Technische Universität Berlin
Chair of Chemical & Process Engineering

Berliner Wasserbetriebe

Induced MAP-precipitation in digested sludge for reuse as magnesium ammonium phosphate for fertilizer

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Introduction of the cooperation project

Figure 1: MAP-precipitation at BWB, current situation (09/2009)

Process at Berliner Wasserbetriebe (BWB):

- ► Aeration of the digested sludge → carbon dioxide is stripped, thereby raising the pH-value → Magnesium chloride is added → phosphorus is precipitated as MAP (magnesium ammonium phosphate or struvite)
- ► Induced precipitation enables a safe treatment process (prevention of incrustations in equipments of sludge treatment)
- ► After separating and cleaning, the obtained MAP could be reused as a fertilizer

Main objectives:

- ► Dimensioning for an optimized precipitation tank as an airlift reactor
- ► A high yield of precipitated crystals for a maximum P-recovery
- ► Enhanced crystal separation from digested sludge in continuous operation

The research work is conducted at TU Berlin, Chair of Chemical & Process Engineering in cooperation with Berliner Wasserbetriebe (Berlin Water).

Methods

- ► The pilot reactor was designed as an airlift reactor for an improved mixing and stripping of the dissolved CO_2 and enhanced separation of the MAP-crystals from digested sludge (see Fig. 2)
- ► Relevant parameters: aeration rate, Mg-dosing, geometric dimensioning, stoichiometric ratio of crystallization partners, yield of MAP, washing process
- ► Pilot plant tests in batch and continuous mode

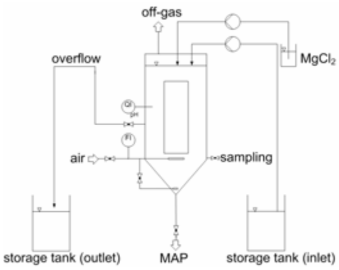

Figure 2: Pilot plant - airlift reactor, reactor volume = 45 L, aeration rate: 500 L h^{-1}

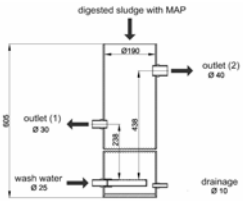

Figure 3: Laboratory wash tank

Results

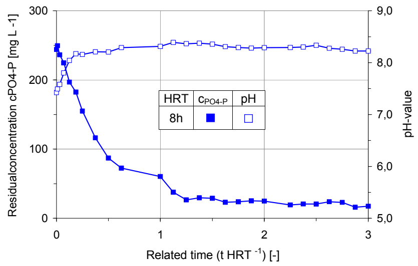

Figure 4: MAP-precipitation in digested sludge at continuous operation

As shown in Fig. 4, MAP crystals precipitated after a few minutes of stripping CO_2 (indicated by the decreasing residual dissolved phosphate concentration and increasing pH). The steady state is reached in the beginning of the 2nd HRT in the continuous operation with digested sludge. It becomes clear that:

- ► About 90-95 % of phosphorus could be precipitated as MAP
- ► An airlift reactor is suitable for an enhanced MAP-precipitation

Fig. 5 shows the results of sieve-experiments (particle size distribution):

- ► Similar results between the sludge of the digester and the pilot plant trials
- ► Light trend to more MAP due to precipitation and further growth of the crystals
- ► Average crystal sizes are still too small for a maximum separation (micro particles get lost with the digested sludge outflow)

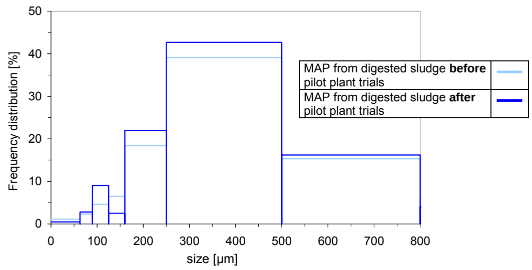

Figure 5: MAP-particle size distribution before and after a 24h-pilot plant test (HRT=8h).

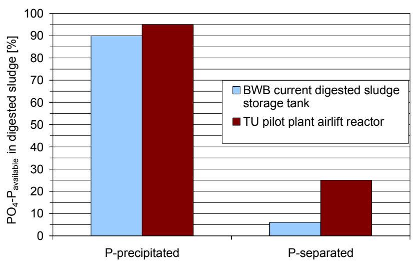

Figure 6: Separated P-amount from digested sludge by MAP-precipitation

For the reuse of MAP crystals for fertilizer, it is necessary to separate the precipitated crystals from digested sludge and to clean them by a washing process. Fig. 6 illustrates that:

- ► A high amount of the available orthophosphate in digested sludge is precipitated in an airlift reactor.
- ► The separated yield of MAP crystals in the pilot plant tests is higher than in the current digested sludge storage tank at BWB. But the separation should still be optimized further for an improved MAP-yield, as well as the washing process, where the smaller fraction of the separated MAP crystals can also get lost.

MAP crystals were identified under a microscope. Fig. 7 shows a microscopical picture of MAP crystals in digested sludge. The precipitated crystals have a typical orthorhombic shape.

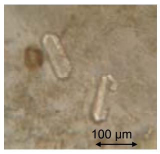

Figure 7: Microscopical pictures of MAP crystals in digested sludge

Conclusion

The precipitation of MAP crystals in digested sludge in an airlift reactor is efficient. The separation of the crystals has to be improved for a maximum P-recovery.