SWELLING AND DISSOLUTION IN CLEANING OF WHEY PROTEIN GELS

P. Saikhwan[1,2], R. Mercadé-Prieto[1,3], Y.M.J. Chew[1], W.R. Paterson[1] and D.I. Wilson[1]
[1]*Department of Chemical Engineering and Biotechnology, New Museums Site, Pembroke Street, Cambridge, CB2 3RA, UK*
[2] *Thammasat University, 99 Moo18 Paholyothin Road, Ampher Khlongluang, Pathumthani 12121,Thailand*
[3] *School of Chemical Engineering, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK*

ABSTRACT

Cleaning of proteinaceous fouling layers is a regular step in dairy manufacturing and is likely to persist as thermal processing is widely used. Understanding the fundamental mechanisms involved in cleaning behaviour, and particularly those involved in cleaning-in-place (CIP) operations, is important for interpreting operational data, optimising cleaning strategies and designing new formulations. Most industrial CIP techniques employ acidic or alkaline solutions to convert the soil into a more readily removable form, so that cleaning efficiency depends on the reaction behaviour and rheology of these materials as well as heat and momentum transfer. Fundamental studies on milk deposits is challenging as milk is subject to natural variation. Several workers have used simplified mixtures as simulants to study cleaning behaviour. Relating the results obtained with simulants back to milk and milk-related materials is nevertheless challenging.

The swelling of the proteinaceous deposits in alkali is one step occurring in cleaning, but its significance has just been studied recently by Mercadé-Prieto and co-workers using a very simplified system, with β-lactoglobulin (βLg) as a model protein. It has been shown that swelling is important because if swelling is suppressed, for example by adding salts or by using high alkali concentrations, the dissolution of the deposits proceeds very slowly. Understanding the swelling behaviour of whey protein deposits is essential to understand why and when cleaning is feasible. This feasibility has been characterized in βLg gels as a double dissolution threshold, one with the pH and one with the extent of swelling.

In this paper we report an extended study of the swelling behaviour of βLg and related gels using the dynamic gauging technique. Kinetic swelling data – essential for the study of short cleaning experiments – at different pH and salts concentrations is compared with that obtained in the literature from swelling measurements at equilibrium. A good agreement is found with the present kinetic data and that of the literature for βLg gels, particularly the existence of a double dissolution threshold with the pH and with the degree of swelling. Results for pure βLg gels have been compared with deposits made with other typical compositions, such as WPC80 and WPI. The swelling of whey protein deposits shows a linear increase with time, whereas pure βLg show Fickian-like behaviour. In addition, the pH required for the whey mixture deposits to swell and start dissolving is higher than for βLg.