

Editorial

Catalytic Decomposition of N₂O and NO

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As generally known, nitrogen oxides NO_x (NO, NO₂) and nitrous oxide (N₂O) are significant pollutants. The emissions of NO_x produced by fossil fuel combustion in power plants, by transport and chemical industry, represent a serious environmental problem, since they contribute to the formation of acid rains and photochemical smog. More than 90% of emitted NO_x from stationary sources is NO. Various techniques have been developed for NO elimination, such as commercially commonly used selective catalytic reduction of NO_x (SCR) and selective non-catalytic reduction of NO_x (SNCR). In particular, less efficient SNCR technology will no longer be appropriate due to the tightening of emission limits. Conversely, SCR NO_x technology is very effective, but its disadvantage, like that of SNCR, is the need to add a reducing agent (ammonia, urea), which increases costs, causes undesirable ammonia slip and requires increased safety precautions. From this perspective, direct catalytic decomposition of NO to oxygen and nitrogen, without a reducing agent, is a big challenge.

Since the beginning of 20th century, many catalysts have been studied, including noble metals, simple metal oxides, rare-earth oxides, complex metal oxides and zeolites [1,2], with the aim to find catalysts which are suitable for practical applications. In spite of the great scientific effort, direct catalytic NO decomposition remains in the stage of basic laboratory research. Mixed oxides with alkali metal promoters appear to be active for this reaction, but there are a number of issues that need to be addressed. These are the stability of catalysts, sufficient activity at industrially suitable temperatures and inhibition of the reaction by oxygen and other components present in waste gases.

While the promotional effect of potassium on Co₃O₄ catalytic performance has already been established in the literature [3,4], it remains unknown if K is also a promoter of NO decomposition over similar simple first-row transition metal spinels like Mn₃O₄ and Fe₃O₄. The answer to this question can be found in an interesting paper written by researchers at the Toyota Research Institute of North America [5].

Potassium also has a beneficial effect on Co₄MnAlO_x mixed oxide for NO catalytic decomposition [6,7]. However, the disadvantage of K/Co₄MnAlO_x catalysts and generally of K doped catalysts, is that potassium is not stable at the reaction temperature of NO decomposition (above 650 °C) and desorbs from the catalyst surface [6]. Therefore, other promoters such as cerium, known for its redox properties and oxygen storage capacity, was tested for modification of Co₄MnAlO_x. In the study of a Czech research group [8] presented here, the following question has been answered: does the presence of cerium in K-promoted Co₄MnAlO_x catalysts substantially affect the physical-chemical properties, activity and stability in direct NO decomposition?

N₂O, a well-known greenhouse gas, is emitted from some processes together with NO_x. In this case, direct catalytic decomposition of N₂O is also an elegant method for reducing its emissions. This technology is now at the stage of its first commercial applications, mainly in nitric acid plants, which belong to the biggest industrial source of N₂O emission. Different variants for abatement of N₂O emitted from nitric acid plants were analyzed in the work of M. Inger group from Poland [9]. A two-stage catalytic abatement of N₂O from nitric acid plants consisting of high-temperature decomposition in the nitrous gases stream



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and low-temperature decomposition in the tail gas stream was evaluated as economically advantageous.

The effort of researchers in the area of N₂O catalytic decomposition has been focused on increasing catalysts efficiency in conditions simulating real waste gases. Among studied catalysts, nanocrystalline cobalt spinel has been recognized as a very active catalytic material for N₂O decomposition. Bulk, surface and interface promotion of Co₃O₄ for low-temperature N₂O decomposition was studied by the Kotarba group [10,11], while the question of optimal calcination temperature of Co₄MnAlO_x was solved in [12]. The advantages of active Co-spinel phase deposition on zeolite foam support are shown in work [13]. In addition, Co, Fe species were also considered as active sites for N₂O catalytic decomposition, which is discussed in the work of M. Rutkowska et al., [14], dealing with the optimization of iron form in layered 2D zeolite MCM-22.

Another issue is the decomposition of N₂O in the presence of suitable semiconductor materials and light with appropriate wavelength and intensity in indoor and outdoor environments. Research findings focusing on the fundamental exploration of the synthesis, characterization and application of nanostructured graphitic carbon nitride/zinc oxide for N₂O photocatalytic decomposition are explored in the work of the Kočí group [15].

In conclusion, this collection of publications together with references herein well represent the state-of-the art in the area of direct catalytic decomposition of NO or N₂O; methods suitable for the reduction of their emissions in waste gases and the abatement of N₂O in the environment via photocatalytic decomposition.

I would like to express my sincerest thanks to all authors for their valuable contributions and I hope that this Special Issue will be an inspiration for many scholars active in this field. I would also like to thank the Editorial team of *Catalysts* for their kind support and prompt responses. Without them, this Special Issue would not have been possible.

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