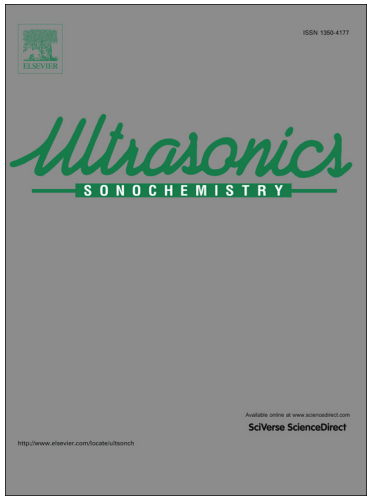

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PII: S1350-4177(18)30317-1
DOI: https://doi.org/10.1016/j.ultsonch.2018.02.045
Reference: ULTSON 4106

To appear in: *Ultrasonics Sonochemistry*

Received Date: 1 October 2017
Revised Date: 9 February 2018
Accepted Date: 26 February 2018

Please cite this article as: H. Lais, P.S. Lowe, T-H. Gan, L.C. Wrobel, Numerical Modelling of Acoustic Pressure Fields to Optimize the Ultrasonic Cleaning Technique for Cylinders, *Ultrasonics Sonochemistry* (2018), doi: https://doi.org/10.1016/j.ultsonch.2018.02.045

Numerical Modelling of Acoustic Pressure Fields to Optimize the Ultrasonic Cleaning Technique for Cylinders

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***Abstract*— Fouling build up is a well-known problem in the offshore industry. Accumulation of fouling occurs in different structures, e.g. offshore pipes, ship hulls, floating production platforms. The type of fouling that accumulates is dependent on environmental conditions surrounding the structure itself. Current methods deployed for fouling removal span across hydraulic, chemical and manual, all sharing the common disadvantage of necessitating halting production for the cleaning process to commence. Conventionally, ultrasound is used in ultrasonic baths to clean a submerged component by the generation and implosion of cavitation bubbles on the fouled surface; this method is particularly used in Reverse Osmosis applications. However, this requires the submersion of the fouled structure and thus may require a halt to production. Large fouled structures such as pipelines may not be accommodated. The application of high power ultrasonics is proposed in this work as a means to remove fouling on a structure whilst in operation. The work presented in this paper consists of the development of a finite element analysis model based on successful cleaning results from a pipe fouled with calcite on the inner pipe wall. A Polytec 3D Laser Doppler Vibrometer was used in this investigation to study the fouling removal process. Results show the potential of high power ultrasonics for fouling removal in pipe structures from the wave propagation across the structure under excitation, and are used to validate a COMSOL model to determine cleaning patterns based on pressure and displacement distributions for future transducer array design and optimization.**

***Keywords*—Cavitation, COMSOL, Excitation, Fouling removal, Numerical modelling, Ultrasonic transducers.**

I. INTRODUCTION

Fouling formation is a major problem for the offshore industry [1]. It is an important factor contributing to the assessment of service lifetime and safety of marine facilities [2]. Consequently, large sums of money are spent in cleaning and preventative measures to maintain offshore structures in a state of operation and efficiency. Current methods deployed for fouling removal include hydraulic, chemical and manual, having a common disadvantage - in that it is mandatory to halt the operation of the structure in order to commence the fouling removal process. Most common fouling mechanisms in offshore structures are; deposition of hard scale and the settlement and growth of marine organisms. This accumulation of fouling can occur in different engineering structures such as pipes and ship hulls. The type of fouling that can be accumulated is dependent on environmental conditions surrounding the structure itself.

Scaling occurs when saturated brine undergoes a temperature or pressure change causing the solubility to decrease, which results in the precipitation of solid crystals. The Calcium Carbonate (calcite) composition in pipelines is an example of the most common scaling problem in offshore structures. Other common scales that form in offshore process lines are Barium Sulphate (barite), Strontium Sulphate and Magnesium Sulphate [3]. Sometimes scaling can develop rapidly causing complete pipe blockage within 24