Catalytic Removal of Volatile Organic Compounds

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Editorial

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Recevied: 18 December 2015; Accepted: 29 December 2015; Published: 5 January 2016

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The degradation of air quality by the release of volatile organic compounds (VOCs) into the air particularly harms human health and our environment. Regulation of outdoor VOC emissions is required to prevent the formation of ground-level ozone, which is principally responsible for photochemical smog. Indoor emissions of VOCs have been the subject of recent consideration for many governments around the world because of the adverse impact of VOCs on the health of people exposed to them.

Because VOCs are numerous and varied, they include alkanes, aromatics, chlorinated hydrocarbons, alcohols, aldehydes, ketones, esters, *etc.*, many technologies have been developed to control their emissions. Depending on their toxicity, concentration, presence or lack thereof in a mixture, and market value, the removal of VOCs from air can be achieved by recovery or destructive processes.

Heterogeneous catalytic oxidation is regarded as the most promising technology to control VOC emissions with low energy consumption and with selective conversion into harmless molecules [1].

The high volume and low VOC concentrations in air could require the coupling of the catalytic oxidation process with other technologies such as adsorption and non-thermal plasma (NTP) in order to control the emissions while reduced operating costs [2].

This special issue covers promising recent research and novel trends in the fields of outdoor and indoor VOC abatement using different technological approaches and including recent developments in material chemistry to achieve more efficient processes.

This special issue collects three reviews and nine articles.

The review by Satu Ojala *et al.* [3] summarizes the commercially existing VOC utilization possibilities and presents utilization applications that are in the research phase. The authors introduce some novel ideas related to the catalytic utilization possibilities of the VOC emissions and underline that catalysis offers not only a way of VOC removal and reduction of their atmospheric reactivity and harms in the working environment but also provides excellent options for novel and sustainable products. Applications of carbon-supported catalysts for VOC catalytic oxidation are reviewed by Francisco José Maldonado-Hódar *et al.* [4]. The authors examine the extent to which carbon-based materials in association with noble metals (Pt and Pd) can be used as catalysts for benzene, toluene and xylenes elimination. In particular the authors point out the influence of the support of hydrophobicity and mesoporosity on the catalyst performances. The review by Sharmin Sultana *et al.* [5] identifies potential research applications of the abatement of VOCs as well as of the regeneration of adsorbents using a newly developed innovative technique, *i.e.*, the cyclic operation of VOC adsorption and plasma-assisted regeneration. The authors clearly show the influence of critical process parameters on the adsorption and regeneration steps and highlight the direction of the future work on this topic which must be focused on for the feasibility and optimization of the duration of the sequential intervals.

Two articles focus on the combination of NTP with catalysis as a feasible way to overcome the poor selectivity towards the target compounds and low energy efficiency of the use of NTP alone. Yoshiyuki Teramoto *et al.* [6] study the reaction mechanism of the zeolite-plasma hybrid system for toluene decomposition. Using different configurations of the zeolite hybrid reactor, the authors show that the main factor enhancing the reaction mechanism is ozone species produced by the plasma which are able to decompose toluene molecules adsorbed onto the zeolite. Mok *et al.* [7] also highlight that the location of catalysts should be carefully considered to observe a positive synergy between plasma and Fe-Mn cordierite honeycomb catalysts. One of the key parameters when designing a catalyst is the support nature which plays an important role in improving the activity and durability of supported noble metals. Two examples are given by Stuart Taylor *et al.* and Leonarda Liotta *et al*. In the total oxidation of naphthalene, Stuart Taylor *et al.* [8] suggest that large platinum particles, in combination with platinum in metallic and oxidized states, are needed to maximize the catalytic activity over SiO_2 support. On the contrary, Leonarda Liotta *et al.* [9], studying different oxides as support, show that formation of highly-dispersed Pd^{2+} species over TiO_2 is required for propene oxidation at lower temperatures. SiO_2 and TiO_2 can be successfully used in combination to produce a simple air and water purification unit. Tsuyoshi Ochiai *et al.* [10] show that a one-end sealed porous amorphous-silica tube coated with TiO_2 photocatalyst layers has great potential for compact and in-line VOC removal.

The use of engineered transition metal containing nanomaterials as catalysts is of interest because of the high price and limited resource of noble metals, most commonly used in practice due to their high intrinsic activity [11,12]. This topic is well illustrated by two articles describing cobalt-based mixed oxides catalysts prepared via the hydrotalcite route. Renaud Cousin *et al.* [13] show that the use of microwaves during catalyst preparation leads to a more efficient catalyst for toluene oxidation while Sonia Moreno *et al.* [14] stress that the catalytic behavior in the total oxidation of the binary mixture of toluene and 2-propanol is dependent on the redox properties and oxygen mobility in Co-Mn mixed oxide.

Finally, two works are devoted to the investigation of VOC adsorption under dynamic conditions. Tarik Chafik *et al.* [15] show clearly that clay mineral is a promising material with interesting adsorptive properties allowing valorization of available local resources with significant value-added application in environmental control. Jean-François Lamonier *et al.* [16] demonstrate that copper-exchanged zeolite material can be considered as a potential hybrid system for the treatment of toluene in low concentrations in air, since this material combines a VOC adsorber with an oxidative catalyst to clean air.

I am very pleased to serve as guest editor of this special issue and I would like to first express my gratitude to Professor Keith Hohn, the Editor-in-Chief of *Catalysts*, for entrusting me with this task. I would like to thank all the authors for their insights and all reviewers for their valuable comments to improve the quality of the papers. Finally, I would like to thank all the staff of the *Catalysts* Editorial Office. I hope that this issue will be a valuable resource for upcoming research on volatile organic compounds removal.

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