PULSED FLOW FOR ENHANCED CLEANING IN FOOD PROCESSING

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The formation of fouling layers during the thermal treatment of milk and milk products is a severe problem for the dairy industry. These layers can lead to a drastic increase in resistance to heat transfer, thereby decreasing the thermal efficiency of equipment such as heat exchangers. Furthermore, the stringent requirements for quality and hygiene in dairy processes require regular and effective cleaning of production lines. Costs are thereby incurred for detergents, rinse water, disposal of spent solutions and energy. This paper considers one method for optimising the cleaning process with respect to duration and energy consumption.

The use of slow (~1 Hz) flow pulsations imposed on a steady flow of liquid has been shown to enhance shear stresses imposed on a surface and to mitigate fouling[1] or enhance cleaning[2]. Flow pulsing is an attractive technology for systems where the liquid is too viscous to achieve turbulent flows, or where the inventory of fluid is to be minimised. Several examples of the application of pulsed flow are presented in this paper.

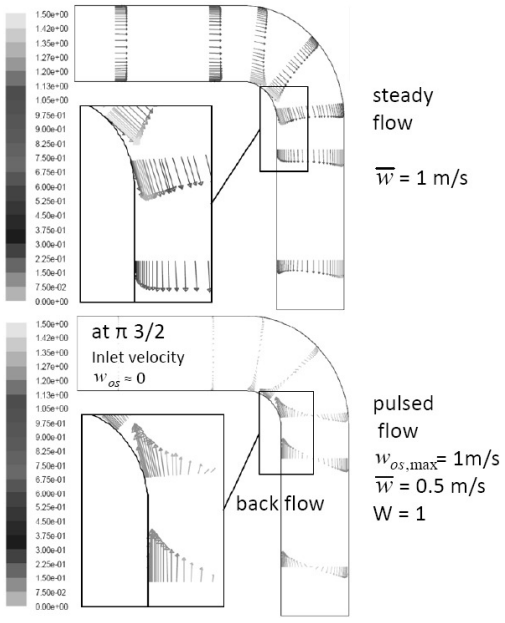

Fig. 1: Velocity profiles in an elbow

A new measuring technique in combination with tailored CFD simulations was developed for monitoring the cleaning of complex piping equipment with pulsed flow. Investigations of pulsed flow cleaning published prior to this work[3] focused on tests with straight pipes, whereas difficulties in industrial cleaning operations more often arise while operating piping systems and plant components with complex geometries. Therefore cleaning experiments were performed in a CIP test rig simulating industrial cleaning processes. The optical monitoring procedure uses a model food soil consisting of starch as matrix material and phosphorescent zinc sulphide crystals as optical tracer. The research objectives are (*i*) to compare steady and pulsed flow cleaning of complex geometries, (*ii*) to analyse the energy efficiency of pulsed flow cleaning for certain configurations and (*iii*) a feasibility study for the industrial generation of pulsed flow. All investigations provide three steps of verification: a first test with starch soil, a CFD verification and a final proof utilizing whey protein based model food soil. The results with pulsed flow show an enhancement of cleaning efficiency at locations difficult to access using steady flows.

[1] Augustin, W. and Bohnet, M., Influence of pulsating flow on fouling behaviour, in: *Mitigation of heat exchanger fouling and its economic and environmental implications*, eds. T.R. Bott et al., Begell House, New York, pp. 161-168, 2001.
[2] Gillham, C.R., Fryer, P.J., Hasting, A.P.M. and Wilson, D.I., Enhanced cleaning of whey protein fouling deposits using pulsed flows, *J. Food Eng.*, Vol. 46, pp. 199-209, 2000.
[3] Bode, K., Hooper, R., Paterson, W., Wilson, I., Augustin, W., Scholl, S., Pulsed Flow Cleaning of Whey Protein Fouling Layers, *Heat Transfer Eng.* 28 (2007) 3, pp. 202-209