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REMOVING ACETYLENE HYDROCARBONS FROM GASES

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The present invention relates to a process of removing hydrocarbons of the acetylene series from gases containing ethylene and hydrogen.

For carrying out reactions with gases containing ethylene and hydrogen it is in many cases desirable that the gases should be previously freed of even small amounts of acetylene or derivatives of the same with which the gases are often intermixed. The drawbacks caused by the said contaminations consist in that the gases cannot be treated in apparatus made of copper or copper alloys, and cannot be compressed but with danger, especially in the presence of small quantities of oxygen, and that undesirable side-reactions will result when working up the ethylene gas by chemical reactions, the output of the desired products being thereby diminished.

For the purpose of eliminating the acetylene from gases, it has been proposed to hydrogenate it, while taking care that the ethylene be not affected in a substantial degree. But this requires special catalysts and comparatively high temperatures with a consequent high expenditure of heating and cooling energies when working on a technical scale.

I have now found that acetylene can be completely removed by hydrogenation at a low temperature and in the presence of nickel as a catalyst, provided that the gases to be purified are given a content of carbon monoxide. The amount of the carbon monoxide to be added to the gases may be varied in wide limits. Additions of from 3 to 12 per cent are suitable in most cases, but smaller percentages, even 0.5 per cent or less, will also be sufficient in some cases. While, it is true, acetylene will also be hydrogenated in the absence of carbon monoxide at rather low temperatures, the ethylene at the same time will be hydrogenated to a substantial extent, often up to 90 per cent of the amount in the gas, to ethane and thus rendered useless.

The process in accordance with my present invention can be practiced in the usual manner by passing the gas to be purified through an externally heated container charged with the catalyst. When starting the operation, the temperature is preferably raised by degrees until the gas leaving the catalyst is found to be free of acetylene compounds. Then the temperature can be lowered again, frequently to a considerable extent, without acetylene compounds reoccurring in the purified gas.

A secondary effect which has been found favorable in certain cases, consists in that any small amounts of oxygen which may be present in such gases, are eliminated too. Such oxygen is removed wholly or to a great extent during the treatment without any prejudice to the ethylene.

In large scale operations it is preferable to heat the reaction chamber by means of a jacket connected to a low-pressure steam pipe line and provided with a manometer. The manometer reliably indicates the temperature of the catalyst chamber. If temperatures below 100° C are to be maintained, the jacket is filled with warm water.

The favorable effect of the carbon monoxide is supposed to be due to the formation of slight proportions of nickel carbonyl, for I have found that the same effect is achieved by adding to the gas to be purified small amounts of nickel carbonyl instead of carbon monoxide. Any heating of the gas to be purified may then be dispensed with altogether in many cases. Use may be made also of other metal carbonyls, such as iron carbonyl, in order to supply carbon monoxide to the catalyst chamber.

When working with nickel carbonyl, the nickel required as a catalyst can be precipitated in the reaction chamber by thermal decomposition of the supplied nickel carbonyl, so that a separate charge of nickel catalyst can be dispensed with. But it will then be preferable to fill the chamber with a carrier substance, such as silica gel or pumice stone.

The following Examples serve to illustrate how the present invention may be carried out in practice, but the invention is not restricted to the Examples.

Example 1

Nickel hydroxide is precipitated on large-pored silica gel from an aqueous solution of nickel nitrate by means of ammonia. The mass is dried at about 450° C and then treated with hydrogen for 4 hours to reduce the hydroxide to nickel. 3 liters of the mass which contains about 30 grams of nickel per each liter, are filled in an aluminum tube surrounded with a jacket which is connected to a low-pressure steam pipe line and provided with a release valve and a manometer. The pressure in the jacket is adjusted to from 1.5 to 1.8 atmospheres, corresponding to a temperature of from 112° to 117° C. A gas containing 30.5 per cent of ethylene, 33.0 per cent of hydrogen, 11.5 per cent of carbon monoxide, 0.5 per cent of acetylene and 0.6 per cent of oxygen, is passed through the aluminum tube in an amount of from 2.5 to 3 cubic meters per hour. The gas leaving the tube is free of acetylene and oxygen, while the percentage of ethylene has remained unchanged. If a gas free of carbon monoxide, but otherwise of the same composition be treated under the same conditions as above, the acetylene, it is true, is likewise removed, but variable percentages of ethylene, say between 20 and 70 per cent, are hydrogenated.

Example 2

A gas mixture containing 32.5 per cent of olefins (more than 90 per cent of the same being ethylene and the balance propylene), 35.4 per cent of hydrogen and 0.5 per cent of acetylene is passed at a velocity of 6 liters per hour through a horizontal tube which is about 8 millimeters in width and half-filled with nickel powder over a length of 40 cm. At a temperature of 28° C the acetylene is completely removed, but the olefins are also eliminated down to a content of only a few per cent. However, when adding to the gas mixture, prior to its introduction into the tube, a slight quantity of nickel carbonyl, say about 0.1 g per hour, the removal of the acetylene is as complete as above, but the percentage of olefins remains unchanged.

Example 5

A gas mixture consisting of 35 per cent of hydrogen, 33.8 per cent of ethylene, 0.5 per cent of acetylene, the balance being ethane and methane, is passed, along with 0.5 per cent of carbon monoxide, through a horizontal tube which is 9 millimeters in diameter and half-filled with carbonyl nickel powder over a length of 30 cm and heated at 80° C by means of an electric oven. The acetylene is completely removed, while the ethylene is practically not affected. In the absence of carbon monoxide a gas free of acetylene is likewise obtained under the same conditions, but the ethylene content is only 8.0 per cent.

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