

**TREATMENT OF INDUSTRIAL WASTEWATER:—
EFFECT OF FLOCCULATION AND CHLORINATION
ON AOX FORMATION AND REMOVAL**

Ph.D. Dissertation

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Abstract

In this research work, distillery wastewater discharged from Taw Win Distillery in Shwe Pyi Thar Industrial zone, Insein, Myanmar, were collected and their *physical* and *chemical* properties were characterized. In the process of reducing/removing the dissolved organic matter (DOM), color and metals (such as Mn, Fe) present in distillery wastewater (DWW II), flocculation was performed by alum flocculant. The optimum flocculation pH was 5.7 – 6.0 and optimum flocculant dosage was $\text{Al}^{3+}/\text{DOC} = 8.0$ (w/w) as determined by Jar Test.

In addition, the formation of nonpurgeable (non-volatile) chlorination by-products (AOX) during chlorination of municipal secondary effluents in Neureut (*Karlsruhe, Germany*) was investigated. The effect of flocculation on the removal efficiency of AOX organic precursors before and after chlorination was evaluated and also these secondary effluents was compared with chlorinated (NaOCl) humic model solutions [brown water (HO13) and Aldrich humic acid (AHA)] before and after flocculation with metallic salts, flocculants employed were ferric chloride and polyaluminum chloride (PACl).

The anaerobic biodegradation of synthetic wastewater (starch) was evaluated by using Eudiometers. Biogas production was measured as the monitoring parameter. The removal of DOM and AOX in anaerobic biodegraded samples by flocculation and also the formation of AOX during chlorination of these samples before and after flocculation were investigated.

The character of organic matter in the secondary effluents before and after treating with chlorine was fractionated by using different types of adsorbent (C18 ec and IRA-93). The mass balance was based on the AOX-concentration. The fractionation leads to four classes of compounds: hydrophilic acid (phil-ac), hydrophilic nonacid (phil-n-ac), hydrophobic acid (phob-ac) and hydrophobic

nonacid (phob-n-ac). As reference samples, brown water (HO13) and Aldrich humic acid (AHA) were chlorinated and fractionated and then these samples were compared with surface waters (Rhine river and Moskva river).

Dissolved organic carbon (DOC), ultraviolet absorbance at 254 nm (UV_{254}), color representing absorbance at 436 nm (Vis_{436}) and a simple surrogate parameter, specific ultraviolet absorbance (SUVA): the UV absorbance at 254 nm, normalized by DOC, were used for characterization. The combination of size-exclusion chromatography and DOC-detection gave the insight into molecular size distribution of dissolved organic matter.

Significant amounts of AOX were formed (from 10-15 to 109-136 $\mu\text{g/L}$) during chlorination in secondary effluents and suggested that the formation potential of AOX depended on the character of the organic matter present in the original sample. Flocculation could effectively remove high aromatic character (like humic acid), high molecular weight and hydrophobic organic compounds and consequently reduced the formation potential of AOX during chlorination. The higher SUVA value of water represented the higher formation potential of AOX during chlorination and indicated that highest removal efficiency obtained by flocculation when compared to the lower SUVA value of water. As a result of AOX characterization studies, it was observed that chlorination contributed the relatively small, low molecular weight of hydrophilic acidic pollutants after reacting with high molecular weight, hydrophobic organic compounds — this behavior may be beneficial / retarding but in the present case it was found to be of lower efficiency when flocculated.

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