DESIGN AND TESTING OF A HYDRODYNAMIC CAVITATION MODULE FOR INTENSIFYING THE OXIDATION TREATMENT OF WATER MATRICES

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INTRODUCTION

Process intensification (PI) is the application of innovative principles in the design of equipment and processes to increase the efficiency and economy of technological operations, achieving a greater effect with reduced consumption of energy, time and chemicals.
In this context, HYDRODYNAMIC CAVITATION (HC) is an advanced technology that, through the formation and collapse of cavitation bubbles, generates locally very intense hydrodynamic conditions.

Hydrodynamic cavitation can be applied as an innovative method for the generation of free radicals, the increase of transport coefficients and interfacial area, the creation of extreme temperature and pressure conditions, as well as for emulsification, microbial cell disruption and enzyme recovery, which will contribute to PI, especially in the oxidative treatment of water matrices.

Hydrodynamic cavitation has the potential to become an energy-efficient technique that can reduce the currently necessary use of expensive chemical reagents for enhanced treatment processes, which on the other hand also pose additional concerns when released into the environment.

METHODS

HC can be produced using constructions, mainly an orifice and a venturi, with different geometries in the flowing liquid. The generated radicals and other induced effects can effectively oxidize organic compounds and simultaneously break large molecules into smaller intermediates.

In this work, a self-made hydrodynamic cavitation module (Fig. 1) with different orifices was designed and tested.

The design phase included selecting the system geometry and the pump and selecting and calibrating the pressure and flow rate measurement devices.
The testing phase included defining the basic hydraulic parameters of flow, pressure, temperature, system volume and pump power for the selected operating conditions.

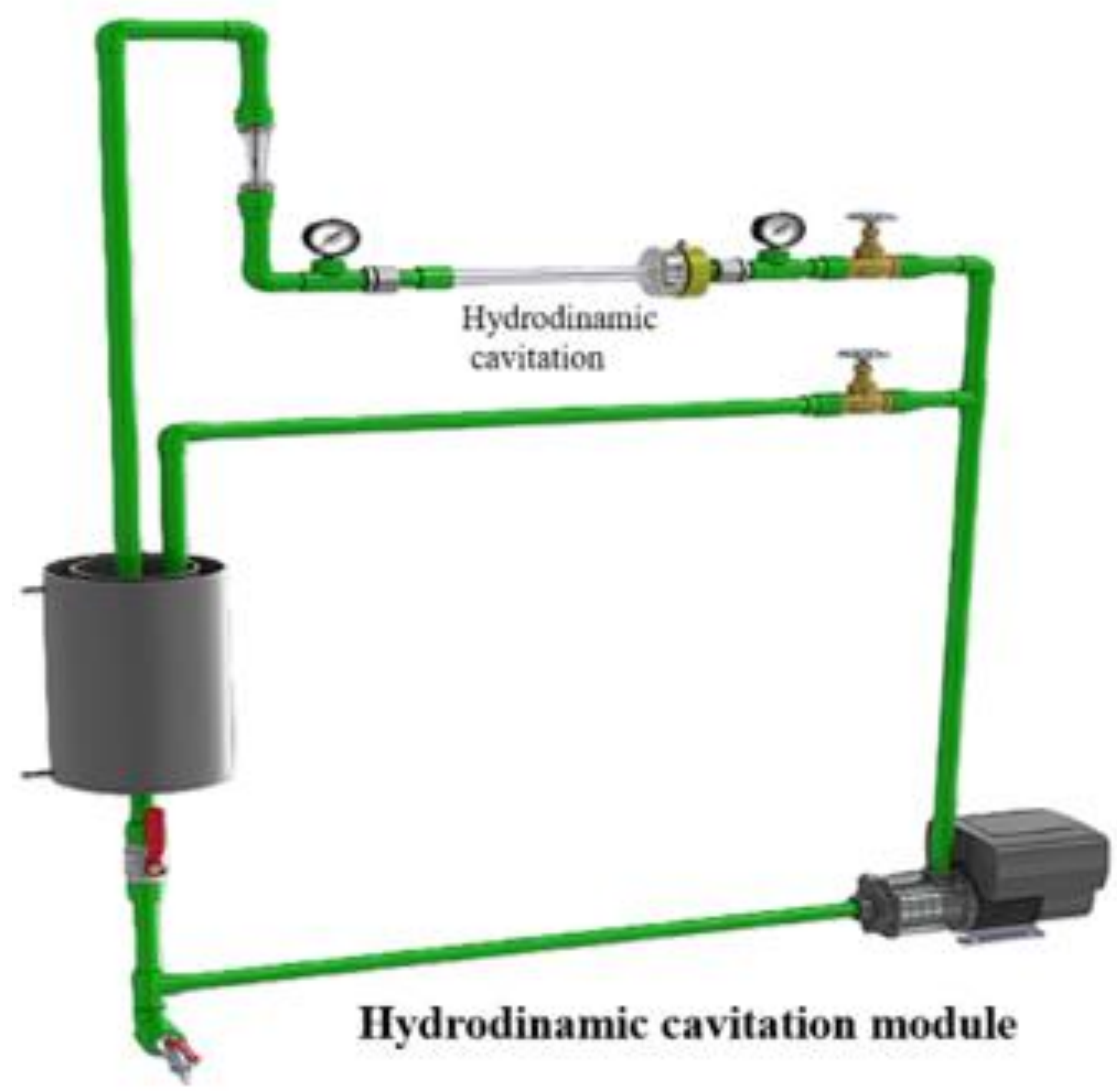
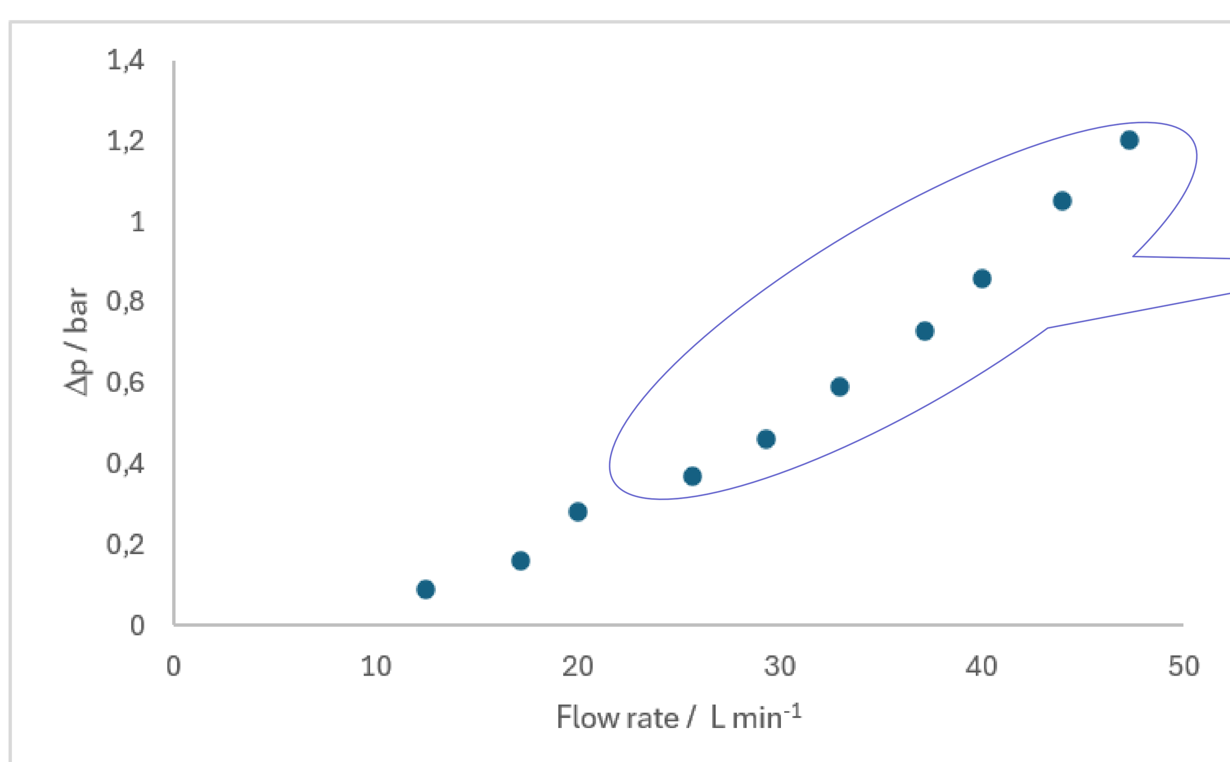


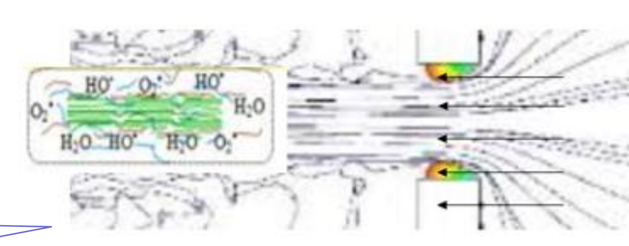
Figure 1. Hydrodynamic cavitation module

RESULTS

Table 1. Operating parameters

Pump power	Flow rate q / L min^{-1}	Temperature T/ ^{o}C	Pressure p_{izl} / bar	Pressure Δp / bar	Cavitation Yes/No
1	12.5	21.0	0.04	0.09	No
2	17.2	21.0	0.09	0.16	No
3	20.0	21.2	0.19	0.28	No
4	25.7	21.3	0.28	0.37	Yes
5	29.3	21.4	0.39	0.46	Yes
6	33.0	21.8	0.50	0.59	Yes
7	37.2	22.4	0.63	0.73	Yes
8	40.0	23.5	0.77	0.86	Yes
9	44.0	24.5	0.91	1.05	Yes
10	47.3	25.4	1.10	1.20	Yes





Hydrodynamic cavitation

Figure 2. Pressure and flow rate parameters for hydrodynamic cavitation formation

CONCLUSION

Cavitation occurred in the designed system under different process parameters. Depending on the constructional and design aspects, as well as on operating parameters such as pressure, temperature, cavitation number and flow rate, HC can be used as a pretreatment technique and has been successfully employed in the degradation of pesticides, toxic dyes, pharmaceutical discharge and other complex organic compounds in water matrices.