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A COMPARATIVE ANALYSIS OF THE INDUSTRIAL PRODUCTION OF N-METHYLPYRROLIDONE

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Today, stipulates lack of manufactured goods due to external political conditions, the development of technologies aimed at import substitution is an extremely relevant issue in terms of economy. N-methylpyrrolidone is a unique substance which is used in the field of selective treatment of various products [1]. The high price of N-methylpyrrolidone on the market is due to the fact that today there is no production of this solvent in Russia. Therefore, the development of technology for the production of this product is of crucial interest in the framework of low-tonnage organic synthesis products.

There are several methods of producing N-methylpyrrolidone in the world. First of all, the classical method of N-methylpyrrolidone according to the Reppe's synthesis that has been produced for several decades is worth noted. The technology involves the formation of acetylene through the reaction of calcium carbide with water and then its reaction with formaldehyde to form 1,4-butyndiol (fig. 1):

1,4-Butyndiol is then hydrogenated to 1,4-butanediol, which is then dehydrocyclized to γ -butyrolactone. The last-mentioned substance reacts with methylamine to form N-methylpyrrolidone. In general, this method is distinguished by high purity of the product, high output and opportunity to increase the volume of N-methylpyrrolidone. However, in the framework of modern production, there are several drawbacks that prevent this method to cor-

respond to the environmental requirements. Some of the reagents and intermediate products used in the process may be toxic and hazardous to health and the environment. A failure to take special precautions can cause an explosion risk and environmental poisoning. In addition, the Reppe's synthesis process is energy-intensive and may require large amounts of energy, which can be economically expensive.

Throughout the development of N-methylpyrrolidone synthesis technology, alternative methods of production are constantly being considered. As a rule, all of them come down to alternative methods of producing γ -butyrolactone which then reacts with methylamine [2].

The availability of raw materials is an important factor in the development of technology as raw material costs can account for up to 60 % of the product's cost. Due to the fact that in 2022 Russia started producing maleic anhydride, the alternative technology for producing N-methylpyrrolidone becomes attractive.

The process of producing N-methylpyrrolidone in industry involves several stages: formation of dibutyl maleate, hydrogenation to γ -butyrolactone, and reaction with methylamine (fig. 2):

The use of selective catalysts and the selection of necessary conditions allows two out of three synthesis stages to be carried out with selectivity and conversion close to unity. In one stage, a by-prod-

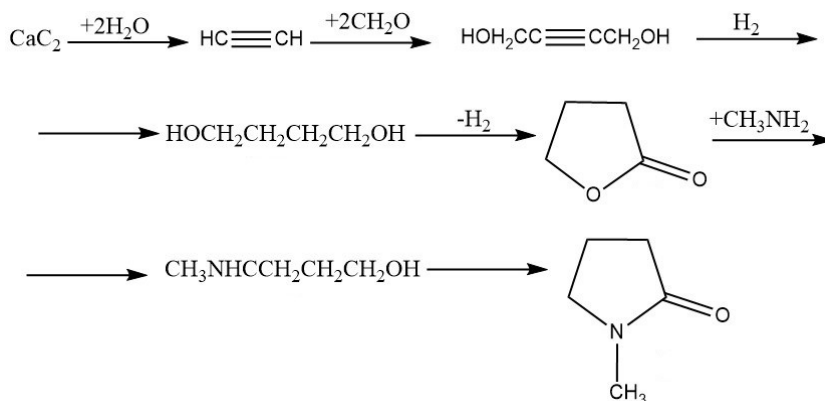


Fig. 1. Reppe's synthesis *N*-methylpyrrolidone producing general scheme

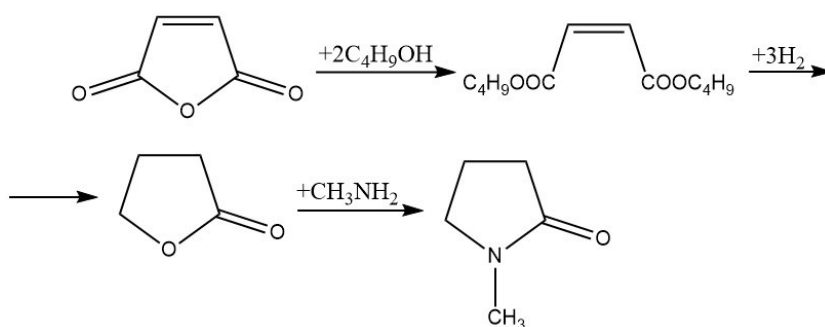


Fig. 2. Scheme of producing *N*-methylpyrrolidone through maleic anhydride

uct is formed, which, during purification, can also be used as raw materials to produce other marginal products. Despite the availability and simplicity of this method of producing *N*-methylpyrrolidone, the method has disadvantages associated with high technological costs in terms of heating, separation, and purification of the produced products.

The process of producing *N*-methylpyrrolidone from maleic anhydride is effective and economically feasible, and it is well suited for small industrial productions. Thus, the choice of the method for producing *N*-methylpyrrolidone in industry depends on various factors, such as the availability and cost of raw materials, technological parameters, and economic feasibility.

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