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CONVERSION OF HYDROCARBONS INTO GASEOUS OLEFINS

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Fig. 1

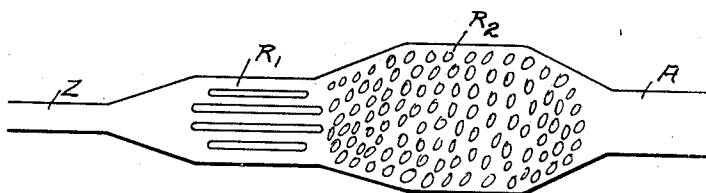
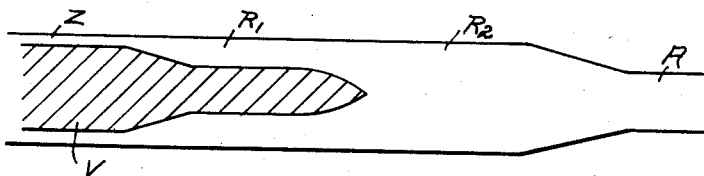


Fig. 2



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CONVERSION OF HYDROCARBONS INTO
GASEOUS OLEFINS

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1 Claim. (Cl. 260-683)

The present invention relates to improvements in the production of gaseous olefins from hydrocarbons.

It has already been proposed to prepare gaseous olefins by the action of oxygen on saturated hydrocarbons at elevated temperature, the oxygen, in order not to obtain the formation of flame and reaction to form acetylene, being kept within certain limits which vary according to the nature of the saturated initial hydrocarbons and the height of the pressure; in the case of propane and when working at ordinary pressure up to about 30 per cent by volume of oxygen are added with reference to the mixture, in the case of ethane somewhat more, in the case of butane somewhat less. In spite of these limited amounts of oxygen, however, the reaction frequently proceeds very turbulently at first, whereby the yields of gaseous olefins are impaired. To counteract this it has already been proposed to work in vacuo. This does indeed prevent the yields of olefins being reduced by overheating, but on the other hand it has the effect that the reaction of the hydrocarbons with the oxygen does not proceed completely in the usual apparatus so that either an unusually long reaction chamber must be used or a certain oxygen content in the final product must be taken into account.

We have now found that in the reaction of saturated hydrocarbons having more than one carbon atom in the molecule with oxygen to form gaseous olefins all the said drawbacks can be avoided and that good yields of gaseous olefins and final gases containing only a small amount of oxygen can be obtained even when working at atmospheric pressure or slightly reduced pressure, as for example about 0.6 atmosphere, by adding amounts of oxygen with which at the prevailing pressure there is no formation of flame and consequently no appreciable formation of acetylene and using a reaction chamber of which the first part has a considerably smaller free cross-section than the following part. Whereas in the known cases the temperature in the reaction chamber measured in the direction of the flowing gases rises very quickly, according to this invention it rises much more slowly and also falls, after reaching its maximum value, much more slowly generally speaking in the second part of the chamber than in the known cases.

By reason of the smaller cross-section, the gas mixture in reaction chambers of the said shape flows in the first part at a considerably higher speed than in the following part. In this way overheating of the apparatus is avoided by the

relatively high speed of flow of the gas in the first part and therefore good yields of olefins are obtained; furthermore by the considerably smaller speed of flow in the following part of the reaction chamber where the oxygen which is only just present in relatively small amounts reacts slowly with the hydrocarbons the oxygen is given sufficient time to act on the hydrocarbons, so that final gases practically free from oxygen are obtained.

The effect of working according to this invention may be seen from the following comparisons:

1. 75 parts by volume of ethane and 25 parts of oxygen are heated to about 600° C. either separately or, when using a non-metallic, for instance ceramic constructional material, jointly, and then flow at a speed of 1.2 meters per second while the temperature rises to about 850° C. through a reaction tube which throughout its whole length has an unchanged cross-section for the passage of gas. A final gas is obtained which contains 25 per cent of ethylene and 0.8 per cent of oxygen.

2. If the initial mixture be led in the same way at a speed of 6 meters per second through the same reaction tube while the temperature rises to about 750° C., the yield of ethylene is increased to 30 per cent but the final gas mixture contains 3.2 per cent of oxygen.

3. If the same gas mixture be led at a speed of 6 meters per second through the first part of a reaction tube and then at less than half this speed of flow through the second part of the reaction tube the free cross-section of which, according to this invention, is about two and a half times as great as that of the first part, the temperature in the first part rising to 750° and in second part to 850° C., the yield of ethylene rises to 32 per cent and the final gas mixture contains only 0.9 per cent of oxygen.

According to this invention it is thus possible to produce a practically complete reaction of the oxygen with the hydrocarbons, which is of importance not only on economical grounds but also for the further use of the resulting gases, and furthermore a yield of unsaturated hydrocarbons is obtained which is considerably higher than that obtained when working at lower speed of flow (1), because in the latter case by the rapid rise of the temperature in the reaction chamber by reason of the turbulent reaction of hydrocarbons with oxygen the yield of unsaturated hydrocarbons is impaired.

The small cross-section for the passage of gas in the first part of the reaction chamber may not only be produced by appropriate shaping of the

reaction vessel but also by introducing filler bodies into the same. The same result is obtained by building in gratings or by lining the walls of the reaction chamber. For the said insertions or filler bodies it is preferable to use materials which do not influence the reaction, as for example clay, quartz or sillimanite. In the first part of the reaction chamber it is preferable to use filler bodies of small resistance; in the second part of the reaction chamber filler bodies of higher resistance may also be used. In all cases care should be taken that no dead corners occur in the reaction chamber.

Figures 1 and 2 of the accompanying drawing show diagrammatically two arrangements of reaction tubes adapted for the process according to this invention by way of example, but the invention is not restricted to these two arrangements.

The preheated mixture of hydrocarbons and oxygen passes through a supply conduit Z, Figure 1, into the first part R₁ of the reaction chamber which is filled with rods, for example of chamotte. After a part of the oxygen has reacted with the hydrocarbons at high speed of gas flow in the said first part, the gas mixture flows through a wider second part R₂ of the reaction chamber which is filled with balls, for example of porcelain and in which at smaller speed of flow of the gas the residual part of the oxygen acts on the hydrocarbons. The final gas mixture leaves the reaction chamber at A.

Referring to Figure 2, the smaller cross-section in the first part R₁ of the reaction chamber is produced by a built-in displacement body V.

The alteration of the cross-section, instead of being as shown in the drawing, may also be gradual, and instead of a unitary reaction cham-

ber one which is subdivided, for example into channels, may be used.

The hydrocarbons to be reacted, as for example ethane or propane, are mixed with oxygen in a ratio of from about 70 to 80 parts by volume to from 20 to 30 parts by volume. The initial gases, before introduction into the reaction chamber, are heated to at least about 450° C. In the first part of the reaction chamber the temperature rises to more than about 700° C. by the heat set free by the reaction. In the second part the temperature is kept at about 800° C. or more. Generally speaking external heating is unnecessary.

The gas mixtures obtained contain only about 0.4 to 1 per cent of oxygen, whereas in a reaction tube of equal length final gases having an oxygen content of several per cent are obtained by the processes hitherto known with the same speed of flow.

What we claim is:

A process for the production of gaseous olefins by the action of oxygen on hydrocarbons at elevated temperature, the oxygen being used in such amounts that at the prevailing pressure there is no formation of a flame, which comprises passing the heated mixture of said hydrocarbons with said oxygen through the first part of a reaction zone at a high speed of flow and through the following part at a lower speed of flow, the speed of flow of the gas mixture being regulated by using a reaction zone the first part of which has an appreciably smaller free cross-section than the following part.

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