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PROCESS OF CARRYING OUT ENDOTHERMIC
TRANSFORMATIONS OF HYDROCARBONS
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Fig. 2.

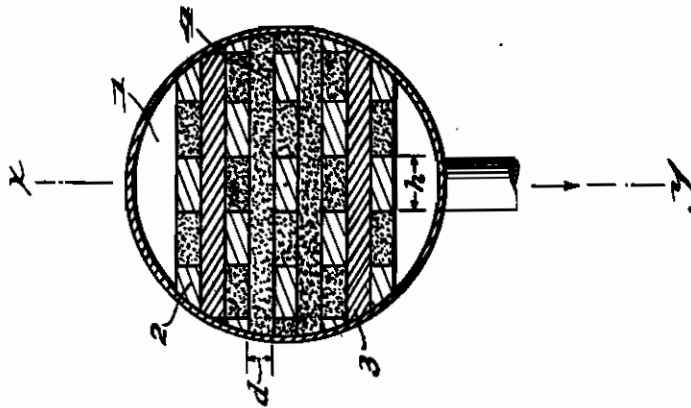
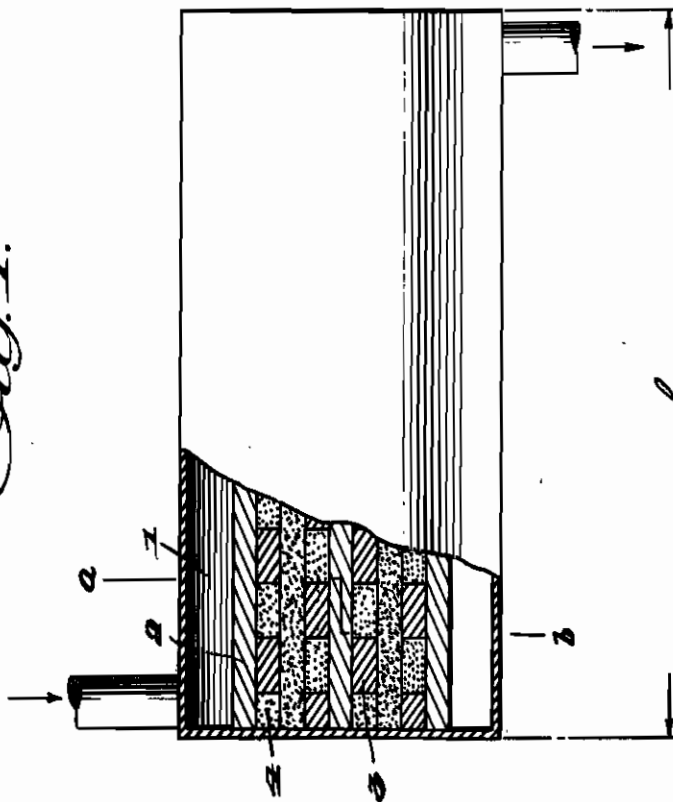


Fig. 1.



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PROCESS OF CARRYING OUT ENDOTHERMIC TRANSFORMATIONS OF HYDROCARBONS

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This invention relates to improvements in carrying out endothermic transformations of hydrocarbons by means of catalysers.

The transformation at elevated temperatures of hydrocarbons such as, for instance, the processes of aromatizing, dehydrating or splitting hydrocarbons by means of catalysts are generally connected with the separation of carbon the amount of which depends upon the extent of the transformation. The resulting coke precipitates upon the catalytic substances employed and makes them unserviceable. Therefore the precipitations must be burned out from time to time. For this purpose oxygenic gases, for instance air, may be passed through the reaction apparatuses (furnaces). The burning out of the precipitated coke takes place under considerable production of heat and increase of temperature. Considerable technical difficulties oppose themselves to the removal of the resulting heat, the more so because care must be taken to prevent excessive heating of the catalyser whereby the duration of life of the contact substances would be considerably diminished.

The heat produced by the burning-out of the coke may be removed through the walls of the apparatus, however this mode of working is only useful in connection with very narrow catalyst pipes and is useless for contact furnaces of large dimensions. On the other hand, it is possible to carry out the burning-out with large volumes of gases containing only a little oxygen so as to remove the resulting heat with the aid of the inert gases. Owing to the large quantities of gases required this method does not yield satisfactory results from a technical point of view.

Now I have found that these difficulties are avoided by regeneratively accumulating in the interior of the reaction apparatus the heat produced by burning out the coke. Hereby I obtain a considerable economic advantage because the regenerated heat may be utilized for supplying heat in the endothermic transformation of the hydrocarbon. By choosing a suitable ratio of the heat accumulating material to the catalytic material an excessive increase of heat during the burning-out operation can easily be avoided.

I am aware that the principles of regenerative accumulation of heat in the art of heating gases are well-known. In this connection also coke masses separated upon the accumulating brickwork were burnt at the same time. In the present case this step (which is well-known per se) is applied in an unprecedented manner to processes in which the separation of coke essentially

takes place upon the contact substances filled into the furnace. I ascertained the surprising fact that the burning-out heat is in a sufficiently rapid manner transmitted from the catalyst to the heat-accumulating brickwork, whence it is reflected during the subsequent reaction phase upon the heat-absorbing catalyst. By suitably alternating the reaction and the burning-out periods the temperatures of the catalyst may be kept within relatively narrow limits (for instance, between 470 and 490° C.) so that a deterioration of the contact material is not to be expected.

In the annexed drawing an apparatus for carrying out the invention is illustrated by way of example.

Fig. 1 is a horizontal cross-section on the line $x-y$ of Fig. 2 of a contact furnace constructed according to the invention;

Fig. 2 is a vertical cross-section on the line $a-b$ of Fig. 1.

1 denotes the mantle of a contact furnace constructed, for instance, in the form of a cylinder. This furnace is filled with ceramic plates 2, 3 placed cross-wise one above the other. From Fig. 2 it appears that a layer of plates 2 placed in a direction vertical to the paper is followed by a layer of plates 3 placed in parallel direction thereto. The plates 2, 3 consist of refractory ceramic material such as chamotte, sillimanit, porcelain, sintered corundum, magnesia stone or the like. Instead of ceramic material also other material, for instance, non-oxidizable metals such as chromium-nickel steel or the like may be used. The filling plates 2, 3 are about 4 inches high (h), 6 inches long (l) and about one third of an inch thick (d) (see Fig. 2). Any desired other dimensions may be used. The distance between the single plates should be as small as possible. In the modification shown in the drawing it may amount, for instance, to one third of an inch.

The interstices formed between the superimposed plates 2 and 3 are filled with the catalyst 4. The latter is prepared in a suitable form, for instance, in the form of balls, granules or filaments. A granulated catalyst with grains of from 1 to 3 millimeters has proved especially advantageous.

The hydrocarbons to be transformed are passed in gaseous form from the top or from the bottom through the contact furnace shown in Figs. 1 and 2. As soon as the corresponding separation of carbon has attained an excessive extent, the supply of hydrocarbon is stopped and the furnace is blown out with an inert gas (e. g. combustion gas). Thereupon oxygenic gases, for

instance, air is passed through the furnace. Under their influence a rapid combustion of the coke particles takes place. The developed heat is at once absorbed by the heat accumulating filling material. In the subsequent reaction period the accumulated heat is remitted to the catalyst which cools down owing to the endothermic character of the reaction.

In the process of aromatizing hydrocarbons the circumstances are such that the heat produced by the burning-out of the coke just suffices for covering the demand of heat necessitated by the reaction and the radiation of heat. Therefore the temperature of such a contact chamber can be kept constant within narrow limits (e. g. between 470 and 490° C.), provided that reaction and burning-out periods are properly alternated and the ratio of contact filling and heat accumulating material (about 60 to 65% ceramic material and 40 to 35% catalyst) is correctly chosen.

If in other processes (e. g. in dehydration processes) too much or too little heat is produced, no automatic equilibrium of temperature can be maintained inside the contact furnace, but the temperature must be controlled by external means. This may be effected in a well-known manner by flushing the reaction chamber before the beginning of the period of reaction for a reduced time with heat delivering or heat absorbing gases (e. g. waste gases).

Whether correction of temperature is used or not, the transformation of the hydrocarbons and the burning out of the coke must temporally fol-

low one after another in such a way that the contact furnace is subject to slight variations of temperature only. For instance, the endothermic catalytic transformation may be started at 490° C. and interrupted when the contact has cooled down to 470° C. Thereupon the burning-out operation, if desired with subsequent correction of the temperature, is effected in such a manner that the temperature of the furnace again rises to 490° C.

The annexed drawing shows a furnace the filling of which is formed by plates. Instead of these plates reaction furnaces filled with tubular or otherwise fashioned bricks may be used. The hollow spaces left free by the heat accumulating material are filled up with the fashioned contact material.

Also an irregularly introduced heat accumulating material may be employed. For instance, thickwalled so-called "Raschig rings" or single filling bodies may be used. Such fillings are introduced into the furnace at intervals, the granulated contact material occupying the interstices left free by the filling material.

Also with irregular configuration of the heat accumulating material the ratio of the accumulating material to the catalyst on the one hand and, on the other hand, of the reaction period to the burning-out period can easily be chosen in such a manner that inside the contact furnace only insignificant variations of temperature occur, for instance from 470 to 490° C.

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