Waterworks sludge management in a sustainable world: novel value-added alum sludge products for harmful gas purification

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Alum sludge is derived from the water treatment process when aluminium sulphate was used as coagulant for raw water purification. It is thus an inevitable by-product in waterworks and treated as a waste for landfilling (Zhao et al., 2016). The aim of this study was to explore the reuse of alum sludge as low-cost adsorbent for some toxic gases (such as H_2S) purification, thus developing the sustainable way of alum sludge disposal. The experiment was designed to concurrently achieve the dual goals of economic and environmental sustainability while closing the loop between gas purification and sludge management (Lyczko et al., 2014; Kemiha et al., 2014; Liu et al., 2016). Two stages investigation were carried out: (i) to focus on the development of novel alum sludge-based products as low-cost adsorbent; (ii) to integrate the resultant alum sludge products into the adsorption process for hydrogen sulfide (H_2S), which is a major ingredient of wastewater treatment odour.

Two sources of alum sludge were collected from the local waterworks in Ireland and France, respectively. Carbonate and phosphate-based solid wastes (Pham Minh et al., 2014; Pham Xuan et al., 2015) were sampled from France and used together with the alum sludge to make the novel sludge products (adsorbent). Chemical and physicochemical techniques including Thermogravimetry (TG), X-ray diffraction (XRD), SEM-EDX, Specific surface area (BET), X-ray fluorescence (XRF), Inductively coupled plasma atomic emission spectroscopy (ICP-AES), were used for analyzing alum sludge and its products before and after the H_2S sorption trials.

Different percentage of carbonate and/or phosphate-based solid wastes mixing with alum sludge was investigated and the optimization ratio of the two major components towards the better H_2S adsorption capacity was used to produce the value-added alum sludge products. H_2S sorption trials were carried out at a glass fixed-bed reactor equipped with alum sludge products. Certain rate synthetic waste gas passing through the sorbent bed and the output concentration was monitored.

In this preliminary study, novel value-added alum sludge products for the sorption of impurities in gas phase has been successfully developed. H_2S gas was efficiently removed by this novel product, thus opened the new prospects towards sustainable water treatment plant sludge management.

References:

Liu, R.B., Zhao, Y.Q., Sibille, C., Ren, B.M. (2016) Evaluation of natural organic matter release from alum sludge reuse in wastewater treatment and its role in P adsorption. Chemical Engineering Journal, **302**, 120–127.

Zhao, Y.Q., Ren, B.M., O'Brien, A. and O'Toole, S. (2016) Using alum sludge for clay brick: an Irish investigation. International Journal of Environmental Studies, **73** (5), 719-730.

Pham Xuan, H., Pham Minh, D., Martínez, M.G., Nzihou, A., Sharrock, P. (2015) Valorization of calcium carbonate-based solid wastes for the treatment of hydrogen sulfide from the gas phase. Ind. Eng. Chem. Res., **54** (18), 4915-4922.

Kemiha, M., Pham Minh, D., Lyczko, N., Nzihou, A., Sharrock, P. (2014) Highly porous calcium hydroxyapatite–based composites for air pollution control. Procedia Engineering, **83**, 394–402.

Lyczko, N., Nzihou, A., Sharrock, P. (2014) Calcium phosphate sorbent for environmental application. Procedia Engineering, **83**, 423-431.

Pham Minh, D., Rio, S., Sharrock, P., Sebei, H., Lyczko, N., Dung Tran, N., Raii, M., Nzihou, A. (2014) Hydroxyapatite starting from calcium carbonate and orthophosphoric acid: synthesis, characterization and applications. Journal of Materials Science, **49**, 4261-4269.