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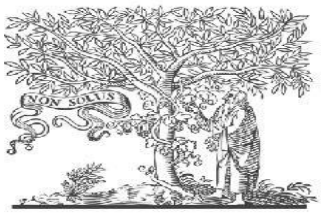

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VINYL CHLORIDE PRODUCTION TECHNOLOGY MODERNIZATION FROM ETHANE

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Abstract: The study of the new method, its thermodynamic analysis, consideration of the mechanism and kinetics of the reaction made it possible to select the design of the reactor for the industrial process. A shell-and-tube reactor with a fixed catalyst bed in tubes was selected.

Keywords: vinyl chloride, contact gas, pressure, tar and coke.

Introduction

Vinyl chloride is a unique and most large-tonnage product in the chemical industry for the complex processing of mineral and organic raw materials. The production of vinyl chloride in Russia is almost entirely (more than 99% of the total volume) focused on the production of polyvinyl chloride, the consumption of which in industry is growing every year. Accordingly, the demand for high-quality and cheaper vinyl chloride is increasing, in connection with which the search for the intensification and modernization of the technology of its production becomes urgent.

As an example of the study, the process of obtaining vinyl chloride has been chosen consists of 2 stages:

Stage I $CH_2=CH_2 + Cl_2 \rightarrow CH_2Cl - CH_2Cl$

Stage II $CH_2Cl - CH_2Cl \rightarrow CH_2 = CHCl + HCl$

Obtaining vinyl chloride from 1,2-dichloroethane by thermal cracking in furnaces at a temperature of 350-500 ° C and a pressure of 0.8-1.2 MPa. Structural and functional analysis of the selected production made it possible to reveal a number of significant disadvantages [5]: 1) high process temperature, as a result of which by-products (1,3-butadiene, chloroprene, etc.) are formed, which leads to low selectivity for vinyl chloride and low conversion 1,2-dichloroethane (62-65%); 2) the deposition of by-products (coke and tar) on the walls of the coils of the reactor (furnace) deteriorates its performance, which leads to frequent shutdowns for cleaning; 3) irrational use of the heat of the contact gas leaving the furnace; 4) the energy intensity of the stages of synthesis and isolation of vinyl chloride; 5) the presence of non-recyclable production waste - tar and coke.

The study of modern world trends in the development of the process of obtaining vinyl chloride and deep patent information search made it possible to find a variant of modernization of the studied production. The essence of the chosen direction lies in the catalytic dehydrochlorination of 1,2-dichloroethane in a mixture with hydrogen and an inert diluent gas at a temperature of 250-375 °C, taken in a molar ratio of 0.01-0.08: 0.94-1.18, respectively, in the presence of as a catalytic system of silicate deposited on an AGN carbon support. The chosen method allows to reduce the process temperature to 250-375 °C; significantly reduce the intensity of coke formation processes; to obtain the selectivity of the formation of vinyl chloride in excess of 94%; to increase the conversion of dichloromethane to 99.7%, which is significantly higher than the indicators of the industrial analogue [1].

The study of the new method, its thermodynamic analysis, consideration of the mechanism and kinetics of the reaction made it possible to select the design of the reactor for the industrial process. A shell-and-tube reactor with a fixed catalyst bed in tubes was selected. When forming the technological concept, requirements were developed for the stages of raw material preparation and the separation of the target product. At the stage of preparing the raw material, it is required to evaporate the required amount of

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1,2-dichloroethane and heat the vapors to a temperature not lower than 200 ° C, and also ensure their mixing with hydrogen in a given molar ratio before feeding into the reactor.

The above requirements for the stages of synthesis and preparation of raw materials make it possible to form a technological scheme of the process of obtaining vinyl chloride by dehydrochlorination of 1,2-dichloroethane (Fig. 1).

Dichloroethane rectified from the tank located in the storage is fed by the NA pump to the tube space of the TE-1 and TE-2 heat exchangers, where it evaporates and heats up to a temperature of at least 200 ° C. Superheated vapors of dichloroethane before entering the reactor RE are mixed in a tee with hydrogen in a molar ratio of 0.01-0.08: 0.94-1.18, respectively. The dichloroethane-hydrogen mixture enters the reactor tubes filled with catalyst. The temperature regime of 250-375 ° C is maintained by supplying a high-temperature organic coolant circulating through the PE furnace to the shell space of the reactor. The PE furnace is operated by burning off combustible gas (flow not shown in Fig. 1). The contact gas leaving the reactor consists of vinyl chloride, hydrogen chloride, unreacted dichloroethane, hydrogen and ethylene (by-product). The contact gas from the RE reactor through the injection nozzle enters the quenching part of the quenching column KK into a layer of liquid dichloroethane for quenching. As a result of injection into the layer of liquid dichloroethane and a sharp expansion, the temperature of the gas mixture drops sharply and the decomposition reaction of dichloroethane stops. The quenching column consists of two parts - quenching and washing. The quenching part is a cube filled with liquid dichloroethane, where the cracking reaction is stopped due to the sharp cooling of the cracking products. In the washing part, the gases are freed from dichloroethane. Further, the stream is directed to purification from hydrogen chloride and the separation of vinyl chloride.

The developed technological concept of vinyl chloride production was calculated using the AspenTech HYSYS 2006 software package, taking into account the kinetic model. This calculation made it possible to determine the parameters of the reactor, the heat load, the required volume of catalyst, as well as to calculate the reaction rate and the temperature of the contact gas at the outlet. So for the production of 100 tons / day of vinyl chloride, a reactor with a volume of 14 m3 (480 tubes 6 m long and an inner diameter of 0.08 m) is required. The achieved conversion of 1,2-dichloroethane is 99%, the product yield is not lower than 98%, the temperature of the contact gas at the outlet of the reactor is 365 ° C.

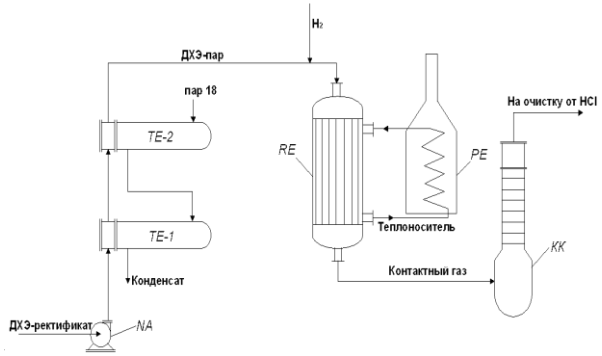

Fig. 1. Technological scheme for the production of vinyl chloride

Thus, the proposed version of modernization of vinyl chloride production by switching to catalytic cracking of 1,2-dichloroethane will significantly reduce energy consumption for the process, increase the specific productivity of the reactor, and improve the quality of the resulting product. The calculation in the program AspenTech HYSYS 2006 revealed the real possibilities of carrying out the catalytic process in industry using standard equipment.

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