Efficiency of chemical, settling and centrifugation methods in the treatment of swine wastewaters

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Lo, K.V., Liao, P.H. and Gao, Y.C. 1994. **Efficiency of chemical, settling and centrifugation methods in the treatment of swine wastewaters.** Can. Agric. Eng. **36**:051-054. In conjunction with settling and centrifugation treatment, swine wastewaters were chemically treated using calcium hydroxide and PERCOL 728. The treatment efficiency was measured in terms of suspended solids and chemical oxygen demand. The results showed that for the high strength wastewater, PERCOL 728 was very effective as a flocculant when used in conjunction with settling. For the low strength wastewater, however, it was marginally effective. The dosage level was not found to increase treatment efficiency.

Conjointement avec un traitement par sédimentation et par centrifugation, des eaux usées porcines ont été traitées chimiquement en utilisant l'hydroxyde de calcium et le PERCOL 728. L'efficacité du traitement a été quantifié en terme de solides suspendus et en terme de la demande en oxygène chimique. Dans le cas des eau usées à forte concentration, le PERCOL 728 s'est avéré très efficace comme floculant quant il est utilisé conjointement avec la sédimentation. Cependant, dans le cas des eaux usées à faible concentration, l'efficacité du PERCOL 728 n'était que marginal. Le niveau de dosage s'est avéré sans effet sur l'amélioration de l'efficacité du traitement

INTRODUCTION

The swine industry in British Columbia produces a large volume of wastewater which requires treatment. While settling will partly reduce the solid concentrations and oxygen demand, the supernatant will still contain significant amounts of organic materials. Investigations have shown that centrifugation and chemical treatment methods are quite effective in further reducing the organic load (Hanna et al. 1985; Miner et al. 1983).

The objective of this study was to investigate the treatment efficiency of both settling and centrifugation in combination with the addition of two chemical flocculants, calcium hydroxide and PERCOL 728.

MATERIALS AND METHODS

Wastewaters and treatments

A high strength wastewater (Wastewater I) and a low strength wastewater (Wastewater II) were used in this study. Initially, Wastewater I and II had suspended solids (SS) of 6.29% and 0.22%, and chemical oxygen demand (COD) of 59.4 $x10^3$ and 8.46 $x10^3$ mg/L, respectively. After 5 hours of settling, the SS and COD for the supernatants were 1.88% and 0.19%, and 31.3 $x10^3$ and 7.04 $x10^3$ mg/L, respectively. The supernatants were used in this study.

Solutions of 5% $Ca(OH)_2$ and 1% PERCOL 728 (a copolymer of quaternary acrylate salt and acrylamide) were used for the tests. Different dosages of the chemicals were added to a beaker containing 500 mL of the supernatant (SN). The mixture was then stirred at 100 rpm for 5 min, then at 25 rpm for 30 min. Following this, the mixtures were divided into two portions. One portion was left to settle for 100 min, while the other was centrifuged. A control without any chemical addition was treated in the same manner.

Analyses

Suspended solids (SS) were determined according to the Standard Methods (APHA 1985). Chemical oxygen demand (COD) was analyzed using the colorimetric method (Knechtel 1978). Figures 1 to 4 present the average results obtained from the four samples. The data were statistically analyzed using SYSTAT (Wilkinson 1990). The Tukey multiple camparison technique was used to compare the treatments' means.

RESULTS AND DISCUSSION

Wastewater I

Suspended solids removal The addition of $Ca(OH)_2$ in combination with settling significantly increased the SS removal ($P = 0.01$). The SS removal was increased from 75% for the control to 82% at a dosage of 2000 mg/L (Fig. 1). In combination with centrifugation, the addition of $Ca(OH)_2$ did not significantly affect the SS reduction.

When used in combination with settling, PERCOL 728 also significantly reduced the SS in the wastewater ($P = 0.01$). The SS removal was increased from 75% for the control to 94% at a dosage of 50 mg/L (Fig. 2). In comparison with the control, the addition of PERCOL 728 combined with centrifugation did not significantly affect the results.

Chemical oxygen demand reduction Using 2000 mg/L of $Ca(OH)_2$ in conjunction with settling, the COD was significantly reduced from 45% (for the control) to 52% ($P = 0.01$) (Fig. 1). In conjunction with centrifugation, the COD removal was not significantly affected (Fig. 1).

With PERCOL 728 in conjunction with settling, the COD was significantly reduced as compared with the control

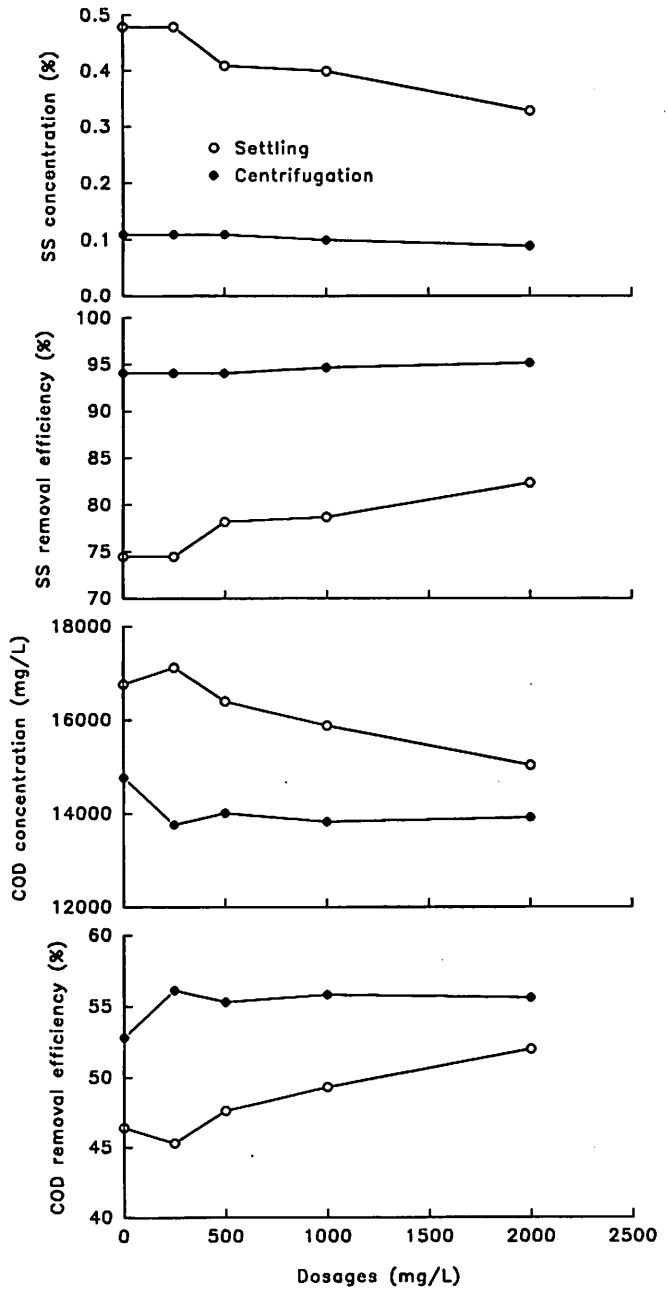

Fig. 1. Removal efficiency of calcium hydroxide for Wastewater I.

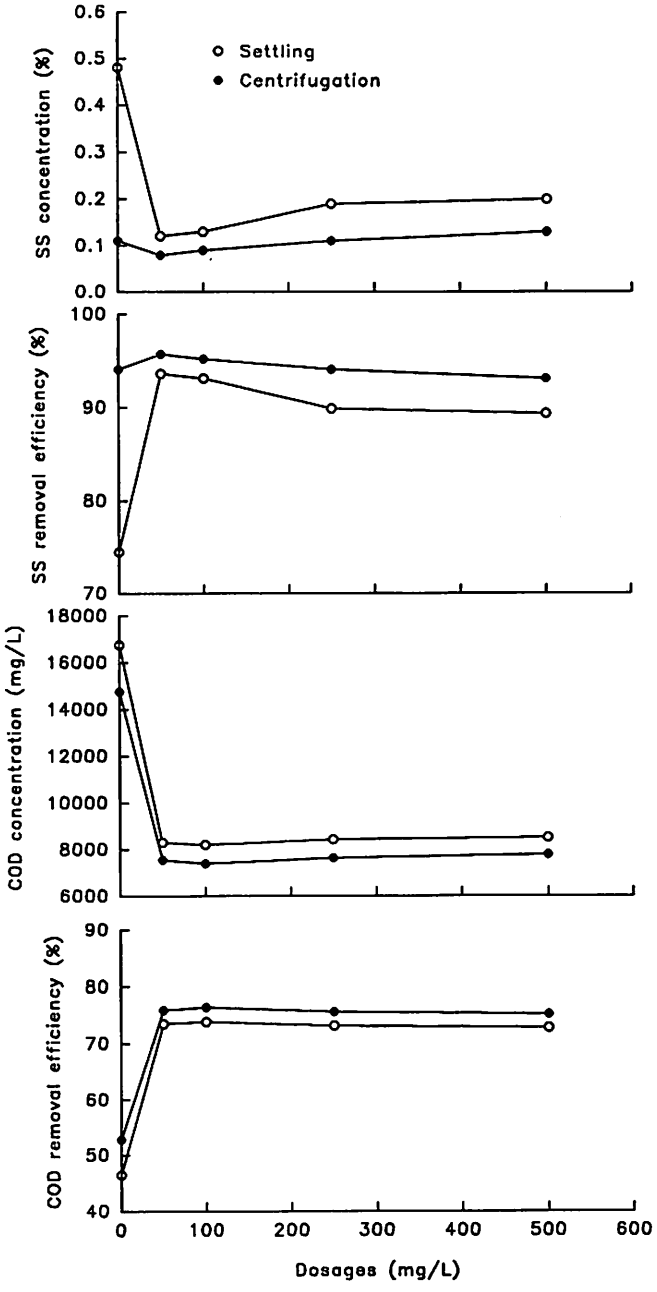

Fig. 2. Removal efficiency of PERCOL 728 for Wastewater I.

(P = 0.01). In conjunction with centrifugation, the COD was not significantly affected. This means that when centrifugation is used, chemical addition is not necessary.

Wastewater II

Suspended solids removal For this low wastewater strength, there was some SS removal with the use $Ca(OH)_2$ both in combination with settling and with centrifugation (Fig. 3). However, Tukey HSD multiple comparison showed that the difference was not significant.

PERCOL 728 did not show the same superiority of results reported for the high strength wastewater (Fig. 4). The results for SS removal with settling were slightly better than those reported with $Ca(OH)_2$. At dosages 10, 25, and 50 mg/L, PERCOL 728 significantly reduced the SS of the wastewater (P = 0.01).

Chemical oxygen demand reduction For this low strength wastewater, the use of $Ca(OH)_2$ in combination with settling and centrifugation did not significantly (P = 0.01) reduce the COD (Fig. 3). However, a dosage of 50 mg/L of PERCOL 728 in combination with centrifugation and dosages of 10, 25, and 50 mg/L of PERCOL 728 in combination with settling resulted in significant COD removal.

Table I. Wastewater used for the treatments

Wastewaters	Wastewater I		Wastewater II	
	SS (%)	COD (mg/L)	SS (%)	COD (mg/L)
Raw water	6.29	59.4×10^3	0.22	8.46×10^3
Supernatant	1.88	31.3×10^3	0.19	7.04×10^3

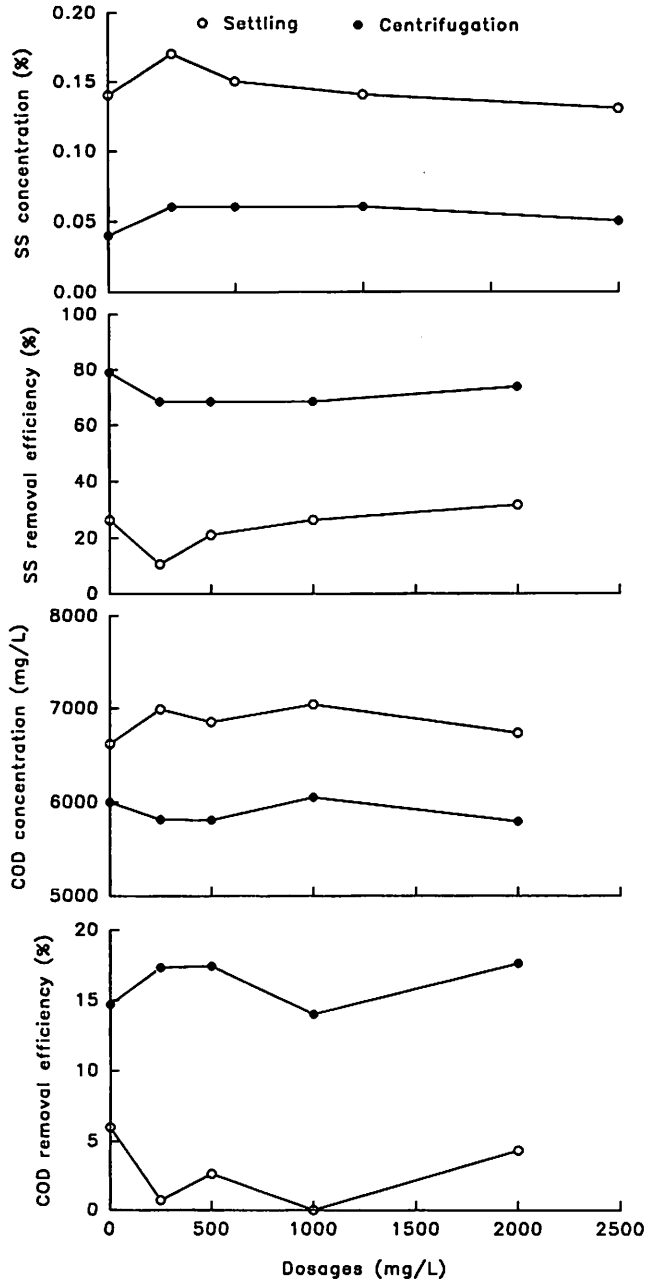

Fig. 3. Removal efficiency of calcium hydroxide for Wastewater II.

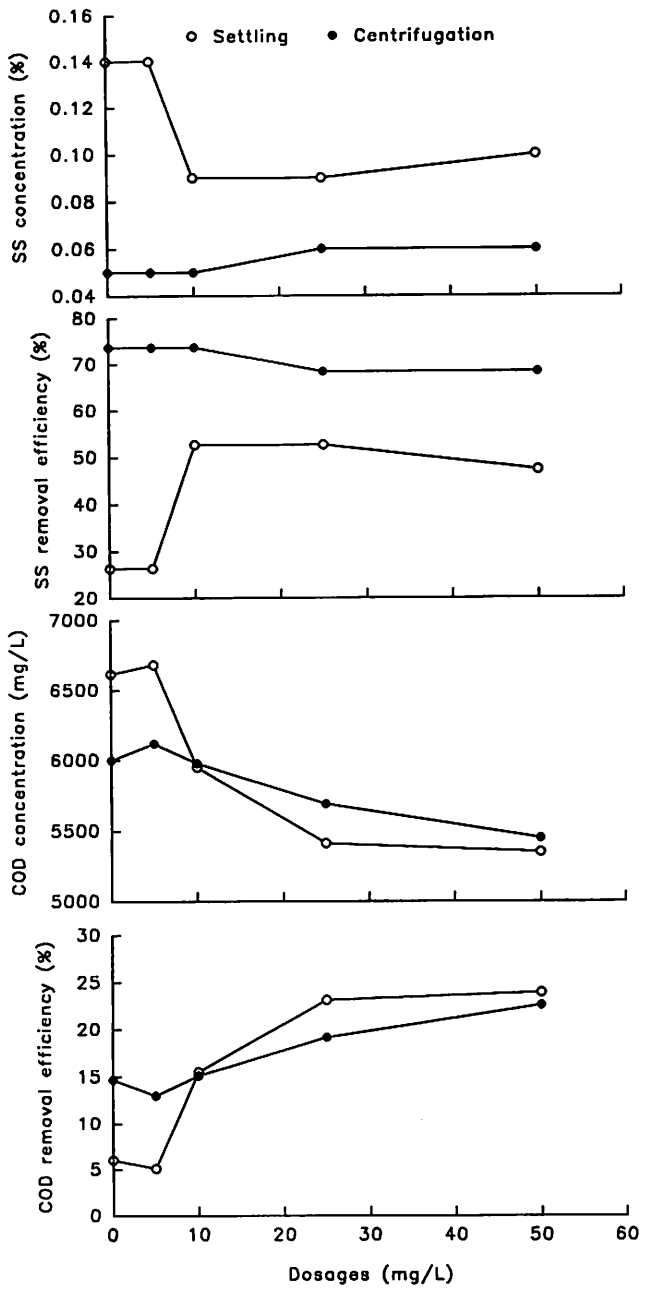

Fig. 4. Removal efficiency of PERCOL 728 for Wastewater II.

RECOMMENDATIONS

PERCOL 728 was shown to be a very good flocculant when used in conjunction with settling for the treatment of high strength wastewaters. At a dosage of 50 mg/L, 94% of the SS and 74% of the COD were removed. Given the low dosage required, treatment with this chemical would be very economical in the case of high strength swine wastewaters. In this case, centrifugation is not necessary. For the low strength wastewater, however, PERCOL 728 did not result in the same high treatment efficiency.

Since the addition of the chemicals does not seem to improve the SS removal, already common centrifugation facilities should be used without any chemical addition.

REFERENCES

APHA. 1985. *Standard Methods for the Examination of Water and Wastewater*, 16th ed. American Public Health Association, Washington, DC.

Hanna, M., D.M. Sievers and J.R. Fischer. 1985. Chemical coagulation of methane producing solids from flushing wastewaters. In *Agricultural Waste Utilization and Management*, Proceedings of the Fifth International Symposium on Agricultural Wastes, 632-637. ASAE Publication 13-85. St. Joseph, MI: ASAE.

Knechtel, J.R. 1978. A more economical method in the determination of chemical oxygen demand. *Water Pollution Control* (Don Mills) 116:25-27.

Miner, J.R., A.C. Goh and E.P. Taiganides. 1983. Dewatering anaerobic swine manure lagoon sludge using a decanter centrifuge. *Transactions of the ASAE* 26(5):1486-1489.

Wilkinson, L. 1990. *SYSTAT: The System for Statistics.* Evanston, IL: Systat, Inc.