Foam Engineering Research Group

Department of Chemical & Materials Engineering, University of Auckland

Paul Stevenson, 14th September 2012

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

General Information about the Foam Engineering Research Group

Team Leader: Paul Stevenson

Personnel: 3 PhD students, 1 post-doc, 1 technician, several honours students. All Chemical Engineers.

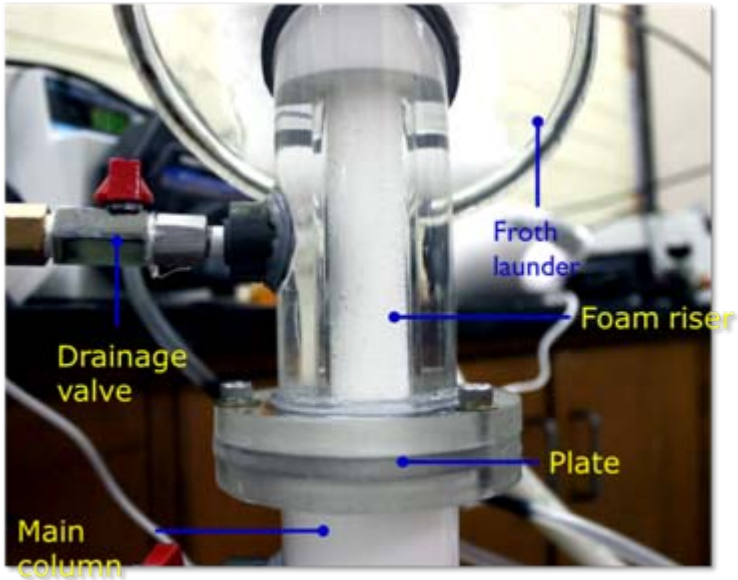
General Research Themes: Application of gas-liquid foams in process systems, including foam fractionation, froth flotation and mass transfer in foam. Understanding the fundamental physics of such processes.

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

Project 1: Industrial Development of Foam Fractionation

Research Question: Can advances in foam fraction by scaled-up to process 210 tonnes/day Nisin (food preservative) broth
Funding: Silver Elephant Biotechnology Company, Zhejiang, China.
People: Paul Stevenson, Ray Li (Chinese Engineering Consultant), Silver Elephant personnel.

- We have spent many years investigating the hydrodynamics of rising columns of gas-liquid foam.
- This knowledge has enabled the innovation of column internals for foam fractionation.
- Currently designing a large-scale foam fractionation installation in China using these innovations.



THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

Project 2: Protein Unfolding on Adsorption to Gas-Liquid Interfaces

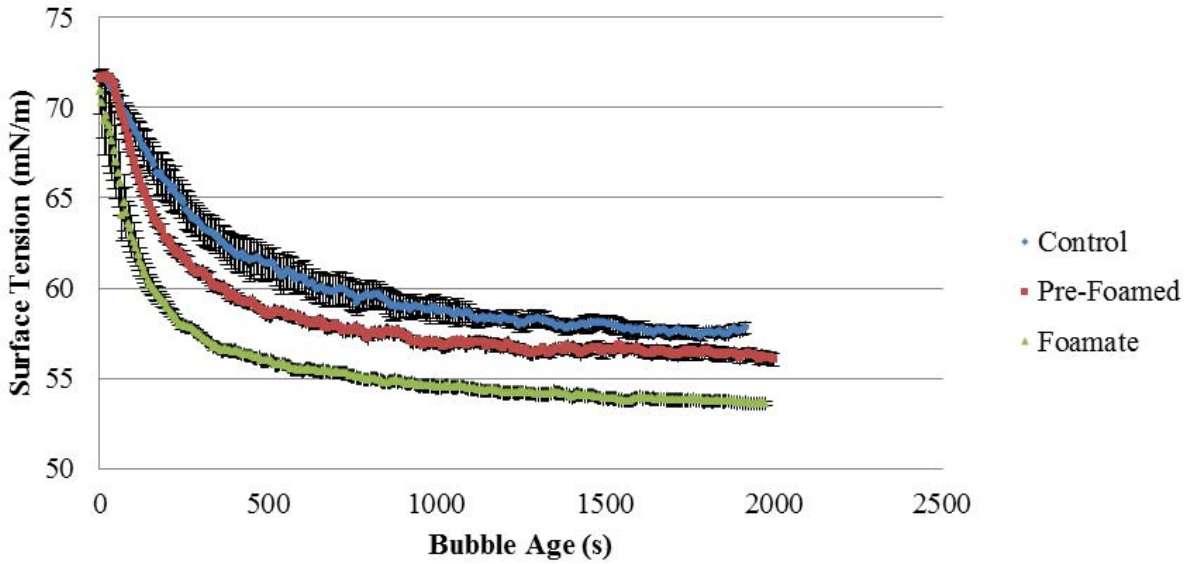
Research Question: When proteins adsorb to foam bubbles (as in foam fractionation) do they lose function by unfolding?

Funding: Fonterra Pty. Ltd. and Institution of Chemical Engineers.

People: Claire Burnett (Honours Student) & Paul Stevenson.

Methods: Dynamic surface tension measurement using a Dataphysics Goniometer.

Results for adsorption of BSA to gas-liquid interfaces: Foam fractionation appears to cause significant denaturation of the protein.



THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

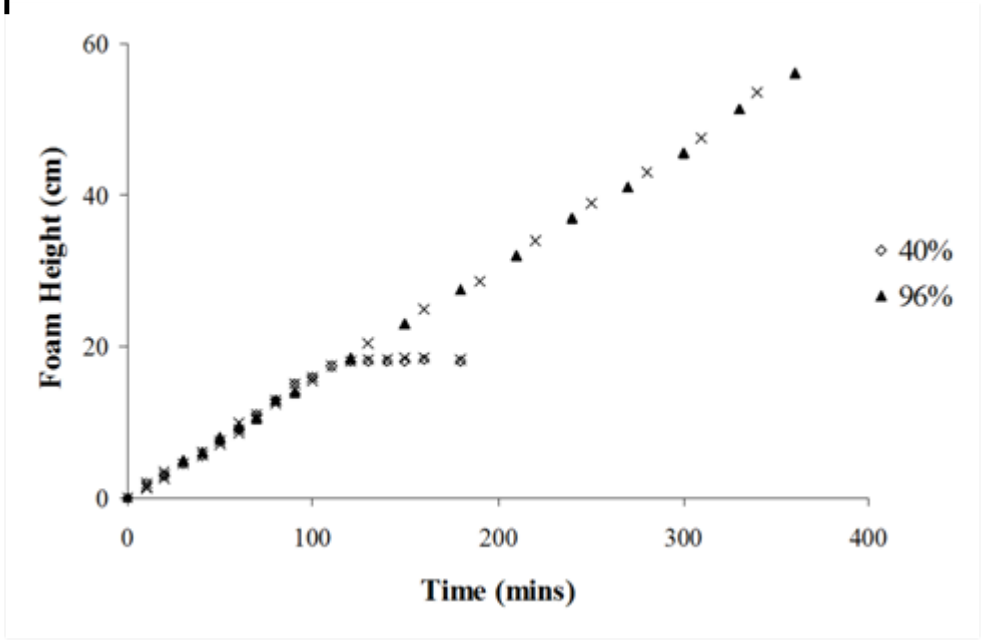
Project 3: Foam Instability at Free Surfaces

Research Question: What causes bubbles to burst on the free surface of foam?

Funding: Australian Research Council

Personnel: Bruce Li (PhD student) & Paul Stevenson

- We have shown that results from the Bikerman foam stability test are dependent upon environmental humidity.
- The implications are that froth flotation performance is dependent upon environmental humidity.
- We have a hypothesis that non-uniform evaporation causes Marangoni flows that promote film instability.



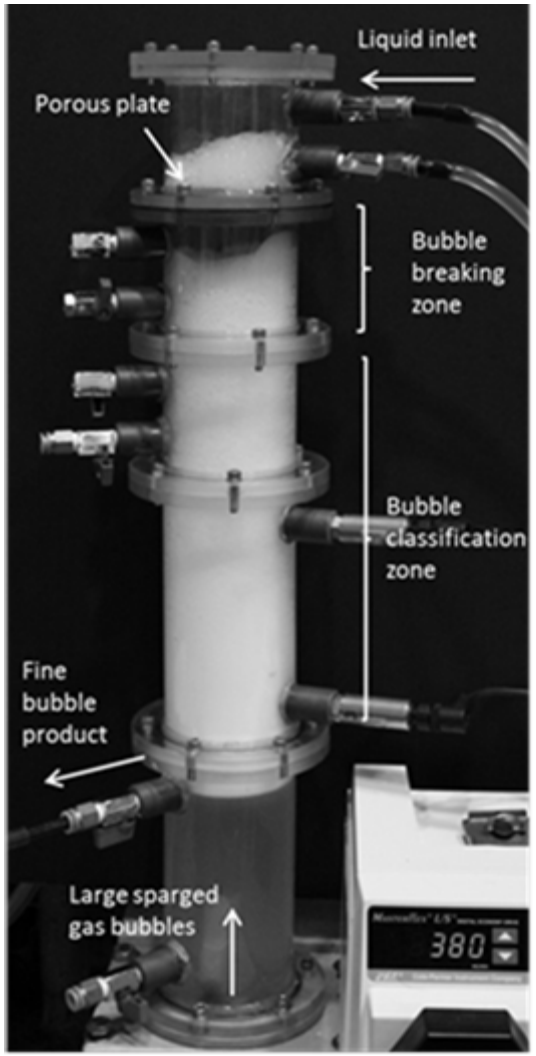
THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

Project 4: Energy Efficient Production of Small Bubbles

Research Question: Can very small bubbles be produced from a foam column by impinging jets?

Funding: Lanzatech Biotechnology, Auckland

Personnel: Paul Stevenson & Lanzatech staff



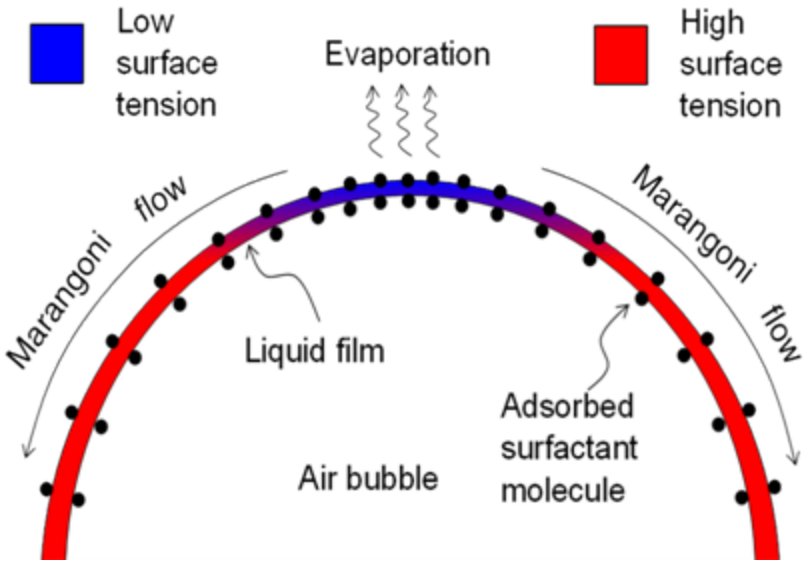
- The production of small bubbles in an energy efficient manner in a novel unit has been investigated.
- Bubble of approximately uniform diameter of 18 microns can be produced.
- Currently measuring energy consumptions and comparing with other devices.
- Designing mass transfer devices for biological digestion of waste gases.

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

Proposal 1: Imaging the Evaporation-Induced Marangoni Flows

<u>Hypothesis to be tested</u>
Non-uniform evaporation from the free surface of a bubble induces a Marangoni instability that causes film rupture.

<u>Expertise required</u>
Thickness (interferometric) measurements of thin films undergoing non-uniform evaporation.



THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

Proposal 2: Imaging Protein Unfolding at Interfaces

We have established that the dynamic surface tension of a protein solution-gas interface is different if the proteins have had opportunity to undergo a previous unfolding process.

We would like to know the extent of unfolding upon interfacial adsorption, as well as ascertaining a rate constant for the segment unfolding process.

<u>Expertise required</u>

We know very little about proteins, or biology in general. We'd like to image the unfolding process at the interface. Do we use "Circular Dichroism"?