Prolonged temperature exposure leads to recrystallization of the catalyst, which is accompanied by a decrease in its specific surface area and the number of active centers.

To prevent the process of recrystallization, special substances are added to the catalyst – *promoters*, which help to strengthen the crystal lattice of the catalyst, being embedded in its structure.

The structure of the catalyst can also be disturbed due to mechanical and thermal effects.

Chemical changes are associated with chemisorption on the surface of the catalyst impurities and reaction products, which are called *catalytic poisons*.

Over time, coking of the catalyst may occur, resulting in its active surface is blocked by coke deposits, and the overall activity of the catalyst decreases accordingly. The activity of the coked catalyst can be restored by treating it with air oxygen or water vapor at elevated temperatures.

The activity of a catalyst (*A*) is a measure of its accelerating effect in relation to a given chemical reaction. It is defined as the ratio of the rate constants of catalytic and non-catalytic reactions.

$$A = \frac{K_{cat}}{\kappa} = \frac{a_1 \cdot e^{-E_{cat}/RT}}{a_2 \cdot e^{-E/RT}}$$

where E is the activation energy of the reaction without catalyst,
E_{cat} is the activation energy of the reaction with the catalyst.
K_{cat} is a reaction constant with a catalyst.

For those cases when the catalytic and non-catalytic reactions are of the same order and, therefore, the pre-exponential coefficients in the Arrhenius equation are equal for them, the catalyst activity will be determined from the previous equation as:

$$A = e^{\Delta E/RT},$$

where: $\Delta E = E_{non-cat} - E_{cat}.$

By reducing the activation energy of the reaction, the catalyst accelerates it by many orders of magnitude. So, for example, for the reaction:

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$
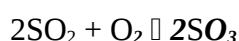
the activity of the vanadium catalyst used in it is $A = 3 \cdot 10^{11}$, that is, the reaction rate increases hundreds of billions of times.

In most cases, the catalyst also reduces the order of the reaction, the stronger the higher its activity. So, for example, if the order of the above reaction without a catalyst is 3, then in the presence of a vanadium catalyst it is only 1.8.

The ignition temperature of the catalyst $T_{ignition}$ is the minimum temperature at which the process begins to proceed with sufficient speed for technological purposes. The higher the activity of the catalyst, the lower the ignition temperature. At a low ignition temperature, the working interval between $T_{ignition}$ and the process temperature mode is extended, the reactor design is simplified, the heat consumption for heating the reagents is reduced, and the process mode is stabilized. For exothermic catalytic reactions, at a certain value of $T_{ignition}$, the rate of heat release becomes equal to the rate of heat removal (heat consumption for heating the reaction mixture and heat entrainment with the reaction products). In this case, $T_{ignition}$ represents the minimum temperature at which the process is autothermic.

The selectivity of a catalyst is its ability to selectively accelerate one of the reactions if several reactions are thermodynamically possible in the system. For a complex parallel reaction that proceeds according to the scheme: