EVAPORATING PROCESS SIMULATION OF BLACK LIQUOR IN FALLING FILM EVAPORATOR (FFE) WITH AIR FLOW OBSERVED FROM INFLUENCE OF AIR FLOW

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ABSTRACT

Falling film evaporator is an equipment constructed for concentrating dilute solution. It is usually conducted by blowing air which aims to reduce the partial pressure of water vapor. The boiling point of the solution will be decreased. Falling film evaporator is used for concentrating fluids that are sensitive to heat. The direction of air flow can be counter current or co current.

This research aims to carry out theoretical analysis (by developing mathematic model) concerning the influence of liquid and gas on falling film evaporator performance for black liquor-air. The influence of air flow direction on the evaporator performance was also studied. This model consist of microscopic heat and mass transfer balance for liquid and gas. This model is generating system of non linear differential system fourth order Runge-Kutta and finite difference method using the MATLAB software. This research is determined heat and mass transfer coefficient by fitting the model with Irawan and Kurniawan experimental data (2010) using Hookjeeves minimization method. The variables studied in this research were liquid flow rate 100 l/h; 110 l/h; 120 l/h, air flow rate 4 m$^3$/h; 6 m$^3$/h with initial black liquor concentration of 5.92%.

The research produced a computer program in MATLAB which can predict distribution of liquid temperature ($T_L$), distribution of gas temperature ($T_G$) and the distribution of
concentration (%) distribution black liquor in a falling film evaporator.

This program also predict performance of falling film evaporator, expressed as the concentration of solute in product solution. This research concluded, for counter current air flow case, the highest concentration of outlet solution is 20.50% for liquid flow rate 100 l/h and air flow rate 6 m$^3$/h and inlet solution concentration 5.92%. While for co current air flow case, the highest concentration gained 15.80% for liquid flow rate 100 l/h and air flow rate 6 m$^3$/h and inlet solution concentration 5.92%. The predicted outlet black liquor concentration using heat and mass transfer coefficient obtained from this study agrees very well with Irawan and Kurniawan (2010) experiment with average error 4.64%.

**Keywords**: simulation, falling film, evaporator, black liquor