Evaluation criterion: **Contribution to knowledge**

Result name: **Synergistic effects of trace concentrations of hydrogen peroxide used in a novel hydrodynamic cavitation device allows for selective removal of cyanobacteria**

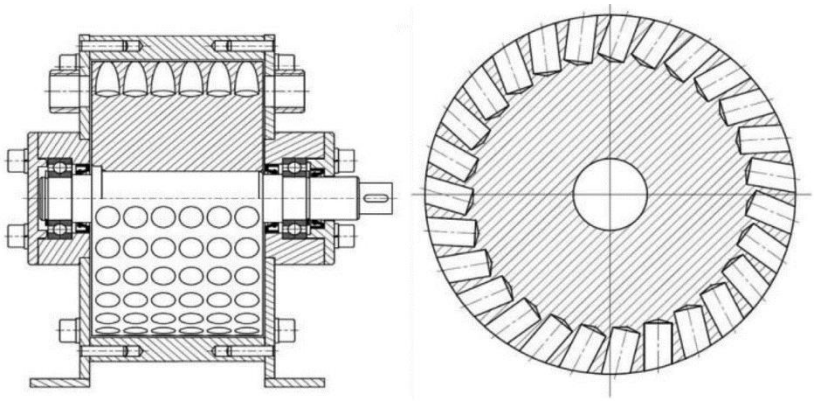
Authors: **Marsalek, B., Zezulka, S., Marsalkova, E., Pochyly, F., Rudolf, P.**

Paper citation:

Marsalek, B., Zezulka, S., Marsalkova, E., Pochyly, F., Rudolf, P.: Synergistic effects of trace concentrations of hydrogen peroxide used in a novel hydrodynamic cavitation device allows for selective removal of cyanobacteria, Chemical Engineering Journal, Vol. 382, 2020, DOI 10.1016/j.cej.2019.122383

Description:

Paper highlights the development of a **novel rotating hydrodynamic cavitation device** (RHCD, rotating speed up to 5000 rpm) designed for the **selective removal of cyanobacteria from water**. Device is based on a rotating drum with holes around the circumference, which is placed within a stator. Cavitation clouds develop in the holes and collapse in the thin gap between rotor and stator. The result is a very effective shear induced cavitation with the power to tear apart the cyanobacteria cells. Coupling of the mechanical part with electrical motor and frequency inverter allows to tune the parameters for desired operating regime.



Whole hydraulic and mechanical design was carried out at V. Kaplan Department of Fluid Engineering, Brno University of Technology (P. Rudolf, F. Pochylý) using computational modelling and vast experience from previous cavitation devices applied for water treatment and purification.

The **key findings and novelty** of this study include:

1. **Efficient Removal of Cyanobacteria**: The RHCD can remove **99%** of cyanobacteria in just one treatment cycle lasting **only 6 seconds**, significantly reducing the time and cycles required compared to previous devices (e.g. Venturi tube, orifice, other types of cavitation reactors).
2. **Synergistic Effect of Hydrogen Peroxide**: The addition of trace amounts of hydrogen peroxide (45-100 μM) enhances the device's effectiveness. This concentration is 10-1000 times lower than those used in previous studies, making it more cost-effective and environmentally friendly, causing no safety issues
3. **Selective Removal Without Damaging Algae**: The device's precise adjustability allows for the selective removal of harmful cyanobacteria without affecting beneficial algae, which is crucial for maintaining ecosystem balance in aquatic environments.
4. **Wide Applicability**: Beyond water treatment, the RHCD shows potential for various industrial applications, including mixing, homogenization, and oxidation processes, where temperature control and enhanced reaction rates are beneficial.

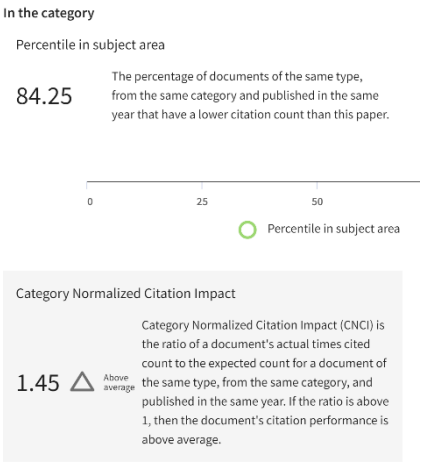
This study provides a **breakthrough in the rapid, selective, and efficient removal of cyanobacteria**, positioning the RHCD as a promising tool for both environmental management and industrial applications. **It has to be highlighted that it was the first application in real conditions.**

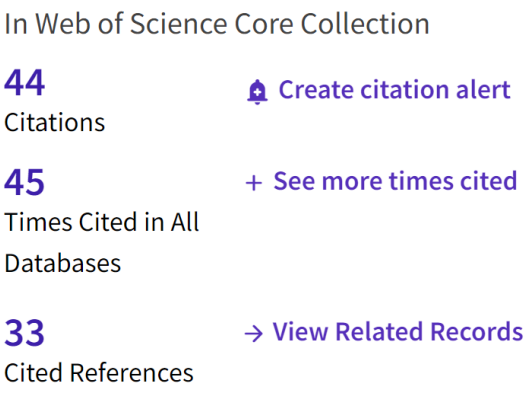
Rotating cavitation generators became a significant topic of research since then and **our paper** became **cited in most of the papers dealing with cavitation generators and their optimization, especially in the field of waste water treatment.**

Paper was **published in Chemical Engineering Journal**, which according to Journal Citation Reports (JCR) had **impact factor 13.273** in 2020. Chemical Engineering Journal ranks 4th out of 143 in Engineering (Chemical) and 2nd out of 54 in Engineering (Environmental) according to JCR, making it top journal in both categories (**D1**) in 2020.

Until 20.9.2024 there are 44 citations in Web of Science and 47 citations in Scopus database.

Paper citations:





Journals citing our paper ranked according impact factor in WoS:

Ranking of citing journal	Number of citing papers
Q1	30
Q2	6
Q3	5
Q4	4

Our paper has 12 citations in journal of Ultrasonics Sonochemistry (Q1), flagship of cavitation research.

Most important citations:

1.) Paper of Xun Sun (h_{index} = 26) very positively evaluates that our team was the first one to apply hydrodynamic reactor in real application

" The Marsalek, et al. [61] were the only ones to apply the ARHCR with sloping CGUs to real applications."

Sun, X. et al: Disinfection characteristics of an advanced rotational hydrodynamic cavitation reactor in pilot scale, Ultrasonics Sonochemistry, 2021 (27 citations) IF = 9.336

2.) Paper by Yadav (h_{index} = 21) highlights the superb efficiency of hydrodynamic reator compared to other relevant devices.

" The rotating device was 1000 times efficient than the orifice type cavitational device, and the processing time was reduced from 200 min to 6 s [92]."

Yadav et al: Microbial disinfection of water using hydrodynamic cavitational reactors, Journal of Water Process Engineering, 2021 (15 citations) IF = 7.34

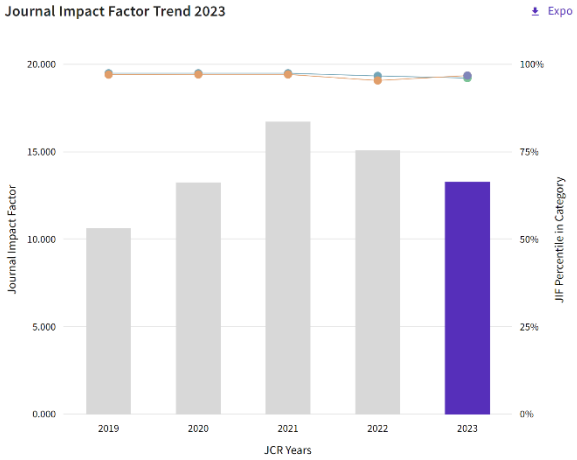
3.) Paper by Gostisa once again highlights and praises superb efficiency of our cavitation reactor and its unique design:

" The cavitation generated in rotating devices is different than the one developed in other HC devices and has been determined as highly efficient and economically feasible [22,27,28]."

" For example, Marsalek and co-workers [27] proposed an improved dimpled rotor hydrodynamic cavitation device, where its particular geometry resulted in cavities with high cavitation energy able to efficiently destroy cyanobacteria."

Gostisa et al: Performance evaluation of a novel pilot-scale pinned disc rotating generator of hydrodynamic cavitation, Ultrasonics Sonochemistry, 2021 (28 citations) IF = 9.336

Chemical Engineering Journal citation metrics (JCR Reports)



CHEMICAL ENGINEERING JOURNAL

Publisher name: ELSEVIER SCIENCE SA

Journal Citation Indicator™

2023	2022
1.88	1.99

JCI Category	Category Rank	Category Quartile
ENGINEERING, CHEMICAL *in SCIE edition*	7/171	Q1
ENGINEERING, ENVIRONMENTAL *in SCIE edition*	3/81	Q1

CATEGORY

ENGINEERING, CHEMICAL

7/170

JCR YEAR	JIF RANK	JIF QUARTILE	JIF PERCENTILE
2023	7/170	Q1	96.2

Rank by JIF before 2023 for ENGINEERING, CHEMICAL

EDITION

Science Citation Index Expanded (SCIE)

JCR YEAR	JIF RANK	JIF QUARTILE	JIF PERCENTILE
2022	5/142	Q1	96.8
2021	4/143	Q1	97.55
2020	4/143	Q1	97.55
2019	4/143	Q1	97.55

CATEGORY

ENGINEERING, ENVIRONMENTAL

3/81

JCR YEAR	JIF RANK	JIF QUARTILE	JIF PERCENTILE
2023	3/81	Q1	96.9

Rank by JIF before 2023 for ENGINEERING, ENVIRONMENTAL

EDITION

Science Citation Index Expanded (SCIE)

JCR YEAR	JIF RANK	JIF QUARTILE	JIF PERCENTILE
2022	3/55	Q1	95.5
2021	2/54	Q1	97.22
2020	2/54	Q1	97.22
2019	2/53	Q1	97.17