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Project # 81867

Foaming and Antifoaming in Waste Pretreatment and Immobilization Processes

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Collaborators

- IIT brings its research is team led by Prof. Darsh Wasan and Alex Nikolov (Research Prof.) along with graduate students.
- IIT has been working with SRTC since 1996 to develop better antifoams for processing HLW in the Defense Waste Processing Facility and the Alternate Sludge Processing.
- IIT had a previous EMSP grant for fundamental foam chemistry that led to the development, deployment and demonstration of better antifoam formulations for SRS-DWPF sludge receipt and adjustment tank process.
- SRTC brings researchers led by Dan Lambert and Bond Calloway along with facilities that allow testing of simulants and radioactive waste critical in the understanding of what causes the foam. Dan and Bond have close ties to the SRS and Hanford facilities that will use the antifoam in their processing.

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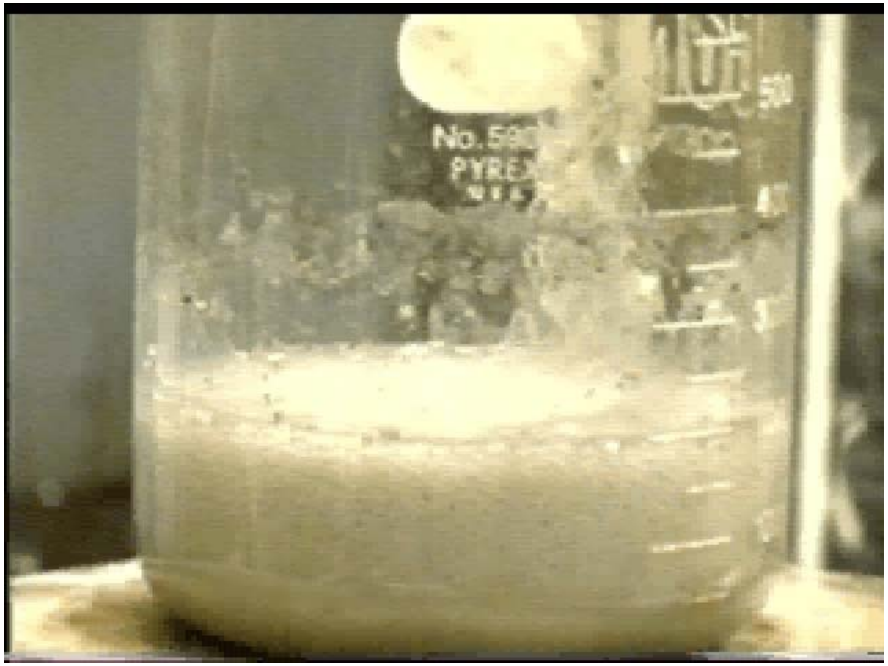
Scientific concept and objectives

- The objectives of this proposed multidisciplinary, multi-organizational research effort are to develop a fundamental understanding of the chemical and physical mechanisms that produce foaming in the DOE High Level (HLW) and Low Activity (LAW) radioactive waste separation processes and to develop and test advanced antifoam/defoamer agents.

PRETREATED AN-107 ATMOSPHERIC PRESSURE (760 mm Hg)

Foam Picture



Foam is unstable

Foam disappears when heat is removed.

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Outline

- Scientific concept and objectives
- Site-specific problems
- Approach
- Key results
- Future directions and plans
- Sample needs/Desired collaborations

Objectives

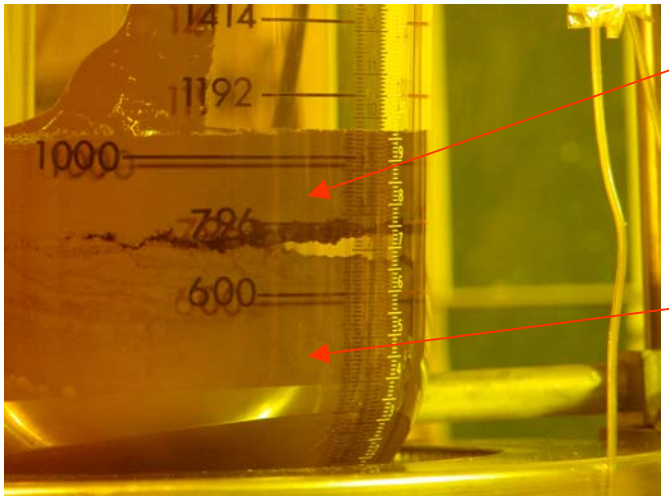
- Establish the effects of soluble and insoluble inorganic components and organic complexants on foam formation and stability in alkaline and acidic defense waste matrixes
- Develop a fundamental understanding of the interaction of organic waste components with insoluble solid waste components
- Develop and test advanced antifoam/defoaming agents on simulates of radioactive wastes and radioactive waste.

Site-specific problems

- Hanford Waste Treatment Plant – Foaming in Evaporators
  - Excess Carryover of Waste in Condensate Systems
- SRS DWPF – Air Entrainment (Foaming) During Sludge Pretreatment
  - Causes Pumps to Lose Prime
  - Limits Melt Rate/Canister Production RateAdds Excess Water

Foam in AN102

2



Sludge Solids Floating on top of the Supernate

Supernate

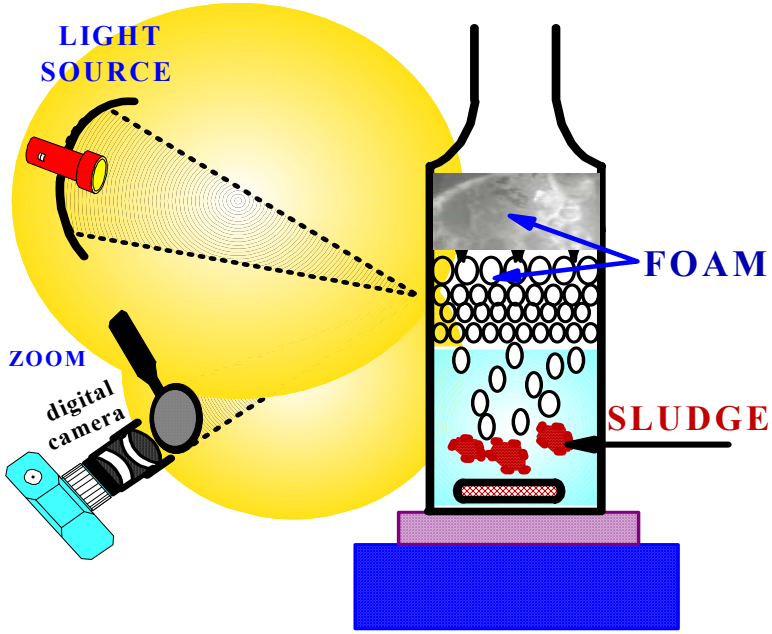
Air Entrainment in SRS Sludges

KTPB slurry

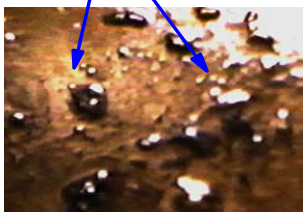
Washed Tank 40 Sludge Slurry to the DWPF Vessel After 4 Settling Time ~1 Hour

Approach

- Experimental and theoretical investigations of the surface phenomena, suspension rheology, and bubble generation that lead to the formation of foam during waste processing were developed under EMSP Project No. 60143.
- These techniques and other analyses will be used to understand the formation of foam in several areas:
  - SRS HLW evaporation
  - Hanford LAW/ HLW evaporation
- Commercial products and/or newly developed antifoamers will be tested to determine effectiveness.



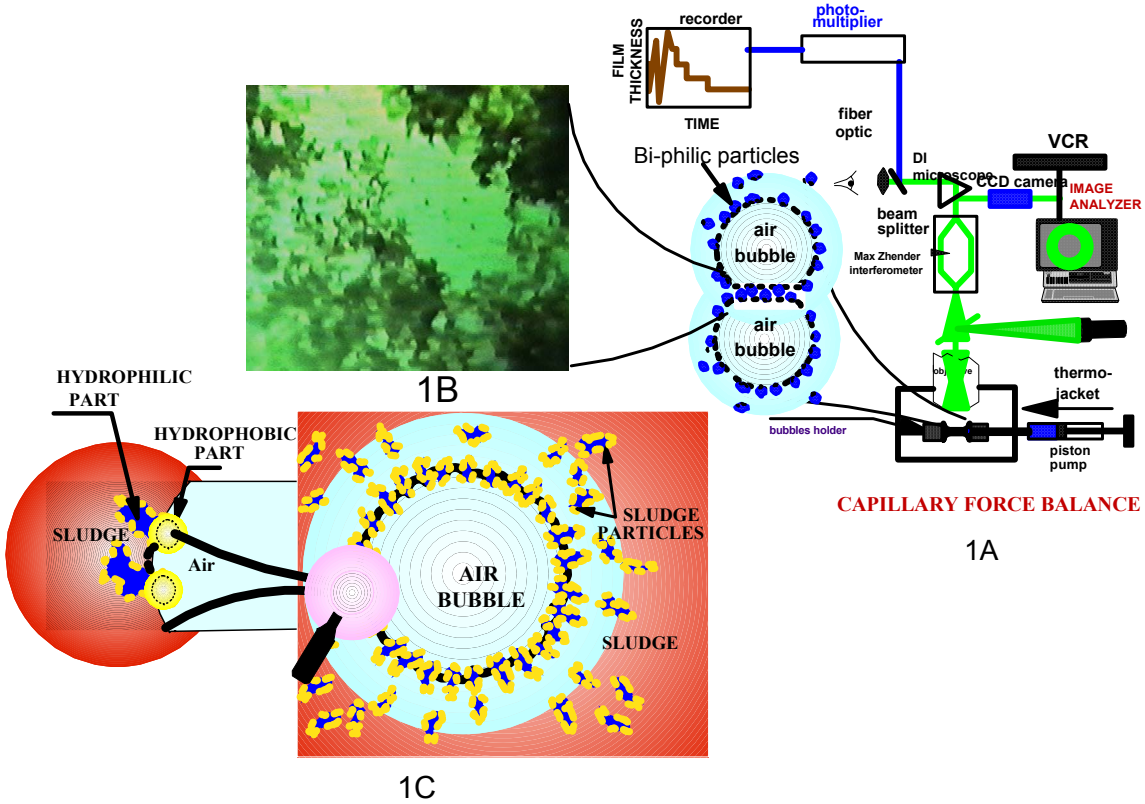
sludge particles



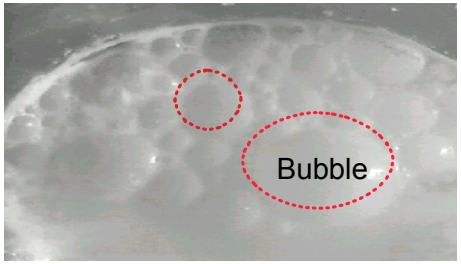
top view

foam lamella

EXPERIMENTAL SET-UP TO STUDY FOAMINESS IN THE PRESENCE OF SLUDGE PARTICLES



A schematic of the Capillary Force Balance for studying the bubble/bubble interactions in the presence of sludge particles



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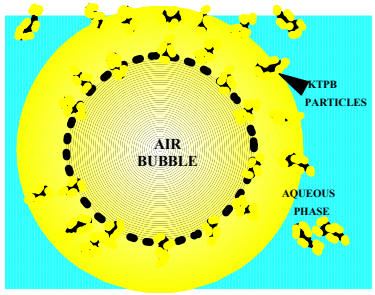
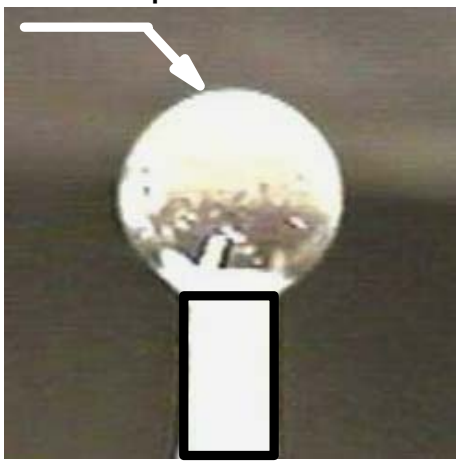
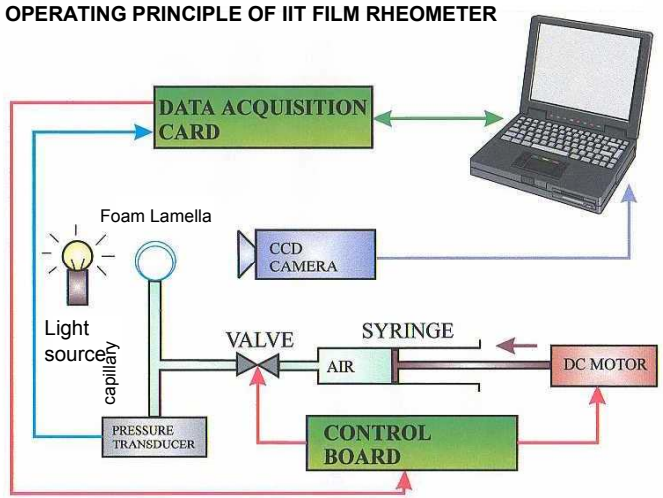


Foam lamella stabilized with KTPB particles



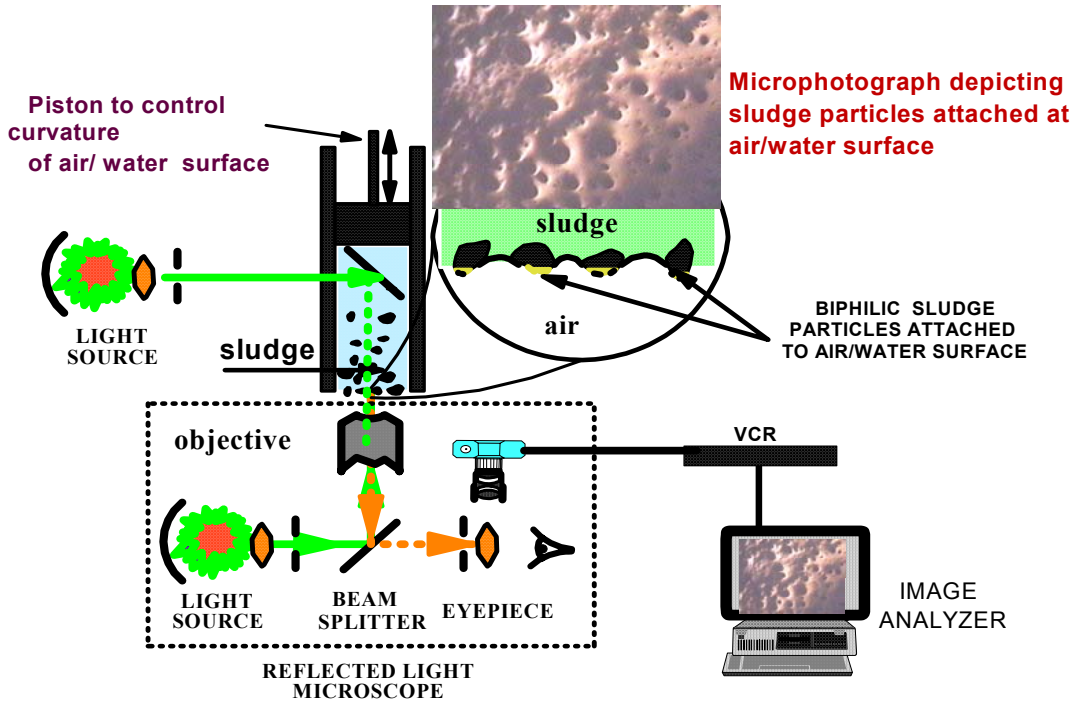
B

OPERATING PRINCIPLE OF IIT FILM RHEOMETER



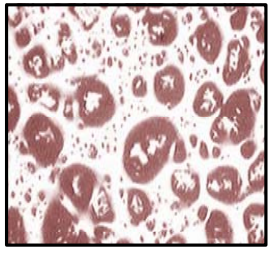
A

Part A: Principle of operation of IIT film rheometer; Part B: foam lamella containing particles; Part C: Photomicrograph of foam comprising foam lamella

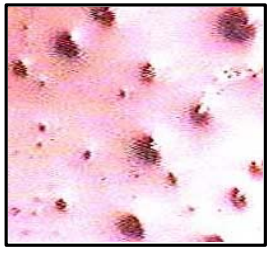


Schematic of an experimental set up to characterize the number of biphilic and hydrophilic particles.

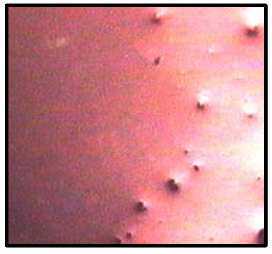
Pictures of amphiphilic particles attached at gas-liquid interface



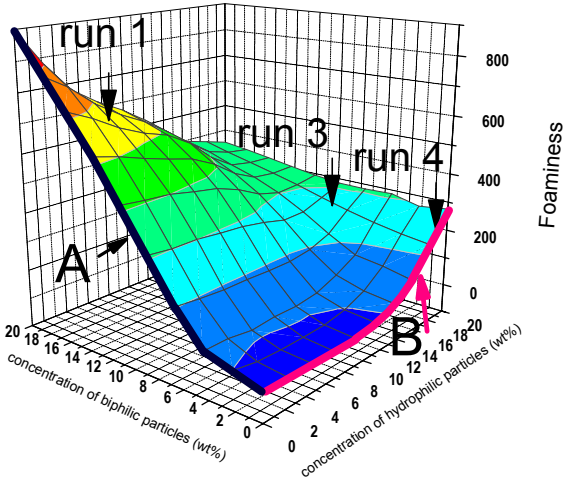
concentration of amphiphilic particles 16 wt%



concentration of amphiphilic particles 5 wt%

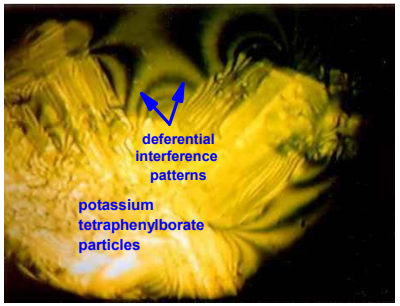


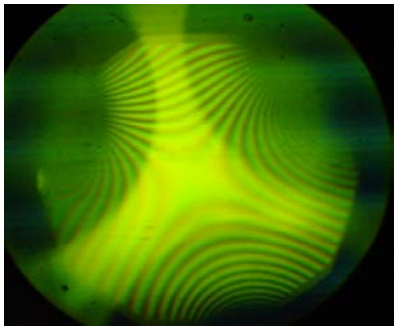
concentration of amphiphilic particles 1 wt%

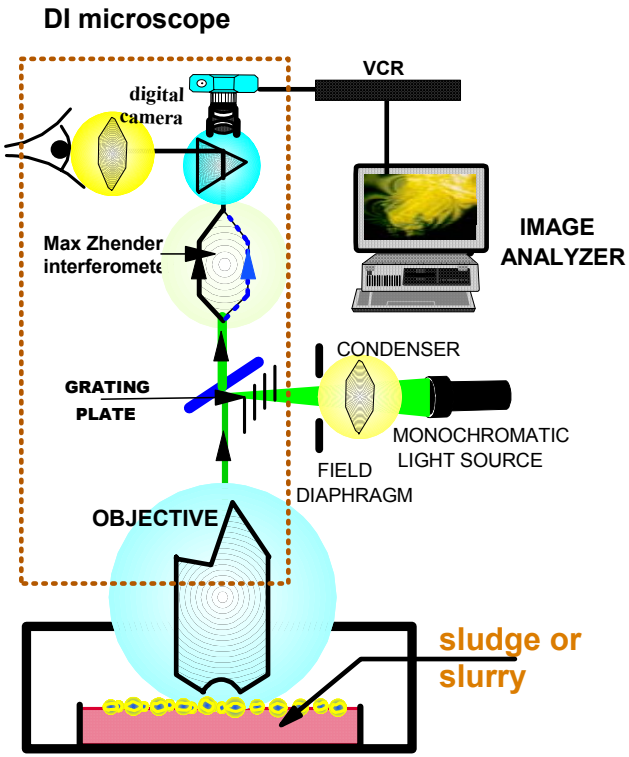


Effect of Amphiphilic and Colloidal particles on Foaminess

Innovative Approaches







Differential interference microscopy to study three-phase contact angle, and interactions of organics with insoluble water components.

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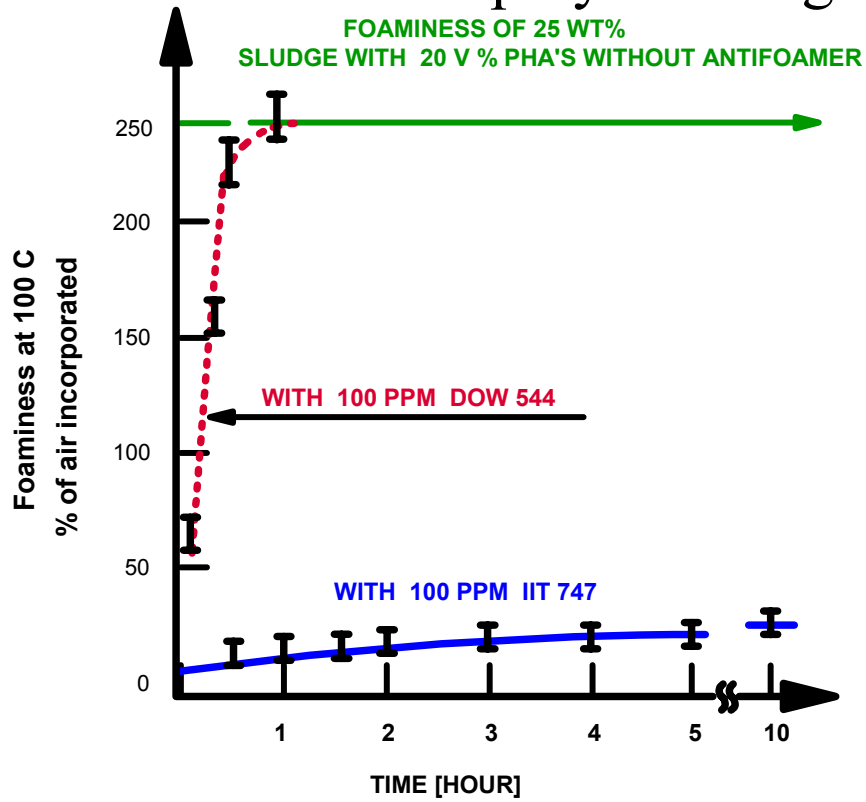
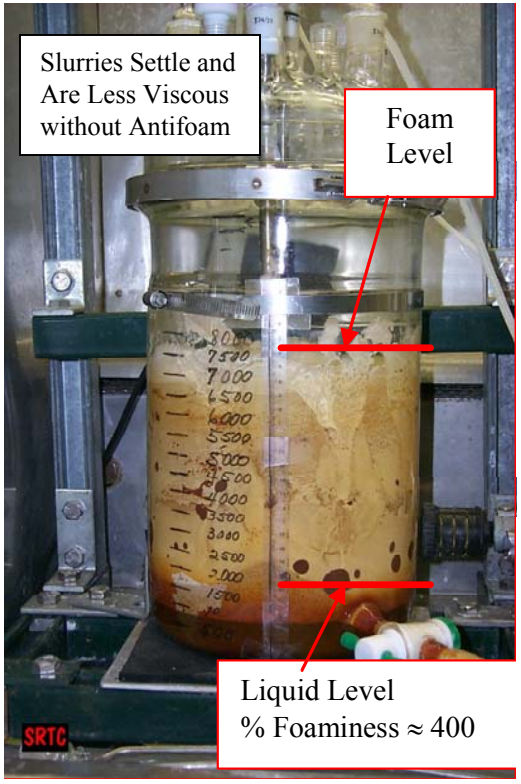
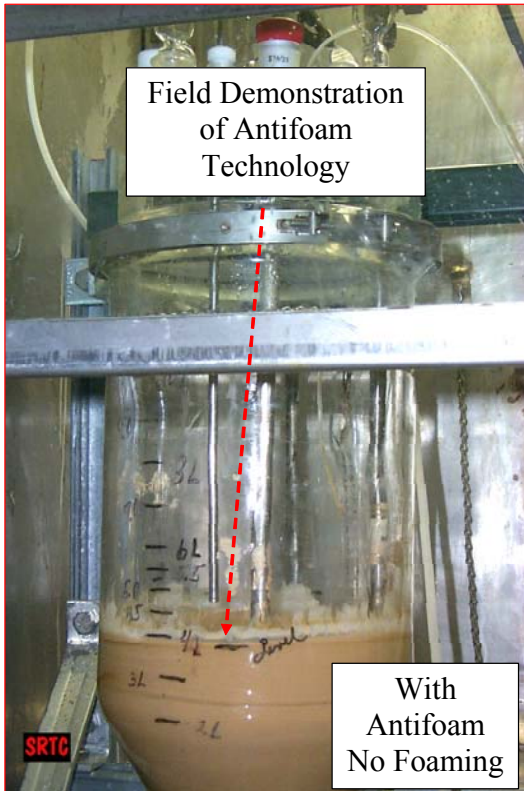
Background: EMSP Antifoam Deployed Using Research Techniques

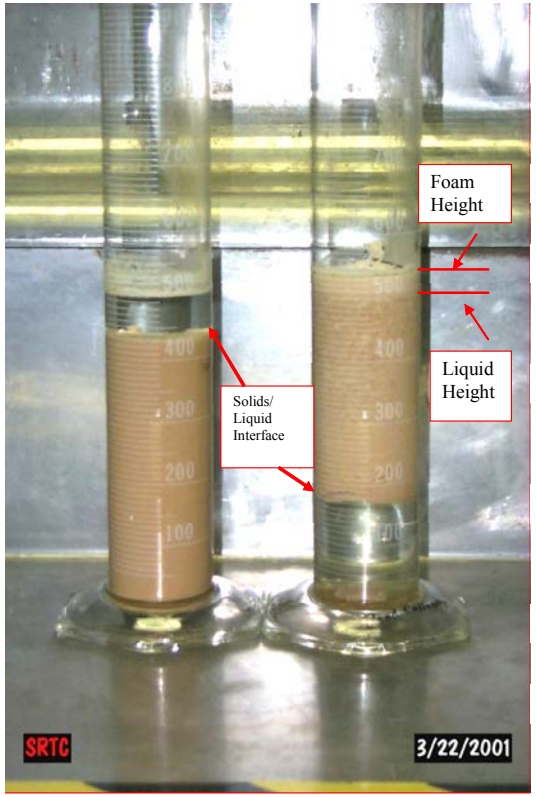


Effect of antifoamers on foaminess with time

Example of Effective Antifoam







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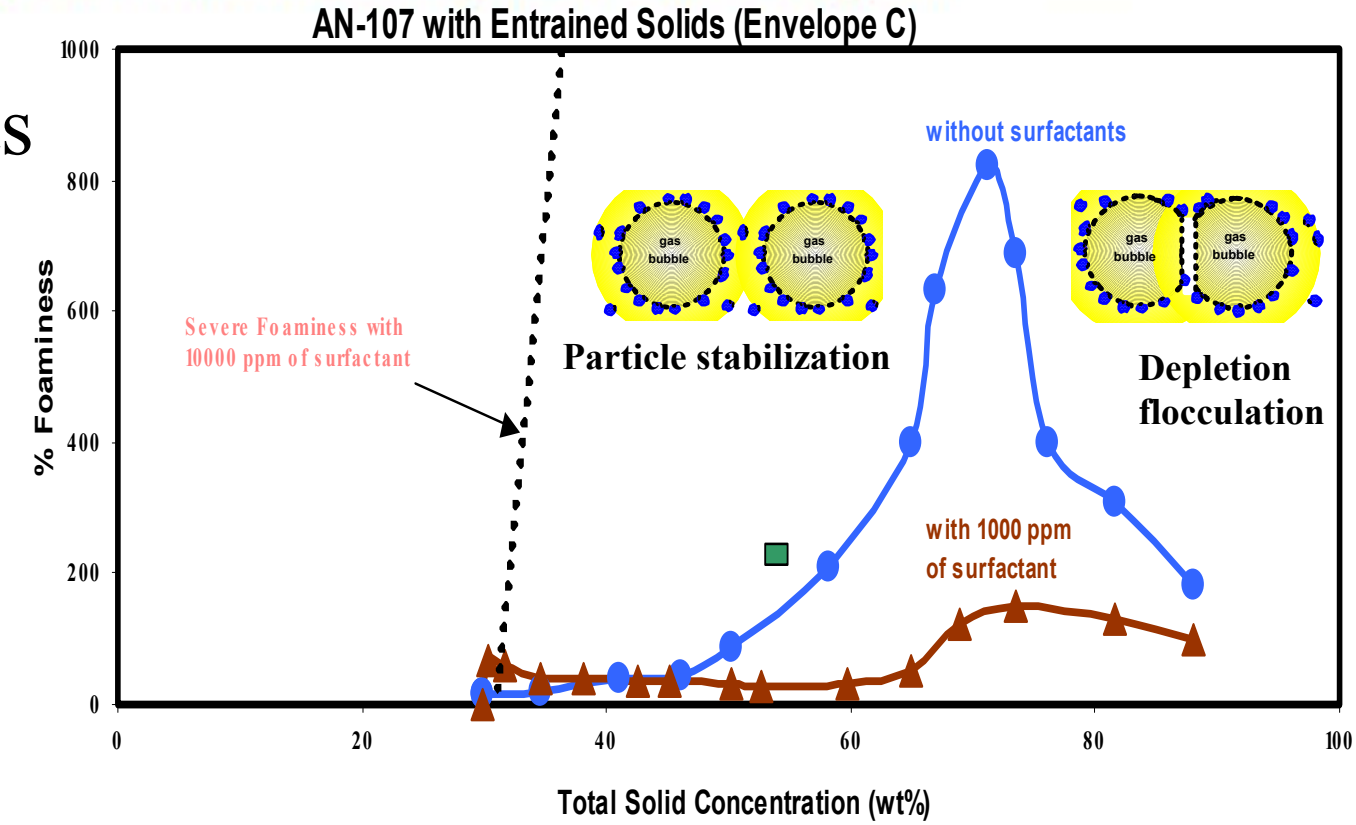
Key Results



Effect of surfactant (Hexadecyl trimethyl ammonium bromide, Found in Turco Cleaning Products Used at Hanford Tank Farm) on AN-107

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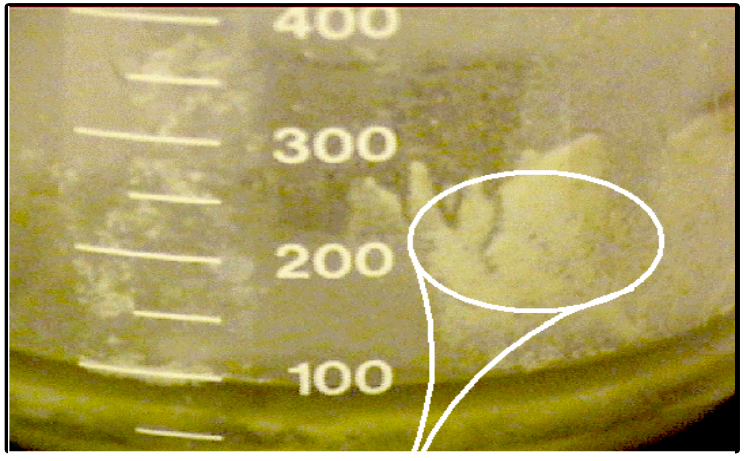
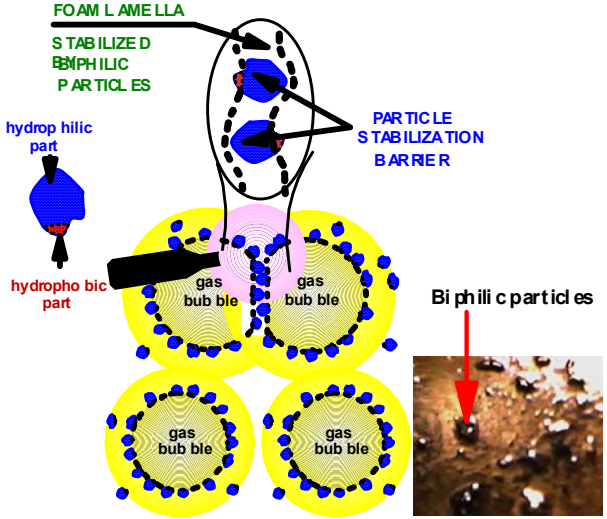


Nucleate particles
on the walls
of fleaker

FOAMINESS AND STABILITY IN THE PRESENCE OF BIPHILIC PARTICLES



FOAMINESS AND STABILITY IN THE PRESENCE OF BIPHILIC POLYDISPERSED PARTICLES. AT LOW CONCENTRATIONS, DUE TO ADSORPTION AT GAS/LIQUID SURFACE, A STABILIZATION BARRIER IS FORMED AND FOAMINESS IS INCREASED

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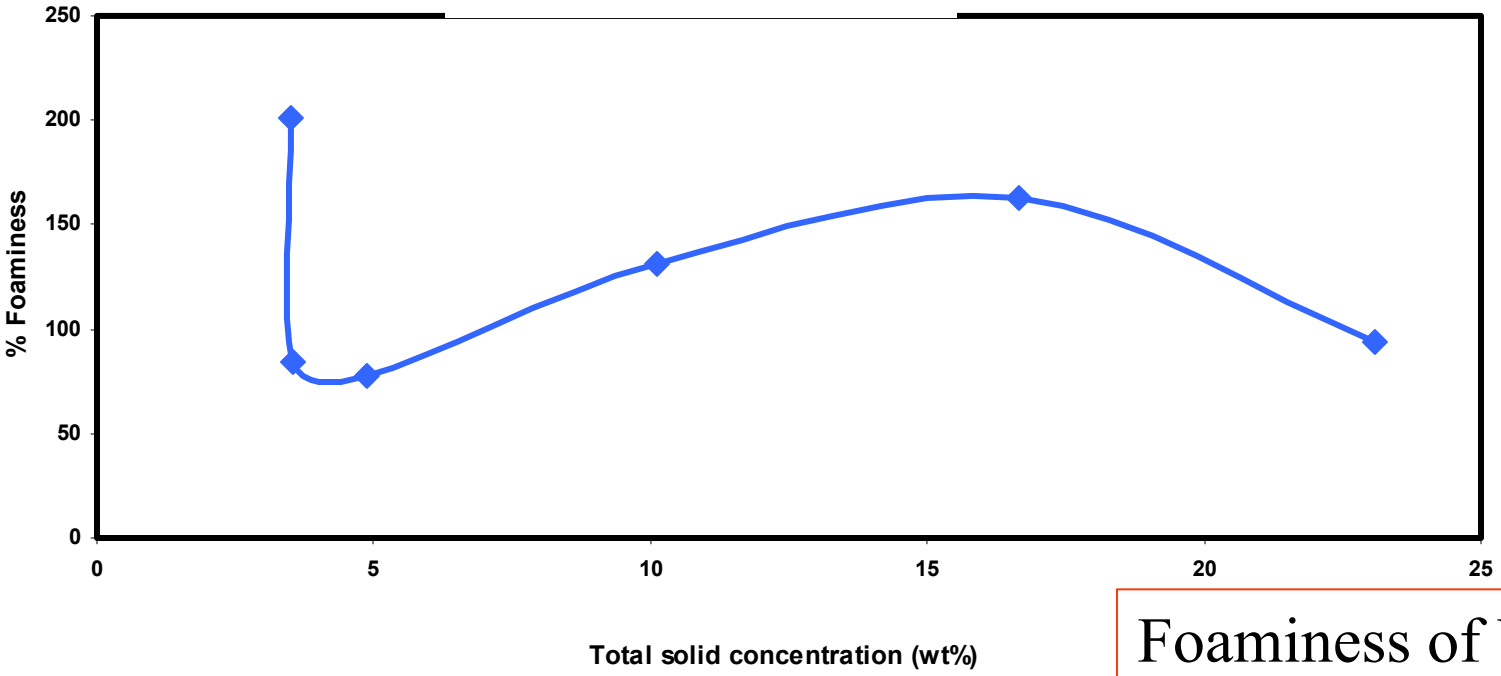
Key Results



Foaminess of WTP LAW Submerged Bed Scrubber Recycle Solution
- Experiment Conducted at Request of WTP

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Annual Site Remediation Users Meeting Held

- Focus on Air Entrainment/Foaming in Sludges – DWPF User Request
- Hanford WTP User Requests
  - Impact of oxalate on foaming
  - Impact of fluidic mixing
  - Impact of permanganate (Sr/TRU precipitation) on foaming
  - Difference between real waste and simulants

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Future directions and plans

- SRS Sludge Air Entrainment & Foaming
  - Air Entrainment/Foaming in DWPF Sludge Process
  - Foaming During Waste Retrieval (Emergent Issue)
- Support WTP Antifoam Selection
- Support Emerging Issues in WTP

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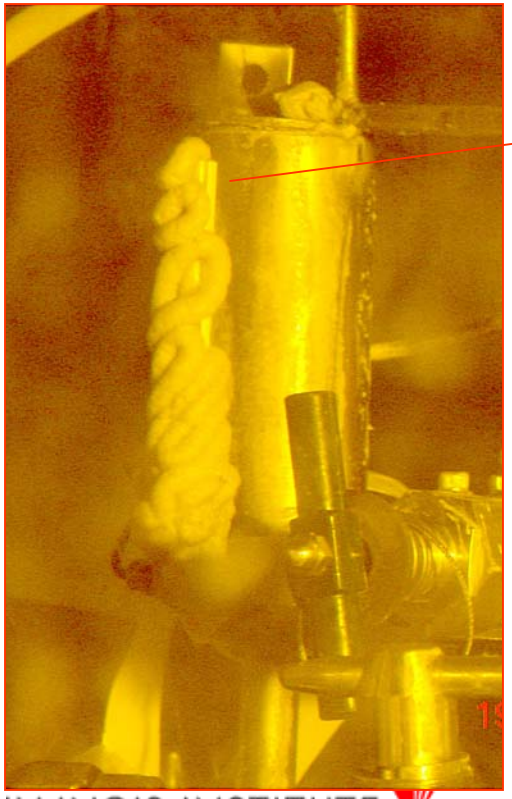
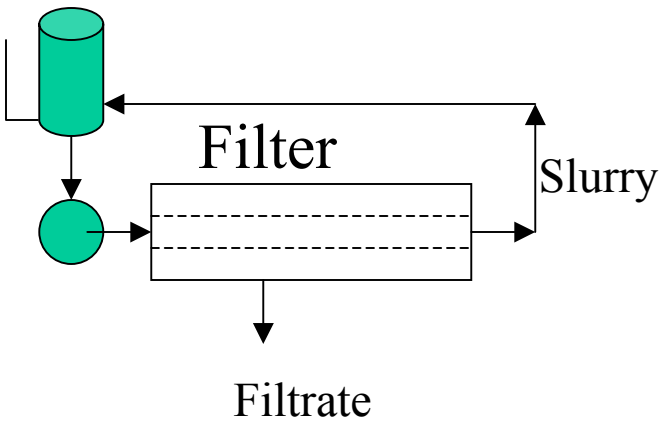
Hanford Tank Sample AN104 Foaming During Cross Flow Filtration



Tank and Sight glass



EMSP Researchers Consult on Emergent WTP Problems

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Current collaborations

SRS DWPF/HLW
John Occhipinti/
Tom Britt/Barbara
Hamm

EMSP
IIT/SRTC

Hanford
WTP
Paul
Rutland

Oakridge

INEEL

Hanford
RPP Tank
Farms

Desired collaborations

Sample Needs

- Work through Existing Site Programs to obtain Access to Existing Samples
- Limited AN104 Sample is available through WTP (only 100 ml) – 1 L is desired
  - Sample of AN102 – 1 L
- SRS Sludge Samples are available through Existing Programs

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Thanks

- Partnership (DOE EMSP, IIT, SRTC) has developed the *Scientific Understanding* of Real World Problems and the *Deployment/Field Demonstration of Technologies (Antifoam 747 and B52)* that Support the *Accelerated Cleanup of EM Sites*