2.4.5 Энергетические системы и комплексы (технические науки)

SYNERGISTIC EFFECT OF COMBINED ULTRAVIOLET AND ULTRASOUND TREATMENT FOR GROUNDWATER DISINFECTION: EXPERIMENTAL AND MODELING STUDY

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Abstract. *The sustainable supply of safe drinking water is increasingly critical due to population growth, industrial expansion, and climate-driven water scarcity. This study investigates the synergistic effect of combined ultraviolet irradiation and ultrasound treatment for the disinfection of microbiologically contaminated groundwater. A custom-designed flow-through reactor was developed, incorporating four ultraviolet-C lamps (254 nm, 200 W each) and two 40 kHz ultrasound generators. Water samples from Qibray District, Tashkent Region, were analyzed for Escherichia coli and total microbial count (TMC) using standard membrane filtration techniques. A mathematical model describing microbial inactivation kinetics was developed, incorporating individual and synergistic effects of UV and US treatments. Experimental results showed that the combined ultraviolet and ultrasound treatment prevented regrowth of E. coli and total microorganisms for up to 8 days, whereas ultraviolet or ultrasound alone allowed microbial regrowth after 2 and 1 days, respectively. The synergistic mechanism arises from ultrasound -induced cell membrane disruption and colloidal particle fragmentation, enhancing ultraviolet penetration and microbial inactivation. The proposed hybrid system provides a chemical-free, energy-efficient, and environmentally safe alternative for decentralized water disinfection. The findings highlight the potential for practical application of ultrasound and ultraviolet technology in rural and remote areas with limited access to conventional treatment infrastructure.*

Keywords: *groundwater disinfection, ultraviolet irradiation, ultrasound, synergistic effect, Escherichia coli, total microbial count, hybrid electro-technology*

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