Numerical and Experimental Studies of a DYNASWIRL® Phase Separator for Space Applications.

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The limited amount of liquids and gases that can be carried to space makes it imperative to recycle and reuse these fluids. Over the past few years, DYNAFLOW INC. has been actively developing a passive phase separator based on its DYNASWIRL® nozzle technology through ground tests and reduced gravity flight experiments. The unique design of the swirl chamber comprises two concentric cylindrical chambers. The two-phase bubbly flow introduced in the space between the two cylinders enters the inner cylinder through several tangential inlet slots to generate a strong swirling flow. This configuration is able to generate a stable vortex core to capture gas bubbles even at low flow rates. Using an experimental facility constructed at DYNAFLOW that mimics the NASA breadboard to be tested in International Space Station (ISS), extensive experiments have been conducted on the ground to characterize the flow and gas extraction under different conditions. The corresponding void fraction, pressure profile, flow field, and liquid and gas flow rate are obtained and compared with the numerical simulation results. The numerical simulations of the phase separator have been achieved by coupling a Navier-Stokes flow solver to model the overall two phase flow field of the DYNASWIRL® phase separator, and a bubble tracking and dynamics and motion solver. Without conducting additional reduced gravity flight tests, the numerical simulations are used to predict the performance of the phase separator under reduced gravity and to highlight the effects of gravity on the performance. Results from these numerical and experimental studies will be presented in the paper.

Supported by NASA under Grant No. NNX11AO76A and NNX16AB85A, Dr. Eric L. Golliher, Project Scientist, Mr. William A. Sheredy, Project Manager.