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TECHNOLOGY OF PARAFFIN OXIDATION PROCESS

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Abstract

This article describes the technological process of paraffin oxidation and the required products, used catalysts, and methods of supplying oxygen or air. Also formation of high molecular acids and high fatty alcohols during oxidation of high molecular weight paraffinic hydrocarbons. The main consumer of high-fatty acids is the soap-making industry, and the production technology of high-fatty alcohol detergents is highlighted.

Keywords: Paraffin, polyethylene, SFM, catalytic oxidation, carboxylic acids, fatty carboxylic acid.

INTRODUCTION

Oxidation of hydrocarbons is a complex process. In the course of the reaction, many intermediate products are formed, which lead to the formation of stable and unstable reaction products, and they undergo further changes. Such a unique feature leads to the study of the kinetics and mechanism of oxidation processes

Chemical reactions usually do not mean formation of a reaction product molecule as a result of the interaction of the initial molecules. They go through several stages. Oxidation of hydrocarbons requires a lot of energy to break the S-N bond for the movement between hydrocarbon and oxygen, or to break one bond in the oxygen molecule - O-O- (which is 80 kcal/mol), that is, the oxidation reaction is from the point of view of energy. The molecular mechanism of the process cannot explain the properties of oxidation. We cannot use the ion mechanism here, because saturated hydrocarbons are non-polar compounds, and the formation of ions during the reaction is very complicated. Most of the chemical processes take place with the formation of free radicals, which play the role of an active center. Independent radicals interact with valenced saturated with low activation energy. As a result of such a reaction, a new independent active radical will be formed instead of the lost active radical (as a result of keeping the independent valence in the interaction of the radical with the hydrocarbon molecule). This radical interacts with the molecule, leading to the formation of a third radical and so on. Here, when a chain reaction occurs, a significant amount of energy is spent only for the formation of the primary radical (chain formation), and each subsequent link of the cycle (chain continuation) does not require much energy. Oxidation of hydrocarbons by molecular oxygen has been proved based on experimental results. For example, it has been proven that the reaction rate increases sharply with the introduction of substances that are easily decomposed into radicals, as well as the influence of ionizing radiation on the system, which allows the formation of independent radicals. The auto-acceleration after the induction period is associated with the accumulation of hydroperoxides, which later break down into independent radicals during oxidationx.

RESULT:

Free radicals can be formed from initial substances as a result of monomolecular decomposition or bimolecular interaction. Sometimes, such formation takes place in the walls of the reactor.

As it was said, the formation of free radicals can occur through an external influence on the system, in this case the process is called initiation.

$$RH \rightarrow R\cdot + H\cdot$$

or

$$RH + O_2 \rightarrow R\cdot + H_2O\cdot$$

Elementary stages of a chain reaction with the consumption of initial substances and the formation of reaction products are called chain continuation reactions. Such reactions take place in Hol, which preserves free radicals.

$$R\cdot + O_2 \rightarrow RO_2$$

$$RH + RO_2\cdot \rightarrow ROOH + R$$

Breakage of chains leads to loss of free radicals [1].

Chain breakage can occur as a result of interaction with a radical inhibitor molecule or a mixture in the system, as a result of capturing free radicals on the walls of the reactor (the rate of chain breakage increases as the diameter of the reactor decreases). For example, during the oxidation of hydrocarbons in the presence of diphenylamine, the free radical (RO)2 interacts with it according to the following scheme.

$$RO_2\cdot + NH(C_6H_5)_2 \rightarrow ROOH + (C_6H_5)_2N\cdot$$

Due to the low activity of the free radical , it cannot extend the chain and is lost as a result of recombination with another free radical[2]:

$$(C_6H_5)_2N\cdot + R\cdot \rightarrow RN(C_6H_5)_2$$

A chain break can occur as a result of the interaction of two free radicals.

The modern view of hydrocarbon oxidation reaction mechanism is based on the theory of chain processes with partial branching properties.

Like chain-branched processes, the peculiarity of such reactions is that they accelerate by themselves. This can be explained by the fact that the intermediate substances formed during the development of the main chain can give free radicals more easily than the initial substances. The process develops and continues with a significantly increased speed.

For example, in the oxidation of a hydrocarbon, the main chain develops until the formation of hydroperoxide:

$$R\cdot + O_2 \rightarrow RO_2$$

$$RO_2\cdot + RH \rightarrow ROOH + R\cdot$$

Hydroperoxide is mostly converted to an inactive end product. But it can dissociate into radicals:

$$ROOH \rightarrow RO\cdot + \cdot OH$$

or

$$ROOH + HOOR \rightarrow RO\cdot + H_2O + RO_2\cdot$$

These call for new oxidation chains of the original hydrocarbon - partially branched chains are formed. Such a partial branching occurs only after the main chain is formed, developed and broken. Therefore, the self-acceleration of partially branched reactions is prolonged, that is, the speed is much lower than the usual branching. Through this situation, we can understand the reason why the induction period of prematurely branched reactions is prolonged. The mentioned hydroperoxide decomposition schemes are an example of the formation of partially branched chains[2].

During the oxidation of hydrocarbons, partial branching can also occur as a result of the rotation of aldehydes. For example, formaldehyde formed during the oxidation of methane reacts with oxygen as two free radicals are formed and

$$CH_2O \to O_2 \to HO_2 \cdot + HCO \cdot$$

may cause the formation of partial branching chains.

Aldehydes formed during the oxidation of high-molecular-weight paraffinic hydrocarbons can carry partially branched chains through radicals according to the following scheme.

$$RCHO + O_2 \to RCOO \cdot + HO \cdot$$

$$HO \cdot + RH \to H_2O + R \cdot$$

$$RO \cdot + RH \to ROH + R \cdot$$

In addition to chain reactions involving intermediate products, these products can be transformed into more stable products without the participation of free radicals (for example, the transformation of alcohols and aldehydes into acids under the influence of molecular oxygen).

The considered hydrocarbon oxidation mechanism shows only the qualitative aspect of this complex process.

Oxidation of high molecular paraffinic hydrocarbons produces high molecular acids and high fatty alcohols. The main consumer of high fatty acids is the soap making industry; higher fatty alcohols are used to manufacture detergents. Previously, high fatty acids were obtained from vegetable and animal fat. Therefore, it is related to the problem of obtaining synthetic fatty acids and alcohols, replacing food raw materials with synthetic products for technical purposes. Higher fatty alcohols can be obtained by hydrogenation of esters of acids or by oxosynthesis. Until recently, the main raw materials for obtaining high-fat alcohols were whale oil and a small amount of vegetable oils. Such a source cannot be a stable base of raw materials; Although these alcohols are much better than synthetic alcohols in terms of quality, seasonal hunting of whales cannot support the high tonnage industry of alcohols. Primary alcohols are obtained by hydrogenation of fats[3].

$$CH_3 - (CH_2)_n - COOR + 2H_2 \to CH_3 - (CH_2)_n - CH_2OH + ROH$$

In the presence of boric acid, secondary alcohols are formed during the oxidation of paraffin

The process of oxidation of paraffins with air oxygen in the liquid phase is approximately similar to the oxidation of low-molecular paraffinic hydrocarbons in the gas phase and takes place according to the same mechanism. But in this case, the course of the reaction is not explosive, and also the primary products of the reaction are oxidized to acids. Molecular oxygen combines with a hydrocarbon molecule to form hydroperoxide. In the presence of isoform hydrocarbons, oxygen is attached to the third position of the carbon atom, and in the presence of hydrocarbons with a normal structure, it is attached to the methylene group[4].

CONCLUSION

The paraffin oxidation reaction involves only the part of dissolved oxygen in the paraffin. Therefore, the more oxygen dissolved in paraffin, that is, the higher the pressure, the faster the oxidation process. When the pressure increases from 15 to 60 at (the same oxidation depth), the reaction rate decreases from 8 to 2 hours. Air consumption of paraffin is 40-60 m3/t per hour. The higher the oxidation towers, the lower the Air consumption per 1 t of paraffin. The increase in the area of contact between air and paraffin has a great effect on the increase in the output of acids. For this purpose, the supplied air is distributed through special chambers or Rashig Rings according to the section of the tower.

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