



Рис. 2. Внешнее окружение ПАК

## Список литературы:

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2. Marichev V. Pomerantsev YI., Marichev N.. The development of "Virtual office" system with micro and nanoelectromechanical equipment. IEEE International conference on signal processing communications and computing (ICSPCC), Hong Kong, 2012.

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## Catalytic ammonia oxidation to nitrogen (I) oxide

**Abstract:** The process of synthesis of nitrous oxide by low-temperature catalytical oxidation of NH has been investigated for organic synthesis. The investigation has been carried out by the stage separation approach with NH oxidation occurring in several reaction zones, which characterized by different catalytic conditions. The selectivity for N<sub>2</sub>O was 92–92,5% at the ammonia conversion of 98–99,5% in the optimal temperature range

**Keywords:** Mn-Bi-Ce-Cu-O catalyst; ammonia oxidation; nitrous oxide, technological parameters, pilot testing.

The process of low-temperature catalytical oxidation of NH has been investigated for production of N<sub>2</sub>O for organic synthesis. The investigation has been carried out by the stage separation approach with NH oxidation occurring in several reaction zones, which characterized by different catalytic conditions.

**Introduction.** In the recent years, nitrous oxide has become used as a mild oxidizer for partial oxidation of hydrocarbons, for example oxidation of benzene to phenol. That is why, the process for direct ammonia oxidation is of interest to numerous researchers [1–4]. For these applications the substantial attention is focused on the improvement of the N<sub>2</sub>O production technology. Nitrogen (I) oxide is produced for medical purposes by thermal decomposition of ammoniac saltpeter. The hazards of the existing methodology of the thermal decomposition of ammonia nitrate involve the possibility of explosion of ammonia nitrate at heating and speeding up of the side reactions with increasing temperature.

The catalytic oxidation of ammonia to N<sub>2</sub>O at low temperatures (200–400°C) is a promising and more economically efficient technique. The catalytic oxidation of ammonia by technical oxygen to N<sub>2</sub>O has been investigated by N. I. Il'chenko [4]. N<sub>2</sub> and N<sub>2</sub>O are formed during low temperatures ammonia oxidation in reactions  $4\text{NH}_3 + 3\text{O}_2 = 2\text{N}_2 + 6\text{H}_2\text{O}$  and  $2\text{NH}_3 + 2\text{O}_2 = \text{N}_2\text{O} + 3\text{H}_2\text{O}$ .

In the course of these reactions the formation of unstable intermediate particles (OH, ONH<sub>3</sub>, ONH<sub>2</sub>, NH<sub>2</sub>, N, NH etc.) is also possible in parallel and sequential stages. In the present work we study different steps of the ammonia oxidation process and determine the influence of each step on the product yield. For this purpose, the ammonia oxidation reaction steps are carried out in separate reaction spaces, each having a different catalyst. To some extent, this approach avoids parallel reactions that may occur within a single reaction space and that are responsible for nitrogen unbounding. The influence of various technological parameters and various catalysts [5] on the ammonia oxidation process and production of nitrogen (I) oxide can be investigated as well.

**Experimental.** The measurements have been carried out in a reactor with two spatially separated catalysts. This allowed us to investigate individual stages of ammonia oxidation and the influence of various stages on the product yield as well as to avoid the parallel reactions that can occur in same reaction space and result in unbounding of nitrogen. The influence of technological parameters on the process of ammonia oxidation to N<sub>2</sub>O is studied for a variety of catalysts.

The catalysts for ammonia oxidation were prepared from oxides of Mn, Bi, Cu and Ce as well as from nitrates of these metals by sol-gel method. Before ammonia oxidation the catalysts were heated to 200°C for two hours at the presence of an oxygen flow. A layer of catalyst 2 was stacked on the quartz grid of the reactor. A layer of broken quartz glass with particle sizes from 3 to 4 mm was located above the catalyst layer. A layer of catalyst 1 was stacked on top of the broken quartz glass layer. The design of the device allowed us to vary the distance between the catalysts up to 55 mm. The experiments show that in the system containing two separate catalyst layers, the N<sub>2</sub>O yield can be sharply increased by 7 to 15% depending on the separation distance between layers. However, the some negative phenomena were observed in parallel with increase of the yield. If the catalyst 1 begins to work in an autonomous thermal mode, the ammonia oxidation process takes place solely on catalyst 1, and the temperature of this catalyst sharply increases. As a result the temperature of catalyst 2 decreases below the ignition temperature and catalyst 2 stops working. If the catalyst 2 is heated externally, then catalyst 2 switch on and dominates in the catalysis. As a result catalyst 2 uncontrollably heats up and catalyst 1 stops working as soon as its temperature decreases below the ignition temperature.

In order to eliminate the mutual influence of the catalysts and provide the more stable working conditions a series of experiments have been carried out in a quartz reactor (d = 20 mm). The design of reactor allowed us to increase the distance between the catalysts up to 90 mm. In this way, the temperature of one of catalysts was fixed in the range 200–225 °C, while the temperature of the other catalyst was slowly changed. The outlet nitrous gases were tested for the content of N<sub>2</sub>O by gas chromatography method.

**Results and Discussions.** A low-temperature oxidation of ammonia exhibits several unusual feature. At low temperatures the reaction mainly proceeds to N<sub>2</sub> and N<sub>2</sub>O, while at high temperatures NO is produced much more efficiently. Formation of unstable intermediate products, such as O, OH, ONH<sub>2</sub>, NH<sub>2</sub>, N, NH, HNO etc., is also possible at low temperatures. The dependence of the N<sub>2</sub>O yield on the temperature differences between the two catalysts was studied.

The data were obtained with Mn-Bi-Cu-Ce-O as catalyst 1 and manganese (II) oxide promoted by palladium [3] as catalyst 2. The study shows the maximum yield at ΔT=0. The date temperature dependences of the

nitrogen (I) oxide yield at various gas flow rate show that at optimum temperatures and low concentrations of ammonia in the gas mixture the N<sub>2</sub>O yield can reach 98–99%.

At high ammonia concentration the N<sub>2</sub>O yield can be decreased considerably. The N<sub>2</sub>O yield reaches 80–82% for a given catalyst at the linear gas flow rate  $v = 0.005$  m/s and NH<sub>3</sub> concentration of 10%. Under these conditions an optimal temperature of the process is in the range 210–270 °C. The N<sub>2</sub>O yield reaches 98–99% at optimal temperature and 4.14% ammonia concentration in gas mixture. It is necessary to note that the competing side reactions leading to the formation of nitrogen do not take place at the optimal temperature. At temperatures below 200 °C the reaction rate is decreased considerably and NH<sub>3</sub> remains in the gas mixture even after passing through the catalyst.

The transformation of NH<sub>3</sub> to nitrogen (I) oxide at various temperatures and the linear gas flow rate  $v = 0.015$  m/s and the temperature dependence of the degree of transformation of NH<sub>3</sub> to N<sub>2</sub>O and the yield of the higher oxides of nitrogen were studied. The data indicate that an optimal temperature of transformation of NH<sub>3</sub> to N<sub>2</sub>O at the ammonia concentration of 10% can be found in the range 340–480 °C, while at the ammonia concentration of 7.7% it is situated in the range 330–370 °C. With the ammonia concentration 4.4% the degree of transformation of NH<sub>3</sub> into N<sub>2</sub>O is very close to 98–99% at temperatures above 340 °C. For the ammonia concentrations 10%, 7.7% and 4.4% the parallel side reactions occur at temperatures above 250, 290 and 330 °C, accordingly.

Comparison of the N<sub>2</sub>O yields at various levels of ammonia specific loading on the catalyst and at various NH<sub>3</sub> concentrations gives the following results. With the specific ammonia loading on the catalyst 11.76 kg/m<sup>2</sup> and NH<sub>3</sub> concentration of 7.7%, the N<sub>2</sub>O yields 75% at 280 °C that avoids formation of the higher nitrogen oxides. The same yield was obtained at the specific ammonia loading on the catalyst 11.4033 kg/m<sup>2</sup>. At the 10% NH<sub>3</sub> concentration in gas mixture and the specific ammonia loading on the catalyst 15.27 kg/m<sup>2</sup>, the N<sub>2</sub>O yield at 280 °C was 57%. Thus, at the ammonia concentration of 10% the N<sub>2</sub>O yield is lower than at the ammonia concentration of 7.7%. Moreover, the higher nitrogen oxides can be formed at 280 °C and NH<sub>3</sub>

concentration of 10%. A pure nitrogen (I) oxide without the higher oxides is formed at the NH<sub>3</sub> concentration of 10% only if temperature is decreased to 250 °C. However, at this temperature the degree of NH<sub>3</sub> transformation is 40% and the N<sub>2</sub>O yield is only 7.9 kg/m<sup>2</sup>. At the NH<sub>3</sub> a concentration in the initial gas mixture equal 4.4% and the specific loading on the catalyst equal 6.7 kg/m<sup>2</sup>, N<sub>2</sub>O yield is as low as at the NH<sub>3</sub> concentration of 7.7%. The concentration of NH<sub>3</sub> in gas mixture is a more valuable parameter in the oxidation process than the catalyst specific loading.

An increase of catalyst specific loading at the ammonia concentration of 10% results in a sharp decrease in the degree of transformation of NH<sub>3</sub> into N<sub>2</sub>O. The N<sub>2</sub>O outlet sharply decreases as well. For example, the growth of catalyst specific loading by factor of 5 increases the N<sub>2</sub>O yield only by factor of 2.45. At the same time with the ammonia concentration of 7.5% a factor of 5 growth of the catalyst specific loading increases the N<sub>2</sub>O yield in 4.44 times. With a further decrease of the ammonia concentration to 4.1–4.4%, the N<sub>2</sub>O yield is increased 5.2 times at 5.3 times growth of the catalyst specific loading. With a simultaneous decrease of the ammonia concentration and increase of the catalyst specific loading, the N<sub>2</sub>O yield is increased as well. The temperature interval within which the N<sub>2</sub>O yield is near 98–99% is reduced. For example, if the gas flow rate is 0.005 m/s and ammonia concentration in gas mixture is 7.6%, the width of the favorable temperature interval is about 140 °C. If the gas flow rate is increased to 0.025 m/s, the width of the favorable temperature interval decreases to 60 °C.

**Conclusions.** The results of the investigation of the low-temperature NH<sub>3</sub> oxidation process using two catalysts located in separate reaction zones allows us to control and optimize the yield of N<sub>2</sub>O. The proposed design of the reaction chamber provides the increase of the N<sub>2</sub>O yield by 7–15% under autothermally conditions of NH<sub>3</sub> oxidation. The degree of NH<sub>3</sub> oxidation into N<sub>2</sub>O is increased without any detectable nitrogen unbounding. The results of the investigation of the ammonia oxidation process using several catalysts and a variety of gas mixture flow rates, temperatures and catalyst specific loadings show that under optimal conditions a practically complete transformation of ammonia into N<sub>2</sub>O is possible.

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## **Application of gis technology in the analysis of relief the south slope of Greater Caucasus**

**Abstract:** We consider the evolutionary development of geographic information systems (GIS) in the Republic and the concept of providing a high-rise in the South slope of the Greater Caucasus (Qabala).

**Keywords:** geodesic height, normal height, geodetic measurements.

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## **Применение гис- технологий при анализе рельефа южногосклона большого Кавказа**

**Аннотация:** Рассмотрено эволюционное развитие географических информационных систем (ГИС) в Республике и концепция системы высотного обеспечения на территории Южного склона Большого Кавказа (Габала).

**Ключевые слова:** геодезическая высота, нормальная высота, геодезические измерения.

**Введение.** Абсолютная высота всех точек в пространстве стран СНГ принимаются от уровня Балтийского моря, являясь составной и неотъемлемой частью решения общих задач геодезии. На современном этапе развития географической науки установлены связи между нивелирными сетями Республики со странами СНГ, входящих в единую сеть нивелирования Европы (UELN), участие которого требует определения оптимальных высот в общеземной системе.

Изучением данного направления в зависимости от постановки задачи занимались как зарубежные, так и Азербайджанские исследователи, которые в своих трудах уделили достаточного внимания в освещении результатов исследований. Так, Антипцевой Ю. О., Думит Ж. А. [1] проведен морфометрический анализ

рельефа с использованием ГИС — технологий при оценке рекреационного потенциала. Загорулько В. А., Хамарин В. И. и др. [2] осветили морфометрический подход рельефа средствами ГИС. Хромовым В. В. [3] ГИС применялись в геоморфологических исследованиях, в определении точной кривизны земной поверхности при выявлении овражно — балочной сети территории.

В Азербайджане применением ГИС- технологий глубоко занимаются акад. Мехтиев А. Ш. [4], который при оценке колебания уровня Каспийского моря применил ГИС. Чл.-корр. НАНА Исмаиловым А. И. [5] разработана информационная система почв Азербайджана. Акад. Мамедовым Г. Ш. [6] — единая система координат и др. Автор подчеркивает, что геодезия является наукой важной отрасли в обеспечении

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