Interface length during product changeover

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The causes of waste in two different UHT(**U**ltra **H**igh **T**emperature)/Pasteurisation lines have been identified, measured and quantified in terms of their overall cost. Changeovers, an operation where the fluid flowing through the system is switched to a second and different fluid, is shown in this analysis to be a large contributor to the overall waste level. Changeovers are common in multi-product factories and occur whenever production switches to a different product, to a water rinse or a CIP (**C**leaning **I**n **P**lace) cycle or vice versa.

UHT/Pasteurisation lines and food factories typically consist of long pipe lines, over which an extended interface between the two fluids develops. This interface length is hypothesised to be a function of the length of the pipe and equipment system, the system geometry, the rheology and density of the fluids and the flow conditions. This research aims to explore the influence these parameters have on the interface length in order to identify means to actively reduce changeover lengths during production.

ANSYS Fluent is being used to model a short pipe section designed to resemble a subsection of a UHT/Pasteurisation line at changeover (geometry is shown in Figure 1.). At time zero this pipe is filled with one fluid with defined properties. The incoming fluid has different properties to the fluid already in the pipe.

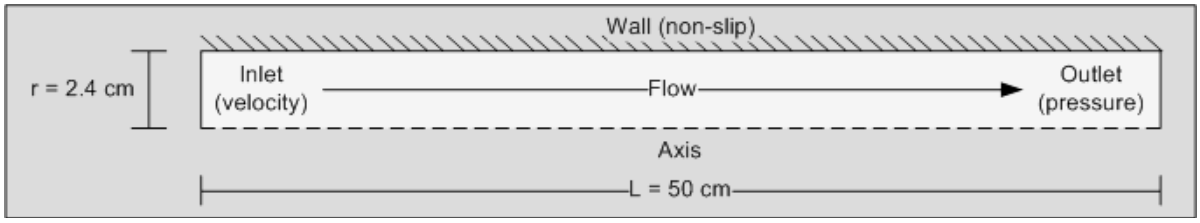

Figure 1.: The model/experimental geometry

The model is being validated using PLIF (**P**lanar **L**aser **I**nduced **F**luorescence). This involves a transparent pipe test section with the same geometry as in the ANSYS Fluent model as shown in Figure 1. In this experiment the pipe is initially filled with a dyed fluid which is then flushed out with a dye free second fluid. This flow passes through a plane of laser light which causes the dye to fluoresce and makes it possible to visualise the spatial distribution of both the dyed and undyed fluid. Figure 3 shows a typical PLIF image of a pipe cross section.

The modeling results suggest that changeover length is shorter in situations where the second fluid has a higher viscosity than the fluid initially filling the system. This trend can also be seen in the PLIF experimental results (see Figure 2.). Furthermore, the ANSYS Fluent model results and PLIF experiments suggest that the changeover length can be estimated/predicted from the residence time distribution of the test section.

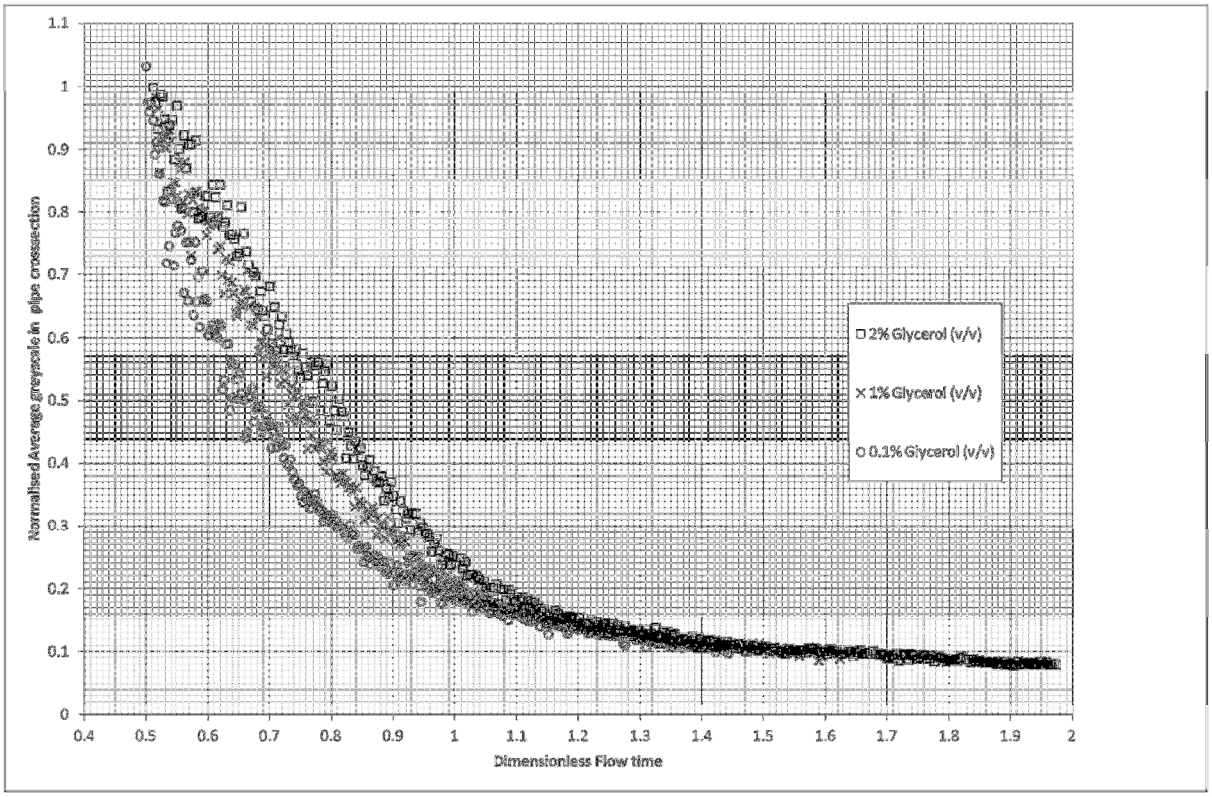

Figure 2: The effect of initial fluid viscosity on changeover length.

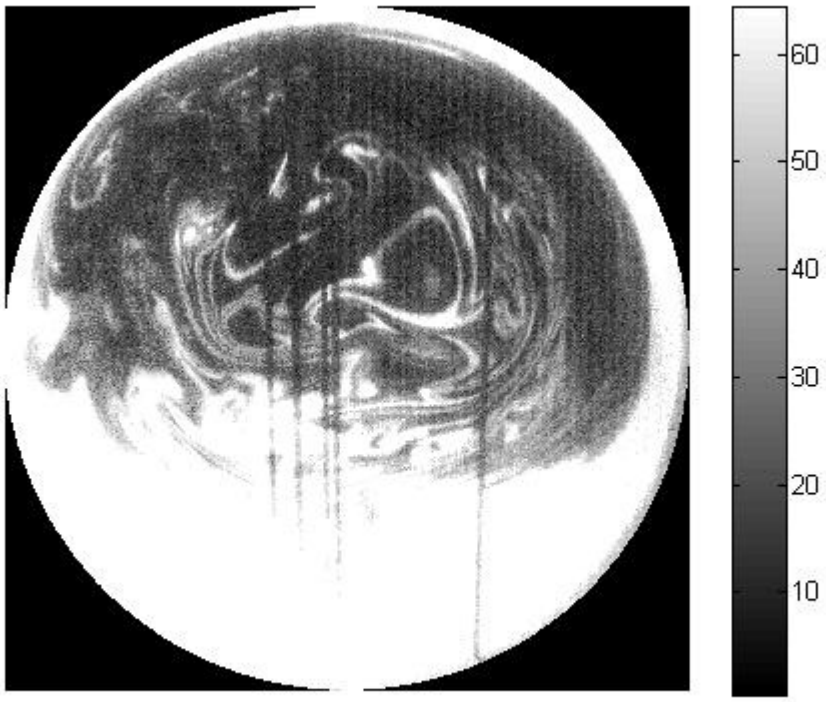

Figure 3: A typical PLIF image. This is an image of the plane through which the laser penetrates. The high value areas of the image (white) represent highly fluorescing sections of fluid and the low value areas (black) represent areas with lesser fluorescence.