SURFACE MODIFICATIONS TO INCREASE DAIRY PRODUCTION RUN LENGTH

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ABSTRACT

Fouling is the build-up of undesired deposits on surfaces. In the dairy industry, fouling is mainly seen in heat exchangers where dairy fluid is heated or concentrated. It is one of the primary reasons for restricted run length, causing financial losses from downtime, the use of cleaning chemicals and reduced product quality.

Fouling is a complex process and is due to number of factors including the properties of the heat transfer surface. A silica based coating is known to alter the surface properties. This study was carried out to investigate the effect of a silica based coating on fouling by whole milk in a falling film evaporator.

Seven independent trials were conducted. In each trial, a control run was carried out followed by a full cleaning of the equipment and then either another control run or a coating run with pasteurized milk from the same batch. There was a six hour interval between the start of the control run and start of the coating run. Since prolonged milk storage may have some effect on fouling rate, control-control runs were carried out to see the effect of prolonged storage. The results obtained from control-control runs were used in analysing the effect of the coating on fouling rate.

All coating trials showed consistently lower fouling rate as compared with corresponding control trials. The Pearson's correlation coefficient of 0.83 showed a strong effect of coating on the fouling rate. Further, a regression analysis gave a p-value of 0.033, indicating that, at the 96.7% level of confidence, coating reduced the fouling rate. The extent of reduction in fouling rate varied from trial to trial. It was estimated that the coating had the potential to increase the run length by a maximum of 34% under the conditions these experiments were carried out.

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Nomenclature

OPT - On-product time

q - Amount of heat transferred (W)

U - Overall heat transfer coefficient (W/m^2K)

A_i - Heat transfer area (m^2)

ΔT - Temperature driving force (K)

h_c - Convective heat transfer coefficient of condensate film (W/m^2K)

S_s - Thickness of steam-side scale (m)

k_s - Thermal conductivity of steam-side scale (W/m^2K)

S_w - Thickness of foulant layer (m)

k_w - Thermal conductivity of wall (W/m^2K)

S_f - Thickness of foulant layer (m)

k_f - Thermal conductivity of foulant layer (W/m^2K)

h_e - Convective heat transfer of product film (W/m^2K)

N - Number of tubes

d_i - Internal diameter (mm)

L - Length of tube (mm)

RE - Research Evaporator

β-lg - Beta-lactoglobulin

α-la - Alpha-lactalbumin

BSA - Bovine serum albumin

Ig - Immunoglobulin

IEP - Isoelectric point

CIP - Clean in place

NCG - Non-condensate gas

BPE - Boiling point elevation