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Development of a contact reactor for ammonium removal from concentrated wastewater with integrated classification and separation of sorbent particles according to their loading degree

Ammonium containing wastewater is a major challenge for sewage and biogas plants in terms of process technology and economy. In particular, the dewatering of anaerobically treated municipal, agricultural and industrial (sewage) sludge generates liquors containing ammonium in high concentrations. This can be removed by conventional biological processes, for which up to 20% of the treatment capacity must be used. This results in high running costs, since state-of-the-art elimination processes are very energy-intensive and it is not possible to use the removed ammonium as a fertilizer, for example.

Within the scope of scientific research, it has already been proven for the zeolite clinoptilolite and mixtures of clinoptilolite and mordenite that ammonium present in low concentrations (< 40 mg/L) can be removed from the effluent of municipal wastewater treatment plants. Ammonium-rich partial streams such as sludge dewatering liquors have not yet been the subject of investigations on ammonium removal and nutrient recovery using clinoptilolite. Such a treatment process offers great advantages, because - in contrast to conventional biological processes - it is not necessary to maintain a defined temperature and nutrient regime and continuous aeration. In addition, the use of clinoptilolite enables the subsequent use of the ammonium contained in the turbid water as a fertilizer without the need for additional chemicals.

In order to harvest ammonium from sludge dewatering liquors without the hydromechanical and procedural disadvantages of a fixed bed (e.g. danger of clogging, high hydraulic resistance, long contact time), an innovative process technology is being developed which quickly mixes in the finely ground clinoptilolite, ensures sufficient contact and reliably separates the loaded fraction from it. In addition, it will be investigated whether this process makes it possible to use the removed ammonium as a fertilizer.

The contact reactor to be developed combines three functions:

(1) the removal of ammonium by means of clinoptilolite within the shortest possible contact time;

(2) maximum utilization of the available absorption capacity;

(3) the separation of the (almost completely) loaded clinoptilolite particles and the return of the only partially loaded particles back into the loading process.

In order to technically achieve these functions, the use of finely ground clinoptilolite (grain size <200µm) with a large specific surface area is planned. By providing a large contact area, a fast sorption process is expected. In addition, a high gradient of ammonium and available sorptive sites must be maintained in order to achieve fast sorption and high loading. This can be achieved by continuous removal of fully loaded clinoptilolite and recycling of partially loaded clinoptilolite.

Figure.: Contact reactor for ammonium removal from waste water

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