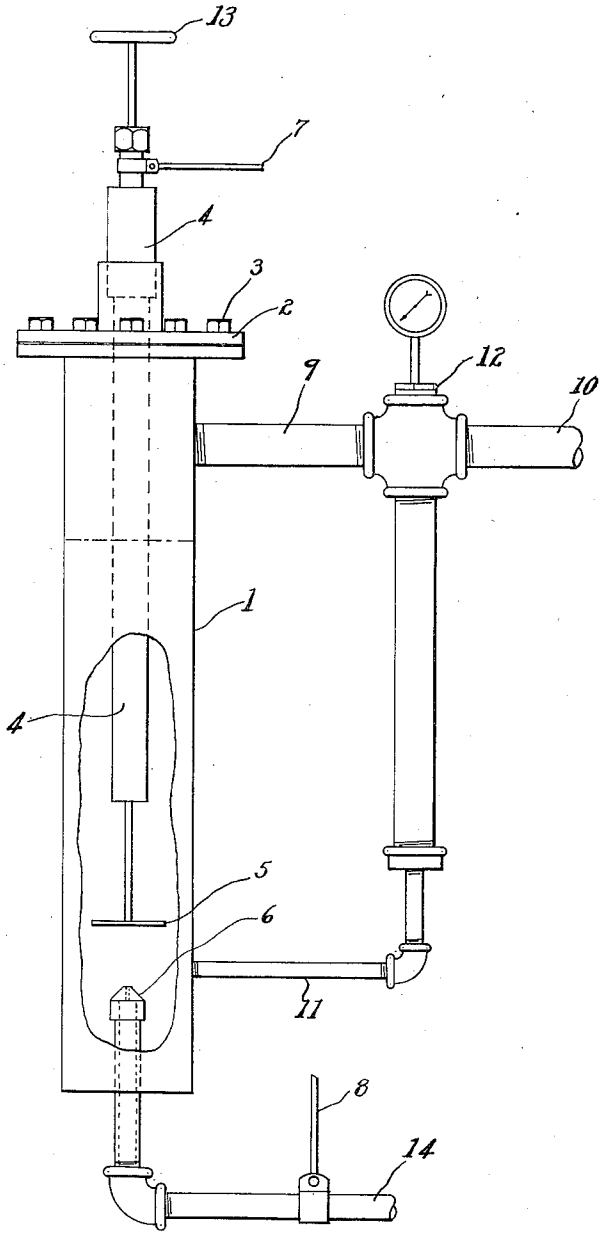
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PROCESS OF CONDUCTING CHEMICAL REACTIONS

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PROCESS OF CONDUCTING CHEMICAL REACTIONS

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This invention relates to a process for conducting chemical reactions and has for an object the manufacture of chemical products by bringing reactive substances, either gaseous or liquid or both, into intimate relation in the zone of an electric arc submerged in a suitable liquid. The submerging liquid may be so chosen in many cases that it furnishes one or more of constituents of the desired product. In the case of many compounds, and particularly organic compounds, while it has been recognized that they could be formed by subjecting suitable materials to the action of the electric arc, it has been impossible to produce them in quantity by that method because of their tendency to decompose under the temperature conditions obtaining. By submerging the arc in a suitable liquid which serves as a cooling medium, decomposition of the newly formed compound or compounds is prevented.

While many reactions which may be carried on under the conditions above indicated will readily suggest themselves to one skilled in the art, the invention will be described with particular reference to the manufacture of nitrogen compounds, for example, hydrocyanic acid, and one of the objects of the invention consists in the provision of a simple process for the manufacture of this product with a high operating efficiency.

Hydrocyanic acid has been made heretofore by passing a mixture of acetylene and nitrogen through an electric arc. This method has not, however, proven commercially feasible because of the comparatively high cost of acetylene as a starting material. It has also been proposed to use cheaper hydrocarbon gases as well as the vapors of liquid hydrocarbons, but with all of these materials difficulties have occurred due to the deposition of carbon and consequent obstruction of portions of the apparatus used. Further, the yields of hydrocyanic acid which were obtained by the use of the cheaper materials above-mentioned have been low.

I have found that good yields of hydrocyanic acid can be obtained by operating an electric arc while submerged in a suitable liquid and bringing nitrogen and a hydrocarbon compound into reactive relation in the vicinity of the arc. While I do not intend that my invention shall be restricted by any theory advanced, it is probable that the arc decomposes the hydrocarbon in such manner that its elements are brought into atomic condition. In part at least, they combine with nitrogen according to the equation:—

$$H+C+N \rightarrow HCN$$

The surrounding liquid acts as a cooling medium, preventing decomposition of the hydrocyanic acid after it has been formed.

According to the preferred embodiment of my invention, I submerge the arc in a bath containing a hydrocarbon and introduce a stream of nitrogen into the bath in the zone of the arc. The bath may contain a single hydrocarbon or a mixture of hydrocarbons, and these may be dissolved in or emulsified with other liquids. The cheap and fluid commercial hydrocarbon mixtures, such as kerosene and fuel oil, are preferred, but any hydrocarbon which can be maintained in a liquid condition under the conditions obtaining in carrying on the process may be used. Such a bath, in addition to acting as a cooling medium, furnishes the hydrogen and carbon necessary for the formation of hydrocyanic acid.

In the accompanying drawing, which shows a vertical elevation of an apparatus suitable for carrying out the process, 1 is a retort or a reaction vessel having a cover 2 secured thereto by screws or bolts 3. Electrodes 5 and 6 are positioned within the lower portion of the retort, the electrode 5 being suspended from the cover 2 and insulated therefrom by suitable insulation 4, and the electrode 6 being passed through the bottom of the retort 1 and held in fixed relation thereto. The electrode 5 is adjustable to and from the electrode 6 by means of the hand wheel 13. Suitable leads 7 and 8 connecting the electrodes in circuit with a suitable source of current are provided. The electrodes 6 is shown as hollow and in the form of a nozzle through which nitrogen or other gas may be introduced into the field of the arc from a suitable source of supply by means of the pipe

14. An outlet pipe 9 is connected to the upper part of the retort for the purpose of leading off the gaseous products of the reaction. The pipe 9 is shown as connected through a suitable T connection with a pipe 10 leading to means for separating the gaseous products and recovering the hydrocyanic acid. One outlet of the T is connected to a pipe 11 leading to the lower part of the retort 1. The remaining outlet of the T is provided with a removable closure 12 through which oil or other liquid may be introduced for filling the retort.

In carrying out the invention the retort 1 is filled with kerosene, fuel oil or other suitable liquid hydrocarbon to a level considerably above the electrodes, as shown for example by dotted line in the drawing. An arc is then struck between the electrodes and at the same time nitrogen gas is forced into the retort through the hollow electrode 6. The hydrocyanic acid gas formed passes upward through the overlying oil, which acts as a cooling medium preventing decomposition of the hydrocyanic acid, and is led off through the pipes 9 and 10 and recovered in any suitable way as it is well understood.

Free carbon released by decomposition of the hydrocarbon is not deposited but is held in suspension in the oil. If desired, it may be recovered as carbon black by separating it from the bath in any convenient manner.

In addition to hydrocyanic acid considerable quantities of acetylene, ethylene and hydrogen are produced. Under some conditions other nitrogen compounds may be formed. The hydrocyanic acid gas may be separated from the other gaseous products of the reaction in any suitable manner, as for example, by treating the gaseous mixture with caustic alkali and recovering the hydrocyanic acid as alkali metal cyanide. The other gaseous products may be separated from one another by known methods and utilized commercially.

By the expression "suitable liquid" is meant any liquid which will not in decomposing under the influence of the electric arc furnish decomposition products which are incompatible with the carrying on of the desired reaction. In addition to the oils above mentioned many other liquids may be used.

It is to be understood that my process may be carried out either by maintaining a pool of oil about the arc and leading a stream of nitrogen thereinto, or by circulating both the oil and nitrogen about the arc.

I claim:

1. Process of making hydrocyanic acid which consists in maintaining an electric arc beneath the surface of a bath containing a hydrocarbon oil and bringing nitrogen into reactive relation with the oil in the vicinity of the arc.

2. Process of making hydrocyanic acid which consists in locally decomposing a portion of a bath containing a liquid hydrocarbon and bringing nitrogen into reactive relation with said decomposed portion beneath the surface of the bath.

3. Process of making hydrocyanic acid, which consists in introducing a stream of nitrogen into a liquid hydrocarbon, passing the mixture through the field of an electric arc, and utilizing the cooling action of the undecomposed liquid hydrocarbon to prevent decomposition of the hydrocyanic acid formed.

4. Process of making hydrocyanic acid which consists in maintaining an electric arc beneath the surface of a bath containing a liquid hydrocarbon oil, bringing nitrogen into reactive relation with the hydrocarbon in the vicinity of the arc, and separating the resulting hydrocyanic acid from the other gaseous products formed.

5. Process of making a nitrogen containing compound which comprises maintaining an electric arc, and submerging the arc in a liquid containing a hydrocarbon oil and nitrogen.

In testimony whereof, I affix my signature.

GLEN D. BAGLEY.