Improved wastewater ultraviolet disinfection by ultrasonic pre-treatment

Jin Xin

University of Science and Technology Beijing
School of Civil and Environmental Engineering
Centre for Sustainable Environmental Sanitation
Xueyuan Road 30 / Haidian District
Tu Mu Huan Jing Lou - Office 1214 - Beijing, 100083 - P.R. China
Phone / Fax +86 10 6233 4378          website: www.susanchina.cn
1. Background

Infectious diseases
- Highly pathogenic avian influenza
- Epidemic situation of “SARS”
- Epidemic situation of H1N1

Cause problems
- Ecological safety
- Environmental sanitation
- Other aspects.

The environmental safety of WWTPs tail water plays an important role in the whole ecological environment protection, thus tail water’s disinfection became a significant defense line in both protecting the receiving water’s ecological safety and preventing the epidemic situation from being spread out.
1. Background

People have been paying more attention on the disinfection of wastewater treatment plants effluents. Traditional disinfectants have many disadvantages, finding new safety and efficiency disinfection technologies became more and more important. The work was carried out based on project of “Research on Mechanism of Ultrasonic Synergy Disinfection” which supported by NATURAL SCIENCE FOUNDATION of CHINA (NSFC).
2. Introduction

The project “Research on Mechanism of Ultrasonic Synergy Disinfection”--(NSFC) focus on studying the synergy disinfection effect. The main work:

- Find out the mechanism of ultrasonic disinfection as a pre-treatment method;
- How it works with other disinfectants;
- The key influence factors in ultrasonic disinfection.
2. Introduction

The objective of this work is

- To evaluate the newly proposed method of applying a ULTRASONIC (US) as a pretreatment step in combination with ultraviolet irradiation to improve the disinfection efficiency of wastewater by breaking up the large particles;
- To explore the fundamental characteristics of how particles and bacteria in wastewater respond to ultrasonic (US);
- To find the mechanism of synergistic disinfection.
3. Materials and Methods

Ultrasonic generator and transducer are made according to our specially need. Ultrasound frequencies are 21.51kHz (horn) and 83.03kHz (column); UV light: SJD-I desktop UV germicidal lamp, AC220V-50HZ, quartz tube lamp’s power is 15W.
3. Materials and Methods

Main Elements:

- $\text{COD}_{cr}$ (potassium dichromate method)
- SS
- E.Coli (multiple-tube fermentation technique)
- Energy Consumption
4. Results and Discussion

a. COD\textsubscript{cr}

Ultrasonic has great effect on COD\textsubscript{cr} during the first 50 seconds. The value of COD\textsubscript{cr} increasing rapidly with time increase.
4. Results and Discussion

b. SS

The experimental results show that, SS concentration decreasing with the increase of US acting time. The size of big particle became smaller, samples became turbid.
4. Results and Discussion

c. E.coli

The number of E.coli increased with disinfection time in the initial stage of the experiment, and then decreased rapidly, it will below the initial value after 20 minutes.
4. Results and Discussion

d. E.coli

The number of E.coliform decreased with time increasing of ultraviolet irradiation.
The total coliform number reduced by 2.8 log units when UV light disinfect for 30S, the total coliform number reduced by 3.4 log units when UV light disinfect for 40S, sterilization rate reach to 99.9%. However, the number of coliform became more and more during the following two days. Some bacterias which seem be killed reappeared.
4. Results and Discussion

d. Synergy effect

In the synergy disinfection experiment, US can improve the UV disinfection effect noticeably. With US pretreatment it only takes about one-third of the ultraviolet light exposure time to achieve the same disinfection results as ultraviolet treatment.
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<th>number</th>
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<th>time/min</th>
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K<sub>1j</sub>(COD) 56.9 68 82.4
K<sub>2j</sub> 76.6 72.8 64.2
K<sub>3j</sub> 69.3 63.5

R<sub>1</sub> 19.7 4.8 18.9

K<sub>1j</sub>(E.coli) 1257 923 1267 2000
K<sub>2j</sub> 812 923 300 577
K<sub>3j</sub> 1033 1313 303

R<sub>2</sub> 445 110 1013 1697

K<sub>1j</sub>(Tur) 2.95 3.06 2.95
K<sub>2j</sub> 2.99 2.92 3.07
K<sub>3j</sub> 2.95 2.97

R<sub>3</sub> 0.04 0.14 0.12
4. Results and Discussion

e. Energy consumption

The energy consumption is large when only using ultrasonic for disinfection. Very short time of US pretreatment, it can not only improve the disinfection effect of ultraviolet radiation, but also achieve the same premising effects take shorter UV radiation time. At the same time, the energy consumption is smaller than UV alone.
4. Conclusions

- Ultrasonic working as a pre-treatment method and followed by UV radiation for disinfection is a much better way in practice;
- The experiment results revealed that the particle size distribution (PSD) in the test samples were apparently shifted toward the small size range;
- The synergy effects can raise the disinfect efficiency compare with single UV. It can reduce radiation time in reaching the same disinfect efficiency;
- The application of a US step might also be beneficial in terms of cost-effectiveness.
- During the follow-up monitor, the phenomenon of photoreactivation was under control.
4. Conclusions

The experimental results in this study showed some degree of variation for similar experiments. This is not unusual for this kind of study, due to many uncontrolled factors, such as:

- Characteristics of tested samples,
- Random error in the microbiology tests.

However, these experiments clearly showed that the proposal of using the US to pre-treat wastewater could be a very attractive alternative to enhance ultraviolet disinfect efficiency.
THANK YOU FOR YOUR ATTENTION !!!