April 3, 1928. 1,664,484

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METHOD OF REMOVING TAR FROM GASES

Filed March 25, 1925

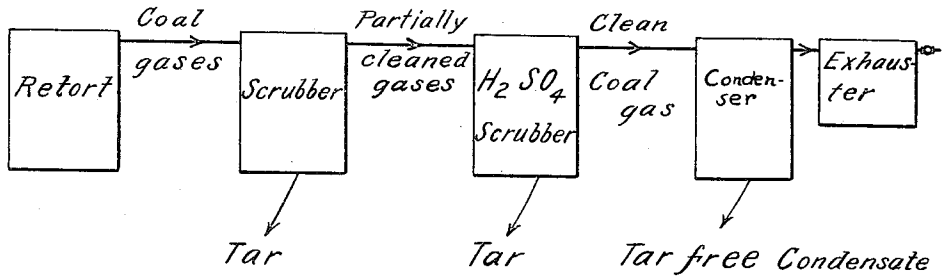


Fig. 1.

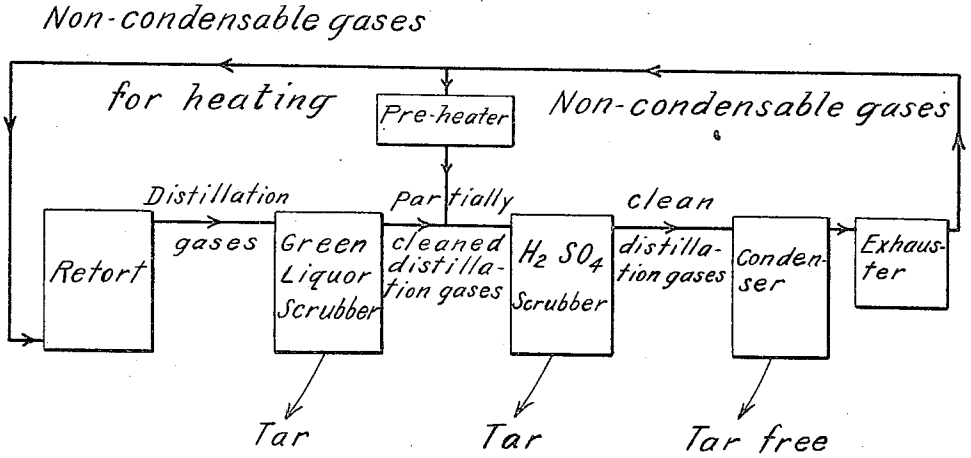


Fig. 2.

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Patented Apr. 3, 1928. 1,664,484

UNITED STATES PATENT OFFICE.

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METHOD OF REMOVING TAR FROM GASES.

Application filed March 25, 1925. Serial No. 18,102.

My present invention relates to removing impurities, particularly tar, from gases containing them. My invention has particular reference to the removal of those impurities produced by the destructive distillation of carbonaceous substances, e. g., of coal and wood. As examples of gases containing tar produced by the distillation of coal may be mentioned coal gas, water gas and producer gas.

In general, my experiments have led me to the conclusion that the difficulty of removing fully the tarry substances from gases is due to the fact that the ordinary scrubbing media remove only the tar physically present as such and do not remove certain tar-forming elements which later appear in the form of tar after the gases have passed through the scrubbers.

In carrying out my invention, therefore, I preferably first subject the gases from the retorts or other source (by gases it is intended to include what, strictly speaking, may be vapors) to a preliminary scrubbing operation, using a known scrubbing medium suitable for the particular gas undergoing purification, whereby the major portion of the tar is removed from the gases, or, if my theory is correct, substantially all of the tar then present in the gases as such. I then subject the gases, while maintaining them at a suitable temperature, to the action of one or more substances which I have found will effectively remove all the remaining tar and tar-forming elements, whereby the gases will be left substantially entirely free of tar. The substances which I have found to possess this tar-removing property are, first, those which exert a moderately strong oxidizing action under the conditions present, and, second, strong acids which are not volatile under the pressure and at the temperature prevailing in the scrubber. Among the first class of substances, I may mention chlorin, potassium permanganate, potassium dichromate, and hydrogen peroxide, while in the second class, sulphuric, phosphoric and oxalic acids have been found effective. I greatly prefer, however, sulphuric acid of suitable concentration as the sole scrubbing medium, since it is not only an acid which meets the above-named requirements as an acid, but it is also an oxidizing agent as well, so that by using sulphuric acid alone, I obtain results as good as, if not better than, those obtained by using a separate oxidizing agent and a separate acid. It will be understood that the tar may be removed by the oxidizing agent alone, but I have found that the action of such agent is not only facilitated by the presence of the acid, but the character of the tar separated renders it more easily removed from the scrubber. It now seems that the action of the two classes of substances is that the oxidizing agent initiates the conversion of the tar-forming substances into tar while the acid acts as a catalyzer in such reaction.

As above stated, I preferably remove the greater part of the tar by a preliminary washing or scrubbing with a medium having no appreciable chemical effect upon the tar itself; however, if desired, all of the tar may be removed in one scrubbing step, as by scrubbing with sulphuric acid of the proper concentration alone or by scrubbing with other media in the presence of sulphuric acid or the other substances I have mentioned. In this case, however, the tar obtained will be contaminated with the special scrubbing material used and in general must be separated from it, as by neutralization, etc. For this reason, I prefer to remove the tar in two or more steps, as stated.

Fig. 1 of the accompanying drawing illustrates diagrammatically an arrangement of apparatus suitable for carrying out my improved method as applied to coal gas, while Fig. 2 shows an arrangement of apparatus for applying my improved process to the distillation of wood.

Referring to Fig. 1, the gases from the retort pass to a scrubber and are there subjected to the cleansing action of a suitable scrubbing medium, as, for example, water. The now partially cleaned gases are passed to the sulphuric acid scrubber, where they are brought into intimate contact with a sulphuric acid solution of suitable concentration. The latter may be varied over considerable limits. In practice, I have found that a sulphuric acid solution of about 30 Bé. is suitable, although, as will be readily understood, an acid of this strength may either take up or lose moisture, depending upon the temperature of and amount of moisture present in the gases. Ordinarily I prefer that the temperature of the coal gas shall be between 50 and 80 degrees C., but as will be readily understood, this tempera-

ture may be varied within wide limits, so long as the gases are not cooled to the dew-point. The now substantially entirely tar free gas is propelled to the system by means of the exhauster indicated, from which the gas is delivered into the mains.

The sulphuric acid may be recirculated through the scrubber until sufficient tar has been collected to render its removal from the acid desirable, whereupon such removal may be accomplished by decantation and the acid used over again. If desired, this separation step may, of course, be made continuous. Some of the acid combines with the impurities of a basic nature, but the amount of such impurities is relatively small. Ordinarily, when it is desired to recover the ammonia content of the coal or other gas, it is removed prior to the sulphuric acid treatment for the removal of the tar. Unless this is done, the ammonia will, of course, be removed from the gases with the tar, a condition which is undesirable when the recovery of the ammonia is sought.

In the case of wood distillation, the condensable products from the wood retorts are roughly classified into two products, viz, the non-aqueous, including the various light oils and tar collectively termed "tar", and an aqueous portion containing acetic acid, methyl alcohol, acetone and other substances including water itself, known as pyroligneous acid or "green liquor". Heretofore it has been customary practice to condense both pyroligneous acid and tar (including the light oils) together, allowing the aqueous and non-aqueous portion to separate and then to decant one layer from the other. It is not practicable, however, to fractionate the separated pyroligneous liquor directly, due to the fact that the separation of the tar is never complete and the tar present, clogs the condensing and fractionating apparatus. It is, therefore, necessary first to subject the entire pyroligneous acid to a preliminary distillation in order to eliminate tar as much as possible.

Due to the expense involved in this preliminary distillation step, numerous methods have been proposed for eliminating the tar from the distillation gases prior to the condensation of the pyroligneous acid. In all of these methods, some tar scrubbing medium is used, but so far as I am aware, none of these methods has been entirely successful, due to the fact that a slight amount of tar or tar-forming material is left in the pyroligneous acid vapors which, however small, will gradually plug up the plates of the distilling columns and render cleaning necessary at frequent intervals. It is not, therefore, practicable to remove all the tar by purely physical means alone.

Referring to Fig. 2 of the drawing, the distillation gases from the retort are first passed through what I have denominated a "green liquor" scrubber, in which the gases are scrubbed and deprived of a large proportion of their tar using ordinary green liquor or crude pyroligneous acid as the scrubbing medium. This liquor is recirculated through the scrubber which is maintained at a temperature above the boiling point of the pyroligneous acid. Of course, some of the green liquor is evaporated, but enough is used so as to accomplish a thorough scrubbing.

From the green liquor scrubber, the gases pass to the sulphuric acid scrubber. Prior to their introduction to this scrubber, I generally find it necessary to raise the temperature of the gases and do so preferably by mixing therewith a sufficient quantity of heated uncondensable gases from the condenser and thereby prevent the temperature of the gases being lowered to a point below the condensation of the pyroligneous liquor constituents. In practice, I have found it satisfactory to maintain the temperature within the sulphuric acid scrubber slightly above 100° C. so that the concentration of the sulphuric acid solution remains at about 30 Bé. It will be noted that the temperature of the scrubber determines the strength of the acid, since, if a strength of acid is used which has a higher boiling point than the scrubber temperature, water will be absorbed from the vapors until an acid of this boiling point is reached, whereas if the acid has a boiling point lower than the scrubber temperature, water will evaporate until the boiling point of the acid mixture corresponds to that of the scrubber temperature.

As in the former instance, after the acid has recirculated sufficiently, it is drawn off and separated from the tar by decantation, whereupon the acid may be used over again. If desired, this separation step may, of course, be made continuous. Here, again, some of the acid combines with impurities of a basic nature, but the amount of such impurities is relatively small.

From the sulphuric acid scrubber, the gases pass to a condenser where the pyroligneous acid is condensed. As shown, the residual gases are conducted from the condenser by means of a suitable exhauster and are led back to be burned beneath the retorts or for other disposition. A portion of them is preferably passed through a reheater and then introduced into the sulphuric scrubber, as above described. The pyroligneous acid obtained is substantially entirely free from tar and tar-forming elements and may be fed directly to the fractionating columns and the acetic acid and methyl alcohol recovered immediately without neutralization of the acetic acid.

It will be seen that, by thus completely

eliminating tar from the pyroligneous acid, many advantages and economies result. For example, my improved method is applicable to sawdust containing large amount of water, wet sawdust being very difficult to dry. The pyroligneous acid obtained from such a material is naturally very dilute, rendering prohibitive the cost of a preliminary distillation thereof for the purpose of removing the tar. In my method, however, this step is obviated. A further advantage of the improved method is that it permits the direct fractionation of the pyroligneous acid into acetic acid and methyl alcohol without previously neutralizing the acetic acid. Moreover, it gives a liquor from which an acetate of lime of higher concentration can be obtained.

From the above detailed description of the application of my method of coal gas and to the distillation gases from wood retorts, its application to other gases containing tar will be readily apparent to those skilled in the art.

This application is a continuation in part of my previous application Serial No. 957, filed January 7, 1925.

I claim:—

1. In the art of wood distillation, the method of removing tar and tar-forming elements from distillation gases, which consists in washing said gases with a scrubbing medium having substantially no chemical action upon the tar constituents to remove the greater portion thereof, heating said gases, then scrubbing said gases with a sulphuric acid solution while maintaining the temperature of the gases during said scrubbing steps above the condensing point of the non-tar vapors, condensing the pyroligneous acid, heating a portion of the non-condensable gases formed and adding it to the gases prior to the scrubbing with sulphuric acid to constitute said heating step, said heating being sufficient in amount to keep the temperature during the step of scrubbing with sulphuric acid above the condensing point of the non-tar vapors.

2. The method of removing tar and tar-forming elements from gases containing them, which consists in scrubbing said gases with crude pyroligneous acid to remove the major portion of the tar and then washing said gases with a solution of sulphuric acid while maintaining the temperature of the gases above the condensing point of the non-tar vapors.

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