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CATALYSTS FOR THE OXIDATION OF METHANOL TO FORMALDEHYDE

Kokanbayev Ikramjon Ibrokhimovich
Associate Professor of the Department of Chemistry
Kokand State Pedagogical Institute, Candidate of Technical Sciences.
The Republic of Uzbekistan, the city of Kokand
E-mail: iqoqonboev@mail.ru

Annotation

The article provides feedback on the catalytic production of formaldehyde, one of the main raw materials of the chemical industry, the composition of the methanol oxidation catalyst and its mechanism of action.

Keywords: Catalytic oxidation, iron-molybdenum oxide catalyst, silver oxide catalyst, iron-copper catalyst.

The initial theoretical studies of the catalytic oxidation of methanol under heterogeneous conditions date back to the 80s of the XIX century. The platinum catalyst in asbestos was exposed to a methanol-air mixture to produce formaldehyde with a content of 48.5% productivity. Later, at the beginning of the 20th century, various catalysts that oxidize methanol to formaldehyde were studied in detail. Of these, Cu, Ag and their alloys were found to be relative activators. These studies formed the basis for the creation of an industrial technology for the production of formaldehyde by oxidation of methanol.

Mixed catalysts are characterized by their activity in relation to this reaction, and in practice, their components are in commensurate quantities. Mixed contact massing agents interact with each other during the formation of the catalyst to form a new, relatively active compound.

Most oxide catalysts exhibit catalytic properties when methanol is oxidized to formaldehyde in accordance with this kinetic equation $CH_3OH + 0.5O_2 \xrightarrow{kat} HCOH + H_2O$. This is evidenced by the fact that the interaction of oxygen with alcohol on the surface of the catalyst determines the reaction rate. In this case, the value of the oxygen coating of the catalyst surface is close to one. In the process, the same interaction with the resulting alcohol complex is formed.

Iron-molybdenum catalysts are less sensitive to the quality of methyl alcohol and the effects of catalytic poisons.

Thus, the industrial use of iron-molybdenum catalysts is significant, since it reduces the stage of purification of formaldehyde from unaffected methyl alcohol. In one cycle, the degree of conversion of methanol to formaldehyde made it possible to obtain 98.5-99.5% of the finished product containing 0.2-0.3% (by weight) methyl alcohol.

Recently, intensive research has been conducted on the oxidation of methanol to formaldehyde under the action of oxide catalysts. Many of them have also found application in foreign industry. For this reason, with the help of scientifically based studies, it is of serious interest to see the catalytic activity of oxides and their selective effect (selectivity) [1].

One of these catalysts is silver oxide, which is obtained by absorption of silver nitrate into crushed pumice stone. The catalyst consists of particles of glossy grey of irregular shape with a size of 2-3 mm. Silver is deposited in the pores of the carrier (pumice) in a fine crystalline state and makes up 35% of the total mass.

The fact that the components of catalysts that selectively oxidize methanol to formaldehyde, such as iron, molybdenum and oxygen, were determined experimentally. Therefore, the iron-molybdenum oxide catalyst is the most favourable catalyst for the oxidation of methanol to formaldehyde [2].

Iron and molybdenum oxides exhibit clearly low specific activity, in addition to the fact that iron oxides exhibit little selective action. However, together they are an acceptable catalyst for the same process. Iron molybdate and molybdenum (III) oxides are known to be industrial catalysts with mechanical strength. These substances have an ordered crystal structure and are usually used without promoters and carriers. Even recently, are these two components necessary in the composition of an industrial catalyst? The arguments continued. It was advisable to determine which of the phases the catalyst in reality. It is currently known that the greater the catalytic activity of iron molybdate during the oxidation of methanol to formaldehyde, the greater the catalytic activity of molybdenum (III) oxide also shows.

It has been found that comparative activity tends to decrease because of the volatility of the active components or because of the interaction of the components with the product. For example, the oxidation of methanol to formaldehyde occurs when an iron-molybdenum catalyst is heated, and iron molybdate decomposes to form molybdenum oxide. At 400°C, after three months of operation, the catalyst disintegrated. On the 4th floor of the reactor, a new phase, iron oxide, appeared at the entrance to the methanol-air mixture [3, 4].

It is advisable to consider that, in an iron-molybdenum catalyst consisting of iron molybdate with a ratio of iron and molybdenum oxides equal to 1.5:1. The low activity of the catalyst, in which the ratio of oxides is different, is the result of iron molybdate and an excess of Fe_2O_3 or MoO_3. The oxidation of CO_2 on an iron-copper catalyst leads to the formation of complex $CuFeO_2$, $CuFeO_4$, Cu_2FeO_4-containing iron-copper compounds. This, in turn, causes a sharp increase in activity compared to pure iron and copper oxides. The increased activity of catalysts of mixed composition is due to the fact that the reaction does not affect various types of surfaces due to their flow at the phase boundary.

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