UNIVERSITI TEKNOLOGI MARA

IMC-PID CONTROLLER WITH FRACTIONAL-ORDER FILTER FOR STEAM DISTILLATION ESSENTIAL OIL EXTRACTION PROCESS

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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

One of the main compounds in the pharmaceutical, food and perfumery industries is essential oil. Essential oil is volatile and sensitive to excess heat. Many studies had shown that the major influence of the quality of essential oil is the temperature during the extraction process. In this study, the steam distillation method had been considered. Steam distillation is a separation process for temperature-sensitive substances where the steam is injected into the plant to release the aromatic molecules. The steam needs to be maintained at a certain range of temperature to give a satisfactory quality of the essential oil. In order to maintain the desired steam temperature, this study proposed an Internal Model Control (IMC) based PID with fractional-order filter (IMC-PID FOF) as a controller to control the temperature during extracting the essential oil. IMC is a model-based control structure where the process model and the internal model are assumed identical. The assumption of equality in both processes contributes to the ability of disturbance estimation. In the development of the IMC, there are two parts involved where the first part is the internal model of the plant and the second part is the control filter that affects the IMC controller's response which has proven to be robust when used in the control loop of common industrial processes. The implementation of a fractional-order filter cascaded to the IMC controller may enhance the system robustness to process gain with its iso-damping properties. This study was conducted by simulation using MATLAB R2018a. The comparison in terms of step test, set point change test and load disturbance rejection test between the proposed IMC-PID FOF, IMC-PID and IMC based PI Improved (IMC-PIIM) controllers were conducted. The results indicated that the IMC-PID FOF controller produced the best response in all tests where the transient is faster with minimal overshoot below 3%. The proposed controller did also respond well to an external disturbance which injected during simulation where it had the fastest recovery time of 198.70 seconds.

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TABLE OF CONTENTS