

PAPER • OPEN ACCESS

Highly efficient catalysts from waste water sludge of thermal power plants and waste of machine-building industries for gas purification from nitrogen oxides

To cite this article: A. F. Mahotkin *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **288** 012014

View the [article online](#) for updates and enhancements.



IOP | ebooks™

Bringing you innovative digital publishing with leading voices to create your essential collection of books in STEM research.

Start exploring the collection - download the first chapter of every title for free.

Highly efficient catalysts from waste water sludge of thermal power plants and waste of machine-building industries for gas purification from nitrogen oxides

A. F. Mahotkin ¹, I. A. Mahotkin ², A. E. Suharnikov ³

^{1,2}Kazan Scientific Research Technological University, Russia, K. Marx Str., 68
420015 Kazan, Tatarstan, Russia.

³Kazan State University of Architecture and Engineering, Russia, Zelenaya Str., 1
420043 Kazan, Tatarstan, Russia.

oxzkstu@kstu.ru, Sukcharnikov@yandex.ru

Annotation. Relatively cheap and high-efficient catalysts for purification of waste gases of thermal power plants from nitrogen oxides have been developed. Pilot batches of catalysts were manufactured. The analysis of the results of research and testing of new catalysts in industrial conditions of thermal power plants of chemical enterprises.

When operating thermal power plants on fuel oil on the surface of boilers, a precipitate of incomplete combustion products is usually formed. Washing coppers from the sediment was previously carried out with water. At the same time, waste water was sent to the sludge collector. The study of the sediment composition in the sludge collector of Zainsk State district power plant showed that the main components of the sludge are: incomplete combustion products, iron oxides and vanadium pentoxide. The latter substances are known as effective components for the preparation of catalysts [1]. Drying, sifting, grinding, mixing with clay of the Kuganak Deposit, annealing and pressing allowed to turn the toxic sludge of the Zainsk State district power plant into a non-toxic high-efficient catalyst for selective catalytic purification of gases from nitrogen oxides. Fabrication and study of catalysts was carried out at the Kazan scientific research technological University, Bugulminsky porcelain factory. New catalysts have been tested in industrial conditions for purification of waste gases from nitrogen oxides at three thermal power plants in the cities: Zainsk, Naberezhnye Chelny, Moscow [2]. Modern sanitary standards for purification of waste gases from nitrogen oxides by ammonia at a temperature of 350 °C have been achieved. Ammonia is dosed with an excess of 30-40 %. The maximum degree of purification of exhaust gases is achieved on the granular catalyst. Minimum hydraulic resistance is achieved on a honeycomb catalyst. The required phase contact time in the catalyst bed is about one second.

The total amount of sludge in the sludge collector of Zainsk State district power plant alone reaches 15 000 tons, including vanadium pentoxide in the sludge about 1000 tons. It should be noted that this amount of valuable raw materials is sufficient for the manufacture of catalysts to solve the environmental problem of purification of waste gases from nitrogen oxides of all thermal power plants and all chemical enterprises of the Republic of Tatarstan. The technology of manufacturing new catalysts is relatively simple and can be implemented in red brick factories. The term of reliable



operation of the catalyst is three years.

The creation of a modern production of high-performance catalyst in Zainsk would represent a solution to a complex scientific, technical and environmental problem of great importance for the Republic of Tatarstan. From the slurry Zainsk SDPP can be made highly efficient catalysts for the sum more than two billions roubles.

However, at present, the sludge collector has been eliminated. The sludge of Zainsk State district power plant is almost completely covered by the land and solid waste of the city. The Republic was left without cheap valuable raw materials for the manufacture of high-performance catalyst.

Further development of the effective scientific direction on creation of catalysts on the basis of processing of waste of various productions allowed to receive one more type of the simplest cheap and effective catalyst in Kazan scientific research technological University. The study showed that the effective catalyst for the reduction of nitrogen oxides with ammonia is carbon steel shavings taken from scrap metal. Simple rusty twisted shavings at 350 °C and phase contact time for one second provides effective cleaning of waste gases from nitrogen oxides with ammonia to modern sanitary standards. The period of reliable operation of the chip as a catalyst is one year. In the early stages of the study, we took care of ways to prepare the active surface of the chip. Tests in industrial conditions of power plant - 11 of Moscow and chemical enterprises in the cities of Solikamsk, Sterlitamak showed that preliminary preparation of the chip surface is not required. Conventional rusty and even oily twisted carbon steel chips taken from scrap metal in an industrial catalytic gas treatment reactor are rapidly converted into a highly efficient catalyst. Tested in Moscow at the power plant – 11 was conducted with the flow rate of the gas flow of 60 000 m³/h, in Solikamsk and Sterlitamak tests conducted with the flow rate of the gas flow 30 000 m³/h. the Hydraulic resistance of the layer of chips was in the range of 50-100 mm water column.

Among the developed catalysts, granulated iron-oxide catalysts have maximum efficiency in the conditions of thermal power plants and chemical enterprises [2]. Pilot tests of iron-oxide catalyst for purification of waste gases from nitrogen oxides were carried out in the conditions of the Moscow power plant – 11 at a gas flow rate of 60 000 m³/h and a temperature of 350 °C. Comparison of the tested catalysts at a cost, starting from the cheapest, looks the following way: the turnings of carbon steel, zhelezovanadievoj granular catalyst from slurry waste Zainsk SDPP, cell catalyst from slurry waste Zainsk SDPP, plate, the catalyst sheet of carbon steel, the catalyst in the form of pipes made of carbon steel, zhelezobaktery granular catalyst. Therefore, the rational use of waste from various industries for the manufacture of catalysts can give a significant economic effect.

References

- [1] Khodakov Yu.S. Nitrogen oxides and heat power engineering: problems and solutions. Monograph. Moscow:AST-M, 2001, 432 p
- [2] Makhotkin I. A. Purification of gas emissions from vapors, aerosols and dust of toxic substances: abstract of dissertation ... kand. techn. sciences: 03.02.08. Kazan: KAZAN state technical University, 2011, p. 20