

# Pilot-Scale Testing of the Small Tank Tetraphenylborate Process

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**Hanford Pilot Plant  
Lessons Learned  
Meeting**



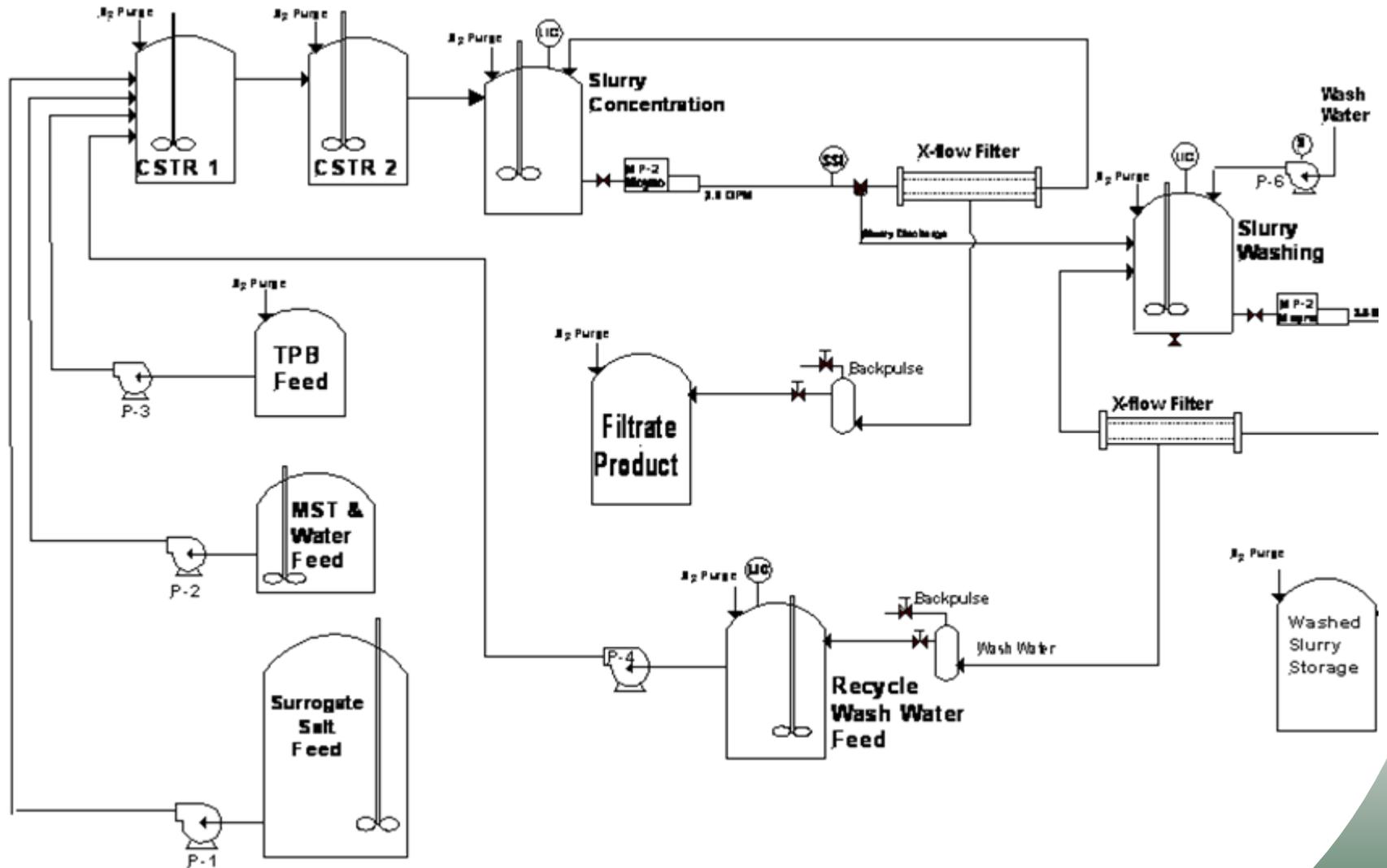
# Small Tank Tetraphenylborate Process (STTP)

- **Tetraphenyl borate is used to precipitate cesium from tank supernates**
- **In-tank test of TPB in 1995 caused excess formation of benzene, due to catalyst metals in the waste and high temperature in the tank**
- **Use of smaller processing tanks would reduce benzene formation by controlling temperature**
- **STTP was one of three technologies that were extensively tested prior to selection of the solvent extraction process for the Salt Waste Processing Facility (SWPF) at SRS**

# A Pilot-Scale STTP System Was Tested at ORNL

- **System consisted of two 15-L stirred tank reactors, in series, a sludge concentration tank and cross-flow filter, and a sludge washing tank and filter**
- **Conceptual design for full-scale system used two 15,000 gal reactors, operating in series**
- **Tanks have stirrers and cooling coils**
- **Goals were to measure cesium, strontium and actinide removal, determine benzene generation rate, and demonstrate integrated operation of system**
- **Benzene is measured in off-gas, from nitrogen purge of vessels, and in treated effluent**
- **Four extended time period runs were completed**

# Flow Diagram of Pilot-Scale System



# Photo of Pilot-Scale System, Prior to Installation in Hot Cell



# Composition of Feed Surrogate

Component	Conc. (M)
Na <sup>+</sup>	6.25
K <sup>+</sup>	0.0167
OH <sup>-</sup>	3.526
NO <sub>3</sub> <sup>-</sup>	1.319
NO <sub>2</sub> <sup>-</sup>	0.566
AlO <sub>2</sub> <sup>-</sup>	0.337
CO <sub>3</sub> <sup>2-</sup>	0.174

Component	Conc. (M)
SO <sub>4</sub> <sup>2-</sup>	0.163
Cl <sup>-</sup>	0.0273
F <sup>-</sup>	0.0348
HPO <sub>4</sub> <sup>2-</sup>	0.0108
C <sub>2</sub> O <sub>4</sub> <sup>2-</sup>	0.0086
SiO <sub>3</sub> <sup>2-</sup>	0.0048
MoO <sub>4</sub> <sup>2-</sup>	0.00038

Also added – 20 mg/L Cs plus 5.2 mCi/L Cs-137,  
0.046 mg/L Sr plus 0.0045 mCi/L Sr-85, and 1 mg/L U  
A high concentration of Cs-137 was needed to measure  
the expected DF.

# Trace Metals and Organics Were Added to the Surrogate Feed to Model TPB Degradation in Actual Waste

Compounds	Conc. (mg/L)
<b>Pd(NO<sub>3</sub>)<sub>2</sub></b>	<b>16.7</b>
<b>Cu(SO<sub>4</sub>)·5H<sub>2</sub>O</b>	<b>4.8</b>
<b>(C<sub>6</sub>H<sub>5</sub>)<sub>2</sub>BOH</b>	<b>161</b>
<b>(C<sub>6</sub>H<sub>5</sub>)B(OH)<sub>2</sub></b>	<b>161</b>
<b>(C<sub>6</sub>H<sub>5</sub>)<sub>3</sub>B</b>	<b>161</b>
<b>Hg(NO<sub>3</sub>)<sub>2</sub>·H<sub>2</sub>O</b>	<b>2.9</b>
<b>(C<sub>6</sub>H<sub>5</sub>)<sub>2</sub>Hg</b>	<b>194</b>
<b>C<sub>6</sub>H<sub>6</sub></b>	<b>932</b>
<b>Na<sub>2</sub>MoO<sub>4</sub>·2H<sub>2</sub>O</b>	<b>15.2</b>
<b>Na<sub>2</sub>CrO<sub>4</sub></b>	<b>77.9</b>
<b>Na<sub>2</sub>SiO<sub>3</sub>·9H<sub>2</sub>O</b>	<b>20.9</b>
<b>Na<sub>2</sub>SeO<sub>4</sub></b>	<b>1.3</b>
<b>As<sub>2</sub>O<sub>3</sub></b>	<b>0.048</b>
<b>Zn(NO<sub>3</sub>)<sub>2</sub>·4H<sub>2</sub>O</b>	<b>11.4</b>
<b>Pb(NO<sub>3</sub>)<sub>2</sub></b>	<b>1.5</b>

Compounds	Conc. (mg/L)
<b>Fe(NO<sub>3</sub>)<sub>3</sub>·9H<sub>2</sub>O</b>	<b>3.3</b>
<b>SnCl<sub>2</sub></b>	<b>2.7</b>
<b>Ca(NO<sub>3</sub>)<sub>2</sub>·4H<sub>2</sub>O</b>	<b>15.8</b>
<b>La(NO<sub>3</sub>)<sub>3</sub>·6H<sub>2</sub>O</b>	<b>0.066</b>
<b>Co(NO<sub>3</sub>)<sub>2</sub>·6H<sub>2</sub>O</b>	<b>0.048</b>
<b>Cd(NO<sub>3</sub>)<sub>2</sub>·4H<sub>2</sub>O</b>	<b>0.48</b>
<b>Ce(NO<sub>3</sub>)<sub>3</sub>·6H<sub>2</sub>O</b>	<b>0.38</b>
<b>Rh(NO<sub>3</sub>)<sub>3</sub></b>	<b>1.8</b>
<b>AgNO<sub>3</sub></b>	<b>8.8</b>
<b>RuCl<sub>3</sub>·xH<sub>2</sub>O</b>	<b>7</b>
<b>Isopropanol</b>	<b>64.6</b>
<b>Methanol</b>	<b>6.7</b>
<b>C<sub>6</sub>H<sub>5</sub>OH</b>	<b>162</b>
<b>(C<sub>6</sub>H<sub>5</sub>)<sub>2</sub></b>	<b>194</b>

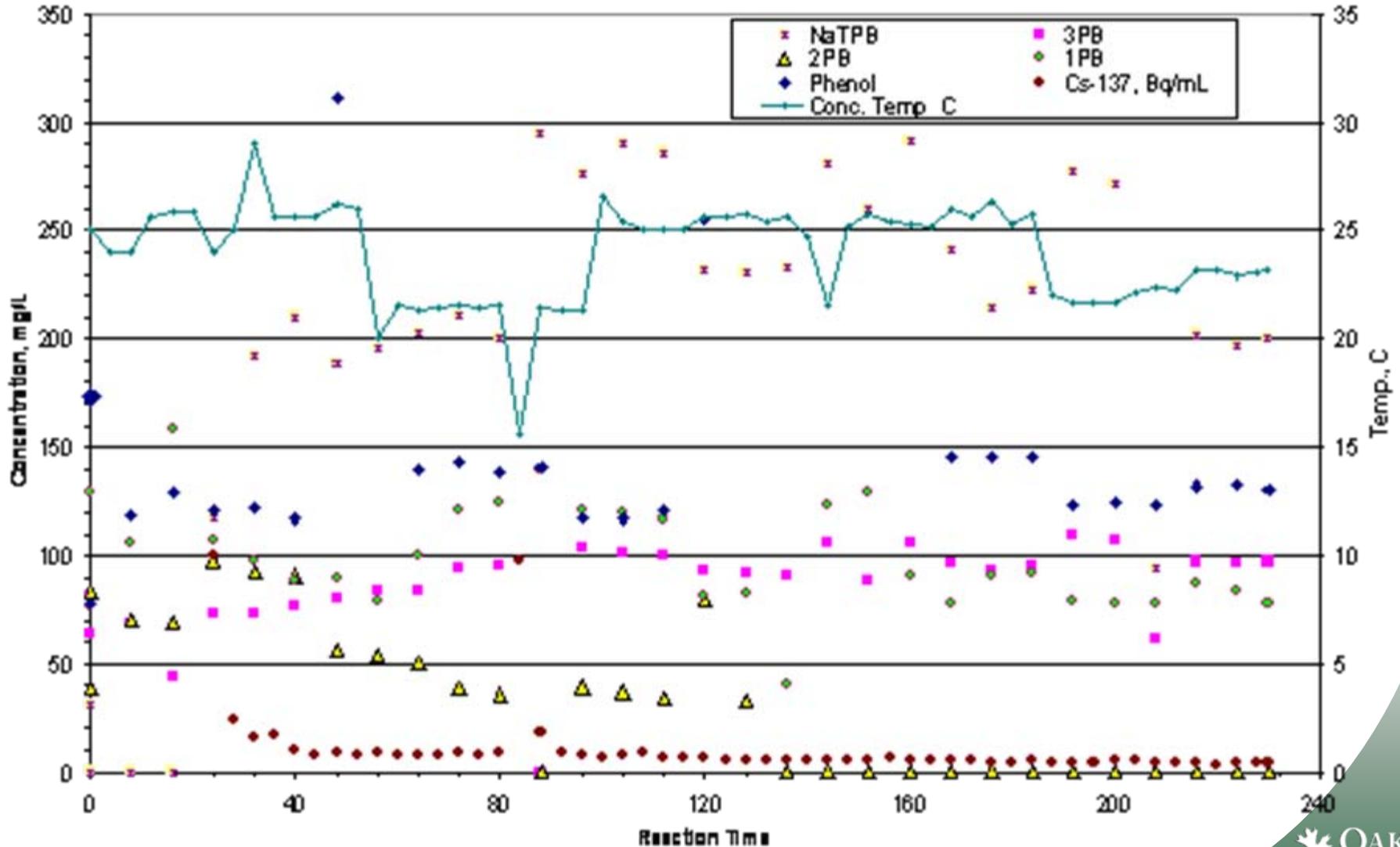
Simulant test without antifoam showed that a thick, persistent foam could be produced



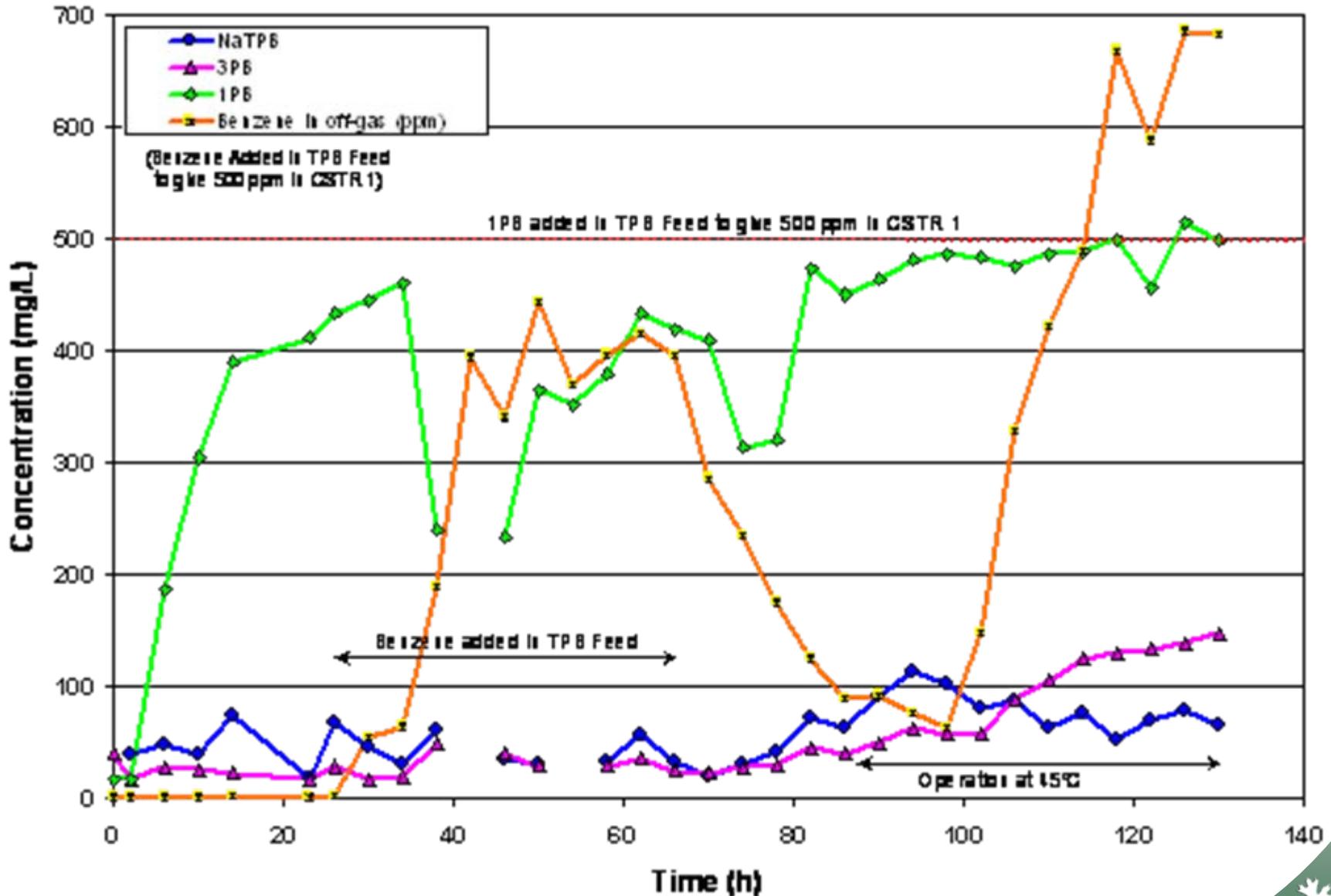
**During testing, the antifoam prevented excessive foam from interfering with operation of the system.**

# Concentration of TPB and Breakdown Products in Effluent Remained Essentially Constant

Decomposition Products from Concentration Filtrate  
Test 2



# Run 4 Used Extra Catalyst and Benzene in Feed, and Higher Temperatures to Stimulant Benzene production



# Test Results

- **Four runs were completed, 60-230 hrs long**
- **Cesium removal efficiency was maintained under all operating conditions**
- **Benzene production was only significant at higher operating temperatures**
- **Control of foaming was successful**
- **System was very labor intensive to operate, mostly because of sample handling**