UNIVERSITI TEKNOLOGI MARA

INVESTIGATION OF SWIRL EFFERVESCENT ATOMIZATION USING DESIGN OF EXPERIMENT AND PHOTOGRAPHIC-BASED TECHNIQUE

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Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science

Faculty of Mechanical Engineering

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CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 18th March 2015 to conduct the final examination of Zulkifli bin Abdul Ghaffar on his Master of Science thesis entitled "Investigation of Swirl Effervescent Atomization Using Design of Experiment and Photographic-Based Technique" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiners recommends that the student be awarded the relevant degree. The panel of Examiners was as follows:

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Swirl effervescent atomizer consists of a combined atomization mechanism of swirl and effervescent atomization. Despite of the advantages and potential of various applications, this type of atomizer was not widely used. This is due to the lack of extensive studies on the external and internal flow of this atomizer. Therefore, there is a need to understand the behaviour of the external and internal flow of this atomizer. In this study, the atomizer was designed, fabricated and later tested with water as the working fluid and nitrogen gas as the atomizing gas. An experimental test rig was built to evaluate the relation of swirl-generating vane angle, gas-to-liquid ratio (GLR) and discharge orifice diameter with spray angle, breakup length and gas core diameter respectively. To ensure optimization of experiment, Box-Behnken design of experiment was applied. High-speed shadowgraph was utilized during the recordings of resultant spray patterns and internal flow structure. The acquired images were analyzed using image processing software. Spray angle increases with swirl-generating vane angle and orifice diameter but unchanged with GLR. Increased of every independent parameters shortened the spray breakup and enlarged the gas core diameter but the GLR produced the most optimum results. The maximum spray angle is 28° which achieved from the interaction between the swirl-generating vane angle and discharge orifice diameter. Shortest breakup length (6mm) obtained with swirl-generating vane angle and GLR interact at the highest levels of both parameters. Gas core diameter expanded by 0.12mm with the interaction of the swirl-generating vane angle and discharge orifice diameter.

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