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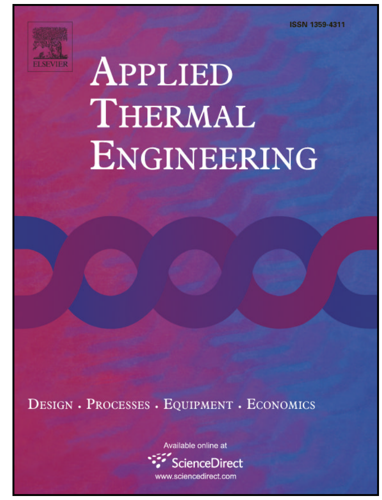

Research Paper

Industrial scale engineering estimation of the heat transfer in falling film juice evaporators

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Industrial scale engineering estimation of the heat transfer in falling film juice evaporators

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Abstract

Falling film, shell-tube type evaporators are commonly used heat exchangers for the production of fruit juice concentrate. Evaporators are one of the main energy consumers in the fruit processing plants. Number of effects influences energy consumption. The main problem in the design of the exchanger is the reliable estimation of the overall wall heat transfer coefficients for all effects in real operating conditions. Most literature sources for the heat transfer coefficients are based on laboratory measurements, where the tubes are usually short, no fouling exists and the flow rate is carefully adjusted. This paper shows the heat transfer coefficients estimated in real industrial operating conditions, on the basis of several operating evaporators investigations in the fruit processing plants. Estimated values are compared with recognised formulas from literature. As a summary, the design heat transfer coefficients are given for each effect of the falling film evaporator for juice concentrate production.

Key words: heat transfer, falling film evaporator, industrial conditions.

Nomenclature:

Latin letters:

A - area m^2

b - sugar content in solution ^oBrix

c_p - solution specific heat $kJ\cdot kg^{-1}\cdot K^{-1}$

c_{pw} - water specific heat $kJ\cdot kg^{-1}\cdot K^{-1}$

d_{in} - tube internal diameter

d_{out} - tube external diameter

g - gravity acceleration = 9.81 $m\cdot s^{-2}$

h - specific enthalpy $kJ\cdot kg^{-1}$

I, $\dot{I}$ - enthalpy kJ, enthalpy flux kW

k - wall heat transfer coefficient $kW\cdot m^2\cdot K^{-1}$

l - length m

$\dot{m}$ - mass flow rate $kg\cdot s^{-1}$