An AI-Controlled Underwater Floating Robot for Photochemical Treatment of Cyanide-Contaminated Industrial Wastewaters

Ibrahimova, Banu (School: School-Lyceum 6)
Ahmadbayli, Mikayil (School: School-Lyceum 6)

Industrial wastewaters from gold mining and other industries often contain highly toxic cyanide-based compounds that threaten ecosystems and human health. This project bibliographically investigates the transformation of these species, using UV-photochemical processes. Under UV light (185 nm wavelength), water molecules split to produce highly reactive hydroxyl (OH) radicals, oxidize cyanide ions and convert them into less toxic products of NH3 and CO2. In the final step of the pathway, nitrogen atoms can be released as N2 gas. It suggests nearly complete conversion. Based on these findings, an AI-controlled floating robot, has been designed to operate in situ in polluted waters. The prototype is equipped with xenon UV lamps enclosed in quartz tubes. Modified sensors continuously monitor parameters such as pH, temperature, conductivity, cyanide concentration, turbidity, distance, and radiation background. Collected data enable real-time assessment of process efficiency and optimization of the photochemical cleanup during treatment. Model wastewaters containing thiocyanate, phenol, and naphthalene were used to evaluate the treatment efficiency of the robot. Contaminants' concentrations were monitored by ion chromatography and HPLC. The results show continuous decrease in pollutant concentrations with increasing irradiation time. After 42 h of treatment period, conversion efficiencies were approximately 90.2%, 86.1%, and 61% for thiocyanate, phenol and naphthalene, respectively. The formation of intermediate products of NH3, NO3–, and SO4– ions confirm the occurrence of oxidative degradation pathway. The proposed approach suggests reagent–free, by real–time monitoring of waters, as an efficient and sustainable technology for industrial wastewater remediation.

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