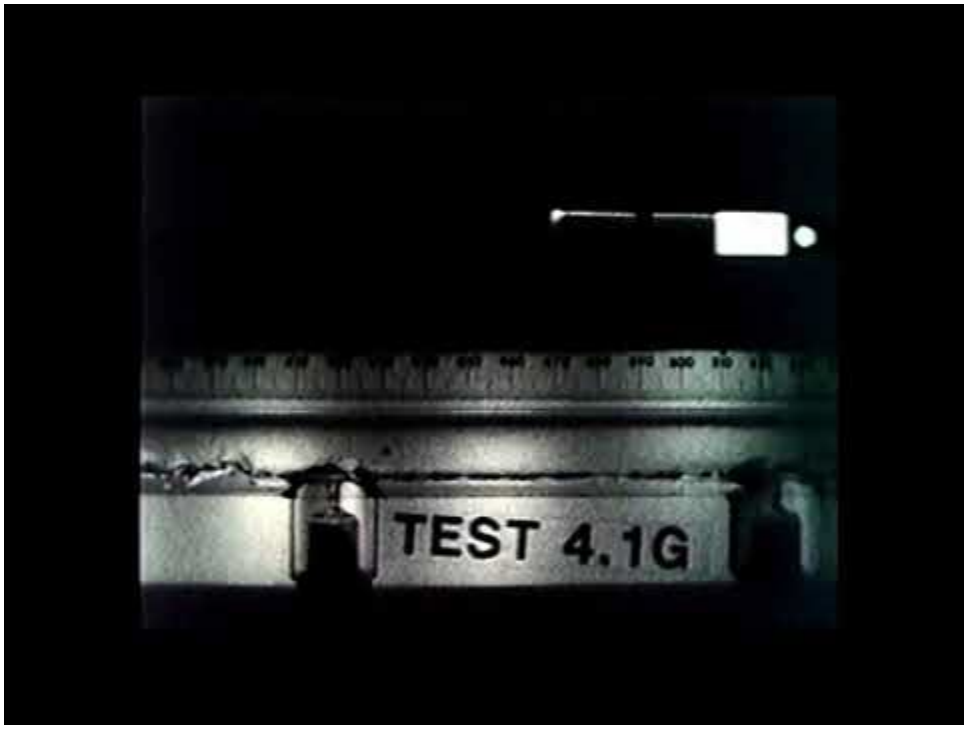
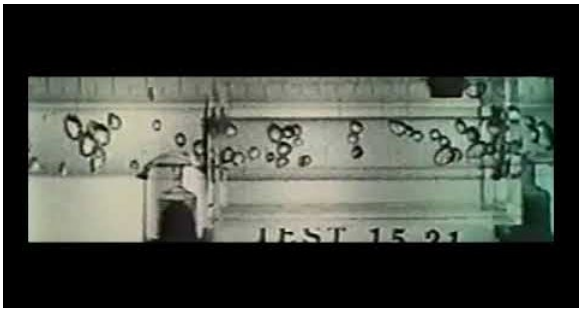
Two-Phase Flow in a Microgravity Environment

The Fluid Physics branch of the Microgravity Science Division at NASA Glenn Center is conducting research on the effects of microgravity on two-phase flow. Flow is essential to many processes, and there are seven kinds of flow distinguishable on earth due to forces imposed by gravity. Microgravity can simplify flow due to the almost non-existent amount of gravity present; there are three principal types of flow regimes in microgravity: bubbly, slug, and annular.

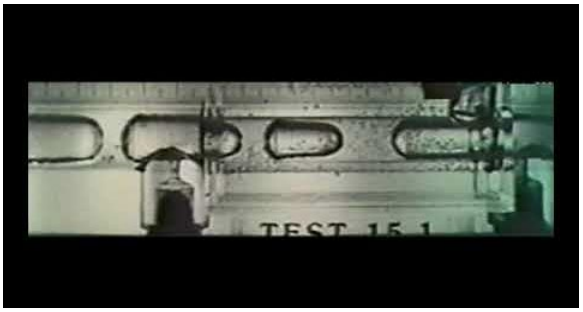


Two Phase Flow Regimes in Reduced Gravity (5-17-1987)

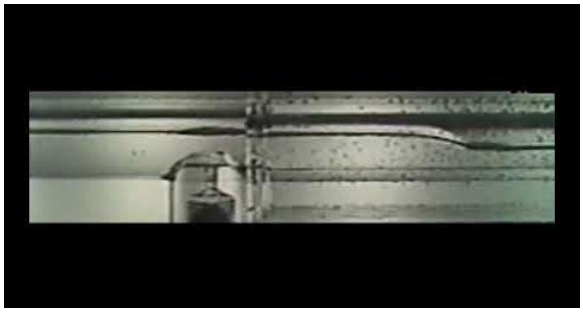
Principal types of flow regimes

Type of Flow	Microgravity	Normal Gravity
Bubbly		
	807 kBytes	371 kBytes

Slug

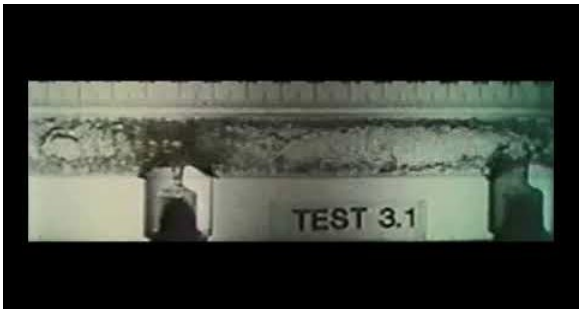


1,867 kBytes



863 kBytes

Annular



543 kBytes

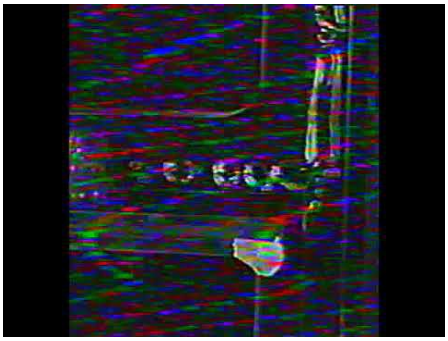
575 kBytes

However, flow systems do not consist of entirely straight pipes. The following pictures and movies have been taken in microgravity for a variety of tubing configurations.

Tubing configurations – flow through tees

The first set of movies involves flow through tees.

Bubbly

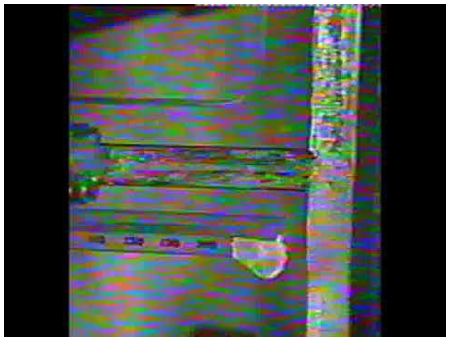


1,417 kBytes

Slug

779 kBytes

Annular



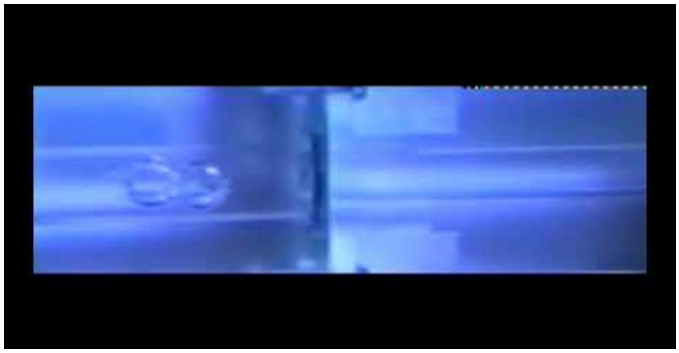
815 kBytes

The flow enters the tee at the bottom of the image and is split between the “side-arm” branch and the “run”. The tee has 1.27 cm inner diameter.

Vena Contracta

A contraction is a reduction in the tubing size. Within the contraction, there is a fluid recirculation zone called a “vena contracta.” The “wet” image is when the liquid is recirculating with the vena contracta; however, there are conditions whereby the gas phase gets caught in the vena contracta and dries out the wall.

Wet **Dry**



1,191 kBytes

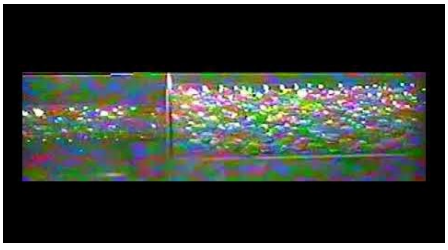
937 kBytes

Wet flow through vena contracta is a bubbly slug flow from a 25mm diameter tube into a 19mm tube; as the liquid is forced to contract, the flow changes from bubbly flow to slug flow. Dry flow through vena contracta is an annular flow from a 25mm diameter tube into a 12.7mm diameter tube.

Fluid recirculation near the “corner”

fluid recirculation near the “corner” An expansion is an increase in the tube size. Again, there is an area of fluid recirculation near the “corner” of the sudden expansion. Depending on the flowrates, either bubbly liquid or gas are trapped in this region.

Normal **Gap** **Jet**



1.633 kBytes

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2003 kBytes

At the inlet, fluid moves from a 12.7mm diameter pipe to a 25mm pipe. Normal expansion takes place at the beginning of flow, and soon a gap expansion occurs as the flow is recirculated and flow velocity continues to increase. A two-phase jet is created eventually, with regions of air flowing above and beneath a region of bubbles.