Efficient wastewater treatment combined with CO_2 removal from exhaust gases via gas hydrate technology

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Given the growing global demand for clean water and the reduction of greenhouse gas emissions, the sustainable use of water and the capture of CO_2 are becoming increasingly important. For this reason, the GFZ Helmholtz Centre for Geosciences and the University of Potsdam launched the innovative project *ECO - Efficient CO_2 capture from exhaust gases and coupled treatment of industrial wastewater using gas hydrate technology*, which combines wastewater treatment with CO_2 capture from exhaust gases using gas hydrate technologies. Furthermore, the project addresses the treatment of the resulting highly contaminated wastewater concentrate, which contains large amounts of pollutants, and utilizes specific adsorbents for this purpose.

The use of gas hydrates for seawater desalination was developed as early as the 1960s, and in recent decades, numerous patents have been filed, protecting both variations of the process and the developed reactors (Babu et al. 2018). Besides desalination, wastewater can also be purified through the formation of gas hydrates, such as landfill leachates or wastewater from industrial processes. Using gas hydrate formation, for example, 65–95% of inorganic contaminants (Lee et al. 2017) or 88–90% of existing heavy metal ions such as Cr^{3+}, Cu^{2+}, Ni^{2+} or Zn^{2+} (Song et al. 2015) could be removed. A challenge for utilizing gas hydrate formation for desalination or industrial wastewater treatment is the fact that salt and other contaminants act as inhibitors, preventing hydrate formation.

Gas separation using gas hydrate formation has also been increasingly investigated in recent years, as the preferential incorporation of certain components into the gas hydrate structure leads to an enrichment of this component in the hydrate phase and a depletion in the coexisting gas phase.

Within the ECO project, we combine wastewater treatment and gas separation. By using specific adsorbents, the contaminants in the aqueous phase will be reduced and hydrate formation promoted. The process will be tested on wastewater and gas mixtures from industrial partners to demonstrate realistic application areas. The experimental set-up as well as preliminary results will be presented.

Babu, P.; Nambiar, A.; He, T.; Karimi, I.A.; Lee, J.D.; Englezos, P.; Linga, P. (2018) A review of clathrate hydrate-based desalination to strengthen energy – water nexus. ACS Sustain Chem Eng 6:8093–8107.

Lee, J.D.; Kang, K.C.; Hong, S.Y.; Seo, S.D. (2017) Evaluation of hydrate-based desalination and wastewater treatment. Proceedings of the 9th international conference on gas hydrates, Denver, USA

Song, Y.; Dong, H.; Yang, L.; Yang, M.; Li, Y.; Ling, Z.; Zhao, J. (2015) Hydrate-based heavy metal separation from aqueous solution. Sci Rep 6:21389

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