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SLUDGE TREATMENT PROCESS WITH THERMAL CONDITIONING

L. Spinosa, G. Mininni, G. Barile,
F. Lorè and R. Ramadori

CNR — Istituto di Ricerca Sulle Acque (IRSA), via De Blasio 5, 70123 Bari, Italy

INTRODUCTION

The best means of sewage sludge disposal would be its use in agriculture; however, incineration represents a valid alternative when technical and local conditions do not permit spreading of sludge on land. Main problems of sludge incineration are energy consumption and potential toxicity of gaseous emissions, especially with industrial sludges. Autothermal combustion may provide great savings in running costs but, for this, a sludge solids concentration of 35-40% is necessary. Filterpressing following thermal conditioning of sludge is effectively capable of easily affording this goal.
Advantages of thermal conditioning are:
- good thickenability and filtrability characteristics
- solids and pathogens reduction
- stabilizing effect in spite of presence of toxics
- insensitivity to changes in sludge composition
- possibility of heavy metals recovery

Disadvantages are:
- high capital and running costs
- production of an odorous gas stream
- production of a liquid sidestream with high concentration of organics, ammonia nitrogen and colour.

Lab-scale experiments have been carried out by IRSA for the evaluation of a sludge treatment process consisting of the following operations: thermal conditioning, thickening, filterpressing, incineration and anaerobic digestion of liquid sidestreams. Energy for thermal conditioning can be thus recovered from biogas and incineration hot gases.

LAB-SCALE EXPERIMENTS

A raw mixed activated sludge from a municipal sewage treatment plant with DR=1.5%, VS=0.94% and CST Ø10=149 s was used.

Sludge was conditioned in a 4 l reactor at 200 °C for 1 h. Conditioned sludge was then gravity thickened by settling in a WRC standard cylinder equipped with a low-speed stirrer. This operation was very easy and was completed in few minutes. About 1/5 of the initial volume was separated and collected as solid fraction for subsequent filterpressing; the CST Ø10 resulted reduced to 27 s. The residual supernatant had a very low suspended solids content (150-350 mg/l) and an average COD of 8.9 kg/m^3.

A lab device with a single 165 cm^3 chamber and a filtering surface of 159.6 cm^2 was used for filterpressing. Cakes with a solids concentration of 59% were obtained after 1 h pressing at a pressure of 8.5 kg/cm^2; however, less than 30 minutes appeared to be sufficient to obtain a cake concentration of 50%.

Previous experiments showed that thermally conditioned thickened sludge still contains the non-mobilized fraction of metals which can be recovered by acid treatment with chemical consumption much lower (70-90%) than necessary without thermal conditioning.

THERMAL BALANCE

Sludge at 15 °C is first pre-heated to 175 °C, through heat-exchangers by conditioned sludge which cools from 200 to 40 °C; heat exchanged amounts to 161,000 kcal/m^3. Sludge is then further heated up to 200 °C with a heat requirement of 25,000 kcal/m^3.

Assuming a COD reduction of 65% and a methane production of 0.3 Nm^3/kg COD destr., a recovery of about 11,000 kcal/m^3 of treated sludge could be obtained from supernatant digestion. Due to the possibility of operating at specific loading of 10 kgCOD/$m^3 \cdot d$, fluidized bed reactors (UASB) would allow the reactor volume, and therefore cost, to be consistently reduced.

As regards cake incineration, considering a 100% excess air and the absence of auxiliary fuel, a hot gas temperature of 740 °C was calculated. If the temperature of hot gases after the heat exchanger is maintained at 300 °C, approx. 10,000 kcal/m^3 of treated sludge could be recovered.

The entire process heat requirement is, therefore:

$$25,000 - (11,000 + 10,000) = 4,000 \quad kcal/m^3$$

which corresponds to 0.42 kg of fuel having a calorific value of 9,500 kcal/kg.

If supernatant COD concentration is higher than that experimentally determined, as commonly reported in literature, the auxiliary fuel need is reduced. In particular, it would become 0 at a supernatant COD concentration of 12.65 kg/m^3. In this case the running costs are consistently reduced and the process can be considered cost-effective.