European cows and pigs jointly produce 1.27 billion ton of manure every year. Its high nutrient content could favor its recovery as struvite (MgNH₄PO₄·6H₂O), a slow-release fertilizer. Particle size is an important characteristic in fertilizers, as bigger particles will have longer effects on soil, increasing the nutrient uptake of plants/crops. Few attempts have been made to increase particle size in lab-scale, only by adding seeding crystals/materials or by increasing the reaction time. The up-flow velocity as a controlling parameter for particle size has not yet been studied.

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**INTRODUCTION**

**THEORETICAL APPROACH**

By applying AIR, a recirculation flow in the riser is induced, which can be calculated according to Merchuk and Glizzi (1999). Then, from the recirculation and the influent flow, the up-flow velocity can be calculated.

Therefore, adjusting the settling and the up-flow velocity, and with the hydrodynamic model:
- The up-flow velocity determines the particle size of the particles that settle in the collector.
- The recirculation flow induced favours growth due to recirculation and fluidization of formed nuclei.
- MINIMUM THEORETICAL EQUIVALENT DIAMETER, considering spherical particles (0.1 mm), that can be obtained can be calculated (Figure 2).

**MATERIALS AND METHODS**

**EXPERIMENTAL SET-UP**

In Figure 1, an scheme of the crystallizer is presented, showing the 3 different zones: RISER, COLLECTOR and EFFLUENT ZONE.

Struvite was recovered from an effluent of wastewater treatment plant, in which the concentrations of magnesium, ammonium and phosphate were increased (200 mg Mg²⁺ L⁻¹, 1000 mg NH₄⁺ L⁻¹ and 500 mg PO₄³⁻ L⁻¹) to have similar concentrations as swine manure.

**RESULTS**

Four different up-flow velocities (15.37; 16.99; 22.55 and 26.33 m h⁻¹) were studied to determine the influence of this parameter in struvite PARTICLE SIZE, PRODUCTION and QUALITY of the product.

Struvite PRODUCTION was assessed, varying from 1.45 g L⁻¹ treated at lower up-flow velocities, to 1.80 g L⁻¹ treated at the highest. Also, optic microscope images were taken (Figure 4).

The designed crystallizer favoured particles growth due to particles fluidization and recirculation of formed nuclei.

**CONCLUSIONS**

- Bigger particles could be obtained by increasing the up-flow velocity in the nucleation zone varying the air-flow applied, without affecting recovery efficiency.
- The system performance, both in terms of production and quality of the harvested product (pure struvite), showed great results, increasing the production at higher up-flow velocities.
- The crystallizer designed (air-lift reactor plus a settler) favoured particles growth due to particles fluidization and recirculation of formed nuclei, promoting secondary nucleation.
- The ‘model-predicted’ equivalent diameters matched with experimental analysis, confirming the theoretical approach done.