Chemical & Petrochemical Industry Wastewater

Applications of UASB system for anaerobic treatment of wastewater from various chemical industries have been reported by investigators. The biodegradability of phenol, 4-cresol, 2-aminobenzoate (2-AB) and 5-aminosalicylate (5-ASA) were determined by measuring compound conversion to methane in batch serum bottles at 30^{O} C under agitated conditions over a period of at least 100 days. It is reported that phenol and 4-cresol were completely mineralized by all the granular sludges tests.

Wastewater with concentrated butyrate was treated in a 2.8 L UASB reactor at 37^{O}C and pH 7.1-7.7 [Fang *et.al.*, 1995]. The process consistently removed 97-99% of COD for loading rates up to 31g COD/L.d. Of all the COD removed, 94.5% was converted to methane; the average sludge yield was 0.037 g VSS/g COD. Zhou *et.al.,* [1997] studied the co-degradation of phenol and m-cresol in a UASB reactor. An UASB reactor operated at 37^{O}C, one-day hydraulic retention plus effluent recycle, was able to degrade up to 98% of phenol and 20% of m-cresol without a carbohydrate co-substrate, for wastewaters containing up to 900 mg/L of phenol and 320 mg/L of m-cresol.

A recycled upflow anaerobic sludge blanket reactor (RUASB) reactor of effective volume 54 liters was employed to treat phenolic wastewater [Bal and Dhagat, 2001]. The synthetic phenolic wastewater contained 2,000 mg/L phenols as the only organic carbon source. With elaborate kinetic control, the RUASB process achieved high-rate performance at 20 kgCOD/m^3 day of volumetric loading. Very high removal efficiencies were obtained at 99.5% of phenol and 98.9% of soluble COD.

Treatment of dilute phenol / PCP wastewaters using the UASB reactor was reported by Sheldon Duff *et.al.*, [1995]. UASB reactors stared up well using phenol as the sole carbon source, and by day 46, COD removal efficiency was 100%. Pentachlorophenol (PCP) was then introduced at a concentration of 1mg/L. Sequential appearance of tri-, di- and ultimately mono-chlorophenols was observed in the reactor effluent. After 70 days of operation only 3-chlorophenol was detected in the reactor effluent. Increasing PCP concentrations led to transit appearance of PCP and other polysubstituted constituents in the reactor effluent. However, no toxic effects were observed over the range of PCP concentrations examined. Using phenol as an additional carbon source, the UASB reactor proved capable of reducing highly chlorinated phenolic compounds into lightly chlorinated phenolics more amenable to subsequent aerobic degradation.

The study has shown that UASB reactors were able to rapidly acclimate to a synthetic wastewater containing low levels of phenol and PCP. This ability to degrade multi-substituted cholorophenols may be applicable to the treatment of chlorine-bleached pulping effluents. The reactors exhibited stable operation over the range of PCP concentrations tested (1-3 mg/L), and after 70 days of operation, produced an effluent containing 3-CP as the only stable intermediate product of PCP decomposition. Biosorption appeared to be a significant removal mechanism at least during the first 20-30 days of reactor operation, prior to induction of dechlorinating activity.

Fang *et.al.,* [1997] studied anaerobic degradation of benzoate and cresol isomers in sulphate-rich wastewater. Results of a continuous wastewater experiment conducted in an UASB reactor at 37^{O}C showed that m- and o-cresols (225 mg/L each) could be partially degraded, and their presence did not adversely affect methanogenesis of benzoate (1000 mg/L) and sulfidogenesis of sulphate (1800-5600 mg/L). Borghans *et..al.* [1998] have reported that the application of biothane UASB reactor to a chemical wastewater, containing phenol and formaldehyde. Hwang *et..al.*,[1991], treated p-cersol with a recirculating UASB reactor using the concept of kinetic control. Christian Kennes *et..al.*[1997], studied the methanogenic degradation of p-cresol in batch and in continuous UASB reactors.

Fang *et..al.*, [1995] studied the performance and sludge characteristics of UASB process treating propionate rich wastewater. UASB reactor consistently removed 97-99% of COD in wastewater containing concentrated propionate at 37^{O}C in 12 h for loading rates up to 23 g-COD/L.d. Of all the COD removal, 95% was converted to methane and the rest was converted to biomass with an average sludge yield of 0.040 g.VSS/ g.COD. Each gram of propionate-degrading granules in the reactor had a daily maximum capacity of converting 0.60 g of COD into methane. The granules were densely packed and did not exhibit any patterned microstructure. A typical propionate granule was composed of micro-colonies of *Met.hanothrix* and several syntrophic micro-colonies with hydrogen-producing acetogens in juxtaposition with hydrogen-consuming *M. hungatei* and *Met.hanobrevibacter*-like bacteria. There was no accumulation of acetate in the effluent, even when the reactor only removed 78%

of COD at 30 kg COD/m^3.d, suggesting that propionate conversion to acetate was the rate-limiting step.

Biodegradation of selected dyes in UASBR was studied by Elias *et.al.,* [1997] Mordant Orange 1 (MO1) and Azodisalicylate (ADS) were completely reduced and decolorized in continuous UASB reactors in presence of co-substrates. Macrie *et.al.,* [1992] attempted the treatment of a petrochemical wastewater from a terephthalic acid plant in a UASB reactor. A pilot-scale -UASB reactor was employed by Sheng-Shung Cheng *et.al.,* [1997], to treat the wastewater of a purified-terephthalic-acid (PTA) manufacturing. The performance of UASB reactor in terms of COD removal was achieved as 62% at the volumetric loading rate of 2.93 kg COD/m^3.d.

Anaerobic biotransformation of the 3-carbon compounds, namely acrolein, acrylic acid, allyl alcohol, and n-propanol was investigated in UASB was investigated in UASB reactors containing granular cultures by Demirer *et.al.,* [1997]. The results of the UASB experiments revealed that granular cultures could be acclimated to utilize acrolein, acrylic acid, allyl alcohol, and n-propanal as the sole substrate. Acrolein concentrations up to 300 mg/L were treated with 90% efficiency. In single-stage UASB reactor, acrylic acid biotransformation and COD removal efficiencies of 95-99 and 45%, respectively, were achieved at an influent concentration of 3000 mg/L. The low COD removal was due to persistence of acetic and propionic acids, as intermediaters of acrylic acid. When a two-stage UASB system was employed at the same acrylic acid influent concentration, the COD removal efficiency increased to 97%.