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SIDES: Space Italian Dressing Experimental Setup

Getaway Special Team 2009

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SIDES



Space Italian Dressing Experimental Setup

Project Overview

SIDES will provide further understanding of fluid segregation and interfacial dynamics by experimenting with three fluids of differing densities in the absence of buoyancy and convective forces. The three fluids water, mineral oil, and gaseous nitrogen are mixed by SFP interaction. Direct comparison to similar experiments on Earth will allow exploration of the effects of microgravity.

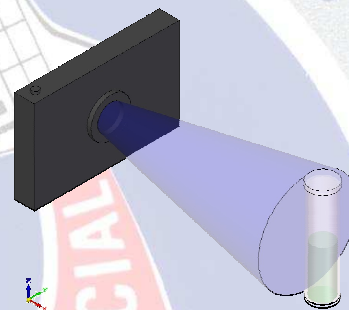
Payload Requirements

Mass: 30 g

Dimensions: 100 mm x 25 mm \varnothing

Power: None

Data Acquisition: 1-2 hr video



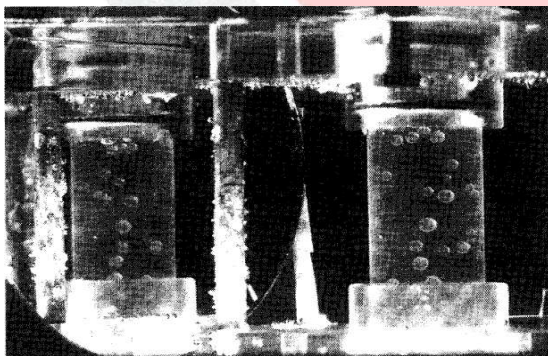
Schematic of experimental apparatus

Experiment Objectives

The primary objective is to observe how fluids separate in microgravity. The secondary objective is to determine if interface bubbles burst due to surface tension or buoyancy forces.

Key measurements to accomplish this are:

- Bubble size versus time to rupture
- Bubble segregation versus time
- Bubble size versus segregation rate



Experimental study of dispersed liquid/liquid two-phase upflow in a pipe. Nigmatulin, T.R. Chemical Engineering Communications, 2000.

Scientific Justification

Scientific study has been performed on pipe flow with two immiscible fluids, but very little research has been found on the time required for fluid segregation in microgravity. Preliminary studies on Earth indicate bubbles of approximately 1 mm in diameter will segregate in approximately 1-3 minutes in SIDES. Preliminary estimates postulate that this separation will take 1 to 2 hours in microgravity. Such segregation times exceed microgravity duration available with drop tower or KC-135 flight opportunities. Understanding the principles of fluid segregation without convection or gravity could aid in more efficient design of fluid storage, fluid mixing, and thermal transfer applications in space.

Experiment Design

The experimental apparatus consists of a 95 mm x 19 mm \emptyset polycarbonate tube filled with equal volumes of colored water, mineral oil, and gaseous nitrogen. The presence of the nitrogen allows for greater mixing between the oil and water as well as acting as a safety precaution by allowing the liquids to expand should the experiment freeze. Video data is acquired by means of a camera focused on the middle 2 cm of the tube. The simplicity of the design allows for high quality video and minimal required resources. A red grid inside the containment cell will provide in situ measurement calibration. Velcro placed on one end cap will allow SIDES to be mounted on the ISS wall after agitation. Timing information and approximate impulse during mixing will be measured directly from the video.



1st generation



2nd generation

SIDES prototypes

Involvement of the Space Flight Participant

Ground tests will be performed and recorded by GAS team members at USU and (if desired) by the SFP prior to launch. The SFP will be required to shake the tube and set up the video camera. The experiment should be run several times, if time permits, and can be restarted as often as the fluids separate. The SFP can note visual observations during the tests on the audio portion of the video recording. Overall, the training is minimal and includes test runs of the experiment to ensure understanding of shaking forces necessary for desired results and correct video and audio recording.

SFP On-orbit Time Required: 15 min

SFP Training Time Required: 30 min

SFP Ground Test Time (optional): 30 min

Critical Safety Issues

The primary safety concern is the rupture of the fluid cell. The fluids used (high purity water, inert dry nitrogen gas, chemical grade mineral oil, and water soluble dye) are non-hazardous, but may pose a threat to electrical systems. High-impact strength polycarbonate components are all fused with methylene chloride solvent. A redundant secondary containment capsule will provide increased safety in case of containment breach. Rupture tests of both inner and outer capsule walls will be performed by filling the cells with fluids and gasses at 1 atm and placing the filled cells in a vacuum chamber. Thermal cycling to sub-zero temperatures will also be performed.

Project Timeline

A prototype fluid tube has been completed. A final test tube will be assembled in a nitrogen gas chamber. Safety testing will follow. An estimated timeline is listed to the right.

| Date | Milestone |
|---------|---|
| May 18 | Safety test completed |
| May 26 | Prototype delivered for safety review |
| June 15 | Safety review completed |
| June 22 | Ground testing & videos completed |
| June 29 | Apparatus and instructions delivered to SFP |

Project Leads

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