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University of Science & Technology Beijing

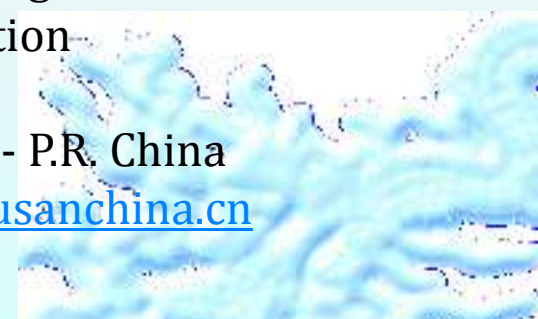


Improved wastewater ultraviolet disinfection by ultrasonic pre-treatment

Jin Xin

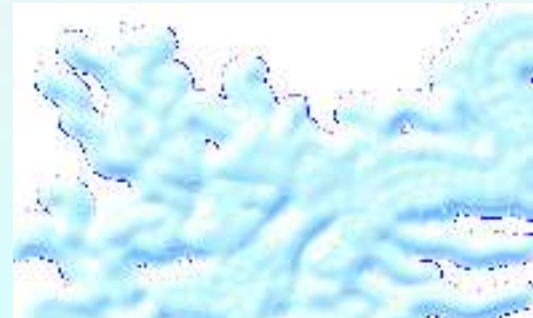
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1. Background

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 pay more attention on the disinfection of wastewater treatment plants effulents. 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).

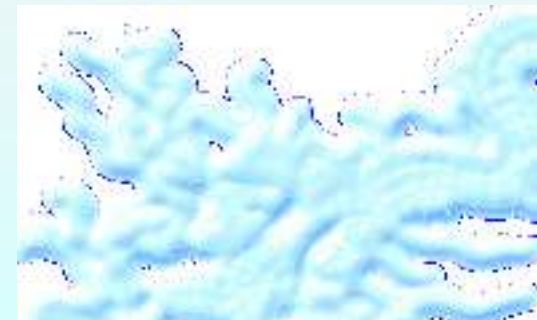




2.Introduction

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

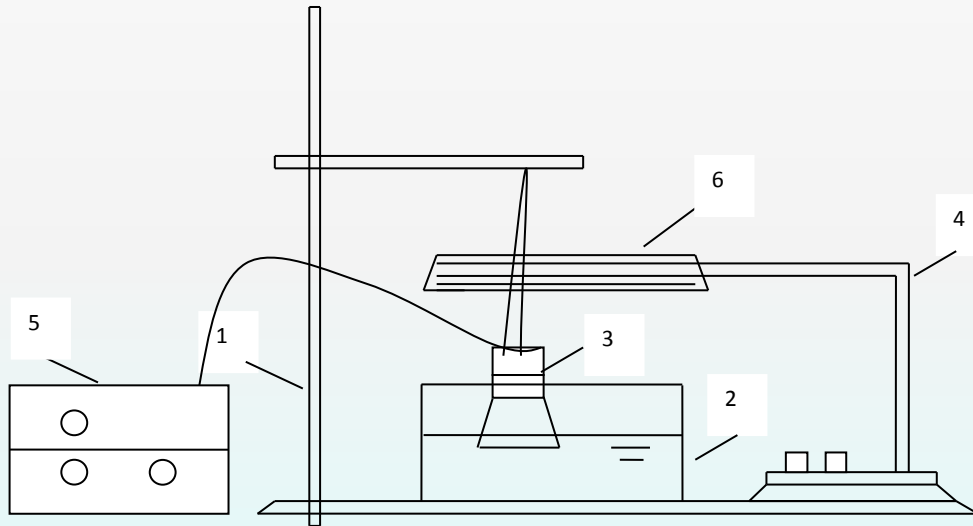
The objective of this work is

- 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 bacterias in wastewater respond to ultrasonic(US);
- To find the mechanism of synergistic disinfection.



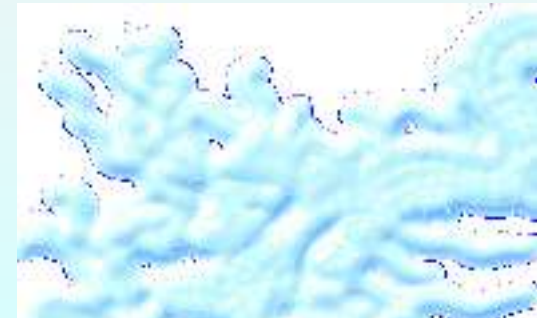


3. Materials and Methods



Lab scale experiment equipment

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

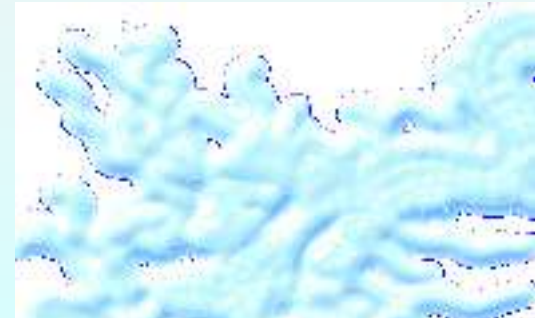




3. Materials and Methods

Main Elements:

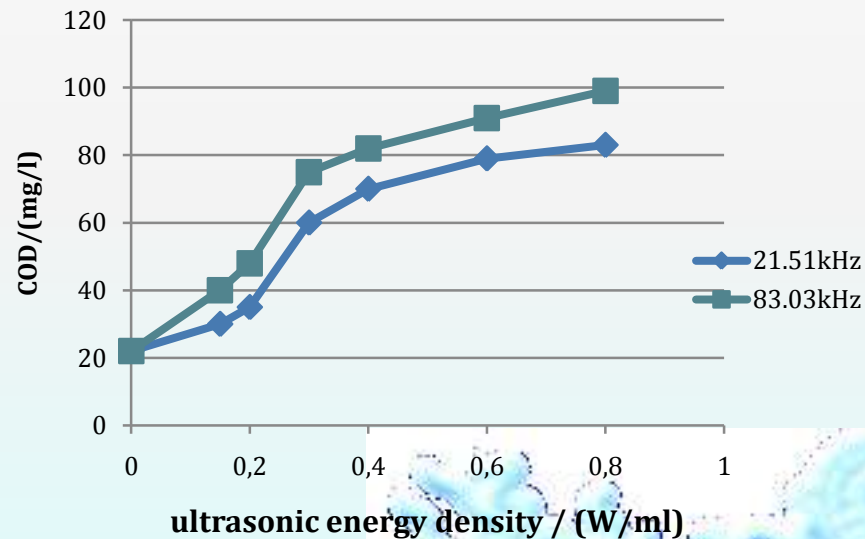
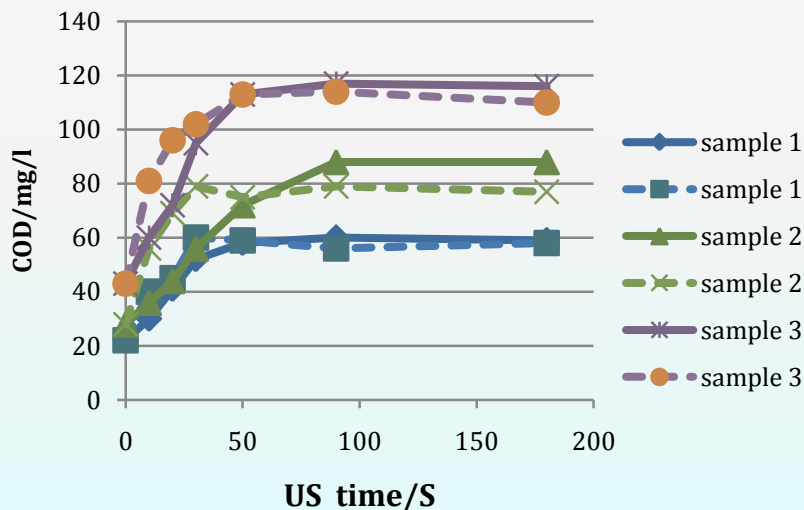
- COD_{cr} (potassium dichromate method)
- SS
- E.Coli(multiple-tube fermentation technique)
- Energy Consumption



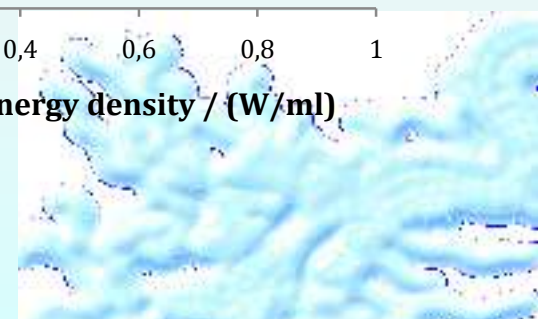


4. Results and Discussion

a. COD_{cr}



Ultrasonic has great effect on COD_{cr} during the first 50 seconds, The value of COD_{cr} increasing rapidly with time increase

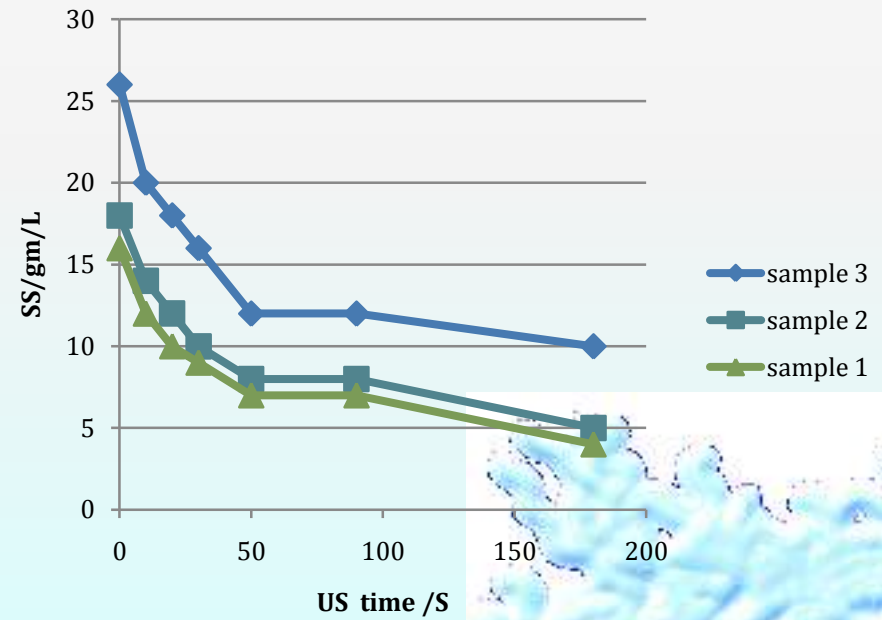




4. Results and Discussion

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.

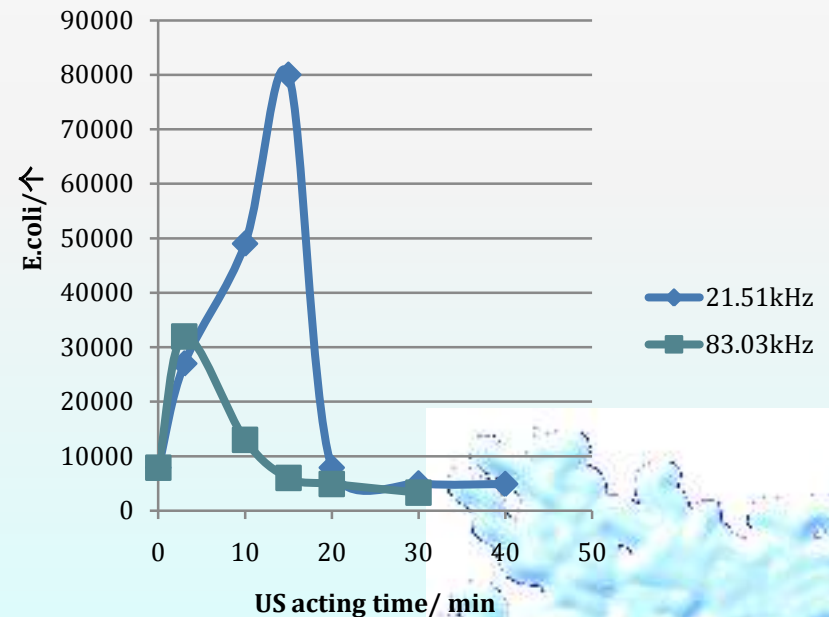




4. Results and Discussion

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 be below the initial value after 20 minutes.



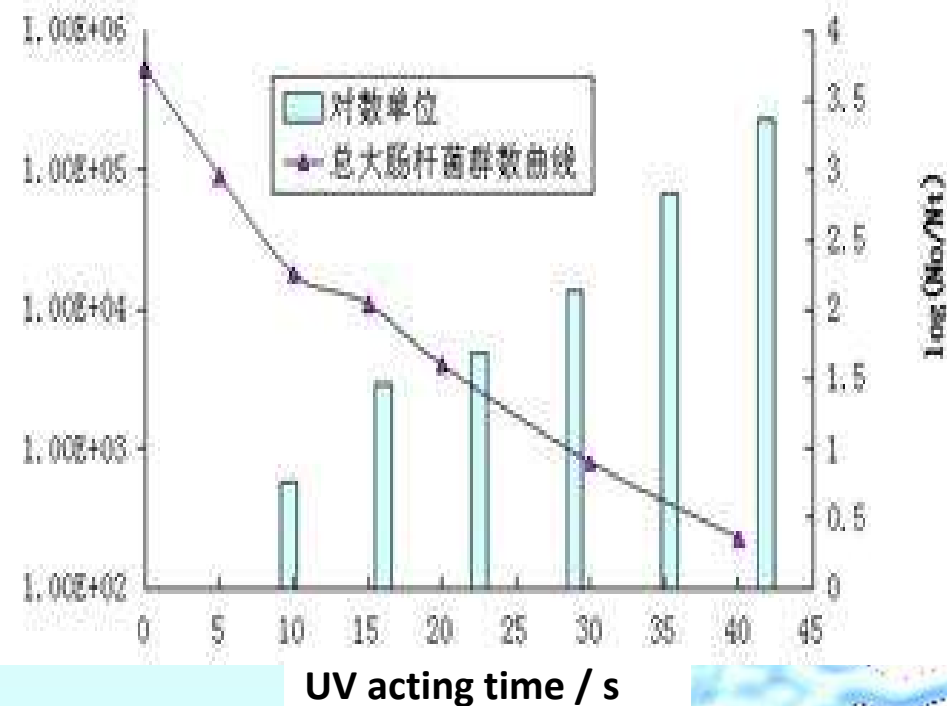


4. Results and Discussion

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.

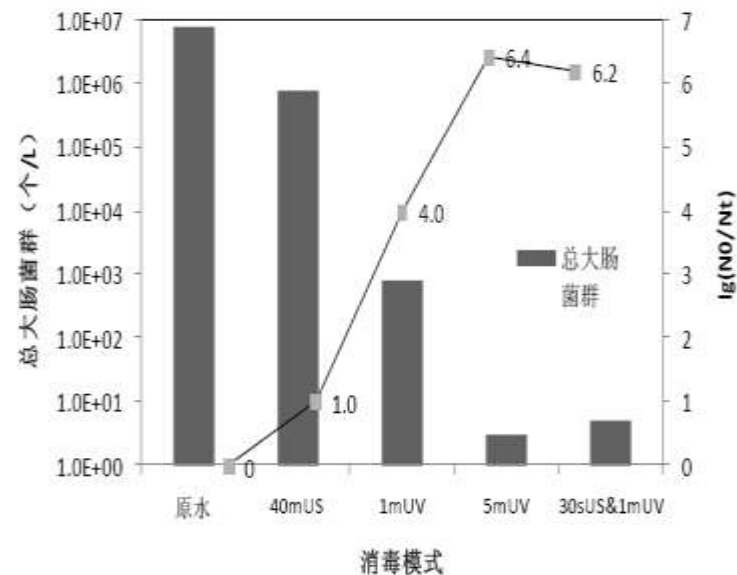




4. Results and Discussion

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.



注：图中 m 为分钟，s 为秒，US 为超声波，UV 为紫外线。



The results of Orthogonal test

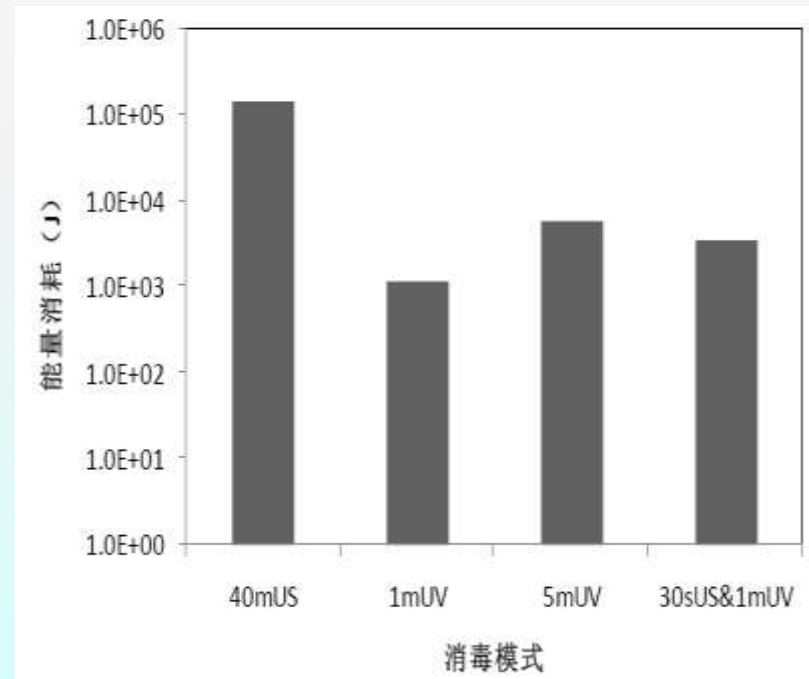
level factor	frequency /kHz	US density W/ml	time/min	UV dose/sec	Monitoring indicators				
number	1	2	3	4	COD _{cr}	E.coli	SS	Turbi	pH
1	21.51	0.2	1	5	56	2300	33	3.0	7.4
2	83.03	0.2	5	10	76	230	31	3.1	7.42
3	83.03	0.2	10	15	72	240	30	3.1	7.43
4	21.51	0.3	5	15	60	170	32	3.0	7.38
5	83.03	0.3	10	5	64	2400	29	2.95	7.4
6	83.03	0.3	1	10	94.5	200	31	2.8	7.41
7	21.51	0.4	10	10	54.6	1300	30	2.85	7.39
8	83.03	0.4	5	15	56.7	500	31	3.1	7.42
9	83.03	0.4	1	5	96.6	1300	32	2.9	7.4
K _{1j} (COD)	56.9	68	82.4						
K _{2j}	76.6	72.8	64.2						
K _{3j}		69.3	63.5						
R ₁	19.7	4.8	18.9						
K _{1j} (E.coli)	1257	923	1267	2000					
K _{2j}	812	923	300	577					
K _{3j}		1033	1313	303					
R ₂	445	110	1013	1697					
K _{1j} (Tur)	2.95	3.06	2.95						
K _{2j}	2.99	2.92	3.07						
K _{3j}		2.95	2.97						
R ₃	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.



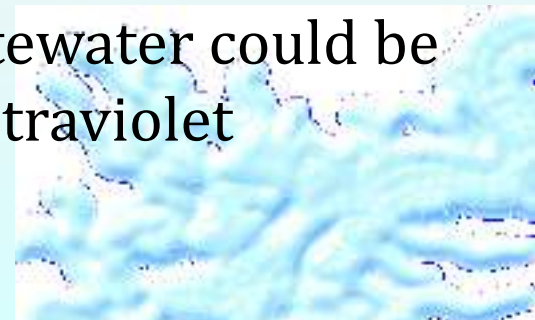


4. Conclusions

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.





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**THANK YOU
FOR YOUR
ATTENTION !!!**

