Influence of toxic compounds on anaerobic digestion of sludge

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SUMMARY

In order to provide sound information to operate Municipal Treatment Plant digesters at highly industrialized areas, studies on metal toxicity to anaerobic digestion were developed. This paper presents results achieved in lab scale digesters with discontinuous zinc additions. Two control digesters plus two test digesters were run, one with $ZnC\ell_2$ additions and the other with $ZnSO_4$ additions. Zn was added to the feed sludge at increasing concentrations until inhibition was observed. Inhibitory concentrations in the digesters were 960 mg Zn/ℓ (added as $ZnSO_4$) and 275 mg Zn/ℓ (added as $ZnC\ell_2$).

INTRODUCTION

Heavy metals toxicity to anaerobic digestion of sludges can be a major problem in Municipal Treatment Plants located at highly industrialized areas. Previous works developed at CETESB (the environment protection agency for São Paulo State) indicated the need to evaluate the toxic effects of Zn, Fe, Ni, Cr, Cu and cyanides, isolately, on anaerobic digestion of sludges. The metals should be evaluated as their sulfates and chlorides and the studies should provide reliable informations for operation of anaerobic digesters which might receive toxic sludges. This poster presents results obtained with shock load tests for $ZnSO_4$ and $ZnC\ell_2$.

MATERIALS AND METHODS

Tests were run in four digesters, 3.6 ℓ each, fed with primary sewage sludge. Digested sewage sludge from a nearby Municipal Treatment Plant was the inoculum for start-up. Digesters were run as completely stirred tank reactors (CSTR) at 30 days retention time and 35ºC. Two digesters were controls and two were for zinc addition tests, which initiated after a period of 3 retention times from start-up. Zn was added as chloride and sulfate to each digester, at the same time. Zn addition refers always to the extra amount of Zn actually added to the feed sludge, besides Zn already present in feed sludge. Additions were discontinuous and at increasing concentrations starting from 50 mg Zn/ℓ feed until severe inhibition was observed. Inhibition was indicated through decreased gas yield plus increased volatile fatty acids concentration. Analytical methods were run according to Standard Methods for the Examination of Water and Wastewater (1980), except for volatile fatty acids analyses (Vieira).

RESULTS AND CONCLUSIONS

Daily variations in the digesters during test period are shown in Figure 1 (digester with $ZnSO_4$ additions) and Figure 2 (digester with $ZnC\ell_2$ additions). For comparison aim, broken lines presented on the figures refer to daily parameters mean values of the two control digesters. These digesters received only Zn concentration usually present in feed sludge, that was about 50 mg/ℓ. Maximum Zn concentrations added to test digesters were 3700 mg Zn/ℓ feed as $ZnSO_4$ and 2250 mg Zn/ℓ feed as $ZnC\ell_2$. Zn concentrations in the digesters were 960 mg Zn/ℓ and 275 mg Zn/ℓ, respectively, at the inhibition threshold. Recovery from inhibition for the digester with $ZnSO_4$ additions was obtained just by stopping metal additions. The digester with $ZnC\ell_2$ additions required some measures to speed up recovering, such as sulfide addition for precipitation of soluble Zn, stop feeding and pH correction. Test and control digesters were very similar, so the observed toxic effect was due only to Zn additions. Sulfide effect to reduce toxicity was observed. In the digester sulfate is reduced to sulfide which precipitates soluble Zn.

Only soluble metal is toxic. This explains higher toxicity due to $ZnC\ell_2$ additions as compared to $ZnSO_4$ additions. It is concluded that the methodological approach was appropriate to evaluate toxic shock loads and to recover digesters after inhibition. The Zn concentrations that caused toxic shock loads are much higher than those expected in São Paulo industrial sludges (up to 600 mg/ℓ). Therefore caution should be used during continuous operation of anaerobic digesters of such sludges.

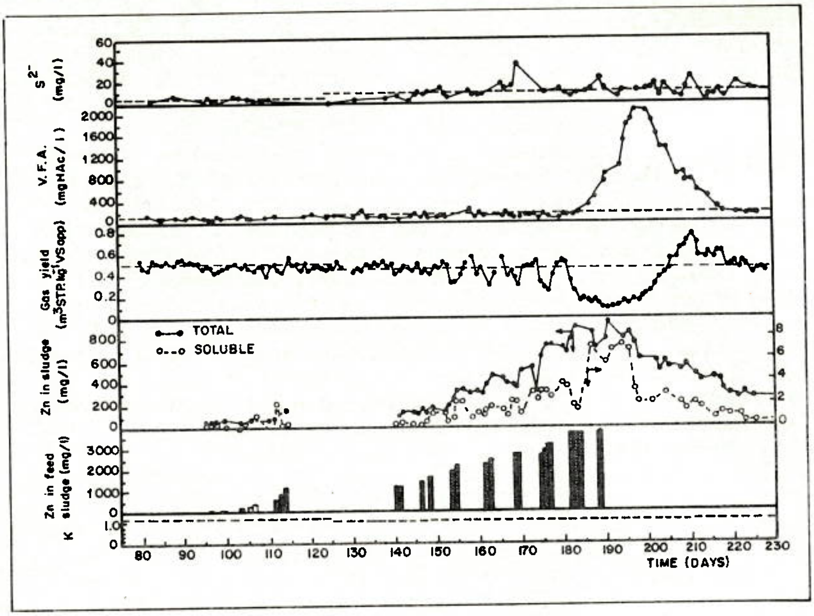

Figure 1 - Daily variations during $ZnSO_4$ additions and digester recovery.

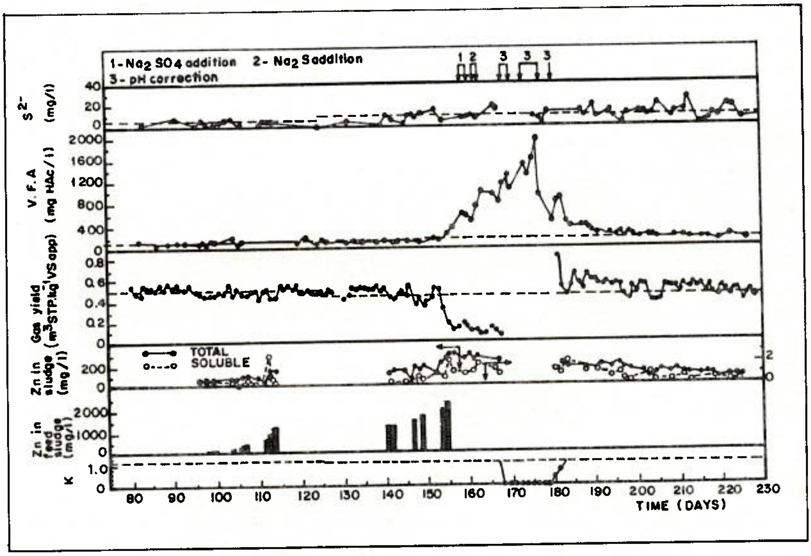

Figure 2 - Daily variations during $ZnC\ell_2$ additions and digester recovery.

K = organic load (kg VS.m^{-3}.d^{-1}) - Figures 1 and 2
V.F.A. = volatile fatty acids - Figures 1 and 2
Zn in feed sludge = Zn concentration in feed sludge - Figures 1 and 2
Zn in sludge = Zn concentration measured in sludge digester - Figures 1 and 2

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Section 3

ANAEROBIC TREATMENT OF RECALCITRANT COMPOUNDS