Phosphate recovery from urine by MAP-precipitation

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INTRODUCTION

Urine contains more than 50% of phosphorus and 80% of nitrogen of the daily excreta. Therefore recovery of these nutrients from urine is an interesting alternative to chemical fertilisers. One common method is to add magnesium to precipitate struvite (magnesium ammonium phosphate = MAP). The chemical reaction occurring is:

$Mg + NH_4 + PO_4 + 6\ H_2O \rightarrow (MgNH_4PO_4 * 6\ H_2O)\downarrow$

MATERIAL AND METHODS

Urine of source separating toilets and waterless urinals from a GIZ office building is collected and stored for at least 2 weeks. Thus, the urine is hydrolysed and pH rises to 8.5-9. In total a capacity of 8000 l of urine can be stored.

Magnesium oxide (MgO) was used in all experiments as a magnesium source. The choosen β-factor for magnesium dosing is 1.5 (50 % overdosing of magnesium).

The precipitation reactor ("NuRec", by HUBER SE, figure 1) works in batches. Urine (40 l) is running into the precipitation reactor by gravity flow where MgO, in water soluble plastic bags, is added to form struvite. After stirring three times with different breaks in between (see also Fig. 2), a sedimentation phase of 90 min follows. Then 5 l of the supernatant is filtered through 10 µm filter bags made of polypropylene. The rest of the supernatant (25-45 litres) is filtered through a second bag. The bags were dried at about 35°C for 4-5 days to reach equilibrium weight.

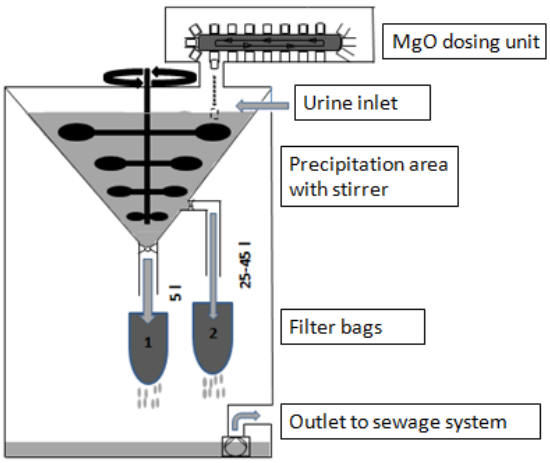

Figure 1: Drawing of the "NuRec" precipitation reactor with filter bags and MgO-dosing unit

RESULTS AND DISCUSSION

Best results with 97% recovery were obtained by stirring three times 0.5 min with 0.5 min breaks in between. In figure 2 influence of the stirring concept on phosphate recovery is shown. Longer stirring times and breaks between the stirring do not increase recovery.

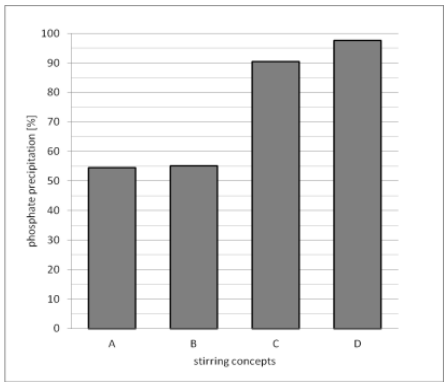

Figure 2: Influence of stirring concept on phosphate recovery.
A = stirring time 3 x 1 min with 20 min breaks;
B = stirring time 3 x 5 min with 60 min breaks,
C = stirring time 3 x 10 min with 10 min breaks,
D = stirring time 3 x 0.5 min with 0.5 min breaks

The mass balance (see Fig. 3) for phosphate and the amount of struvite generated by treating 2000 l of urine shows that 50 cycles treating 40 l of urine each are necessary. About 2.5 kg struvite were generated containing 97% of the total phosphate. 2000 l can be treated in about 5 d (service time for cleaning or repairs not considered).

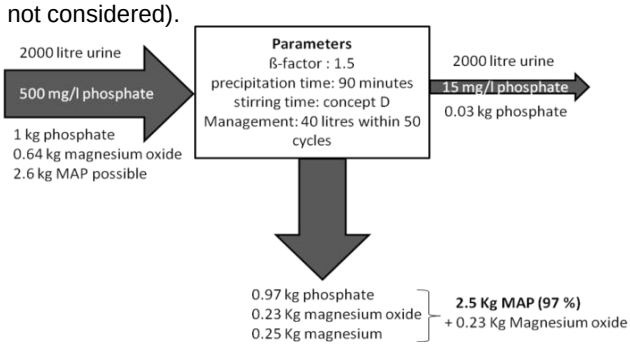

Figure 3: Mass balance for phosphate treating 2000 l of urine

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