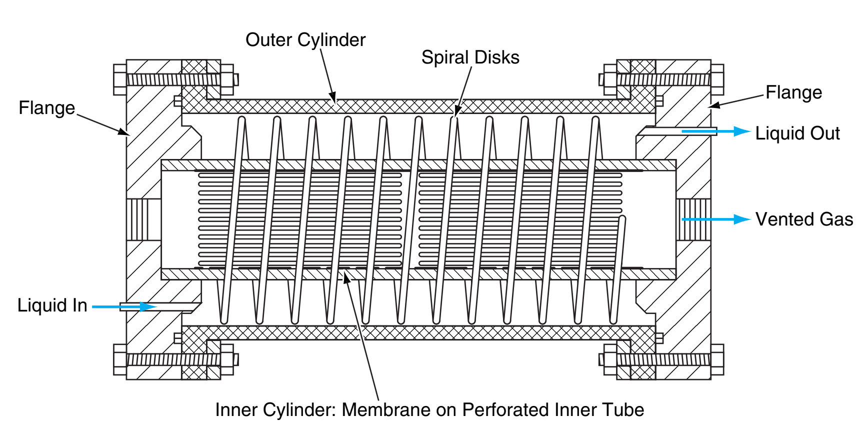
Mechanics

Bubble Eliminator Based on Centrifugal Flow

This device contains no moving parts.

Lyndon B. Johnson Space Center, Houston, Texas

The fluid bubble eliminator (FBE) is a device that removes gas bubbles from a flowing liquid. The FBE contains no moving parts and does not require any power input beyond that needed to pump the liquid. In the FBE, the buoyant force for separating the gas from the liquid is provided by a radial pressure gradient associated with a centrifugal flow of the liquid and any entrained bubbles. A device based on a similar principle is described in "Centrifugal Adsorption Cartridge System" (MSC-22863), which appears on page 48 of this issue. The FBE was originally intended for use in filtering bubbles out of a liquid flowing relatively slowly in a bioreactor system in microgravity. Versions that operate in normal Earth gravitation at greater flow speeds may also be feasible.



The **Spiral Disks Channel the Liquid** into a spiral flow, which gives rise to a pressure gradient that drives bubbles toward the inner cylinder.

The FBE (see figure) is constructed as a cartridge that includes two concentric cylinders with flanges at the ends. The outer cylinder is an impermeable housing; the inner cylinder comprises a gas-permeable, liquid-impermeable membrane covering a perforated inner tube. Multiple spiral disks that collectively constitute a spiral ramp are mounted in the space between the inner and outer cylinders.

The liquid enters the FBE through an end flange, flows in the annular space between the cylinders, and leaves through the opposite end flange. The spiral disks channel the liquid into a spiral flow, the circumferential component of which gives rise to the desired centrifugal effect. The resulting radial pressure gradient forces the bubbles radially inward; that is, toward the inner cylinder. At the inner cylinder, the gas-permeable, liquid-impermeable membrane allows the bubbles to enter the perforated inner tube while keeping the liquid in the space between the inner and outer cylinders. The gas thus collected can be vented via an end-flange connection to the inner tube.

The centripetal acceleration (and thus the radial pressure gradient) is approximately proportional to the square of the flow speed and approximately inversely proportional to an effective radius of the annular space. For a given FBE geometry, one could increase the maximum rate at which gas could be removed by increasing the rate of flow to obtain more centripetal acceleration. In experiments and calculations oriented toward the original microgravitational application, centripetal accelerations between 0.001 and 0.012 g [where $g \equiv$ normal Earth gravitation (≈ 9.8 m/s^2)] were considered. For operation in normal Earth gravitation, it would likely be necessary to choose the FBE geometry and the rate of flow to obtain centripetal acceleration comparable to or greater than g.

This work was done by Steve R. Gonda of **Johnson Space Center** *and Yow-Min D. Tsao and Wenshan Lee of Wyle Laboratories. For further information, contact the Johnson Commercial Technology Office at 281-483-3809.*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-22996.

Inflatable Emergency Atmospheric-Entry Vehicles

Ballutes would act as inexpensive, lightweight atmospheric decelerator "lifeboats."

NASA's Jet Propulsion Laboratory, Pasadena, California

In response to the loss of seven astronauts in the Space Shuttle Columbia disaster, large, lightweight, inflatable atmospheric-entry vehicles have been proposed as means of emergency descent and landing for persons who must abandon a spacecraft that is about to reenter the atmosphere and has been determined to be unable to land safely. Such a vehicle would act as an atmospheric decelerator at supersonic speed in the upper atmosphere, and a smaller, central astronaut pod could then separate at lower altitudes and parachute separately to Earth.

Astronaut-rescue systems that have been considered previously have been massive, and the cost of designing them has exceeded the cost of fabrication of a