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EXPERIMENTAL VERIFICATION OF CAUSTIC-SIDE SOLVENT EXTRACTION FOR REMOVAL OF CESIUM FROM TANK WASTE

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Gatlinburg, Tennessee
October 15-18-2001

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Experimental Verification of Caustic-Side Solvent Extraction for Removal of Cesium from Tank Waste

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Outline

- Objective
- CSSX solvent
- Contactor technology
- Experimental approach
- Test CSSX flowsheet
  - Once through
  - Solvent recycle (4 times)
  - Solvent recycle (42 times)
- Summary

Objective

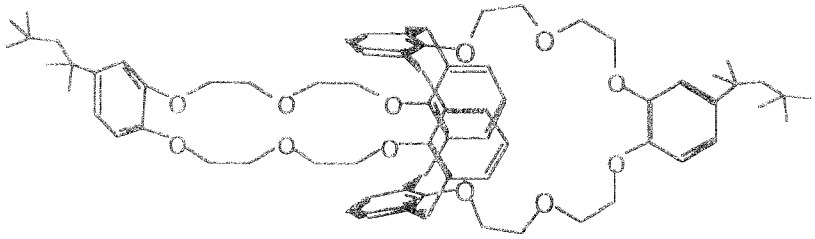
- Demonstrate complete CSSX process flowsheet (Proof of concept)
  - Decontamination factor ≥ 40,000
  - Concentration factor ~15
- Scientific and technical issues evaluated
  - Stage efficiency
  - Temperature control
  - Hydraulic performance
  - Long time (multi-day) operation
  - Short-term shutdown
  - Effect of solids
  - Recovery from Cs moving through strip section

CSSX Solvent

- Extractant (0.01 M):

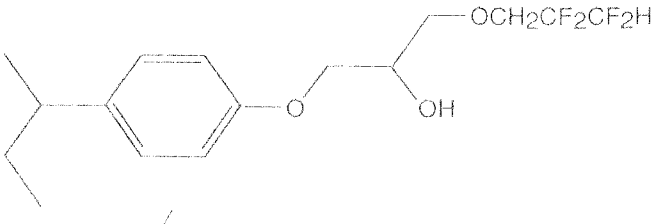
  Calixarene crown

  (BOBCalixC6)

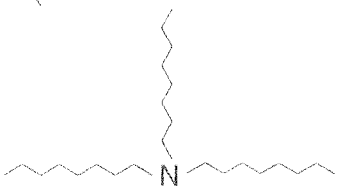


- Modifier (0.50 M):

  Polyether (Cs-7SB)

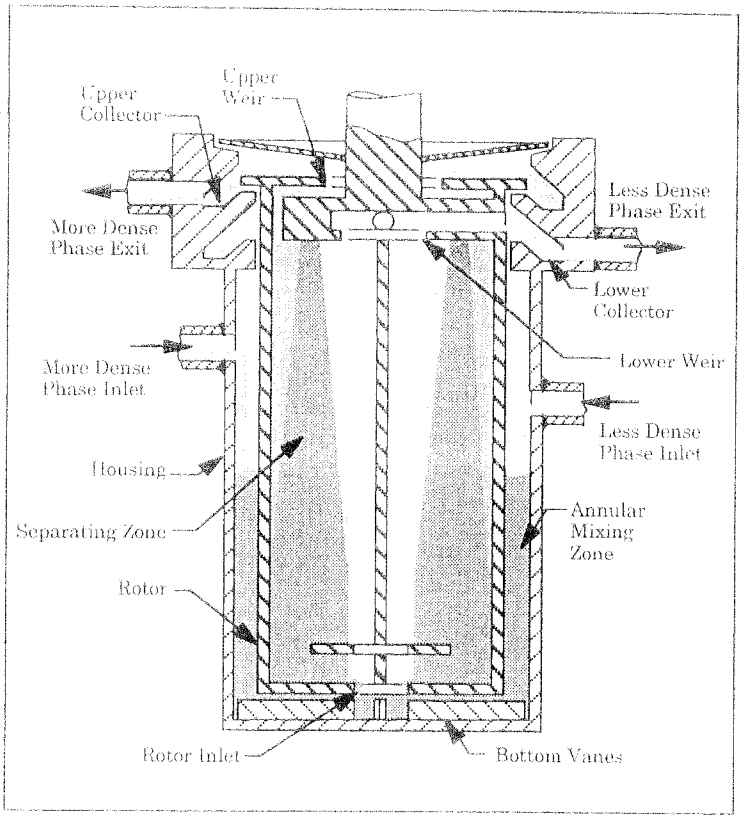


- Suppressor (0.001 M):
  - Trioctylamine (TOA)



- Diluent (rest): Isopar®L

Centrifugal Contactor Schematic



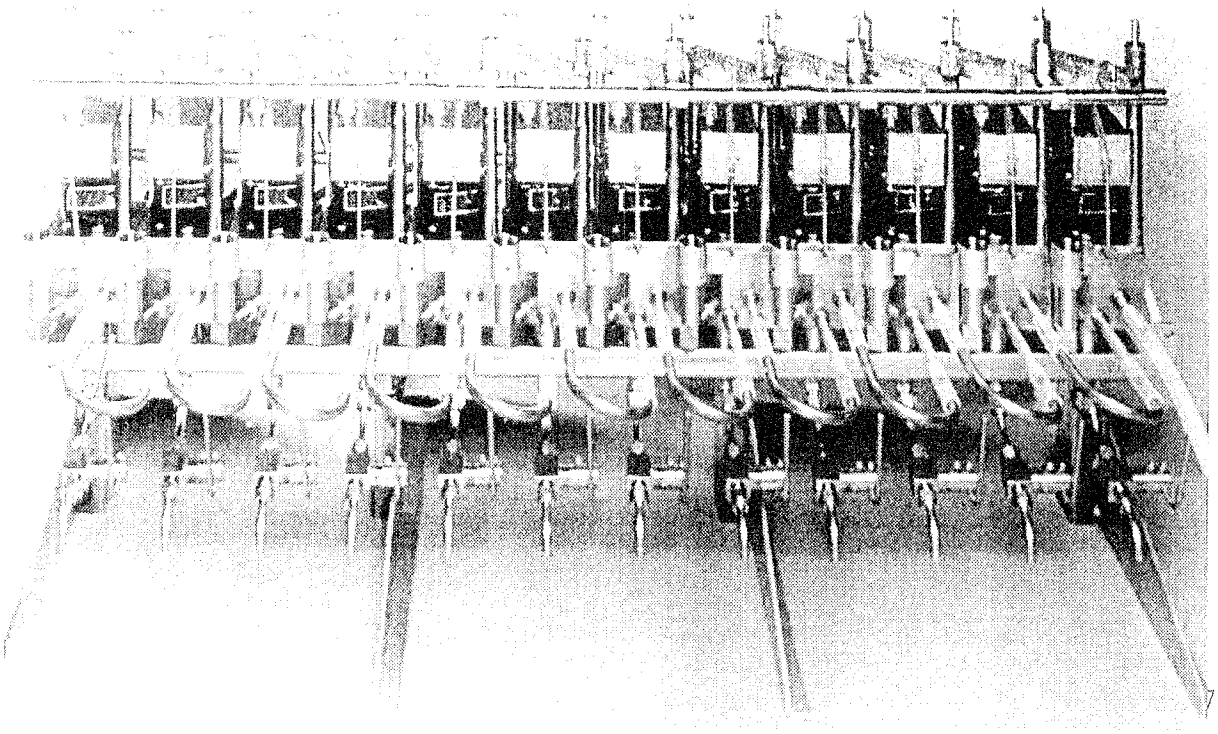
Advantages

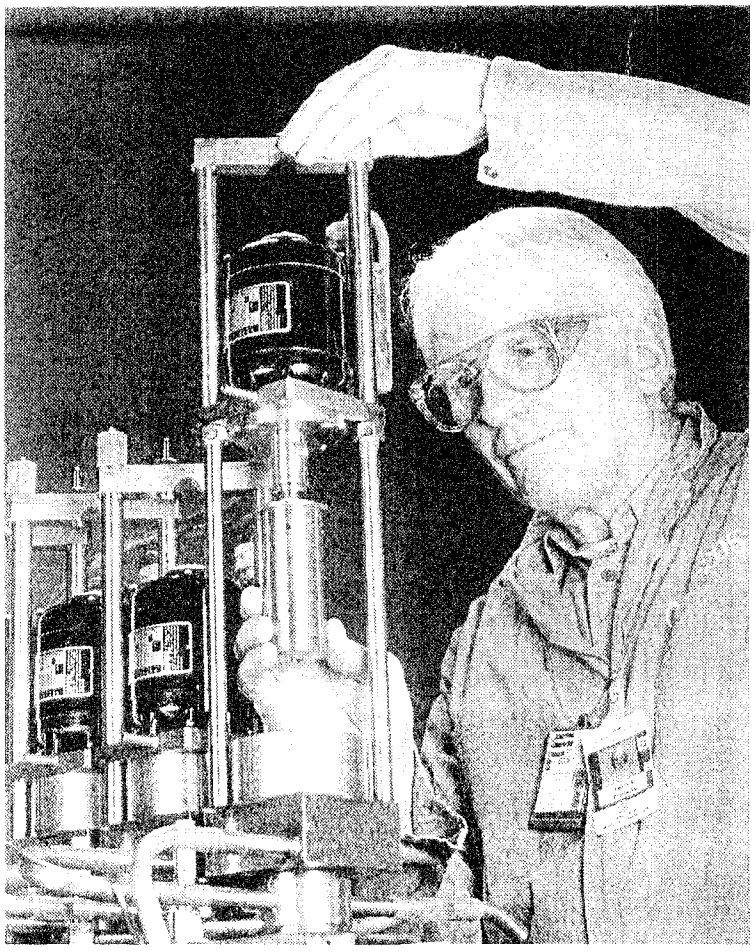
- Small size
- Well-defined stages
- Robust
- Ease of use

ANL Contactors

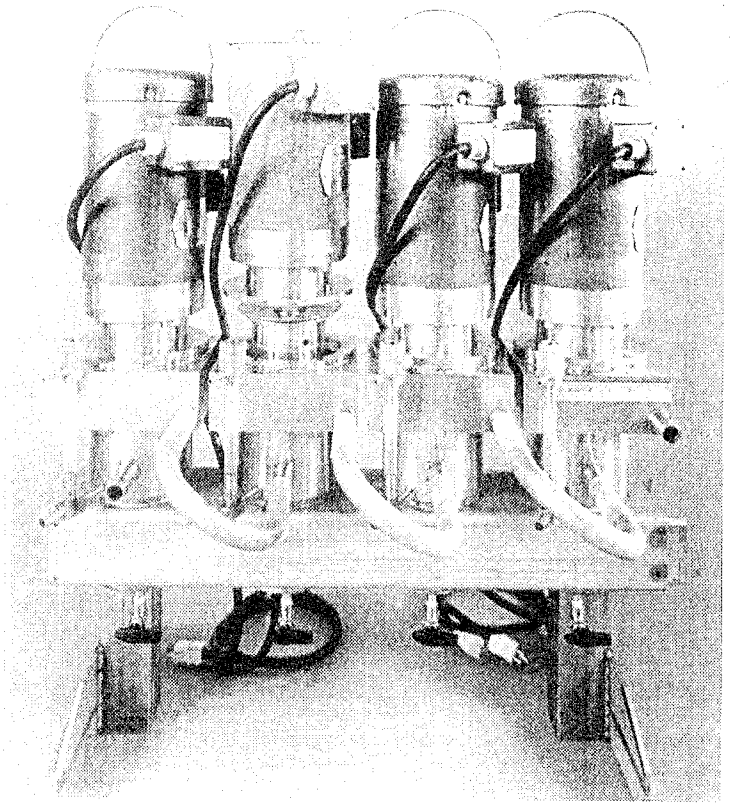
Rotor Diameter, cm	Nominal Throughput, L/min
2	0.04
4	0.4
9	10
10	12
12	20
25	120

Multistage 2-cm Contactor



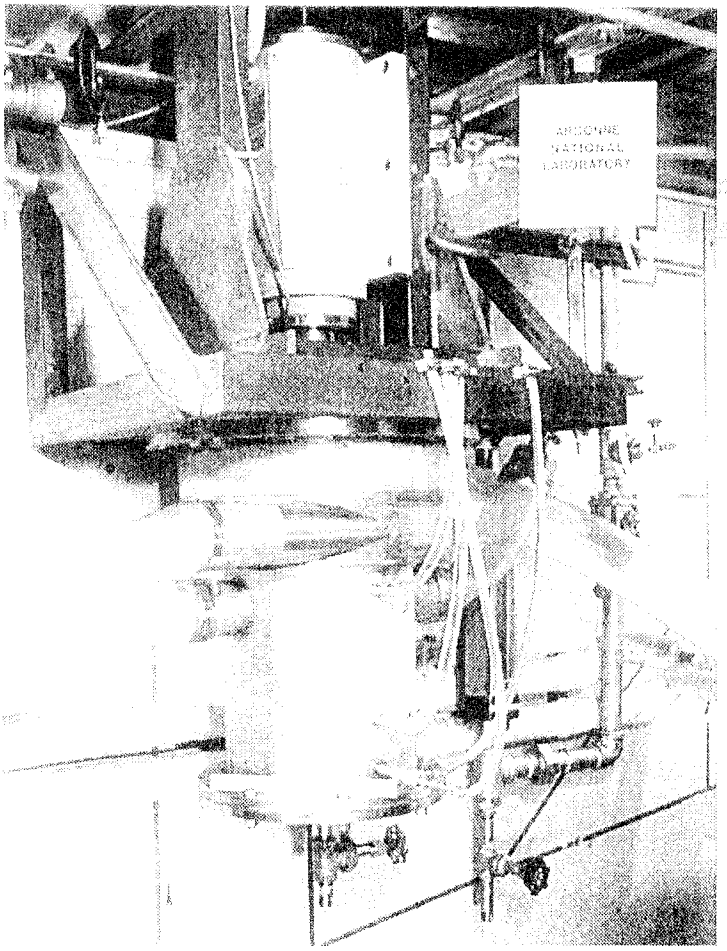


Multistage 4-cm Contactor



Removing Motor/Rotor Assembly

4-stage 10-cm Contactor



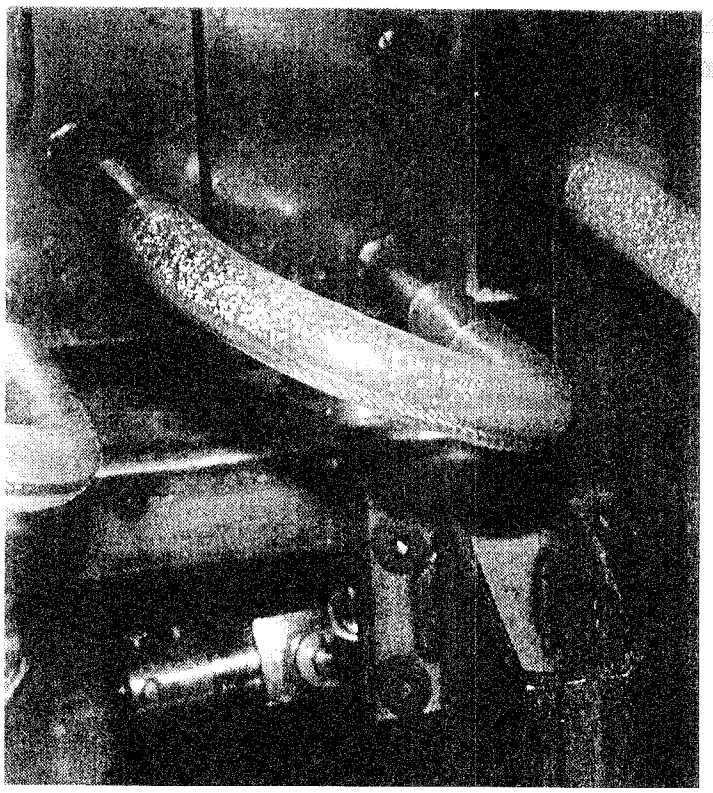
25-cm Contactor

Operating at 100 L/min

Experimental Approach

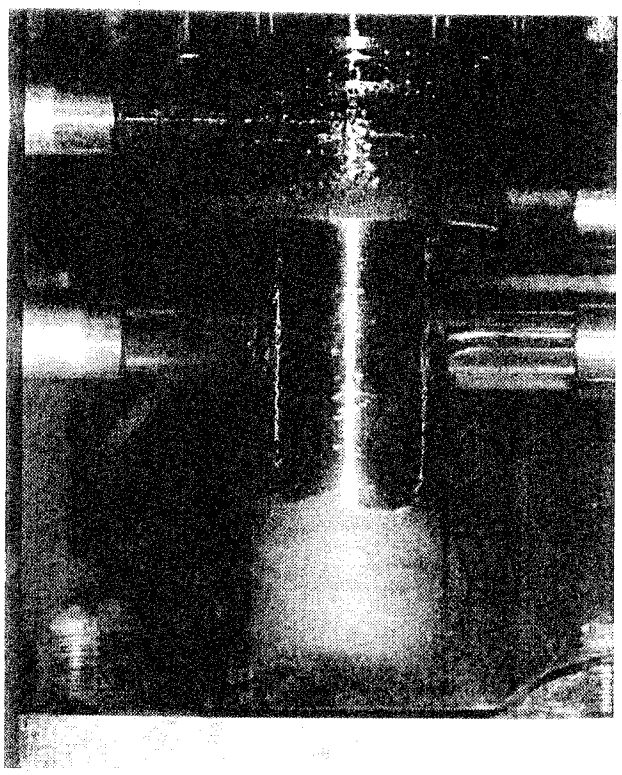
- Use existing 2-cm centrifugal contactor
  - Feed and solvent volumes are small
- Improve stage efficiency
  - Smooth interstage flow
  - Increase mixing-zone volume
  - Increases efficiency from 60 to 90%
- Add more stages
  - From 24 to 32
- Test CSSX flowsheet
  - Once through
  - Solvent recycle

Smooth Interstage Flow

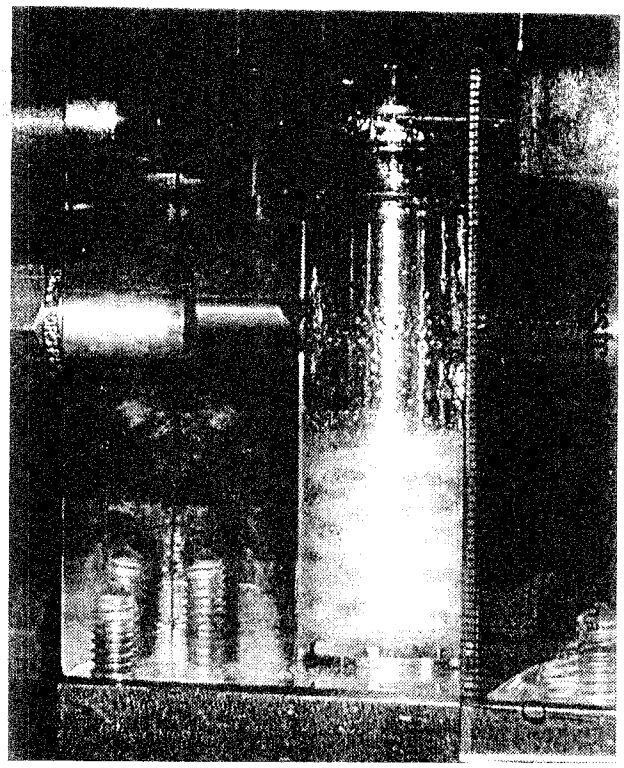


Use 1/16"-diameter S/S wire rope

Increased Mixing-Zone Volume

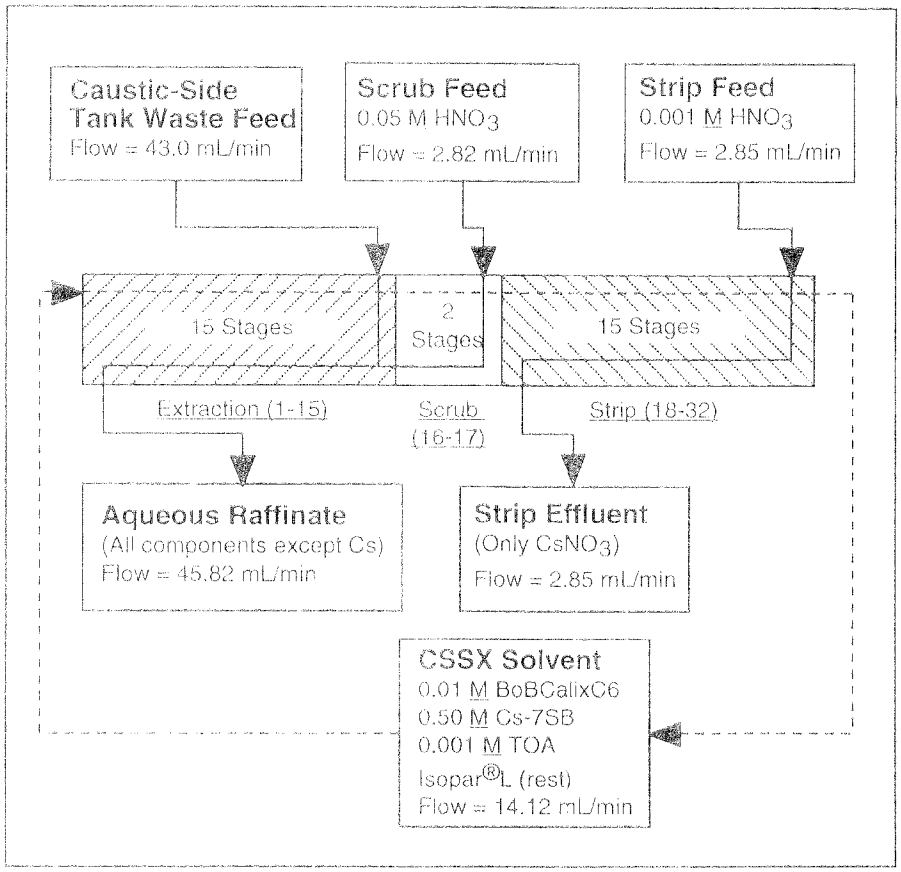


60 mL/min (original)



10 mL/min (modified)

Flowsheet for CSSX Tests



CSSX Flowsheet Tests

- Once-through solvent
  - Temperature problem
  - Resolved problem and demonstrated process
- Solvent recycle
  - 4 solvent cycles (proof-of-principle)
  - 42 solvent cycles (5-day test)
  - 28 solvent cycles (real waste test at SRTC)

Results of Flowsheet Tests

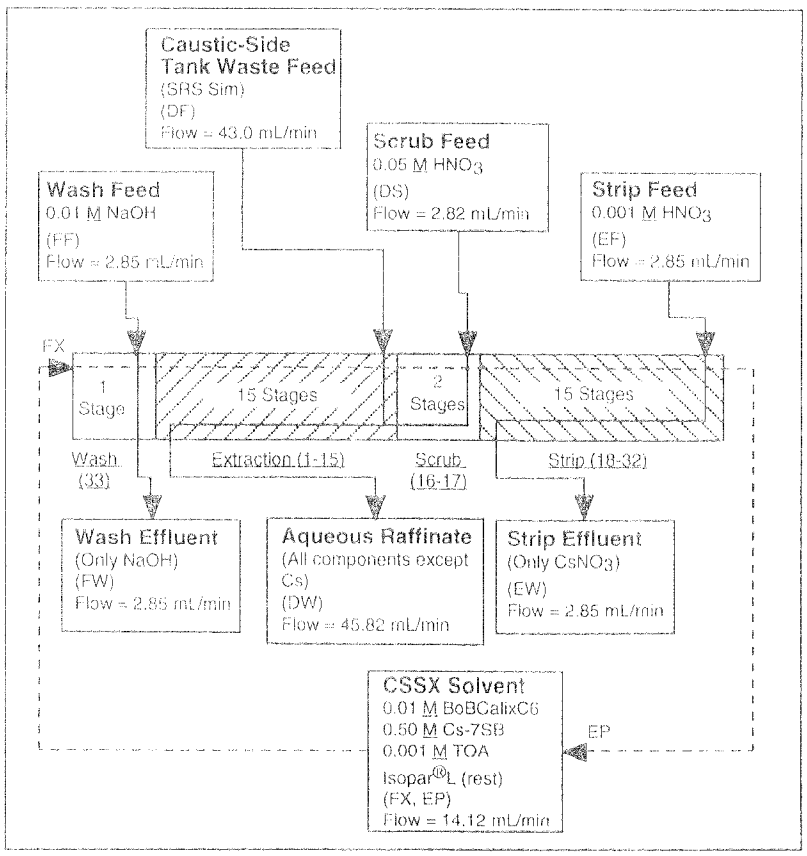
Test Identity with respect to Solvent	Decontamination Factor
Once through (ANL)	69,000
4 cycles (ANL)	82,000
42 cycles (ANL)	159,000
28 cycles with real waste (SRTC)	500,000

- Required Cs Decontamination Factor was 40,000
- Also achieved and maintained Cs Concentration Factor of 15
- CSSX was selected as technology for Cs removal at SRS

Preparations for ANL Multi-day Test

- 42 Solvent cycles
  - 180 L of average SRS (DF) feed
  - 1.4 L of solvent
  - 70-h test
- Solvent wash stage added
  - Stage 33
  - 0.01 M NaOH
- Multistage hydraulic performance
  - Positive feedback between stages
  - Backup in interstage lines
- Temperature control
- Shift work

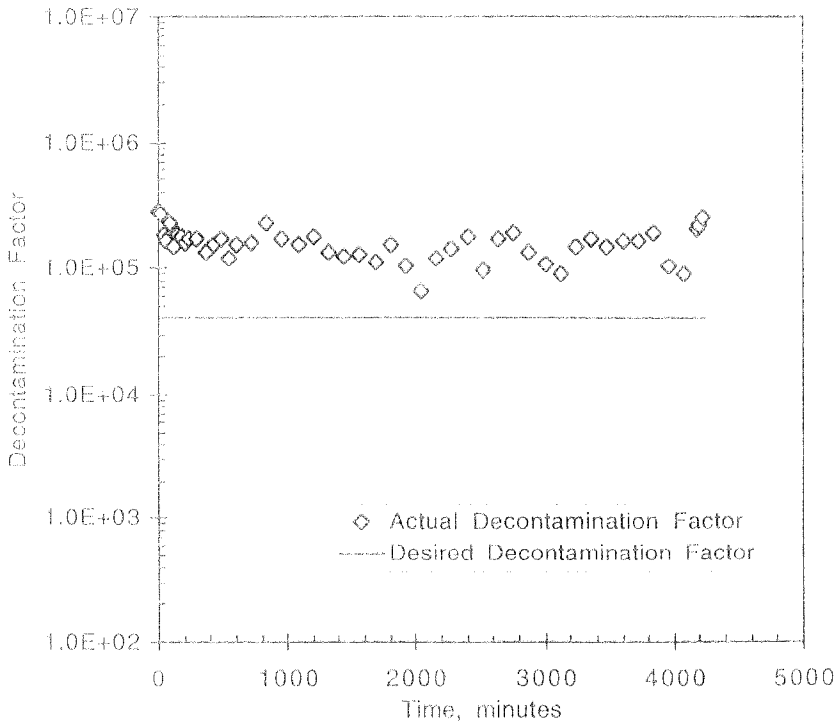
Flowsheet for ANL Multi-day Test



Operating Problems Solved

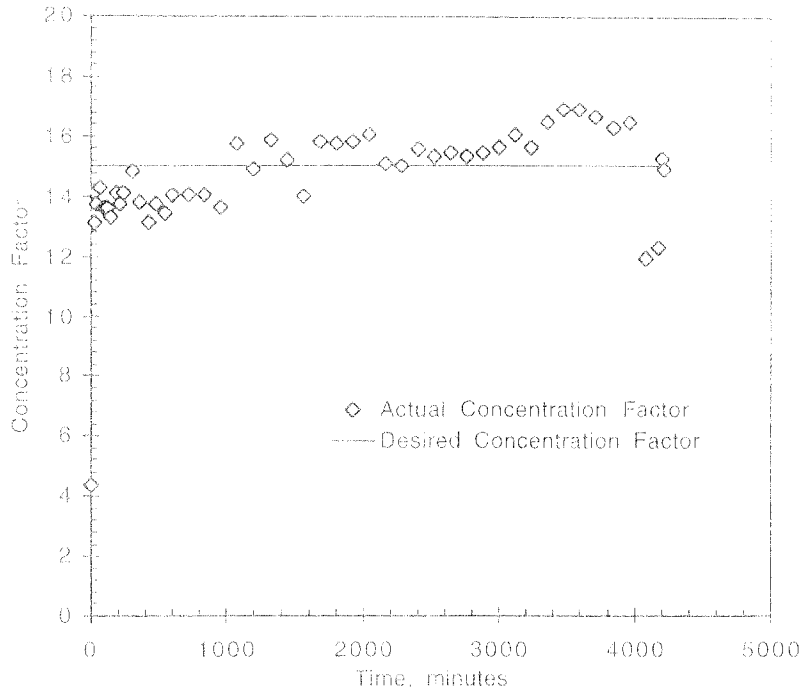
- Stop and restart during steady state operation
- Replace motor/rotor assembly
- Pump failure
- Solids in rotor
  - Feed needed to be refiltered
  - Dissolve out solids with acid
- Cesium moves thru strip section
  - Remove Cs by recycling solvent

Decontamination Factor over 40 Solvent Cycles



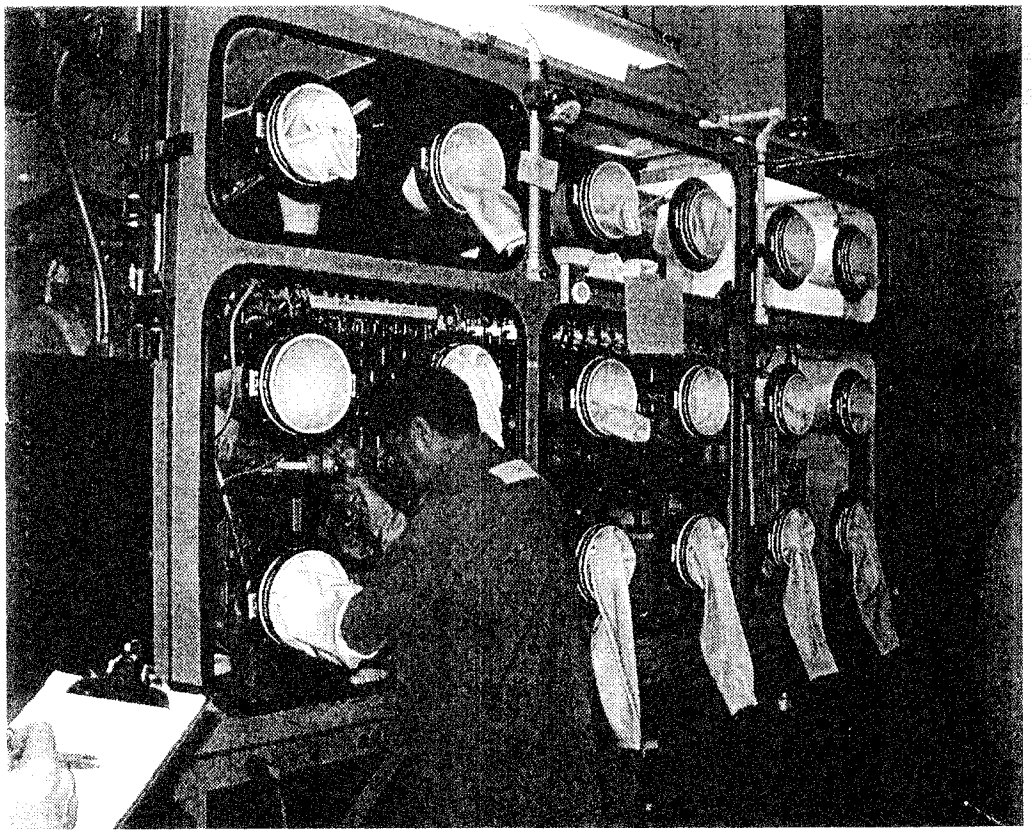
Average of 159,000

Concentration Factor for ANL Multi-day Test

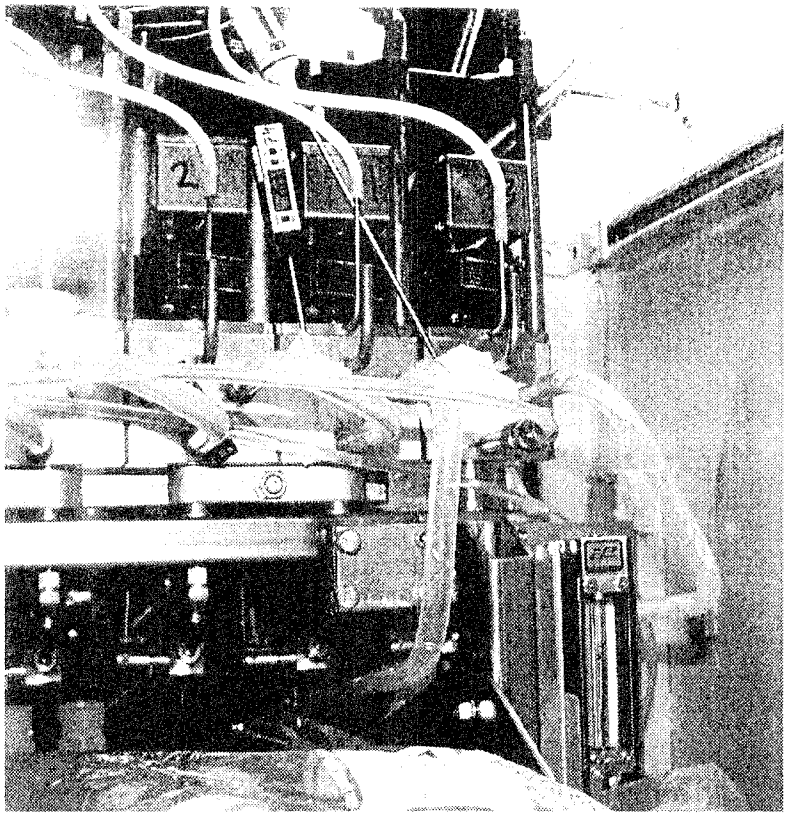


Average of 14.9

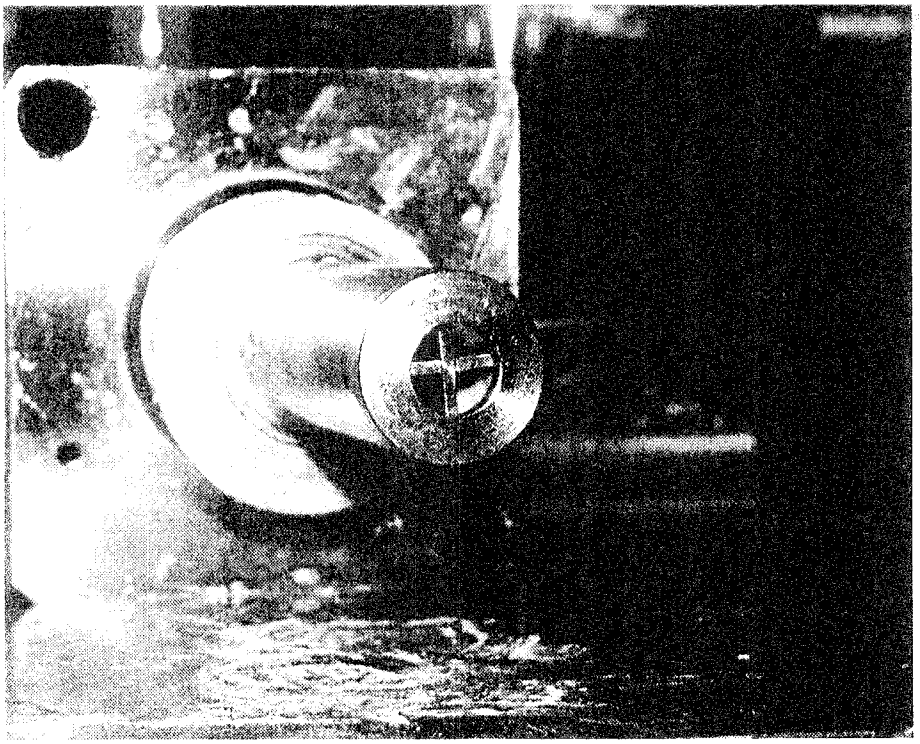
Contactor in Glovebox



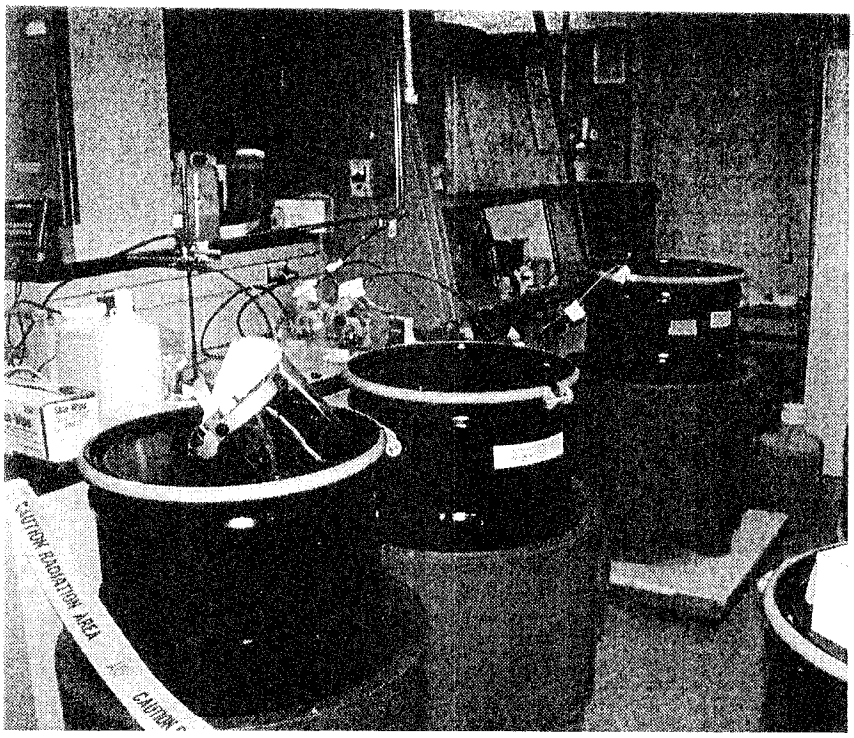
Working 2-cm Contactor



Solids in Rotor



Feed and Effluent Drums



Summary

- Proof-of-concept tests of the CSSX flowsheet were successful
  - Up to 42 solvent cycles
  - Up to 70 hours
- Temperature control is needed
- Developed a better understanding of multistage hydraulic performance in the 2-cm contactor
- Solids removal is required
- CSSX selected as primary cesium removal technology at SRS

Acknowledgements

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- ANL 5-day test team

ANL Multi-Day Test Team