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Development of a Steam Heated Evaporator for Palm Oil Effluent Densification

Abhayawardana N. M. C. S. S., Perera I. M. V. R. T., Siriwardana S. S. G. C. ,
Herath H. M. C. M. and Karunasena H. C. P.*
*Department of Mechanical and Manufacturing Engineering, Faculty of Engineering,
University of Ruhuna*

* *Corresponding Author: chaminda@mme.ruh.ac.lk*

Effluent Treatment is one of the major operations in industries all over the world to meet ever tightening environmental regulations. In this background, this project aimed to develop an effluent densifier catering the high volume effluent output of a palm oil mill in Galle, Sri Lanka, in order to reduce the bulk volume of effluents, providing cost advantage for treatment processes and handling. Before any design works, physical properties of the effluent outlet flow of the mill were measured and it was found that the average pH value is 4.65, moisture content is 96.9%, temperature is 70°C, and the flow rate is 2 l/s. Based on these findings, a small scale evaporator densifier system was designed, fabricated and tested in order to observe the functionality of the concept. The design was such that the least 30% of the water from the incoming effluent flow to the evaporator gets evaporated to produce a densified effluent output. The densifier was designed based on the falling film evaporator technology and to run on waste steam available at the mill at 3.0 barg and 134 °C. Based on the above concept, detailed fundamental calculations, and fluid and thermal simulations were conducted in order to optimise the shape, size and the configuration of the components of the densifier. Using the small scale densifier, a series of lab experiments were conducted by supplying steam from a lab scale steam generator providing above same heating conditions and varying the effluent flow rate from 0.02 l/s to 0.4 l/s. It was observed that 32% to 26% of overall evaporation can be realised by varying the effluent flow rate for a constant supply of steam. This concept can be further improved by connecting similar densifier units in series and also by increasing the evaporation surface area or providing additional forced convective air flow over the evaporating surface.

Keywords: effluent treatment, evaporator design, heat exchanger, palm oil, waste steam