National Aeronautics and
Space Administration

John F. Kennedy Space Center

SPACEPORT
ENGINEERING AND
TECHNOLOGY

New Environmentally Friendly Halon Alternative

Presented by

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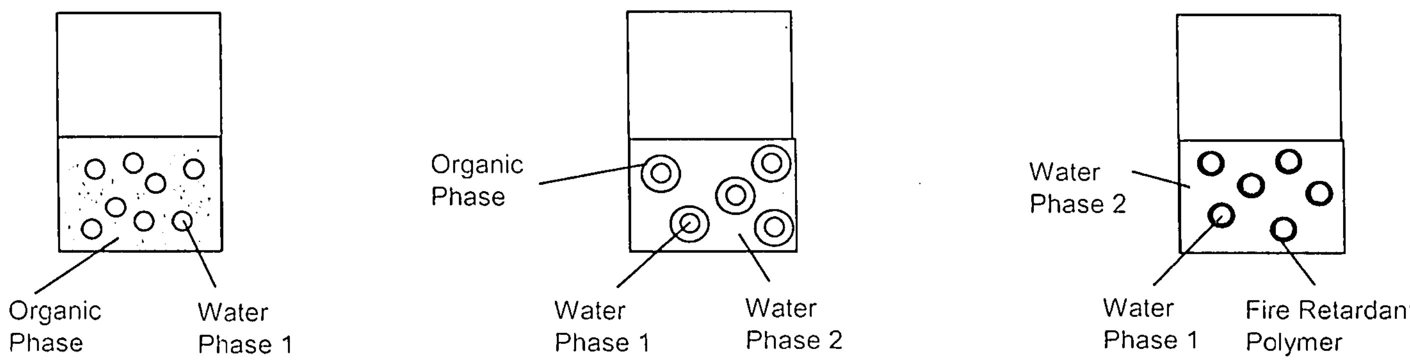
Overview

- Extinguishing Concept
- Methods Used to Prepare Agent, HABx
- Products
- Testing
  - DSC/TGA
  - Density
  - Water Retention
- Performance Data
- Project Status
  - Production of 100 to 200 lbs
  - Testing
  - Current Research
- Future Development

Extinguishing Concept

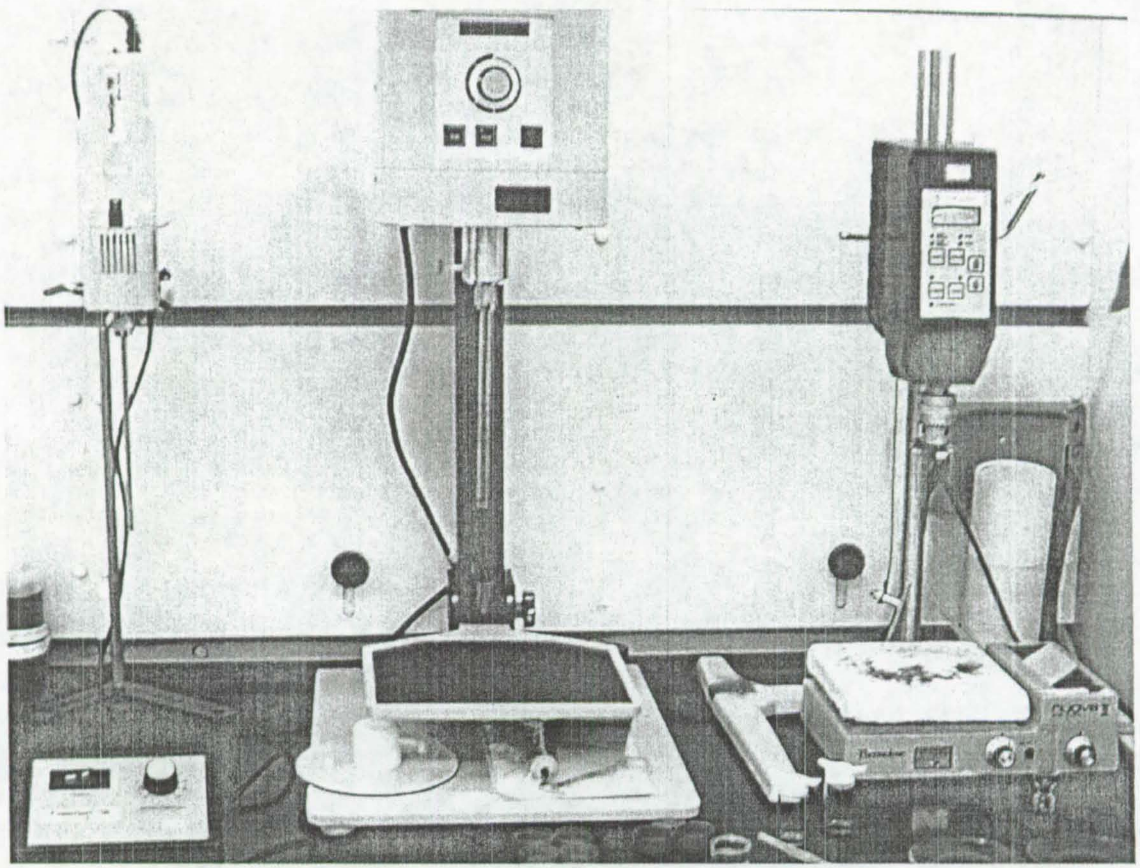
- Effects of Water
  - Energy Extraction
  - Oxygen Displacement
- Halons
  - Inhibition of Combustion Process
  - Oxygen Displacement
- Environmental Effects
  - Global Warming
  - Ozone Depletion
- Toxicity
  - Materials Used
  - Testing

In-liquid Drying

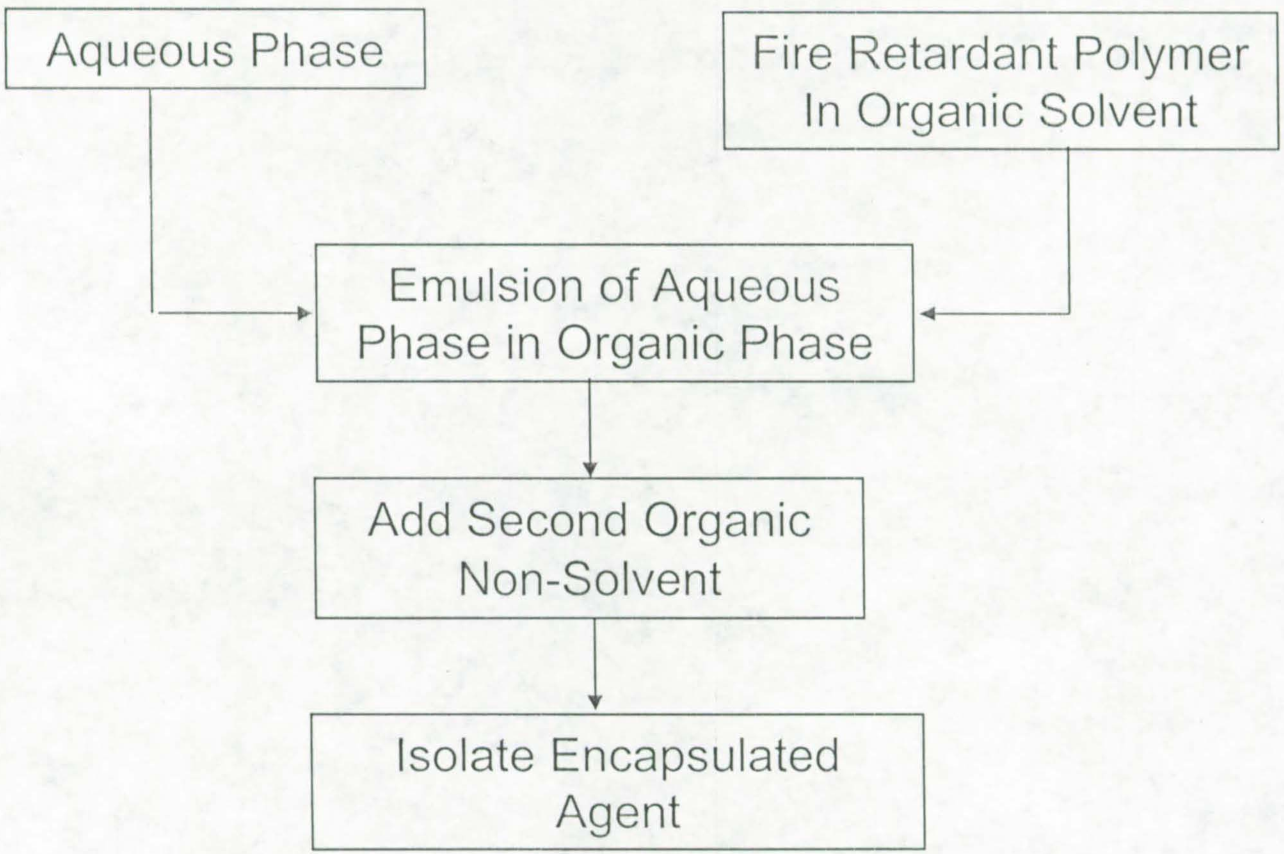


- Water Phase 1 – Encapsulated Water Solution
- Organic Phase – Fire Retardant Polymer in Organic Solvent
- Water Phase 2 – Gelling Agent in Water

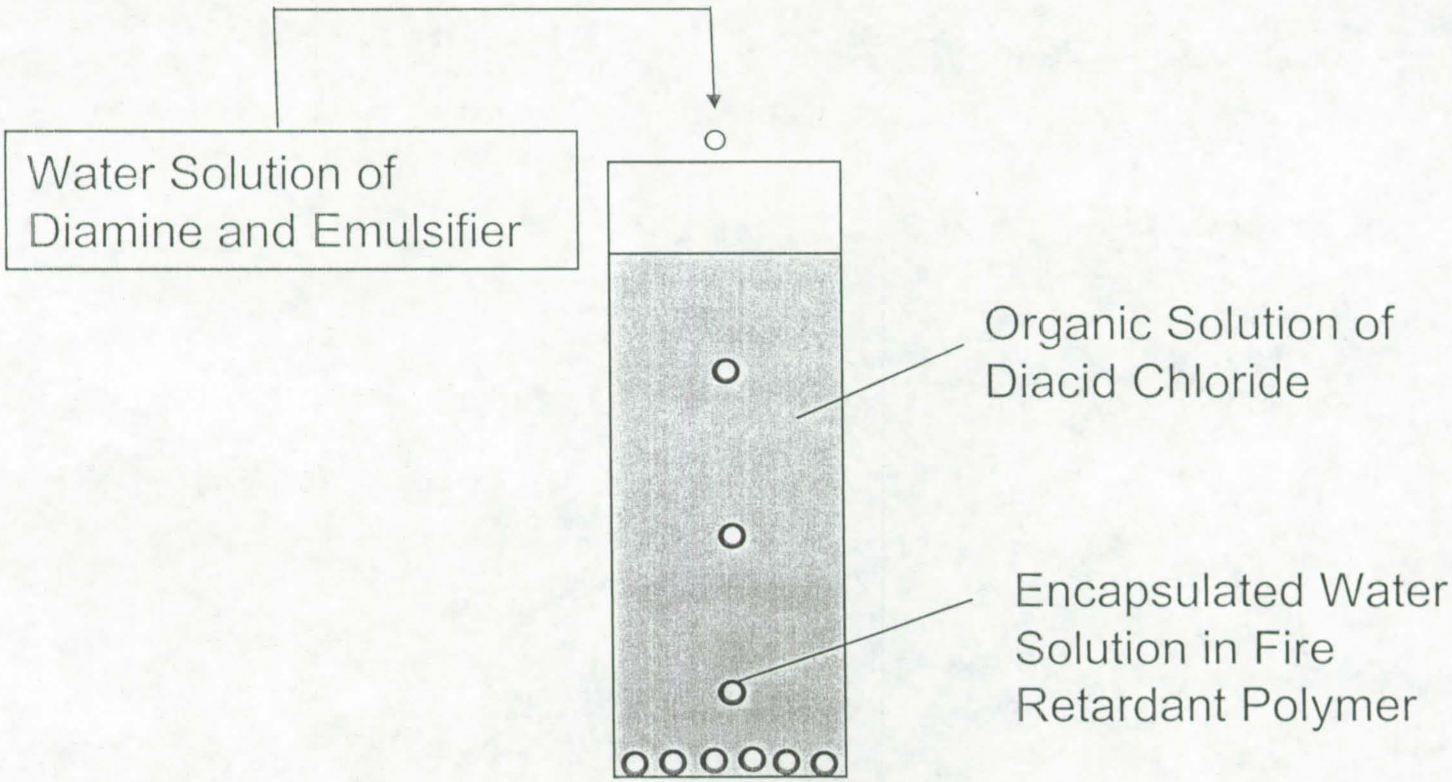
Homogenizers



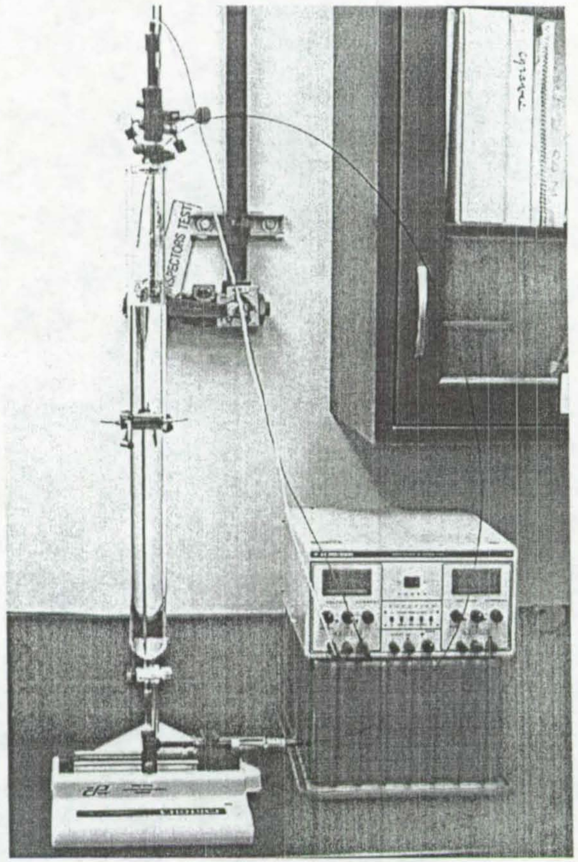
Selective Polymer Solubility



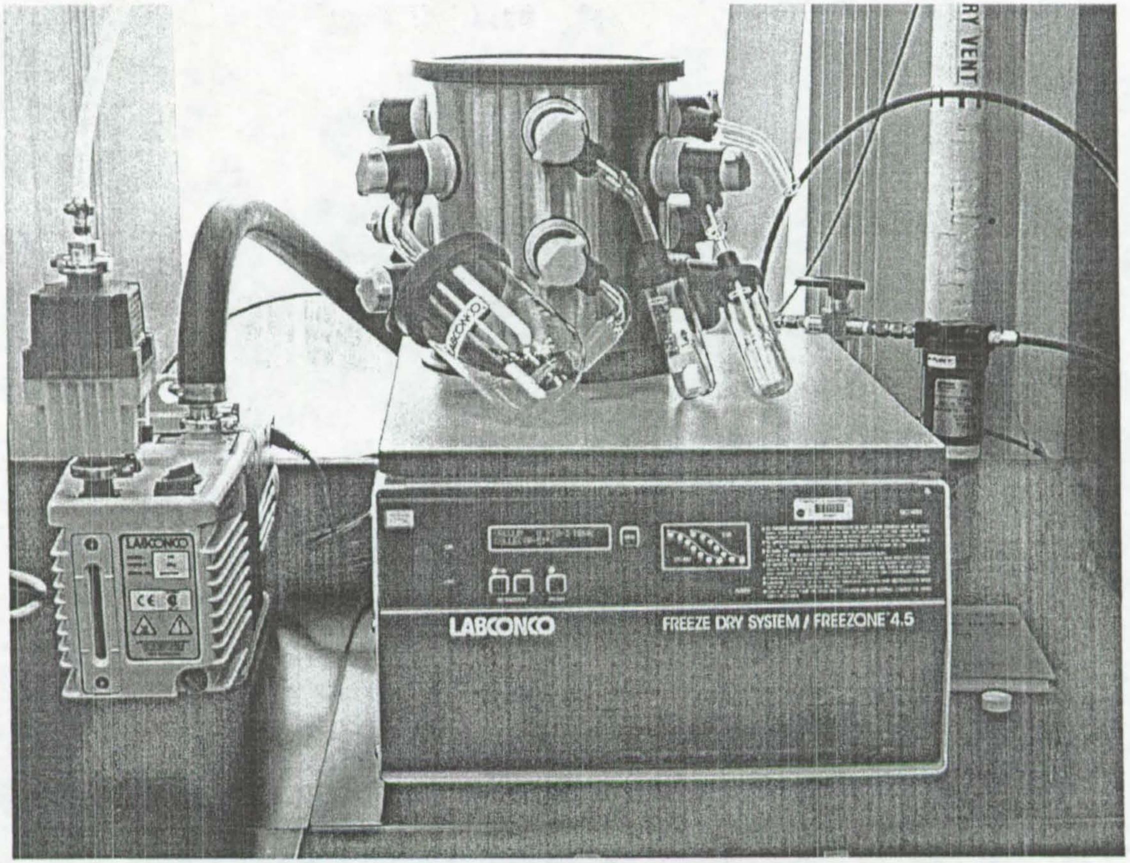
Interfacial Polymerization



Interfacial Polymerization Drop Method



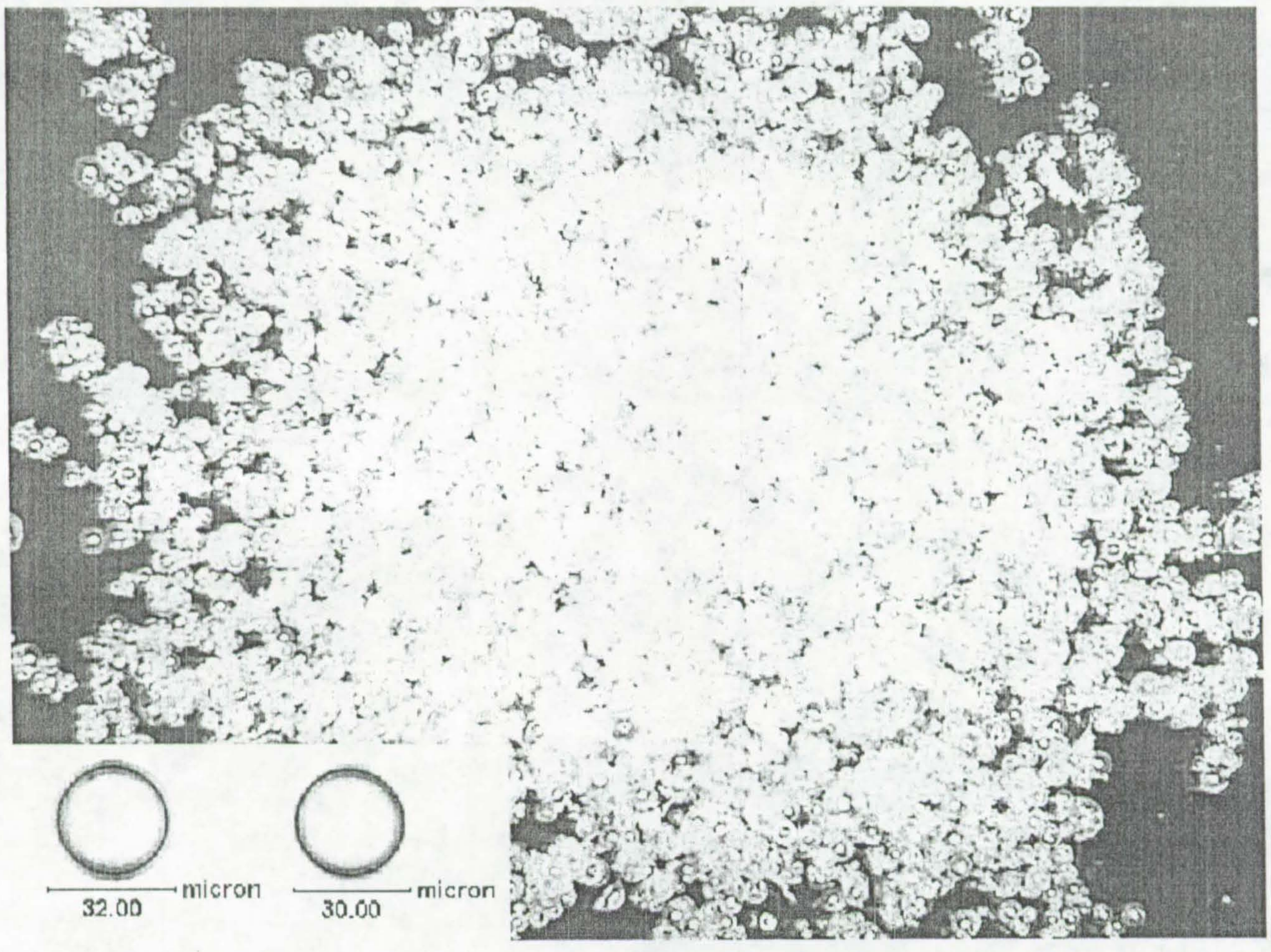
Freeze Drier



Physical Properties

- Density
  - Filled capsules density greater than water
  - Capsules with voids float
- Size Distribution
  - Microscope measurement
  - Sieving
- DSC/TGA Data

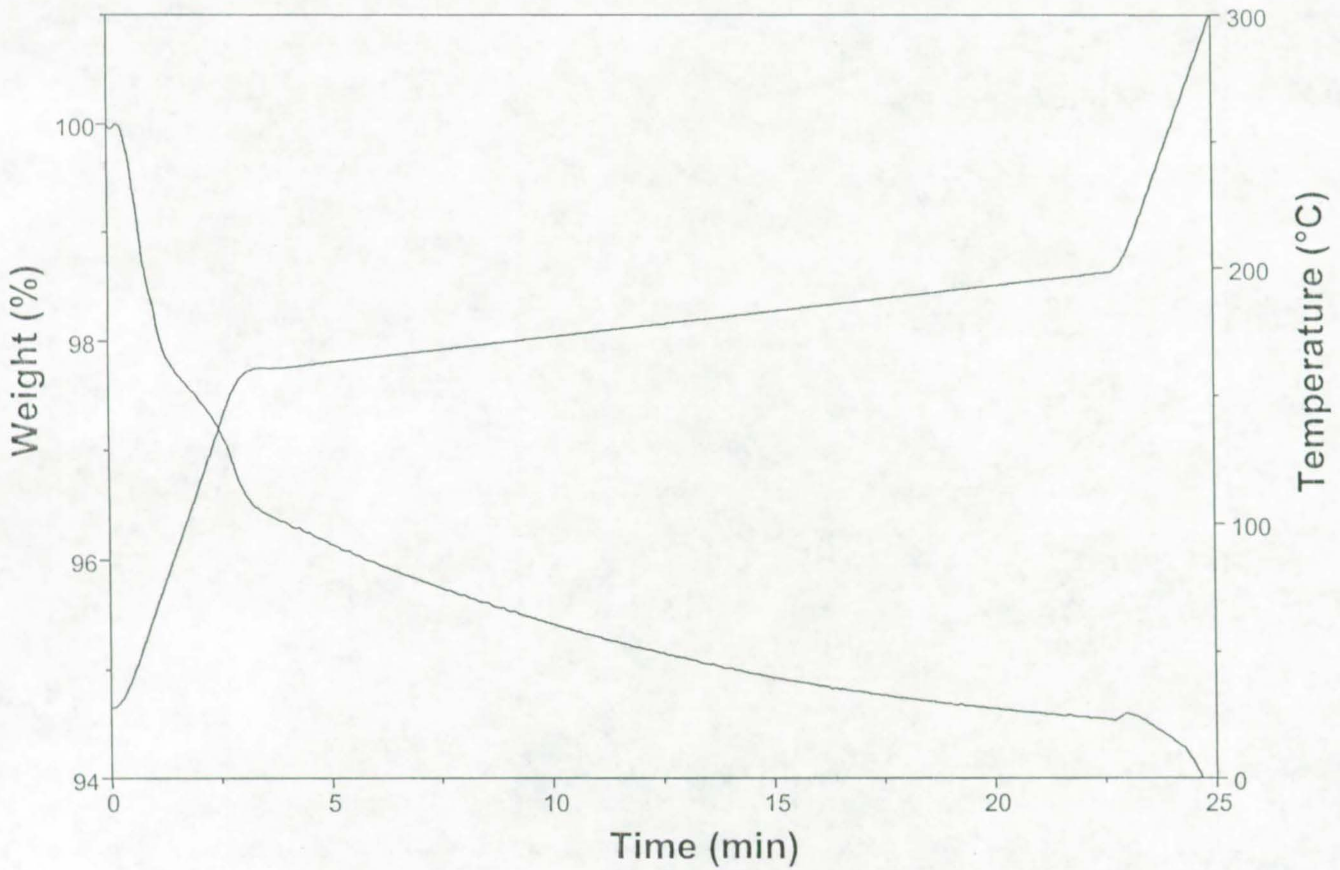
Collection of HABx Microspheres



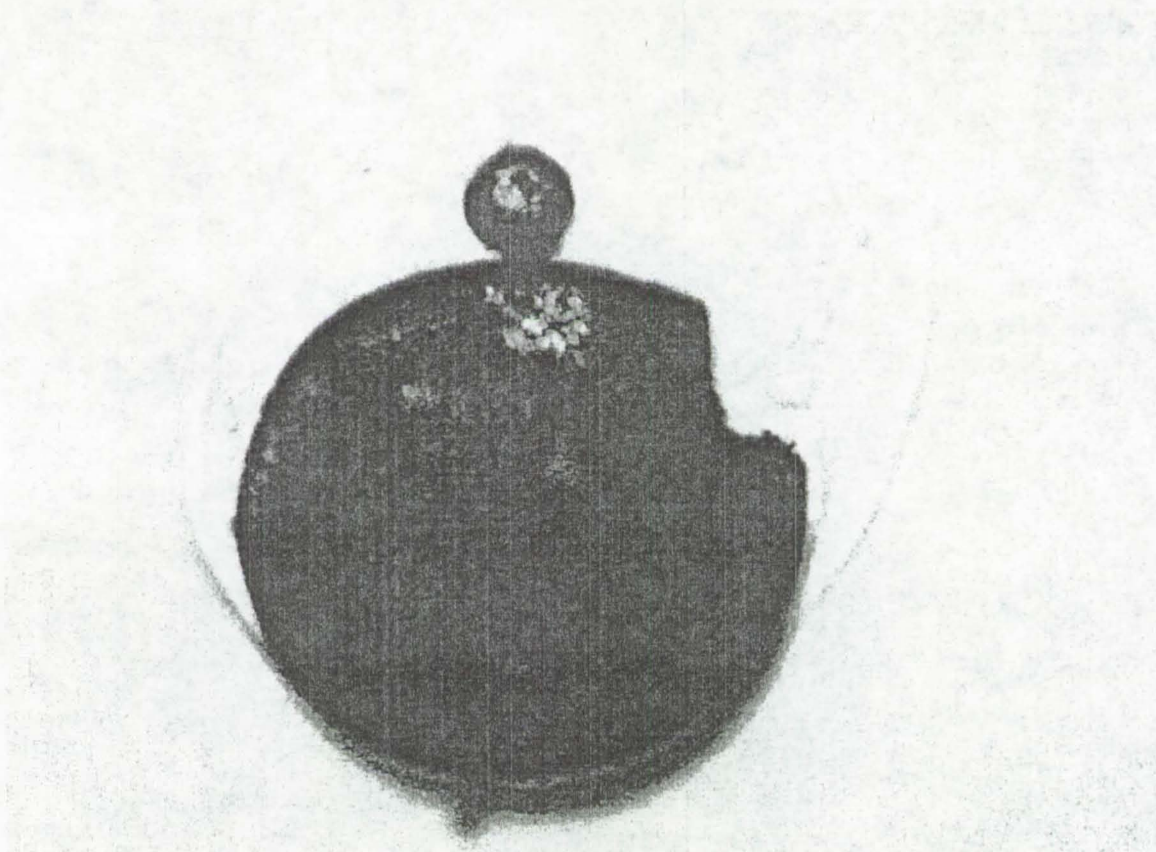
Sonic Sieve

DSC/TGA Analysis of HABx

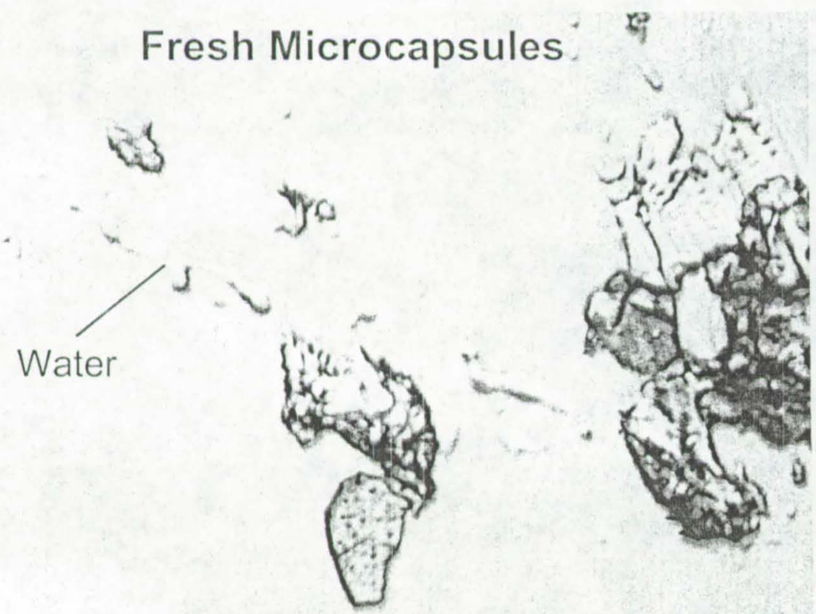
Sample: Polybromostyrene, 4/14/03

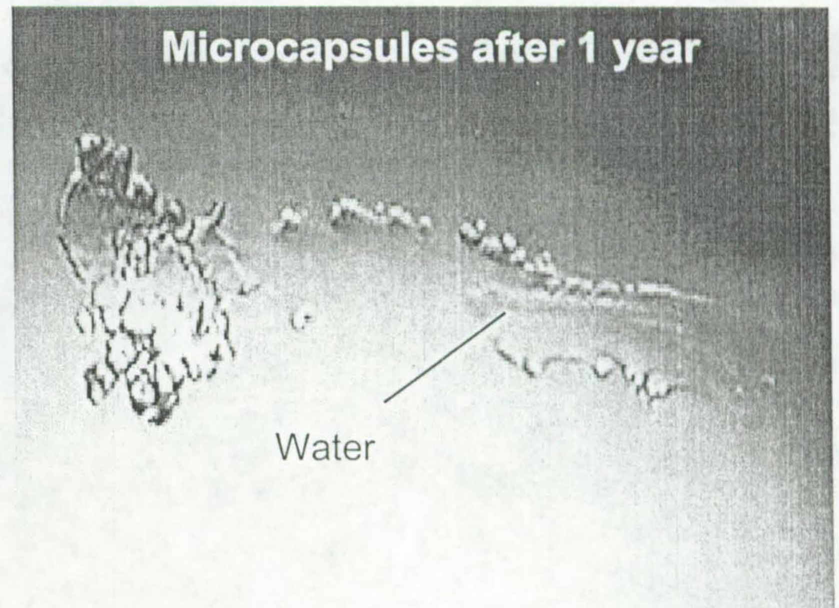


Encapsulated Water



Water Retention





Microcapsules were stored in open container in laboratory at ambient temperatures 70 to 74°F and 45 to 55 percent relative humidity

Performance Testing

- Apparatus
- Preliminary Test Results
- Final Test Results
- Conclusions
  - Particle Size Distribution
  - Flame Residence Time
  - Unreacted Material
- Recommendations
  - Large-scale Testing
  - Combustion Product Analysis
  - Toxicity Testing

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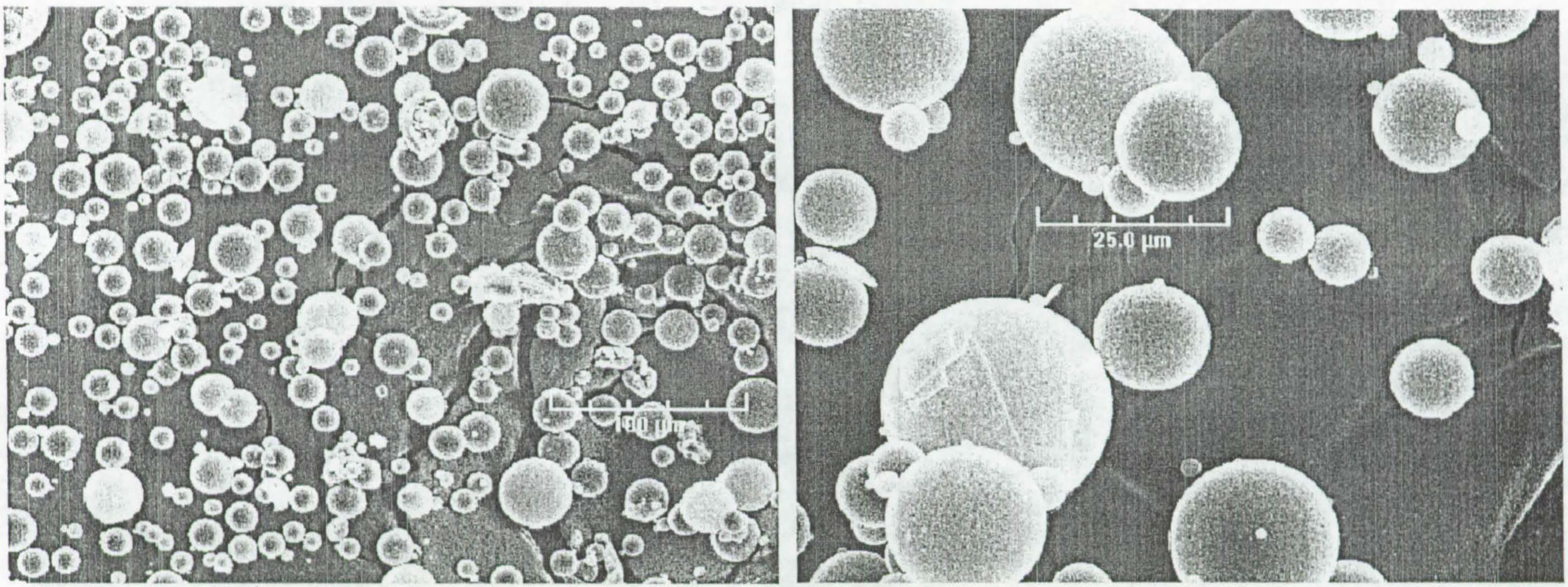
SEM Images* of HABx

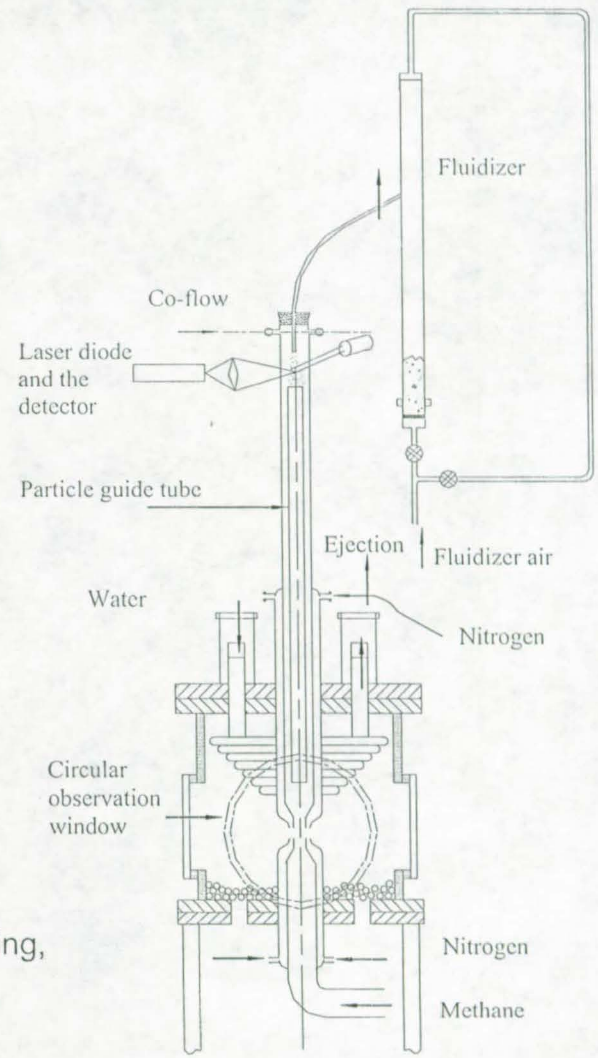


Particle sizes ranged from 1-2 µ to 38 µ with average size 20 to 30 µ. The wall thickness for the larger particles appears to be approximately 0.5 µ and much smaller for small particles.

*Images supplied by Dr. Harsha K. Chelliah, Dept. of Mechanical and Aerospace Engineering, University of Virginia, Charlottesville, VA

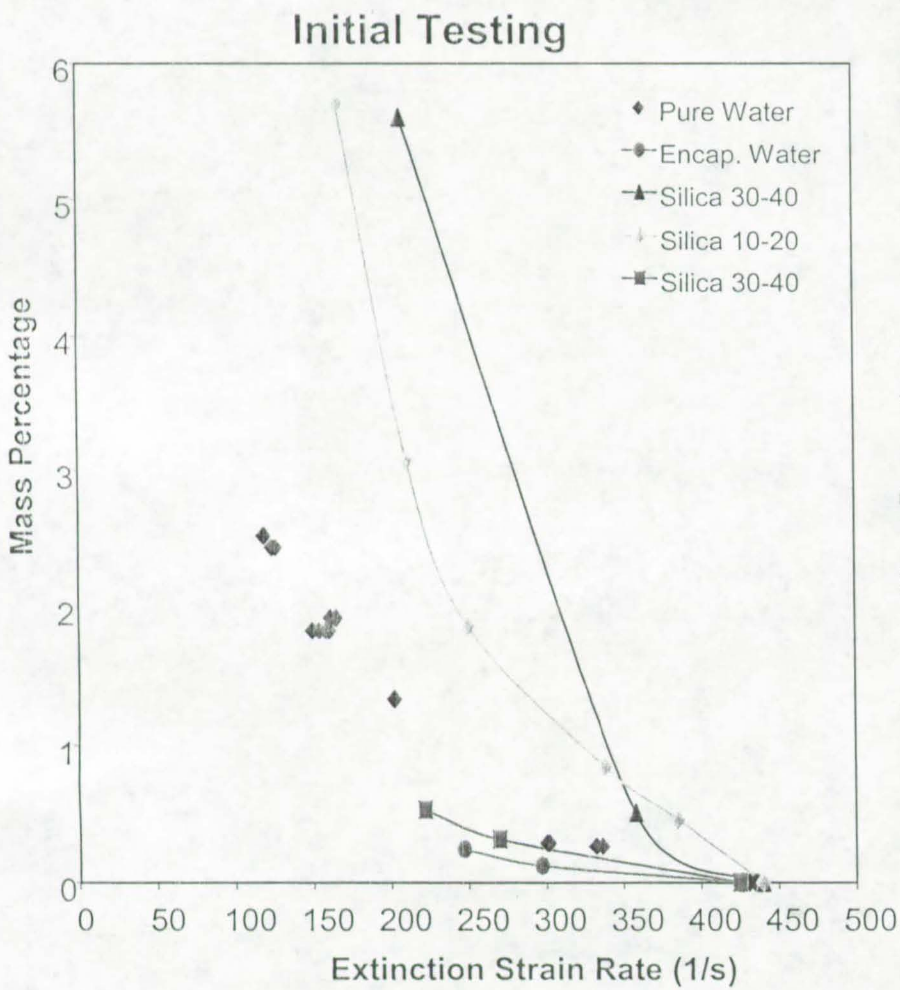
Counterflow Burner with Fluidizer

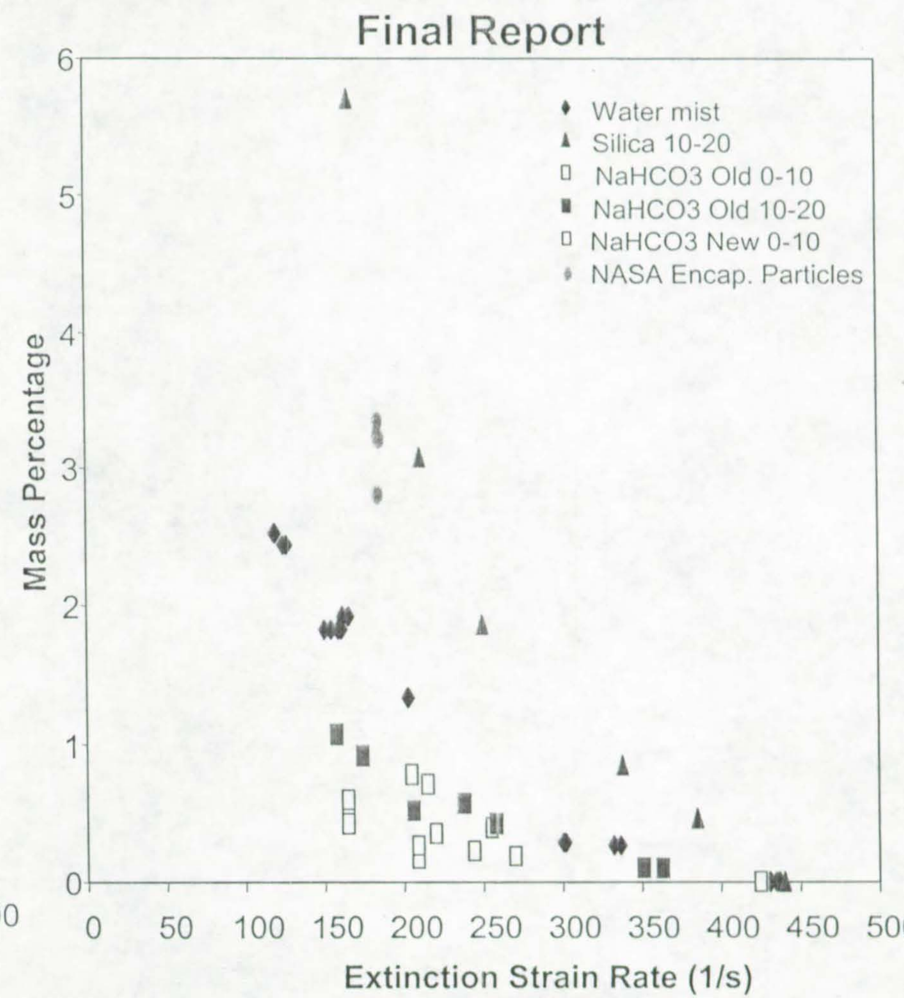
- Counterflow burner
  - Pyrex co-annular nozzles with nitrogen co-flow on both fuel (methane) air sides.
  - Produces stable flat flame
  - Hot combustion gases evacuated with mass flow ejector.
- Particle Seeder
  - Typical particle mass fraction is 1% or approximately 0.1 gm/min
  - Steady feed rates from <10 to 100 μ
  - Best performance with <30 μ particles



Harsha Chelliah, Dept. Mechanical and Aerospace Engineering, University of Virginia, Final Report, NIST Grant No.: 117680

Performance Data





Data from Initial testing and final report (Harsha Chelliah, Dept. Mechanical and Aerospace Engineering, University of Virginia, Final Report, NIST Grant No.: 117680)

Observations and Conclusions

- Observations
  - Best performance with particles less than 30 μ
  - Mass flow determined by weight of trapped particles on filter
  - Orange streaks indicate only small fraction of particles decomposed
- Conclusion
  - Rate of decomposition too slow
  - Heating rate too slow and does not approach decomposition temperature. This is likely for particles greater than 20 to 25 μ
  - Calculated mass of a 35 μ particle is 5.34 times that of a 20 μ particle, which suggests that the measured mass percentage may be high if larger particles did not react in flame

Current Status

- Production of 100 to 200 lbs of HABx for Large-scale testing
- Development of new production technologies
- Testing Program
  - Performance Testing
  - Toxicity Testing
- Development of Manufacturing Capabilities