Waste Management
FACTSHEET

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HOG SLURRY SEPARATION WITH A CENTRIFUGE

The process of centrifugation offers an improvement on the separation of the liquid and solid fractions possible with most conventional manure separators that either screen, press or squeeze out the manure solids. Because the centrifuge uses centrifugal force to remove solids from the slurry, it takes out more of the fine particles which are not removed by most separators, as well as the larger particles. We tested the centrifuge to determine how much of the solids and nutrients (nitrogen, phosphorus and potassium) it could remove. We hoped to improve on the nutrient removal rate of conventional separators.

Centrifuge performance was determined by measuring the removal of nitrogen, ammonia, phosphorus, potassium, solids, total suspended solids (TSS), chemical oxygen demand (COD), 5-day biochemical oxygen demand (BOD_5) from the slurry, and the moisture content of solids.

Effect of Centrifuge Setting

The two variables in centrifuge function are bowl speed and differential speed. The bowl rotating speed determines the centrifugal force applied to the solids and the differential speed is the speed difference between the screw and the bowl, and affects the retention time of the slurry in the centrifuge. The Alfa Laval 518 centrifuge that we tested had two settings; bowl speed 2500 rpm and differential 26 rpm, and bowl speed 3300 rpm and differential 12 rpm.

For three of the parameters tested, solids removal, solids moisture content and phosphorus removal, the 3300 rpm bowl speed and 12 rpm differential speed was best. For five of the parameters, TSS, COD, BOD_5, nitrogen and potassium, there was no difference between the two settings, and for one parameter, ammonium, the 2500 rpm bowl speed and 26 rpm differential speed was best. The data given below was collected using the second setting (3300/12) as it gave the best overall results.

The Use Of Polymer To Flocculate Fine Solids

The centrifuge was tested with and without polymer, a synthetic material which is added to the manure before it enters the centrifuge and which flocculates or binds together very small particles in the manure, making them large enough to be removed centrifugally. There are many different types of polymer available; we tested four and of these, Percol 757 was the most effective. Polymer was tested at six dosing rates; 3, 15, 30, 60 and 120 ppm and a control. It was tested at two contact distances, 60 and 120 feet, by injecting the polymer into the slurry stream at these two distances from the centrifuge.

Effect of Polymer Dosage Rate and Contact Time with Slurry

The addition of polymer enhanced the removal of all measured parameters. The degree of improvement varied with the parameter measured, and the greatest increase was in removal of TSS and COD. Removal of solids and nutrients was also better with the longer polymer contact time. The use of polymer should be considered for optimum centrifuge performance.

Nutrient Removal

The centrifuge was able to remove significantly more phosphorus than conventional separators and a similar amount of nitrogen and potassium.

Without polymer, 13% of nitrogen, 66.3% of phosphorus and 4.8% of potassium were removed. With polymer at 120 ppm, the centrifuge removed 31% of nitrogen, 75% of phosphorus and 20.7% of potassium.

Solids Removal and Moisture Content

The highest rate of solids removal as 57% from slurry with an average of 2.3% solids, achieved with polymer at 120 ppm; without polymer the removal rate was 33.8%. In comparison, the squeezer separator, a conventional type, removed 22% of the solids from a slurry with 2.7% solids. Total suspended solids removal was increased from 50.2 to 90.1% with polymer at 120 ppm.

Removal of solids increased as the solids content of the slurry increased, although the quality of the final effluent was similar. Solids removal efficiency from a slurry with 2.9% solids was 33.8% while removal was 49% from a slurry with 3.6% solids.

Without polymer, the moisture content of the separated solids averaged slightly more than 70%, ideal for direct composting. With polymer, the moisture content of the solids increased to 77-85% because of the increase in fine solids removed. Although the quality of the final effluent was better, the solids were no longer dry enough for direct composting.

Slurry Loading Rate

The centrifuge was operated at loading rates varying from 6.5 to 22.3 m^3 per hour with no significant difference in removal efficiency or effluent quality.

Economic Analysis

The estimated capital and operational cost to run the centrifuge is $2.93 - $6.09 per marketed hog for a 250 sow operation, and $1.77 to $3.39 per hog for a 1000 sow operation. This assumes that the centrifuge and other equipment are purchased by the farm, and it includes estimated electricity cost, maintenance, cost of polymer and labour to run the centrifuge and move the solids. If the equipment was shared between farms, costs would fall considerably.

Optimum Operating Conditions and Performance

An economic analysis showed that Percol 757 at 30 ppm balanced good removal of nutrients with moderate cost. With this polymer dosage rate and at the setting of 3300 rpm bowl speed and 26 rpm differential, the following table shows the expected performance of this centrifuge.

A comprehensive report on the centrifuge tests is available at the BCMAFF, Resource Management Branch in Abbotsford, BC at 604-556-3100.

Expected performance of centrifuge with polymer at 30ppm (compared with FAN Engineering separator)

Parameter	% Removal with centrifuge	% Removal with FAN separator
Nitrogen	22	18
Ammonia	16	2
Phosphorus	68	9
Potassium	11	10
Total solids	41	79
Total suspended solids	85	83
5-day Biochemical oxygen demand	32	9

Written by Hog Producers Sustainable Farming Group

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