Waste Treatment Using Molten Salt Oxidation Technology

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Program Sponsors

- Program Sponsor:
  - United States Defense Ammunition Center
- Contract Administered by:
  - Naval Surface Warfare Center-Crane
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Technology Background

- Molten salt oxidation (MSO) is a flameless oxidation process
- Operates at lower temperature than incineration
  - Approximately 800^0C
- Eutectic salt mixture captures acid gas elements
  - Na_2CO_3 and K_2CO_3 mixture

Process Chemistry

- Described at previous Global Demilitarization Symposiums
- Contaminants of concern
  - Simple organics (explosive, contaminated carbon)
    - $2C_aH_b + (2a + b/2)O_2 \rightarrow 2aCO_2 + bH_2O$
  - Nitrogen-bearing organic wastes
    - $C_aH_bN_c + O_2 \rightarrow CO_2 + H_2O + N_2 + NO_x$

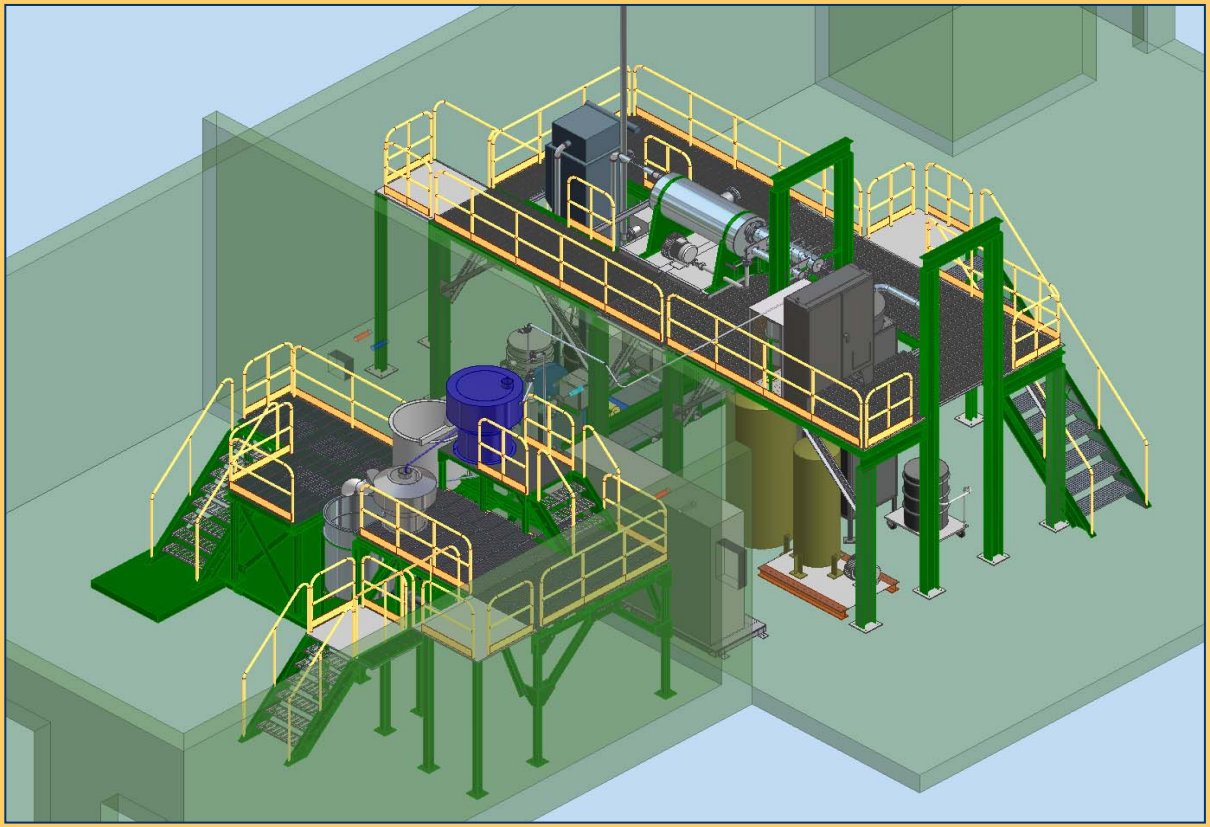
Project Background

- MSE was tasked to design and deliver prototype MSO system for energetic contaminated material and other waste streams at DEFAC facility in South Korea
- Optimized prototype system uses background information developed from pilot-scale system runs at DAC and BGAD
  - Pilot scale operation described in previous Demil Symposiums

Process Design Basis

- Designed to treat secondary wastes resulting from operations at DEFAC facility in Korea
  - Explosive, contaminated, activated carbon
  - Water treatment plant deionization resins
  - Synthetic oils
  - Approximately 2.5 times larger feedrate than pilot-scale system
    - Feedrate of 240 to 250 ml/min

Large Scale Prototype System



Feed Preparation System

- Continuous batch feed preparation system
- Designed to grind feedstock to less than 100 mesh
- Sweco high energy mill
- Sweco vibratory screen
- Progressive cavity pumps to recirculate feedstock
- Explosion proof motors and controls

Grinding Mill Details

- Sweco Model 38L
- 2.5 Hp grinding motor
- Fiberglass lined grinding tub
- Ceramic cylindrical grinding media

Screen Separator Details

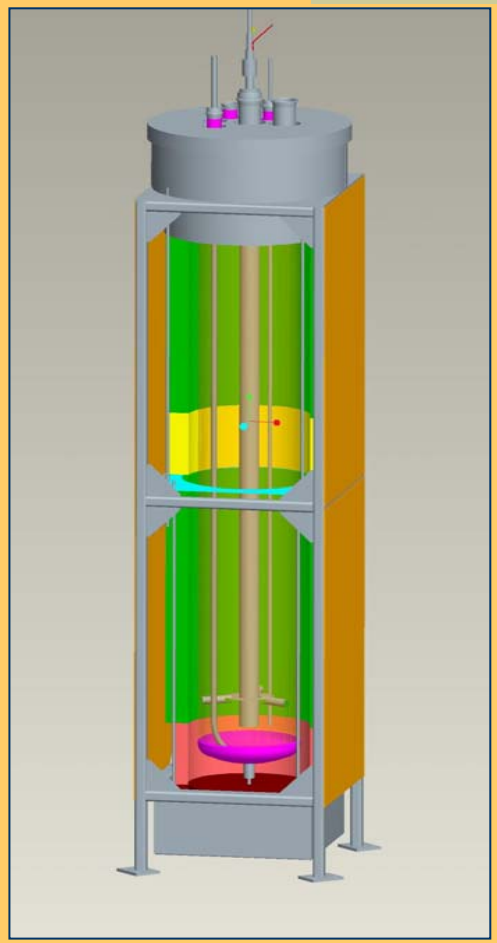
- Sweco ZS30 vibro energy separator
- 0.5 Hp motor
- 100 mesh separator screen
- PVC screen cleaning cylinders

Reactor System General Arrangement

Reactor Description

Reactor Illustration

- 18 inch diameter reactor
- 120 inches high
- Single diameter throughout entire reactor length
- 19 resistance heaters
- Alloy 600 reactor body
- Downcomer assembly injects feedstock into bottom of salt mixture



Reactor Heating Elements

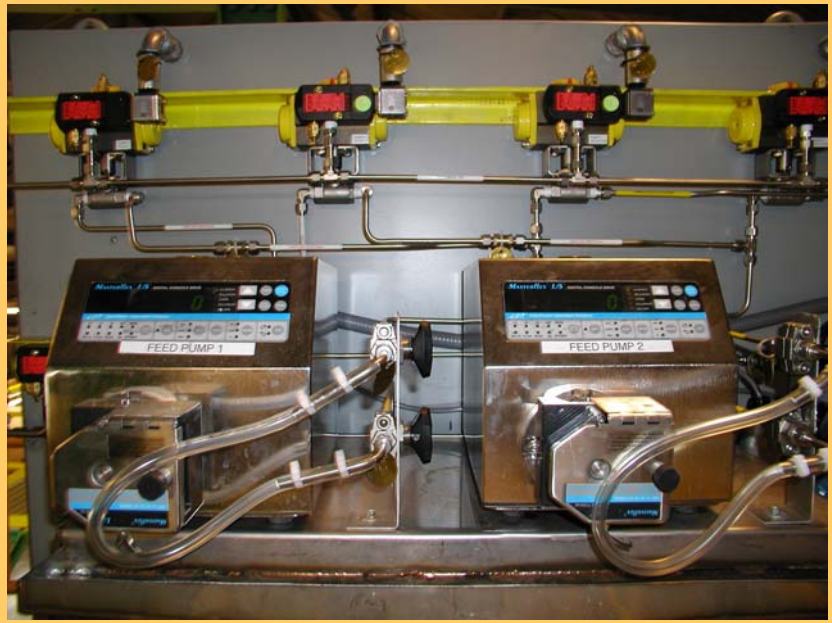
- 19 radiant heating elements
- Elements rated for 5000 watts per element
- Normal resistance of element is approximately 9 ohms
- Reactor operates in excess of 800°C

Reactor Side Heating Element

- Side elements rated for continuous operation at 1500^0C
- Elements approximately 1.5 inches from reactor vessel

Feed Injection System

- Dual Peristaltic Pumps regulate flow of feed into reactor.
- One pump is in standby while one operated



Reactor Top

- Provides penetrations for reactor
  - Relief port
  - Offgas port
  - Salt removal port
  - Temperature measurement port
  - Downcomer port

Offgas System

- Offgas cooler
- Cools gas from approximately 750^0C to 210^0C
- Quick cooling of gas promotes salt re-condensation in salt trap
- Process lines heat traced to decrease heat-up time and keep offgas above dew point

Salt Trap

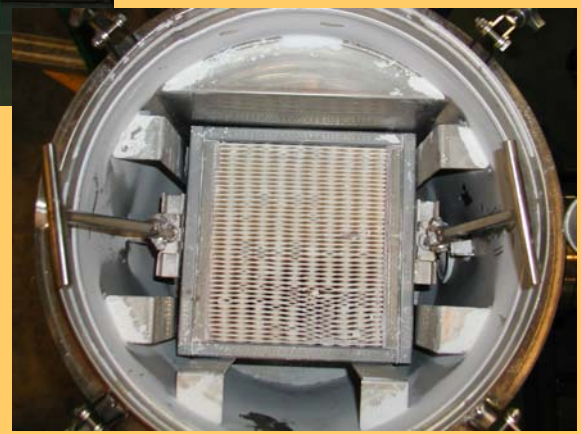
- Salt trap is designed to capture cooled salt particulate

Offgas Treatment System

- Baghouse
  - Automatic cleaning system
  - Insulated and heat-traced
- Bags are constructed of a combination of Teflon and fiberglass
  - Rated for 215^{dc}C continuous duty
  - Nine, 60 inch bags

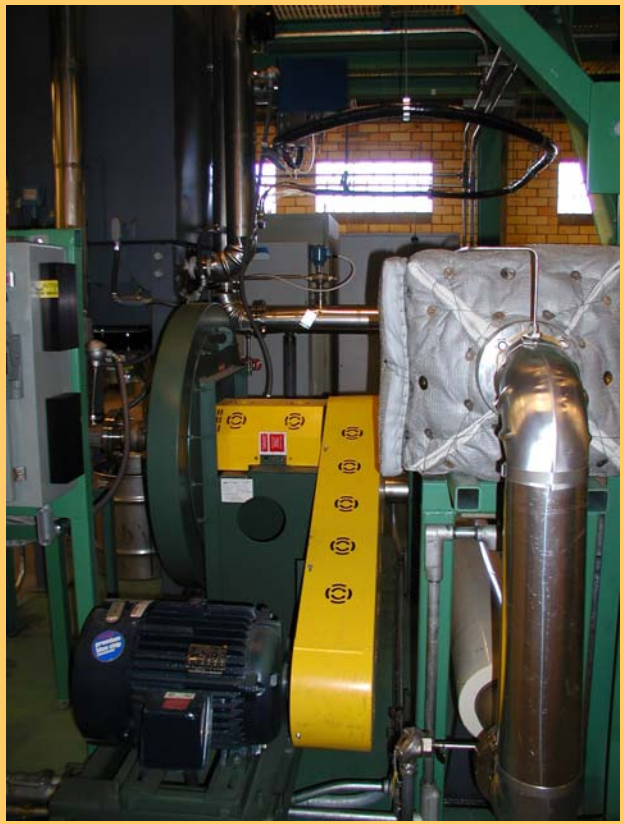
Offgas Treatment System

- High Efficency Particulate Filter
  - HEPA filter
  - Insulated
  - HEPA filter designed for 260^0C continuous duty
  - Designed for 99.97% removal efficiency of particulate less than 0.3 micron



Offgas Treatment System

- Induced Draft Blower
  - Maintains system at negative pressure
  - Nominally maintained at –3 inches water column in reactor
  - 316 stainless steel internals

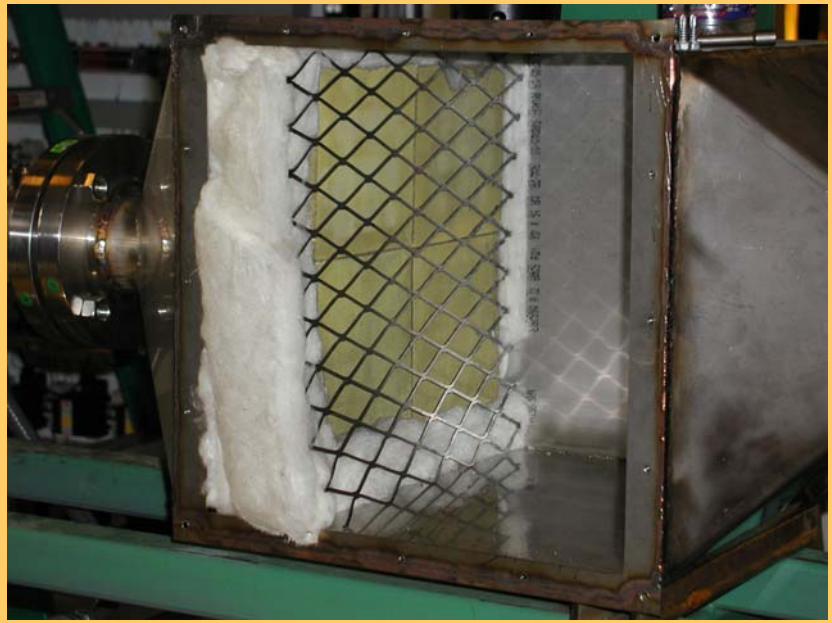


Offgas Treatment System

- NOx reduction System
  - Offgas is reheated to above 300^0C in 30 kW reheater
  - CO catalyst treats carbon monoxide
  - Anhydrous ammonia is injected into system
  - NOx catalyst reacts with ammonia and forms nitrogen and water

Catalyst Internals

- CO catalysts are constructed of platinum doped ceramic
- NOX catalysts are constructed of titanium dioxide doped ceramic
- 400^0C maximum operating temperature



Offgas Treatment System

- Continuous Emissions Monitor
  - Heated probe
  - Automatic calibration
  - Multi analyzer
    - CO, CO2, O2, NO, NO2, SO2, THC, Ammonia

Salt Evacuation System

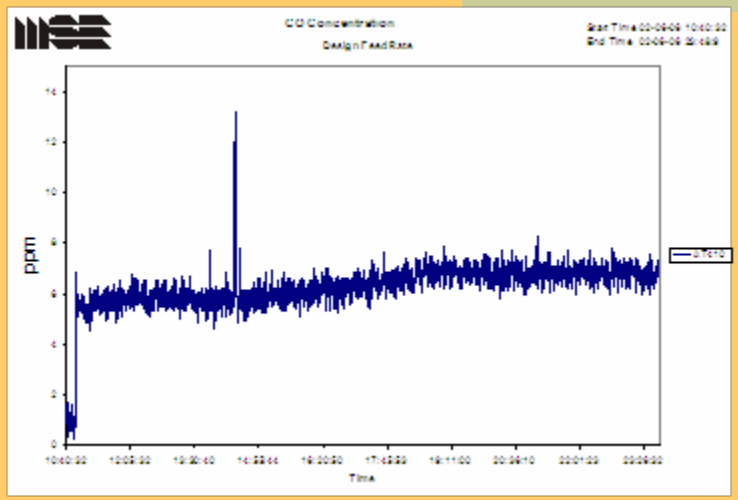
- Draws a deep vacuum on storage vessel to remove salt from MSO reactor
- Remotely controlled from control room

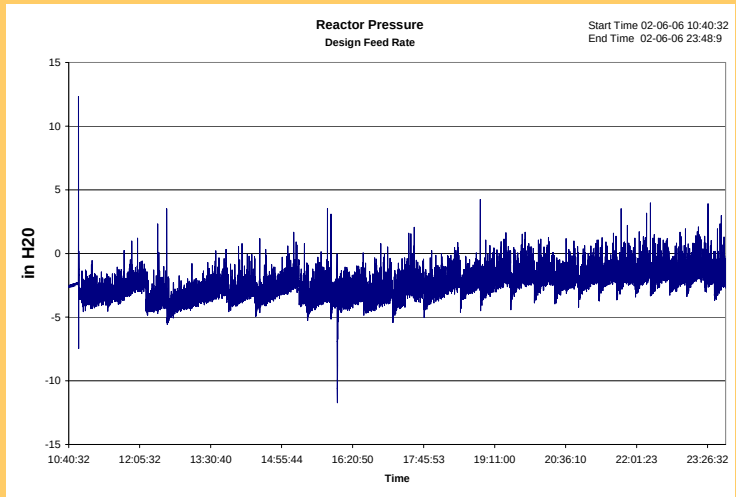
Operation Summary

- Three demonstration test series have been run to define process parameters
- System ran approximately 120% of design basis using simulated feedstocks
- Approximately 150 hours of accumulated operation on the reactor and offgas system
- Starting 300 hour reliability and maintainability test series

Demonstration Test Summary

- Carbon Monoxide concentrations remained well below emission limits throughout test
- Reactor pressure maintained below atmospheric majority of test





Continuously Monitored Emissions

Regulated Constituent	ROK Regulated Limit	Typical Operating Values
NOx	120 ppm *	20 – 30 ppm*
SOx	70 ppm*	5 – 15 ppm*
CO	200 ppm*	20 – 100 ppm*
Ammonia	100 ppm	5 – 25 ppm

Start-up Issues

- Salt carryover from reactor
- Salt is volatilized in reactor and re-condenses in offgas piping upstream of gas cooler

Start-up Issues

- Heater Failures
- Resistance heaters prematurely failed during start-up testing
- Larger diameter reactor requires higher duty cycle of heaters
- New heaters installed with higher duty cycle and temperature rating

DEFAC MSO Project Status

- Performing system RAM tasks through July
- Training DAC staff to operate the system
- Scheduling for installation in the DEFAC facility in FY08