THE EFFECT OF CLEANING FLUID; TEMPERATURE AND FLOW RATE ON THE REMOVAL OF TOOTHPASTE FROM 2 INCH PIPE

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ABSTRACT

Cleaning is a necessary process in the manufacturing industries, in which production time is lost. Substantial product waste can occur, and high water, chemical and energy usage are experienced. As such, it is a process where large environmental emissions result. By studying the effects of varying temperature and flow rate of the cleaning fluid, this project seeks to understand the cleaning mechanisms of fluorinated toothpaste to enable minimization of waste.

The cleaning of fully fouled 2 inch pipes has been studied to find minimal cleaning times, water or energy usage. The fully fouled 2 inch pipework is cleaned by passing water through the system at a known temperature and flow rate. It is monitored by temperature, conductivity and turbidity probes. At the end of the experiment, water is drained from the system and the pipe visually inspected. If the pipeline is visually clean, an ion chromatography swab is taken to confirm whether fluoride traces are acceptably low.

Removal of the paste from the pipeline occurs first via *core removal* from the centre of the pipe which is observed in the first few seconds of the experiment: the time for this process is on the order of the pipe residence time. Following this a thin film layer remains as a coating on the inner walls of the pipe: *thin film removal* then occurs and the coating of toothpaste is gradually eroded over many minutes of continuing fluid flow. This is the rate limiting step.

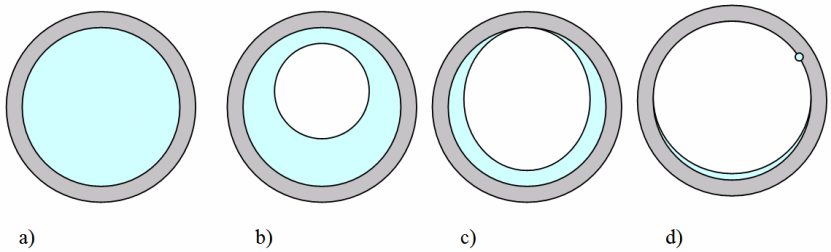

Figure 1: Schematic of toothpaste removal from pipe; a) Initially full of paste; b)Removal of ‘core’ paste – slightly skewed to upper surface; c)Further removal of paste from ‘core’ to leave thin film around edge, with upper erosion most advanced; d) thin layer left at base of pipe with the possibility of small patches remaining on the inner wall surface.

Toothpaste has been chosen as an example of a Type 1 soil (Fryer and Asteriadou, 2009) being a viscous fluid capable of fluid mechanical removal. In fluid mechanics dominated removal, increases in flow would be expected to produce decreases in the cleaning time and this proves to be true. An increase of temperature from 20°C to 50°C does produce some decrease in cleaning time, however the effect of flow is dominant over that of temperature.

Fryer, P.J., Asteriadou, K., A prototype cleaning map: A classification of industrial cleaning processes. *Trends in Food Science & Technology*, **20**, 2009, 255-262