied in 7.

The gas leaving the cooler 3, respectively 4, is warmed in the counter-current cooler 5 in heat exchange with the refrigerant up to about the dew point of the benzene in the fresh gas and then flows out again through the cold accumulator 1, respectively 2.

The gas freed from the benzene can be reheated by the cooling agent in such a manner that a portion of the cooling agent is liquefied not at the temperature of cooling water and correspondingly high pressures, but at low pressures in heat exchange with the cold gas. In multiple stage refrigerating machines that portion of the cooling agent which is condensed at low temperatures, is drawn from the first or second stage of compression. Another working method consists in liquefying the cooling agent in the usual manner at the temperature of cooling water, and undercooling it by heat exchange with the cold gas before the evaporation. Both methods of transmitting the cold may be utilized together. Finally, the reheating of the gas escaping from the cooler 3, respectively 4, may also take place in such a manner that, between the cold accumulators and this cooler, a heat exchanger is intercalated in which an exchange of cold between the fresh gas and the gas freed from the benzene takes place. The gas escaping from this exchanger may then be introduced into the regenerators without a condensation of benzene taking place in them. The counter-current cool-

er is preferably provided doubly so that one cooler is in operation while the other one is freed from the constituents which condense in solid form.

Particularly when obtaining benzene the use of regenerators for cooling the gas is of great advantage, as in this case the separation of the condensates occurring above the dew point of the benzene takes place reversibly so that for this purpose no special demand of cold is required. On the one hand, these condensates have but a low commercial value, and on the other hand, their remaining in the gas is sometimes desirable as they preserve a protecting layer on the pipings the absence of which would, otherwise, cause severe troubles in valves, etc., by deposits of rust and dust.

The new process is of special advance for obtaining benzene if a preceding purification of the gas from naphthalene, especially by cooling to about 0° C., has taken place. In this case the gas is practically completely freed from tar and naphthalene and also, to a great extent, dried so that not many condensates have to be separated and again evaporated in the regenerators. Furthermore, the gas is at disposal in precooled condition. The purification of the gas by cooling to about 0° C. may be very advantageously combined with the described separation of benzene if for the latter cooling multiple-stage compression refrigerating machines are used. In this case the cold required for prepurifying the gas is furnished in a simple and economical manner by the middle pressure stage of the compression refrigerating machine.

The purification of the gas from sulphur which in most cases is necessary, may take place before or after the benzene has been separated. If the purification is performed after the separation of benzene, the purification mass can be utilized in a very favorable degree owing to the high purity of the gas. If the purification takes place before the separation of benzene, a benzene free from sulphur is obtained. As for the usual purification from sulphur the gas is required in a warm and moist condition it is suitable, if the purification from sulphur is to be intercalated between a purification of the gas by cooling and the separation of benzene, to reheat the gas which comes cold and dry from the purification, in countercurrent heat exchange with the warm and moist gas which comes from the purification from sulphur and, at the same time, to moisten it, so that it will transmit its cold and dryness to the gas free from sulphur.

We claim:—

1. Process for condensing vapors from gas mixtures which comprises cooling the gas mixture in periodically alternated regenerators down to the dew point of the vapors to be condensed, condensing the vapors by further cooling by heat exchange with the volatile liquid refrigerant of a refrigerating machine, warming the gases after the condensation of the vapors by heat exchange with the volatile refrigerant and passing the warmed gases through the aforesaid regenerators.

2. Process for condensing vapors from gas mixtures which comprises cooling the gas mixture in periodically alternated regenerators down to the dew point of the vapors to be condensed, condensing the vapors by further cooling by heat exchange with the volatile liquid refrigerant of a refrigerating machine, warming the gases after the condensation of the vapors by condensing a portion of the volatile liquid refrigerant and passing the warmed gases through the aforesaid regenerators.

3. Process for condensing vapors from gas mixtures which comprises cooling the gas mixture in periodically alternated regenerators down to the dew point of the vapors to be condensed, condensing the vapors by further cooling by heat exchange with the volatile liquid refrigerant of a refrigerating machine, warming the gases after the condensation of the vapors by heat exchange with the volatile liquid refrigerant which is hereby undercooled and passing the warmed gases through the aforesaid regenerators.

4. Process for condensing vapors from gas mixtures which comprises cooling the gas mixture in periodically alternated regenerators down to the dew point of the vapors to be condensed, condensing the vapors by further cooling by heat exchange with the volatile liquid refrigerant of a refrigerating machine, warming the gases after the condensation of the vapors by heat exchange with the fresh gas leaving the regenerators in a separate counter-current heat exchanger and passing the warmed gases through the aforesaid regenerators.

5. Process for condensing benzene from gas mixtures which comprises cooling the gas mixture in periodically alternated regenerators down to the dew point of the benzene, condensing the benzene by further cooling by heat exchange with the volatile liquid refrigerant of a refrigerating machine, warming the gases after the condensation of the benzene by heat exchange with the refrigerant and passing the warmed gases through the aforesaid regenerators.

6. Process for condensing benzene from gas mixtures which comprises purifying the gas mixture from naphthalene, cooling it in periodically alternated regenerators down to the dew point of the benzene, condensing the benzene by further cooling by heat exchange with the volatile refrigerant of a refrigerating machine, warming the gases after the condensation of the benzene by heat exchange with the refrigerant and passing the warmed gases through the aforesaid regenerators.

7. Process for condensing benzene from gas mixtures which comprises purifying the gas mixture from naphthalene by cooling it to about 0° C., cooling the gas mixture in periodically alternated regenerators down to the dew point of the benzene, condensing the benzene by further cooling by heat exchange with the volatile liquid refrigerant of a refrigerating machine, warming the gases after the condensation of the benzene by heat exchange with the refrigerant and passing the warmed gases through the aforesaid regenerators.

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