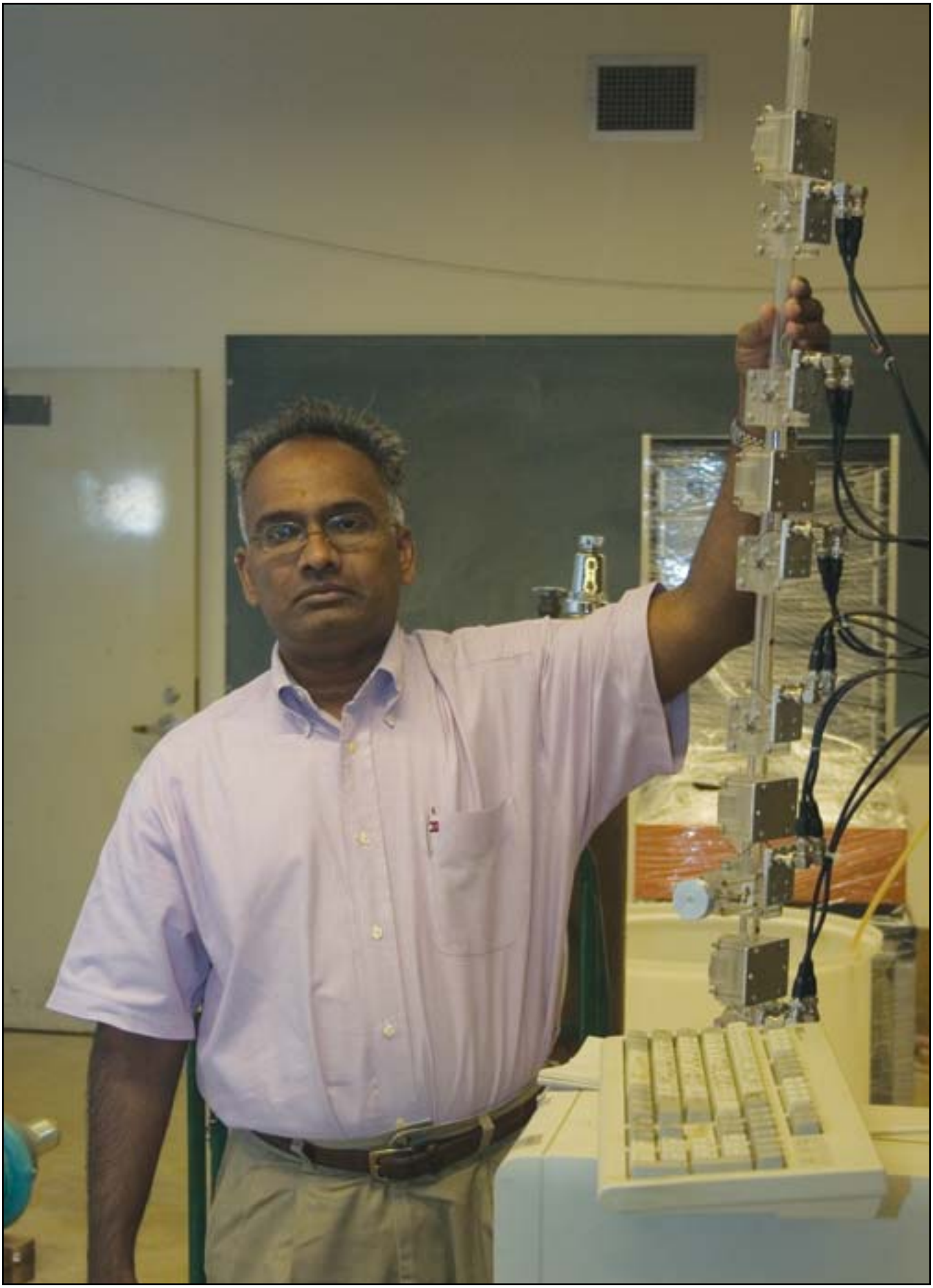

Two-Phase Flow Instabilities in Tubular Reactors Used in Biological Wastewater Treatment in Microgravity

Vemuri Balakotaiah [UH] / Cesar Meza [UH]

Biological processes are currently being investigated for use in spacecraft wastewater treatment. In a biological process, microorganisms are used to degrade organic and inorganic contaminants to carbon dioxide, water, and other metabolic products. One main step in the process is nitrification by which ammonium ions in the wastewater stream are converted to nitrate ions. The reactor used in the process is a small diameter (3 mm) coil of a length about 100 m in which air and wastewater flow co-currently (slug or Taylor flow regime). Aerobic microbes flow on the tube walls. Recent experiments have shown that the bioreactor experienced occasional shedding events where biomass was dislodged from the tube wall.

The work of UH investigators focused upon two-phase flow instabilities in tubular bioreactors, with the ultimate goal of improving the bioreactor performance and scaling it up from normal gravity to the microgravity environment. Flow experiments utilized fluids of different viscosity and surface tension to characterize the critical Reynolds numbers at which the slug-annular transition occurs and investigated the stability of bioreactor in the annular regime. A phenomenon of pressure drop jump and hysteresis in the pressure drop versus flow rate curve was observed near the slug-annular transition point.

Publications

Lastochkin, D., E. K. Dao, and V. Balakotaiah. "Inertial Effects and Wave Suppression on Vertically Falling Films," *Phy. Fluids* (*in review*).

Presentations

Balakotaiah, V. and B. J. Motil. "Fundamental Studies Gas-Liquid Two-Phase Flows Through Packed-Beds in Microgravity," Cleveland, OH, June 2004.

Funding and proposals

Balakotaiah, V. "Fundamental Studies on Gas-Liquid Two-Phase Flows Through Packed-Beds in Microgravity." NASA-Glenn Research Center, 2002-2006, $405,000. With M. J. McCready, Notre Dame and B. J. Motil, NASA-Glenn; Funding for UH is $205,000.

"Gravity Independence of Two-Phase Gas-Liquid Flows." NASA-GSRP grant for Mr. Cezar Meza, $75,000 (3 years) (*not funded*).

"Modeling and Experimental Studies on Gas-Liquid Hydrodynamics and Mass Transfer in Bioreactors for Wastewater Treatment in Low Gravity." NASA Fluid Physics NRA, $400,000 (4 years) (*not funded*).

McCready, M. and V. Balakotaiah. "Determination of Gravity Independence of Two-Phase Gas-Liquid Flows through Conduits," NASA Fluid Physics, UH funding, $200,000 (4 years) (*pending*). (Joint proposal with M. McCready, Notre Dame.)

TWO-PHASE FLOW—Dr. Vemuri Balakotaiah, Professor of Chemical Engineering, studies a 1" ID test section designed by graduate student researchers to measure properties of wave and gas liquid flow in pipes.

RE-DESIGN—Cesar Meza, second-year doctoral student in the Department of Chemical Engineering, has designed and built a 1-1/2" ID two-phase flow simulator control. Meza's research advances methodology in the laboratory of interest to industry. Meza completed a B.S. degree at Lehigh University in Pennsylvania.