

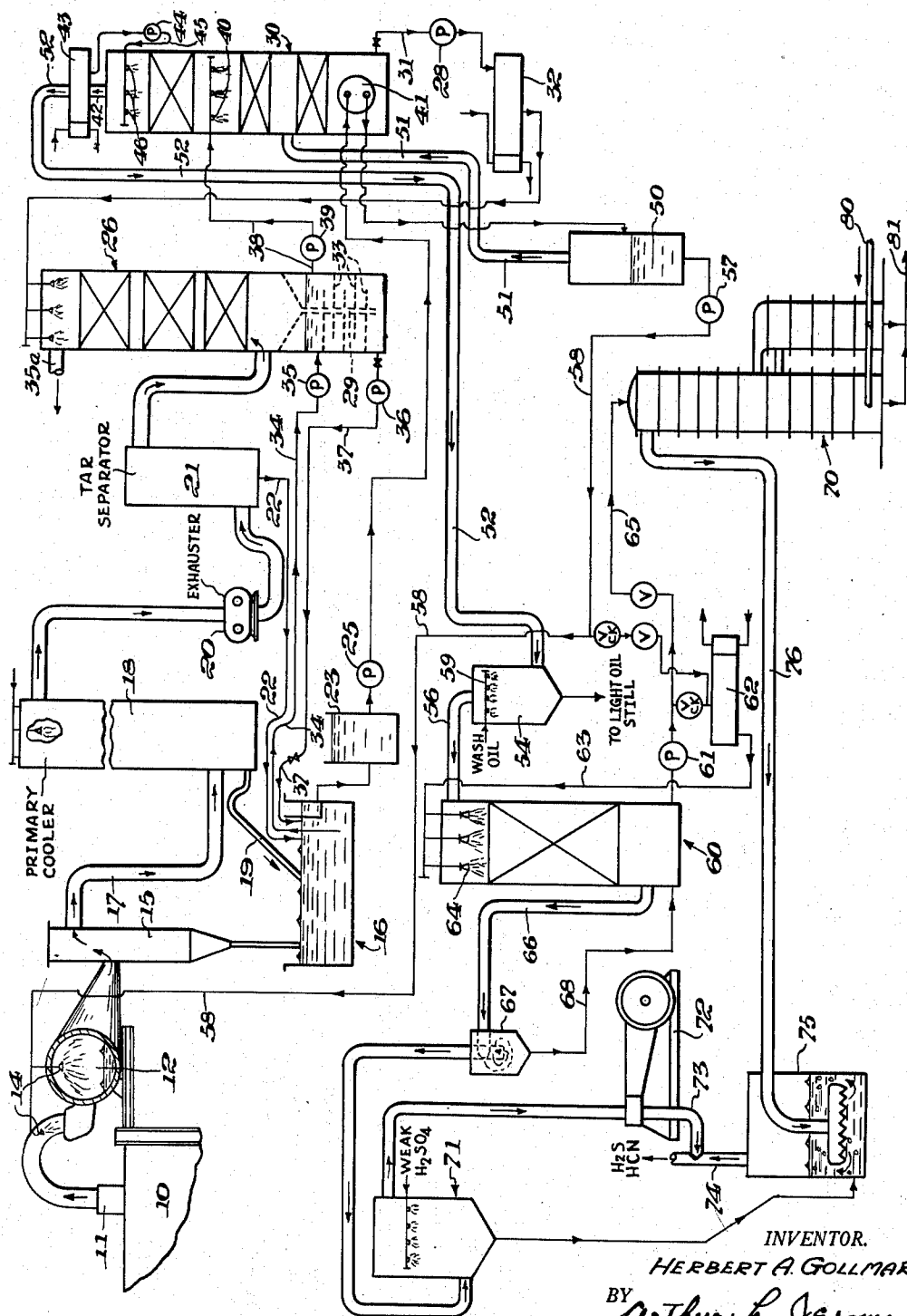
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H. A. GOLLMAR

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GAS PURIFICATION PROCESS

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INVENTOR.
HERBERT A. GOLLMAR.
BY *Arthur L. Jerome*
his ATTORNEY.

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GAS PURIFICATION PROCESS

Herbert A. Gollmar, Pittsburgh, Pa., assignor to
Koppers Company, Inc., Pittsburgh, Pa., a cor-
poration of Delaware

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The present invention relates to the liquid purification of by-product, coke-oven gas, and particularly to an improved process in which the coke-oven gas is scrubbed with an aqueous absorbent which is actified or regenerated by heating under subatmospheric pressure.

An object of the invention is to provide an improved process of the type described which provides for the separation and recovery of ammonia, hydrogen sulfide, and hydrogen cyanide.

A further object of the invention is to provide an improved process of the type described which can be carried out economically.

Another object of the invention is to provide an improved process of the type described which is arranged so that the heat required for the process is reduced to a minimum.

A further object of the invention is to provide an improved process of the type described which is arranged so that the heat required in actification or regeneration of the washing solution is supplied from a source of heat which is normally wasted, as, for example, by the liquor which is employed to cool the gas in the collecting main.

Another object of the invention is to provide an improved process of the type described which is arranged so that the subatmospheric conditions for the actification of the fouled absorbent are provided with a minimum of expense.

A further object of the invention is to provide an improved process of the type described which is arranged so that a vacuum pump of minimum size and operating cost is required to maintain the subatmospheric conditions in the chamber in which the fouled absorbent is actified.

Another object of the invention is to provide an improved process of the type described in which the gases given off during actification of the fouled solution are washed with ammoniacal liquor to thereby reduce the volume of these gases, both by cooling of the gas and by chemical reaction or combination of constituents of the gas with the washing solution, so that the volume of gas remaining to be handled by the vacuum pump is relatively small.

A further object of the invention is to provide an improved process of the type described in which all traces of ammonia are removed from the gas supplied to the vacuum pump to thereby eliminate formation of objectionable deposits as a result of reactions initiated by the heat of compression of the gas passing through the vacuum pump.

Another object of the invention is to provide an improved process for removing ammonia from coke-oven gas and for forming ammonium sulfate therefrom in a saturator.

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A further object of the invention is to provide an improved process of the type described and in which the saturator is of relatively small size so that it can be constructed at low cost and so that it can be fabricated in a shop as a complete unit.

Another object of the invention is to provide an improved process of the type described which eliminates the necessity for passing the entire body of the coke-oven gas through the saturator and thus eliminates the attendant cost of compressing the gas.

A further object of the invention is to provide an improved process of the type described and in which the flushing liquor is employed as the ammoniacal liquid or secondary washing solution for washing the gas given off by the primary washing solution so that the supply of the secondary washing solution to the ammonia still does not increase the load on the ammonia still.

Another object of the invention is to provide an improved process of the type described which includes means for supplying to the actifier from the flushing liquor water in an amount substantially equal in volume to that present in the gas leaving the actifier to thereby prevent any increase in the volume of liquid to be handled by the ammonia still.

A further object of this invention is to provide an improved process of the type described and which incorporates means to recover the naphthalene present in the gas and does so in such manner as to insure that the naphthalene will not interfere with the operation of the apparatus for carrying out the process.

Another object of the invention is to provide an improved process of the type described which eliminates the need for the final coolers which are usually employed in gas purification processes.

A further object of the invention is to provide an improved gas purification process of the type shown in U. S. Patent No. 1,654,782, issued Jan. 3, 1928, to E. H. Bird.

Other objects of the invention and features of novelty will be apparent from the following description taken in connection with the accompanying drawing, the single figure of which is an elevational view of apparatus for treating coke-oven gas with the process provided by this invention.

The apparatus shown in the drawing includes various units ordinarily employed in coke plants. Gases from a coke oven 10 pass through an ascension pipe 11 to the collecting main 12 which is provided with sprays 14 for spraying the gases with ammoniacal or flushing liquor which serves

as a medium to cool the gases. The gas leaving the collecting main is at a temperature on the order of 75° C. (167° F.).

The tar and moisture condensed out of the gas collect in the bottom of the collecting main 12 and, together with the flushing liquor, flow through a downcomer 15 to a flushing liquor decanter or hot drain tank 16. A substantial portion, on the order of twenty percent, of the ammonia in the gas from the coke oven is absorbed in the flushing liquor and remains in this liquor when this liquor flows from the collecting main to the decanter or drain tank 16.

The gas passes through the suction main 17 to the primary cooler 18 which is preferably of the indirect type in which the gas flows over tubes through which cooling water is circulated. Tar and liquid condensing out of the gas in the primary cooler flows to the tank 16 through a pipe 19. In the primary cooler the gases are cooled to a temperature on the order of 35° C. (95° F.).

The cooled gases are withdrawn from the primary cooler 18 by the exhaustor 20 and are pumped through the tar separator 21, from which condensates and collected liquids flow through pipe 22 to the tank 16.

In the tank 16 the tar and ammonia liquor separate into layers, and the ammonia liquor, which forms the upper layer, passes from the tank 16 into a circulating tank 23 from which it is pumped by a pump 25 and thence to the sprays 14 over a path hereinafter described. In addition, as hereinafter explained, a portion of the ammonia liquor is supplied to the ammonia still and another portion is employed in the activation, or regeneration, of the solution which is employed to wash the gas, while water vapor is taken from the flushing liquor and added to the gases given off during regeneration of the washing solution.

The cooled gas, free from tar, is supplied from the tar separator 21 to the lower part of the upper section of the absorber 26 in which the gas is brought into contact with an aqueous alkaline primary absorbent solution, such as a solution of sodium carbonate, which is pumped by a pump 28 from the bottom of an actifier 30 through a line 31 which has a cooler 32 interposed therein. Cooling water is supplied by suitable means from any appropriate source to the cooler 32, and also to the other coolers employed in this process. The upper section of the absorber 26 is preferably in the form of a packed tower through which the gas passes upwardly in countercurrent to the downwardly flowing liquid. The absorber 26 is of such size and the rate of circulation of the primary absorbent solution and the concentration of the absorbent solution are such that the solution absorbs substantially all of the hydrogen sulfide, hydrogen cyanide, and ammonia present in the gas. The acid-forming constituents in the gas combine chemically with the alkaline washing solution, thereby reducing the alkalinity of the solution so that ammonia from the acid dissolves in the solution and reacts with the acid-forming constituents of the gas. In addition, the gas is cooled by the washing solution, and the various parts of the equipment are proportioned so that the gas leaving the absorber is at a temperature of about 25° C. (77° F.). The gas, substantially free of the constituents listed above, leaves the absorber 26 through the outlet or discharge pipe 35a and may be subjected to any desired further treatment for the recovery of by-products present therein.

The bottom of the upper section of the absorber 26 is conical and has a centrally located discharge pipe 29 which extends downwardly to a point adjacent the bottom of the lower section of the absorber. The pipe 29 extends through a plurality of horizontal baffles 33, alternate ones of which extend from opposite sides of the absorber. The baffles 33 are spaced apart vertically a short distance and cooperate to form a tortuous or circuitous path through which liquid flowing downwardly through the pipe 29 must pass to reach the top of the body of liquid in the lower section of the absorber.

Liquid tar from the tank 16 is pumped through pipe 34 by the pump 35 to the upper part of the lower section of the absorber 26, while tar from the bottom of the lower section of the absorber 26 is pumped by the pump 36 through the pipe 37 to the tank 16. Accordingly, there is a continuous downward flow of tar through the lower section of the absorber 26.

The primary absorbent solution which collects in the bottom of the upper section of the absorber is of lower specific gravity than the tar so it flows downwardly through the pipe 29 and thence upwardly through the tar and forms a pool or layer of liquid on top of the tar.

The cool absorbent solution sprayed on the gas in the absorber 26 condenses naphthalene from the gas and this naphthalene is carried by the absorbent solution down through the pipe 29 so that the naphthalene is discharged into the tar. The tar is an absorbent for the naphthalene, and because of the circuitous path through which the absorbent solution must travel in reaching the top of the tar, the naphthalene is almost completely absorbed from the absorbent solution before the absorbent solution reaches the top of the tar. The naphthalene absorbed by the tar is carried by the tar to the tank 16, and is removed from the tar during the refining of the tar by the methods customarily employed.

The pumps 35 and 36 and the associated pipes may be governed in any suitable manner well known in the art to maintain the tar in the lower section of the absorber 26 at a substantially constant level.

In addition, the absorber 26 may have associated therewith means for preparing alkaline absorbent solution and for supplying solution to the circulating system for the absorber. This equipment has not been shown, but may be arranged substantially as shown in my Patent 2,464,805, granted March 27, 1949.

Fouled primary absorbent solution which collects in the bottom section of the absorber 26 is pumped therefrom through the pipe 38 by the pump 39 to sprays 40 in the actifier 30. The pipe 38 communicates with the lower section of the absorber 26 at a point above the level of the tar therein so that only washing solution is withdrawn through the pipe 38.

The actifier 30 is in the form of a packed tower and the nozzles 40 are located at an intermediate point in the tower.

The fouled primary absorbent solution in the actifier 30 is heated by the reboiler 41 mounted in the base of the actifier and having coils through which relatively hot flushing liquor is circulated by the pump 25. The pressure in the actifier 30 is maintained substantially below atmospheric pressure by means hereinafter described so the liquid therein boils or vaporizes at a relatively low temperature. Hence the heat

supplied from a source of heat which is normally wasted is adequate to cause the desired boiling or vaporizing of this solution. For example, the heat required in the actifier 30 may be supplied by circulating flushing liquor through the reboiler 41, or it may be supplied to the actifier from any other source such as directly from the hot gas in the collecting main 12.

The flushing liquor is heated by the hot gas supplied from the ovens 10 to the collecting main 12. Hence, the flushing liquor circulated through the reboiler 41 in the actifier 30 provides means for transferring heat from the coke oven gas to the solution in the actifier.

As a result of the heating of the primary absorbent solution and of the upward flow of vapors through the packing countercurrent to the descending primary absorbent solution, the ammonia, hydrogen sulfide and hydrogen cyanide present therein are largely expelled, and are carried out the top of the actifier together with the water which is vaporized from the absorbent liquor. The regenerated primary solution which collects in the bottom of the actifier 30 is recirculated by the pump 28 and is returned through the cooler 32 to the absorber 26. The pump 28, or the pipe 31, may be governed by appropriate means to maintain the liquid in the bottom of actifier 30 at a suitable level.

The gases emitted from the fouled primary absorbent solution in the actifier 30 leave the actifier through the pipe 42 and pass through the cooler or dephlegmator 43 which condenses a major portion of the water present in these gases. The condensate from the dephlegmator 43 is pumped by a pump 44 through a pipe 45 to sprays 46 in the top of the actifier 30.

The flushing liquor leaving the reboiler 41 flows to a flash tank 50, the upper part of which is connected by a pipe 51 with the actifier 30 at an intermediate level in the actifier. As stated above, the actifier is at less than atmospheric pressure so the space in the flash tank 50 above the level of the liquid therein is also below atmospheric pressure, and there is rapid evaporation of water from the surface of the relatively hot liquid in this tank. In addition, there is rapid escape of vapors, such as ammonia and hydrogen sulfide, from the liquid in the tank 50. These vapors pass through the pipe 51 to the actifier 30 and add to the vapors therein.

As stated above, the dephlegmator 43 cools the gases leaving the actifier 30 and condenses a major portion of the water vapor therefrom, this condensate being returned to the actifier 30 through the sprays 46. However, the gas leaving the dephlegmator 43 contains some water vapor, and if the water represented by this water vapor were not returned to the system, the absorbent solution would soon be consumed.

The flash tank 50 provides means for supplying moisture to the actifier 30 to compensate for the moisture taken from the actifier by the gas discharged therefrom. The surface area of the tank 50, the size of the pipe 51, and the amount of cooling in dephlegmator 43 are selected and proportioned so that moisture supplied from the tank 50 to the actifier 30 is substantially equal in quantity to the moisture carried out of the actifier 30 by the gas leaving the dephlegmator 43. Hence, the volume of the washing solution is not diminished by evaporation in the actifier.

As hereinafter explained, the water carried by the gas leaving the dephlegmator is supplied to an ammonia still. As this water is taken from

the flushing liquor, there is less flushing liquor to be supplied to the ammonia still than would be the case if the water were supplied from a different source, and the total volume of liquid supplied to the ammonia still remains substantially unchanged.

As previously stated, the dephlegmator cools the gases leaving the actifier 30, while condensate from the gases is returned to the actifier. The cooling of the gases reduces their volume, which is helpful in maintaining the subatmospheric pressure conditions in the actifier 30, but it also increases the gases absorbed by the condensate returned to the actifier from the dephlegmator 43. Accordingly, the apparatus is arranged and proportioned so that the gases leaving the dephlegmator 43 are at a temperature on the order of 45° C. This effects a substantial reduction in the volume of these gases without objectionably increasing the concentration of the absorbed gases in the condensate returned to the actifier.

Liquid from the flash tank 50 is pumped by the pump 57 through pipe 58 to the sprays 14 in the collecting main 12, while a branch of the pipe 58 connects with the circulating system for the secondary absorber 60 and provides means for adding flushing liquor to the absorber 60. The pump 57, or the pipes associated therewith, may be governed in any appropriate manner to maintain the liquid in the tank 50 at a substantially constant level.

Although most of the naphthalene is removed from the washing solution in the bottom of the vapor absorber 26, a small quantity of naphthalene may be carried by the washing solution to the actifier 30 and be driven off with the gases leaving the actifier. If permitted to remain in the gas, the naphthalene might solidify in the pipes and interfere with operation of the equipment, and means is provided to remove from the gas leaving the actifier any traces of naphthalene present therein.

The pipe 52 leading from the dephlegmator 43 is connected to the lower portion of a chamber 54 in which wash oil is sprayed by sprays 59. The wash oil employed in these sprays may be the same as is employed in the recovery of light oils from coke-oven gas, while the oil which collects in the bottom of the chamber 54 may be supplied to the stills forming part of the light oil recovery apparatus. The gas in passing through the chamber 54 moves in countercurrent to the oil sprays and any traces of naphthalene present in the gas are absorbed by the oil. Hence, the gas leaving the chamber 54 is substantially free of naphthalene, while the naphthalene removed from the gas is recovered during processing of the wash oil in the light oil stills.

From the chamber 54 the gas flows through pipe 56 to the upper part of the secondary vapor absorber 60 in which the gas is washed with a secondary absorbent solution in the form of ammoniacal or flushing liquor circulated by a pump 61. The vapor absorber 60 is in the form of a packed tower in which the absorbent liquid and the gas both flow downwardly. The pump 61 receives liquor from the bottom of the absorber 60 and circulates it through a cooler 62 which reduces the liquid to a temperature on the order of 32° C. From the cooler 62 the liquid flows through pipe 63 to sprays 64 in the top of the vapor absorber 60.

A portion of the liquor discharged by the pump 61 is supplied over pipe 65 to the ammonia still 70 while this liquor is replaced by makeup liquor

supplied from a branch of the pipe 53 through which flushing liquor is supplied to the sprays 14 in the collecting main 12. Hence, the liquor supplied to the sprays 64 in the top of the vapor absorber 60 contains the makeup liquor and therefore has a substantially lower concentration of absorbed gases than the liquor removed from the bottom of the absorber by the pump 61.

It is to be understood that the pumps 57 and 61 may be regulated to control the pressures developed on the liquids discharged therefrom. It is to be understood also that the branch of the pipe 58 leading to the cooler 62, and the pipes leading from the pump 61 to the cooler 62 and to the still 70 have suitable control valves V and check valves VCK therein to regulate the volume and the direction of the flow of liquid there-through. These valves may be arranged to permit flow of liquid from the pipe 58 to the cooler 62 but to prevent flow of liquid from the pipe 58 to the pipe 65 leading to the still 70, and to also prevent flow of liquid from the pump 61 to the pipe 58.

The ammoniacal or flushing liquor with which the gas is contacted in the absorber 60 reduces the volume of the gas not only by cooling the gas and condensing water vapor present therein, but also by absorbing the constituents of the gas. This liquor, when introduced into the absorber 60, has a relatively low concentration of ammonia, and, therefore, will readily absorb ammonia from the gas in the absorber. Similarly, this liquor, when introduced into the absorber 59, has a relatively low concentration of hydrogen sulfide and hydrogen cyanide so these are readily absorbed from the gas. The ammonia forms an alkaline compound when in solution, while the hydrogen sulfide and hydrogen cyanide have an acid reaction when in solution. Hence, the ammonia combines with the hydrogen sulfide and hydrogen cyanide to form compounds which remain in solution and are removed with the liquor which is withdrawn from the bottom of the absorber 60 by the pump 61 and supplied to the ammonia still 70, which is of conventional construction and includes a free ammonia section, a fixed ammonia section, and a lime leg. The ammonia still 70 also includes a dephlegmator through which passes the gas driven off from the liquor processed in the still. The dephlegmator condenses moisture from these gases, and this moisture is returned to the still.

The rate of circulation of liquor or secondary absorbent through the absorber 60, the temperature of this liquor, the rate of withdrawal of liquor for supply to the ammonia still 70, and the rate of supply of replacement flushing liquor to the circulating system for the absorber 60 are adjusted and proportioned so that at least a large part of the ammonia, hydrogen sulfide, and hydrogen cyanide present in the gas supplied to the absorber 60 are removed therefrom by the liquor. This absorption of gases by the liquor greatly reduces the volume of the gas discharged from the absorber 60.

Gas discharged from the lower portion of the vapor absorber 60 flows through the pipe 66 to the knockdown tank 67 which also serves as a centrifugal separator for the removal of water entrained in the gas leaving the absorber 60. The water removed from the gas in the tank 67 is returned by pipe 68 to the bottom of the absorber 60.

The gas discharged from the tank 67 is supplied to an acid washer 71 where the gas passes

through a spray of weak sulfuric acid which serves to remove traces of ammonia present in the gas. The gas discharged from the acid washer 71 is supplied to the inlet side of a vacuum pump 72, the exhaust side of which is connected by pipe 73 to the gas outlet 74 of the saturator 75. A pipe 76 leads from the ammonia still 70 to the inlet of the saturator 75. The saturator 75 may be of any suitable construction well known in the art, as, for example, in Patent No. 1,964,560, to Fred Denig, but because of the relatively small volume of the gas passing through the saturator, the saturator can be of much smaller size than would otherwise be necessary.

As explained above, the gas leaving the absorber 60 is washed with weak sulfuric acid before being supplied to the vacuum pump 72 so that all traces of ammonia are removed from the gas. This is advantageous because if ammonia is present in the gas supplied to the vacuum pump, the heat of compression will initiate reactions between the ammonia and other constituents of the gas and will result in the formation of complex, gummy substances which will interfere with the operation of the vacuum pump and with other portions of the apparatus. The washing of the gas with weak sulfuric acid before the gas is supplied to the vacuum pump removes the ammonia from the gas and eliminates this difficulty. The ammonia in the gas supplied to the acid washer 71 combines with the sulfuric acid to form ammonium sulfate, while the acid with this sulfate in solution is supplied to the saturator 75 as part of the makeup acid therefore.

As previously stated, some of the liquor pumped by the pump 61 from the absorber 60 is supplied through pipe 65 to the ammonia still 70. This still operates in the usual manner. Steam for operating the still is supplied from a suitable source through a pipe 80, while spent liquor is removed from the bottom of the still through a pipe 81. As a result of heating in the still, the ammonia, hydrogen sulfide and hydrogen cyanide in the liquor supplied to the still are driven off, while contact of the liquor with the lime in the still decomposes the fixed ammonia compounds in the liquor so that the ammonia from these compounds is also driven off.

The gas from the ammonia still 70 is supplied through the pipe 76 to the saturator 75 where the gas passes through the weak sulfuric acid solution in the saturator 75 so that the ammonia in the gas is converted to ammonium sulfate which may be removed from the saturator in the usual manner.

The hydrogen sulfide and hydrogen cyanide present in the gas supplied to the saturator 75 pass through the sulfuric acid unchanged and are discharged through the pipe 74 to which the exhaust of the vacuum pump 72 is connected. These gases may be separated by any desired means and may then be employed in any desired manner.

A part of the liquor supplied to the ammonia still 70 is taken from the absorber 60, but this does not represent an increase in the volume of liquor to be processed by the still 70 since the liquor taken from the absorber 60 is replaced by flushing liquor, thereby reducing the volume of flushing liquor supplied to the ammonia still. Hence, the steam requirements of the ammonia still are not materially affected.

From the foregoing, it will be seen that the coke-oven gas, after cooling and after removal of the tar therefrom, is supplied to the first or

primary absorber 26 where it is scrubbed substantially at atmospheric pressure with an aqueous alkaline primary washing solution in the form of a solution of sodium carbonate. This solution cools the gas and removes substantially all of the ammonia, hydrogen sulfide, and hydrogen cyanide from the gas, while the fouled solution is pumped to the actifier 30 where it is regenerated or actified so that the solution may be recirculated. The regeneration of the solution in the actifier is carried out under subatmospheric conditions so that heat which would otherwise be wasted is effective for this purpose.

The pressure in the actifier 30 is on the order of 4.0 inches of mercury, absolute, so the solution in this absorber vaporizes readily when heated to the relatively low temperature to which it is heated by the flushing liquor circulated through the reboiler 41.

This process is arranged so that the subatmospheric conditions in the actifier 30 are maintained with a vacuum pump of minimum size and minimum operating expense. The secondary vapor absorber 60 is interposed in the communication through which gas is supplied from the actifier 30 to the vacuum pump 72, and the gas flowing from the actifier 30 to the vacuum pump is washed with a secondary absorbent solution in the form of cool ammoniacal liquor in the vapor absorber 60. The volume of the gas is reduced not only by cooling the gas and condensation of water vapor present therein, but is also greatly reduced by absorption of the gas in the washing solution and by chemical combination of the constituents of the gas with the ammonia in the washing solution.

The gas given off by the washing solution during its regeneration or actification in the actifier 30 is composed almost entirely of constituents which will be absorbed by the secondary washing solution in the vapor absorber 60.

The compounds formed as a result of reaction of the constituents of the gas with the ammoniacal washing solution in the secondary absorber 60 remain in solution so the volume of the gas leaving the absorber through the pipe 66 is greatly diminished because of elimination of these elements from the gas. Accordingly, the volume of gas supplied to the vacuum pump 72 is relatively small and is much less than the volume of the gas given off by the absorbent solution being regenerated or actified in the actifier 30. As a result, only a comparatively small volume of gas must be handled by the vacuum pump 72 in order to maintain in the secondary absorber 60, and thus in the actifier 30, a relatively low pressure on the order of 4.0 inches of mercury, absolute. Hence, the vacuum pump 72 may be of relatively small size, and the cost of operation of this pump will be correspondingly small, thus making the process economically attractive.

The solution employed to wash the gas in the secondary vapor absorber is sent to the ammonia still where it is processed in the same manner that the flushing liquor is ordinarily treated. As a result of this treatment of the solution from the absorber, the ammonia and other constituents are released from the solution so that they may be recovered in the usual manner.

The ammoniacal solution employed in the vapor absorber 60 is provided from the flushing liquor, and as the flushing liquor is normally sent to the ammonia still, the solution sent from the vapor absorber to the ammonia still does not increase the total amount of liquid sent to the

ammonia still, nor does it increase the heat required by the ammonia still.

In addition, water is extracted from the flushing liquor and is supplied to the actifier 30 in volume equivalent to water present in the gas leaving the actifier. This prevents reduction in the volume of the washing solution, and it also prevents an increase in the volume of liquid to be processed by the ammonia still. While this is the preferred arrangement, it is to be understood that the invention is not limited to this specific source of water vapor and that water vapor may be supplied from any other suitable source.

Although it is preferred to employ flushing liquor as the ammoniacal solution in the vapor absorber 60, the invention is not limited to this arrangement and it is contemplated that solution for the vapor absorber 60 may be provided in other ways. For example, condensate from the dephlegmator which forms a part of the ammonia still may be employed as the solution in the absorber 60 instead of being returned directly to the ammonia still, or a special ammoniacal liquid may be provided for the purpose.

Although I have herein illustrated and described in detail one form of gas purification process embodying my invention, it should be understood that the invention is not limited to these details and that numerous changes and modifications may be made without departing from the spirit and scope of the following claims.

Having thus described my invention, what I claim is:

1. A process for treating gas containing ammonia, and acidic gases for the separation and recovery of ammonia and acidic gases therefrom comprising: scrubbing the gas in a primary scrubbing step with an aqueous solution of an alkaline-reacting metal compound to absorb the acidic gases and ammonia, heating the fouled alkaline solution in an actifying zone under subatmospheric pressure to drive off the absorbed acidic gases, ammonia and water while regenerating the absorbent solution, thereafter passing the acidic gases and ammonia under said subatmospheric pressure in a secondary scrubbing step into contact with a separate aqueous ammonia solution to absorb the acidic gases and ammonia under said subatmospheric pressure, whereby the volume of gas is reduced sufficiently so that it can be practically handled in a vacuum pump to establish the required subatmospheric pressure in the said actifying zone, passing the thus treated gases through a vacuum pump to draw the vacuum necessary in said actifying zone, and distilling the rich aqueous ammonia solution to separate acidic gases and ammonia therefrom, in which the acidic gases and ammonia driven out of the alkaline absorbent solution are passed through a condenser to separate a major portion of the water therein before the gases are brought into contact with the ammonia solution, and returning the condensed water to the alkaline absorbent solution.

2. A process for treating gas containing ammonia, and acidic gases for the separation and recovery of ammonia and acidic gases therefrom comprising: scrubbing the gas in a primary scrubbing step with an aqueous solution of an alkaline-reacting metal compound to absorb the acidic gases and ammonia, heating the fouled alkaline solution in an actifying zone under subatmospheric pressure to drive off the absorbed

acidic gases, ammonia and water while regenerating the absorbent solution, thereafter passing the acidic gases and ammonia under said subatmospheric pressure in a secondary scrubbing step into contact with a separate aqueous ammonia solution to absorb the acidic gases and ammonia under said subatmospheric pressure, whereby the volume of gas is reduced sufficiently so that it can be practically handled in a vacuum pump to establish the required subatmospheric pressure in the said actifying zone, passing the thus treated gases through a vacuum pump to draw the vacuum necessary in said actifying zone, and distilling the rich aqueous ammonia solution to separate acidic gases and ammonia therefrom, in which the gas initially contains naphthalene and in which the acidic gases and ammonia driven out of the alkaline absorbent solution and containing the naphthalene which is absorbed in the alkaline absorbent solution and stripped therefrom in the regeneration of that solution are scrubbed with oil to remove naphthalene therefrom before being contacted with ammonia solution.

3. A process for treating gas containing ammonia, and acidic gases for the separation and recovery of ammonia and acidic gases therefrom comprising: scrubbing the gas in a primary scrubbing step with an aqueous solution of an alkaline-reacting metal compound to absorb the acidic gases and ammonia, heating the fouled alkaline solution in an actifying zone under subatmospheric pressure to drive off the absorbed acidic gases, ammonia and water while regenerating the absorbent solution, thereafter passing the acidic gases and ammonia under said subatmospheric pressure in a secondary scrubbing step into contact with a separate aqueous ammonia solution to absorb the acidic gases and ammonia under said subatmospheric pressure, whereby the volume of gas is reduced sufficiently so that it can be practically handled in a vacuum pump to establish the required subatmospheric pressure in the said actifying zone, passing the thus treated gases through a vacuum pump to draw the vacuum necessary in said actifying zone, and distilling the rich aqueous ammonia solution to separate acidic gases and ammonia therefrom, in which gases leaving the second scrubbing step are passed through a sulfuric acid scrubbing zone before such gases are passed through the vacuum pump.

4. A process of treating coke oven gas for the separation and recovery of ammonia, hydrogen sulfide and hydrogen cyanide comprising: collecting coke oven gas from a plurality of coke ovens in a main, scrubbing the gas passing through the main in a first scrubbing step with an aqueous flushing liquor to cool the gas and absorb ammonia therefrom, thereafter passing the gas from the main through a body of an aqueous solution of an alkaline metal compound to remove hydrogen sulfide, hydrogen cyanide, and ammonia, heating the fouled alkaline absorbent solution under subatmospheric pressure to drive off absorbed hydrogen sulfide, hydrogen cyanide, ammonia and water while regenerating the absorbent solution, thereafter passing the acidic gases and ammonia in a second scrubbing step into contact with aqueous ammonia flushing liquor from the flushing main to absorb hydrogen sulfide, hydrogen cyanide and ammonia under said subatmospheric pressure, whereby the volume of gas is reduced sufficiently so that it can be practically handled in a vacuum pump to establish the required subatmospheric pres-

sure in the said actifying zone, passing the thus treated gases through a vacuum pump to draw the vacuum necessary in said actifying zone, and distilling the so-formed rich ammonia liquor to separate hydrogen sulfide, hydrogen cyanide and ammonia therefrom, in which the flushing liquor is cooled prior to contacting therewith the hydrogen sulfide, hydrogen cyanide and ammonia driven out of the alkaline absorbent to secure a maximum absorption of the hydrogen sulfide, hydrogen cyanide and ammonia in the cold liquor.

5. A process of treating coke oven gas for the separation and recovery of ammonia, hydrogen sulfide and hydrogen cyanide comprising: collecting coke oven gas from a plurality of coke ovens in a main, scrubbing the gas passing through the main in a first scrubbing step with an aqueous flushing liquor to cool the gas and absorb ammonia therefrom, thereafter passing the gas from the main through a body of an aqueous solution of an alkaline metal compound to remove hydrogen sulfide, hydrogen cyanide, and ammonia, heating the fouled alkaline absorbent solution under subatmospheric pressure to drive off absorbed hydrogen sulfide, hydrogen cyanide, ammonia and water while regenerating the absorbent solution, thereafter passing the acidic gases and ammonia in a second scrubbing step into contact with aqueous ammonia flushing liquor from the flushing main to absorb hydrogen sulfide, hydrogen cyanide and ammonia under said subatmospheric pressure, whereby the volume of gas is reduced sufficiently so that it can be practically handled in a vacuum pump to establish the required subatmospheric pressure in the said actifying zone, passing the thus treated gases through a vacuum pump to draw the vacuum necessary in said actifying zone, and distilling the so-formed rich ammonia liquor to separate hydrogen sulfide, hydrogen cyanide and ammonia therefrom, in which the hydrogen sulfide, hydrogen cyanide and ammonia driven out of the alkaline absorbent are scrubbed with oil to remove naphthalene therefrom before the gases and ammonia pass into contact with the ammonia flushing liquor.

6. A process of treating coke oven gas for the separation and recovery of ammonia, hydrogen sulfide and hydrogen cyanide comprising: collecting coke oven gas from a plurality of coke ovens in a main, scrubbing the gas passing through the main in a first scrubbing step with an aqueous flushing liquor to cool the gas and absorb ammonia therefrom, thereafter passing the gas from the main through a body of an aqueous solution of an alkaline metal compound to remove hydrogen sulfide, hydrogen cyanide, and ammonia, heating the fouled alkaline absorbent solution under subatmospheric pressure to drive off absorbed hydrogen sulfide, hydrogen cyanide, ammonia and water while regenerating the absorbent solution, thereafter passing the acidic gases and ammonia in a second scrubbing step into contact with aqueous ammonia flushing liquor from the flushing main to absorb hydrogen sulfide, hydrogen cyanide and ammonia under said subatmospheric pressure, whereby the volume of gas is reduced sufficiently so that it can be practically handled in a vacuum pump to establish the required subatmospheric pressure in the said actifying zone, passing the thus treated gases through a vacuum pump to draw the vacuum necessary in said actifying zone, and distilling the so-formed rich ammonia liquor to separate hydrogen sulfide, hydrogen cyanide and

ammonia therefrom, in which a vacuum is created to draw vapors released from the alkaline absorbent in the actifying zone through the second scrubbing step, scrubbing any gases leaving the second scrubbing step with sulfuric acid, and then passing such gases through the vacuum-creating means.

7. A process of treating coke oven gas for the separation and recovery of ammonia, hydrogen sulfide and hydrogen cyanide comprising: collecting coke oven gas from a plurality of coke ovens in a main, scrubbing the gas passing through the main in a first scrubbing step with an aqueous flushing liquor to cool the gas and absorb ammonia therefrom, thereafter passing the gas from the main through a body of an aqueous solution of an alkaline metal compound to remove hydrogen sulfide, hydrogen cyanide, and ammonia, heating the fouled alkaline absorbent solution under subatmospheric pressure to drive off absorbed hydrogen sulfide, hydrogen cyanide, ammonia and water while regenerating the absorbent solution, thereafter passing the acidic gases and ammonia in a second scrubbing step into contact with aqueous ammonia flushing liquor from the flushing main to absorb hydrogen sulfide, hydrogen cyanide and ammonia under said subatmospheric pressure, whereby the volume of gas is reduced sufficiently so that it can be practically handled in a vacuum pump to establish the required subatmospheric pressure in the said actifying zone, passing the thus treated gases through a vacuum pump to draw the vacuum necessary in said actifying zone, and distilling the so-formed rich ammonia liquor to separate hydrogen sulfide, hydrogen cyanide and ammonia therefrom, in which water is separated by condensation from the hydrogen sulfide, hydrogen cyanide and ammonia driven out of the alkaline absorbent solution before the hydrogen sulfide, hydrogen cyanide and ammonia are passed into contact with the ammonia liquor absorbent and the condensed water is returned to the alkaline absorbent solution in the absorbent zone.

8. A process of treating coke oven gas for the separation and recovery of ammonia, hydrogen sulfide and hydrogen cyanide comprising: collecting coke oven gas from a plurality of coke ovens in a main, scrubbing the gas passing through the main in a first scrubbing step with an aqueous flushing liquor to cool the gas and absorb ammonia therefrom, thereafter passing the gas from the main through a body of an aqueous solution of an alkaline metal compound to remove hydrogen sulfide, hydrogen cyanide, and ammonia, heating the fouled alkaline absorbent solution under subatmospheric pressure to drive off absorbed hydrogen sulfide, hydrogen cyanide, ammonia and water while regenerating

the absorbent solution, thereafter passing the acidic gases and ammonia in a second scrubbing step into contact with aqueous ammonia flushing liquor from the flushing main to absorb hydrogen sulfide, hydrogen cyanide and ammonia under said subatmospheric pressure, whereby the volume of gas is reduced sufficiently so that it can be practically handled in a vacuum pump to establish the required subatmospheric pressure in the said actifying zone, passing the thus treated gases through a vacuum pump to draw the vacuum necessary in said actifying zone, and distilling the so-formed rich ammonia liquor to separate hydrogen sulfide, hydrogen cyanide and ammonia therefrom, in which acidic gases and ammonia are driven overhead from the ammonia distillation zone and then passed through sulfuric acid to absorb ammonia while separating the acidic gases from the ammonia.

9. The process defined in claim 7 in which water is evaporated from the flushing liquor and brought into contact with the alkaline solution absorbent in the actifying zone to supply an amount of water to the absorbent solution substantially equal to the amount of water carried by the acidic gases and ammonia away from the condensing zone.

10. In a process for the recovery of ammonia, hydrogen sulfide and hydrogen cyanide from coke oven gases, the steps of cooling the hot coke oven gas, said cooling being effected in part by scrubbing said coke oven gas with flushing liquor whereby tar is condensed from said coke oven gas and ammonia is absorbed into said flushing liquor to provide a rich flushing liquor, separating the condensed tar from said rich flushing liquor, scrubbing the cooled coke oven gas with an aqueous alkaline absorbent solution to strip the ammonia, hydrogen sulfide and hydrogen cyanide therefrom in which scrubbing naphthalene is condensed and contaminates the rich absorbent, scrubbing the rich absorbent containing naphthalene with said condensed tar to scrub naphthalene therefrom, and thereafter regenerating ammonia, hydrogen sulfide and hydrogen cyanide from said rich absorbent.

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