Editorial:

Air pollution control for a green future

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Over the last decades, the production of energy from various sources (e.g. coal, crude oil, natural gas) has rapidly increased all over the world, partly caused by the relatively comfortable and prosperous life sought by people. It is true that energy utilization can bring tremendous benefit to humans. However, along with prosperity, environmental pollution cannot be neglected. To a great extent this pollution can be attributed to energy utilization, especially the combustion of fossil fuel. In general, pollution is the introduction of contaminants into the natural environment causing adverse changes. In the case of combustion, several toxic substance emissions such as sulfur dioxide (SO$_2$) and nitrogen oxides (NO$_x$) have been severely limited to very small values. To protect the environment from the adverse effects of emissions, many countries worldwide have adopted legislation to regulate various types of pollution as well as to alleviate their adverse effects. Both combustion modifications and after-treatment strategies have been employed to achieve the goal of emission control. During this process, various innovative methods have been invented and put into practice. For example, wet flue gas desulfurization (WFGD) can convert over 98% gaseous SO$_2$ into solid CaSO$_4$ while selective catalytic reduction (SCR) reduces gaseous NO$_x$ by NH$_3$ to form water and nitrogen (Zhong et al., 2008; Hu et al., 2017). Both methods have been extensively and rapidly commercialized worldwide, combined with combustion modifications, effectively mitigating the harm to the atmosphere.

Although enormous success has been achieved concerning SO$_2$ and NO$_x$ reduction, other harmful substances remain to be dealt with. One such that attracts more and more attention in recent years is particulate matter (PM), because of its effects on both global climate and human health. For several decades, great efforts have been made to deal with PM emissions from energy utilization and a variety of new theories and control technologies have merged. To realize ultra-low PM emission, more attention is paid on ultra-fine particle removal. Some agglomeration technologies, e.g. acoustic agglomeration (Yan et al., 2016; Zhou et al., 2016), electrical agglomeration (Chang et al., 2015, 2017), and chemical agglomeration (Liu et al., 2016; Hu et al., 2018), are efficient pre-treatment methods to improve ultra-fine particle removal efficiency by enlarging particle size. Recently, condensable PM such as SO$_3$ gains an increasing attention because it can lead to a variety of plant operation problems and plume opacity. Upgrading of wet electrostatic precipitator (Huang et al., 2016; Wu et al., 2017) becomes possible countermeasures to eliminate it to satisfactory emission requirement (Xu et al., 2016; Zheng et al., 2017).

As well as PM, we should also keep an eye on the heavy metals released during the process of energy utilization. Taking mercury as an example, it can be detected in flue gas. Because it is insoluble in water, highly volatile and chemically inert, it can exist in air, water, and soil over long distances and periods of time. Once it returns to the biosphere, mercury can bio-accumulate in the ecosystem and become a major threat to human health (Zhao et al., 2017). Strategies like adsorption/absorption, oxidation/reduction can be used to capture heavy metals and rehabilitate soil and water. However, creative materials, processes, and technologies are also needed.

Besides toxic materials, nontoxic carbon dioxide (CO$_2$) from fuel combustion becomes major concern recently and represents 76.7% of greenhouse gases.
is still challenging (UNEP, 2013). Mu et al. (2018) adopted density functional theory (DFT) to investigate the adsorption mechanism of Hg on a 1T-MoS₂ monolayer. Different possible adsorption positions on the 1T-MoS₂ were examined. The results elucidated that chemisorption dominates the adsorption between Hg₀ atoms and the 1T-MoS₂. It was found that the T Мо (on top of the Мо atom) position is the strongest adsorption configuration among all the possible adsorption positions. Zheng et al. (2018) investigated the co-benefit of hazardous trace elements such as mer-cury (Hg), arsenic (As), and selenium (Se) capture in dust removal devices of ultra-low emission coal-fired power plants. The results indicated that the low inlet temperature of low-low temperature electrostatic precipitator (LLT-ESP) had significant promotional ef-fect on the simultaneous removal of Hg, As, and Se. The smaller particle size of fly ash can be conducive to the adsorption of hazardous trace elements. The in-hibitory effect of sulfur content in coal was significant for the enrichment of Hg and Se in fly ash.

As well as toxic substance removal, the recy-cling of exhaust gases shows promise. A typical case is the catalytic transformation of CO₂ to value-added substances. Sagawa (2018) prepared catalysts with Fe, Ni, and Cu supported on Al₂O₃ and performed dry reforming of CO₂, steam reforming of CO₂, water gas shift reaction, and CO₂ hydrogenation over these catalysts. It was found that by varying the ratios of Fe, Ni, and/or Cu over the composite materials, the yield and selectivity of the useful products such as CO, CH₄, and C are promising for further enhancement. Nowicka and Sankar (2018) reviewed important structural features relevant to Pd-based bimetallic systems and a few reactions relevant to environmental catalysis, i.e. CO oxidation, hydrocarbon oxidation, hydrodechlorination, and NOₓ decomposition were illustrated. They believed that this review will inspire scientists to rationally design catalysts for a green and sustainable future. Wu et al. (2018) developed the rainbow refractometry method for in-situ characteri-zation of gas-liquid precipitation reaction in SO₂ and CO₂ removal process. They tried to characterize the reaction process in-situ using the change of the re-fractive index of droplets during the gas-liquid ab-sorption precipitation reaction process. Based on rainbow refractometry, the in-situ characterization of such a reaction was first studied, and its feasibility and effectiveness were verified through several ex-periments and detailed heat transfer analysis.
We believe this special issue has provided a unique opportunity for researchers to present and discuss recent advances in air pollutant control and air quality management during energy utilization. The interaction of fundamental science and industrial application within topics was also particularly promoted by the high quality of the technical and scientific standard of the selected publications. We sincerely hope the most up-to-date view and outlook of the field that is shared in this special issue will move the research frontier forward, improve the understanding of air pollutant control technologies and strategies, as well as preserve existing know-how. We expect these cutting-edge articles will promote discussions among established scientists and could also provide benefit for the journal readers.

References
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中文概要

目：大气污染治理助推绿色发展

要：化石燃料尤其是煤炭利用过程中排放的二氧化硫、氯氧化物、颗粒物和重金属等污染物以及二氧化碳等温室气体已引起国内外的广泛关注，并已成为能源环境领域的研究热点。近几年，国内外在烟气污染物控制以及CO2捕集和利用方面取得了显著的进展。然而，如何进一步提高污染物的脱除效率、如何实现多污染物高效协同脱除以及如何实现污染物的资源化利用等方面尚需进一步研究；如何实现CO2的资源化和循环利用也得到国际上的普遍关注，亟需基础研究支撑技术突破。本专辑收集了在该研究领域具有影响力的人员的最新研究成果和观点，介绍了该领域的最新研究进展，希望能帮助读者了解相关研究工作并促进研究人员开展讨论，推进该领域的基础研究和技术创新，为实现能源消费清洁化、低碳化和绿色化提供科学和技术支撑。

关键词：化石燃料；大气污染物；二氧化碳；绿色化