Brief communications

Translated from *Uspekhi Khimii* **60** 627–628 (1991)

Catalytic systems for the purification of industrial effluent gases

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The elimination of toxic impurities from industrial effluent gases constitutes an important ecological problem which has hitherto been solved to only a slight extent in our country. Such purification is desirable when the concentration of impurities in air exceeds the limiting permissible concentration (LPC) but is not sufficiently high to make their trapping economically viable. One of the most rational ways of removing such impurities involves, in the given instance, extensive catalytic oxidation.

The specific features of the catalytic purification under industrial conditions consists in the fact that the composition of the impurities removed is in general extremely complex and varied. The extensive oxidation of the effluent gases of different composition can be most effectively achieved with the aid of platinum and palladium catalysts containing the active metal, at a concentration amounting to a fraction percent, on porous and metallic carriers. These catalysts are capable of effecting a stable acceleration of the reaction at low temperatures with conversion of the impurities to give concentrations of the latter corresponding to the LPC and with conversion of functional compounds into non-toxic substances. Some of the effective catalysts are reforming catalysts (AP-56 and its later analogues) extracted from industrial apparatus after deactivation. They retain a high stable activity in extensive oxidation processes. The use of catalysts on a metallic support instead of porous carriers is more useful, since it rules out the blocking of the pores by industrial dust and increases the period of the operation of the catalyst.

Systematic studies on the separate and joint oxidation of toxic impurities under stationary and non-stationary conditions on industrial catalysts have been carried out in recent years at the Zelinskii Institute of Organic Chemistry of the USSR Academy of Sciences jointly with the Dzerzhinsk branch of the NIIOGAZ. These investigations made it possible to establish kinetic models of the extensive oxidation of various classes of compounds (paraffins, aromatic hydrocarbons, aldehydes, alcohols, acids, esters, and organic nitrogen compounds), to discover their common features and significant differences, and to develop a theory of the kinetics of catalytic reactions of mixtures of organic compounds. The latter permits the prediction, on the basis of experimental data for the reactions of individual compounds, of kinetic models for the reactions of mixtures of these substances with the aid of the idea that there is a simple mutual influence in the surface layer of the catalyst.

On the basis of the kinetic models obtained, the Dzerzhinsk branch of the NIIOGAZ together with the Institute of Organic Chemistry of the USSR Academy of Sciences achieved the catalytic purification of the effluent streams of air in the manufacture of synthetic aliphatic acids at the Novokuibyshevsk petroleum processing factory (with a turnover of 240 000 roubles annually) and also additional purification on horizontal and vertical machines for the enamelling of cable at the Moldavkabel' and Moskabel' factories with a turnover of 30 000 – 50 000 roubles annually).

Translated from *Uspekhi Khimii* **60** 629–630 (1991)

Water-soluble polymers for the purification of waste water

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The high anthropogenic stress arising from large cities, industrial undertakings, and large animal husbandry complexes has led to an unsatisfactory state of the water system in many regions of the USSR. An unsatisfactory ecological situation has arisen in the Lake Ladoga – the Neva – Bay of Finland system. The natural capacity of the water system for adaptation has reached its limit.

The question of the purification of large volumes of waste water has arisen. The situation is aggravated by the necessity to disinfect these waters to remove the pathogenic microflora and to achieve its detoxification by removing heavy metal salts which enter the water mainly from industrial undertakings.

The most acute problem is that of the processing and utilisation of deposits from urban purification plant, hundreds of tons of which are carried away to waste dumps because they cannot be converted into fertilisers owing to their high content of heavy metals and pathogenic microorganisms.

One of the most important stages in the processing of deposits from purification plant is their conditioning and dehydration, which is achieved with the aid of high-molecular-weight water-soluble polymers — flocculants, ensuring the rapid coagulation and precipitation of suspended particles and promoting thereby the dehydration of the deposits. The efficiency of the flocculant is determined by its molecular weight and also by its charge. The higher the molecular weight of the flocculant, the lower its amount required for the conditioning of the deposit and for the shortening of the duration of the process. Cationic polyelectrolytes with a molecular weight of at least $10^6 \times (6-10)$ proved to be the most effective.

Bearing in mind the marked variations in the composition of the contaminants and in the properties of the deposits as a function of the waste ejected into water, flocculants of different types are widely used abroad. Despite the fact that the requirement for them runs to tens of thousands of tonnes, high-molecular-weight flocculants are

not manufactured in the USSR. In the purification of drinking and waste water, imported flocculants are mainly employed, a large amount of foreign currency being expended annually for their purchase.

Ultra-high-molecular-weight neutral, cationic, and anionic polymers, which proved to be effective flocculants for the conditioning of waste water deposits in Leningrad, the waste waters from animal husbandry complexes, and also from a number of paper and aluminium-magnesium industries, have been synthesised by novel methods at the Institute of Macromolecular Compounds of the USSR Academy of Sciences. The foundation for the development of a broad assortment of flocculants for different purposes was thereby laid at the Institute.

The "Akromidan-LK" flocculant, which is not inferior to foreign products in its efficiency and in a number of characteristics is superior to them, was most widely tested under different conditions. At the present time a technology for the manufacture of this flocculant is being developed and an experimental plant is being designed in which it is proposed to develop an industrial technology and to produce experimental batches of flocculants for wide scale testing.

In order to organise a wide scale industrial manufacture of new highly effective flocculants, it is essential in the first place to initiate the commercial manufacture of the starting material—amino-acrylates, the plants for the manufacture of which are at present moth-balled. This will make it possible to achieve the industrial production of Soviet highly effective flocculants and to solve the problem of providing flocculants for the existing technology for the dehydration of deposits both on urban purification plants and on purification plants of animal husbandry complexes and paper industrial undertakings.

Translated from *Uspekhi Khimii* **60** 631–632 (1991)

A new chemical technology—the basis of technological processes for the protection of nature

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The dramatic situation as regards the pollution of soil, water containing areas, and air caused by the industrial and agricultural activities and the ejection into the domestic environment of an enormous amount of organic and inorganic substances, various types of dust and gaseous, liquid, and solid products have made it urgently necessary to create fundamentally new technologies designed to protect nature and in many cases to save it.

Such a new technology, which may serve as a foundation for nature-protecting technological processes, is the controlled release technology (CRT). The physicochemical basis of the TRC is spontaneous processes—diffusion, osmosis, and dissolution, described by thermodynamic, Fick, and van't Hoff laws.

The control of the above processes using for this purpose the specific properties of high-molecular-weight compounds (matrix, transport, and constructional) will make it possible to construct entropic macromolecular chemical engines for the long-term and controlled metered injection of chemically and biologically active substances into any medium involving activity (the organism, soil, water-containing area, reactor, etc.). Macromolecular chemical engines (MCE) function without external energy sources as a result of the difference between the chemical potentials in the medium and in the MCE and by virtue of the increase in entropy in the "MCE—disposal medium" macrosystem.

The controlled release technology and macromolecular chemical engines can find and are finding applications in various branches of engineering and the national economy: plant cultivation, animal husbandry, the fishing industry, veterinary science, the health service, the food industry, in chemical engineering processes, in long term food storage, in protection against corrosion, and in autonomous systems, i.e. systems where prolonged controlled injection of various preparations is required: medicinal drugs, fertilizers, pesticides, biostimulators, inhibitors, catalysts, insecticides, herbicides, etc.

The use of the CRT in any of the fields listed above leads to the creation of new technological processes with the following features: ecological cleanliness—by virtue of the possibility of injecting the useful substance at a specified point in a strictly defined amount in the course of a specified period; the saving of resources—as a consequence of the elimination of the non-productive consumption of useful substances involving a balance between the rate of consumption and injection of the required components (for example, fertilizers); energy saving—as a consequence of the absence of the need for external energy sources to permit the functioning of controlled release polymer systems.

In support of the above postulates, three developments concerning the protection of soil, animals, and water containing area may be briefly described: the study and the cultivation of vegetables (cucumbers, tomatoes) by a non-traditional procedure, prophylaxis of strongyloidosis in cattle, and the development of polymeric devices for the measured microinjection of biologically and chemically active substances into water-containing areas.

It was shown in relation to the examples quoted that, in the growing of tomatoes and cucumbers on APION devices (devices for the metering of fertilisers), the consumption of fertilisers is reduced to the biologically necessary level (by a factor of 5–15), the crop is increased, the quality of the produce is improved, and the ecological cleanliness of the technological process is radically improved.

In the therapeutic and prophylactic treatment of cattle with the aid of LAUS devices (devices for the metered release of an antihelminthic preparation in the animal's stomach), the weight increment in the animals fed on pastures increases, and the quality of the pastures is improved by the faeces containing the antiparasitic preparation.

By ensuring prolonged metered injections at a specified rate of molluscocidal preparations into water-containing areas or flowing water systems with the aid of supercharged polymer pumps, one prevents the spreading of severe infective diseases of animals and humans without damaging the aquatic and terrestrial inhabitants of the ecosystem.

Overall, on the basis of the controlled release technology, it is possible to develop radically new technological processes, generating significant ecological, social, technical and economic effects and being directly designed to perform nature protecting functions, the husbanding of resources, and the maximum improvement of the human environment.
