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Treatment of Municipal Wastewater by Means of Uv-Assisted Irradiation Technologies: Fouling Studies and Optimization of Operational Parameters

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Abstract : UV-assisted irradiation technologies are well-established for water and wastewater treatment. UVC treatments are widely used at large-scale, while UVA irradiation has more often been applied in combination with a catalyst (e.g. TiO_2 or $FeSO_4$) in smaller-scale systems. A technical issue of these systems is the formation of fouling on the quartz sleeves that houses the lamps. This fouling can prevent complete irradiation, therefore reducing the efficiency of the process. This paper investigates the effects of operational parameters, such as the type of wastewater, irradiation source, H_2O_2 addition, and water pH on fouling formation and, ultimately, the treatment of municipal wastewater. Batch experiments have been performed at lab-scale while monitoring water quality parameters including: COD, TS, TSS, TDS, temperature, pH, hardness, alkalinity, turbidity, TOC, UV transmission, UV_{254} absorbance, and metal concentrations. The residence time of the wastewater in the reactor was 5 days in order to observe any fouling formation on the quartz surface. Over this period, it was observed that chemical oxygen demand (COD) decreased by 30% and 59% during photolysis (Ultraviolet A) and photo-catalysis ($UVA/Fe/H_2O_2$), respectively. Higher fouling formation was observed with iron-rich and phosphorous-rich wastewater. The highest rate of fouling was developed with phosphorous-rich wastewater, followed by the iron-rich wastewater. Photo-catalysis ($UVA/Fe/H_2O_2$) had better removal efficiency than photolysis (UVA). This was attributed to the Photo-Fenton reaction, which was initiated under these operational conditions. Scanning electron microscope (SEM) measurements of fouling formed on the quartz sleeves showed that particles vary in size, shape, and structure; some have more distinct structures and are generally larger and have less compact structure than the others. Energy-dispersive X-ray spectroscopy (EDX) results showed that the major metals present in the fouling cake were iron, phosphorous, and calcium. In conclusion, iron-rich wastewaters are more suitable for UV-assisted treatment since fouling formation on quartz sleeves can be minimized by the formation of oxidizing agents during treatment, such as hydroxyl radicals.

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