

# **SUPERCritical WATER OXIDATION (SCWO) OF OBSOLETE PESTICIDES**

**Presentation to  
Obsolete Pesticides – A “Burning” Question**

**Utrecht, Netherlands  
September 26, 2008**

**Kevin Downey  
General Atomics  
San Diego, California, USA**

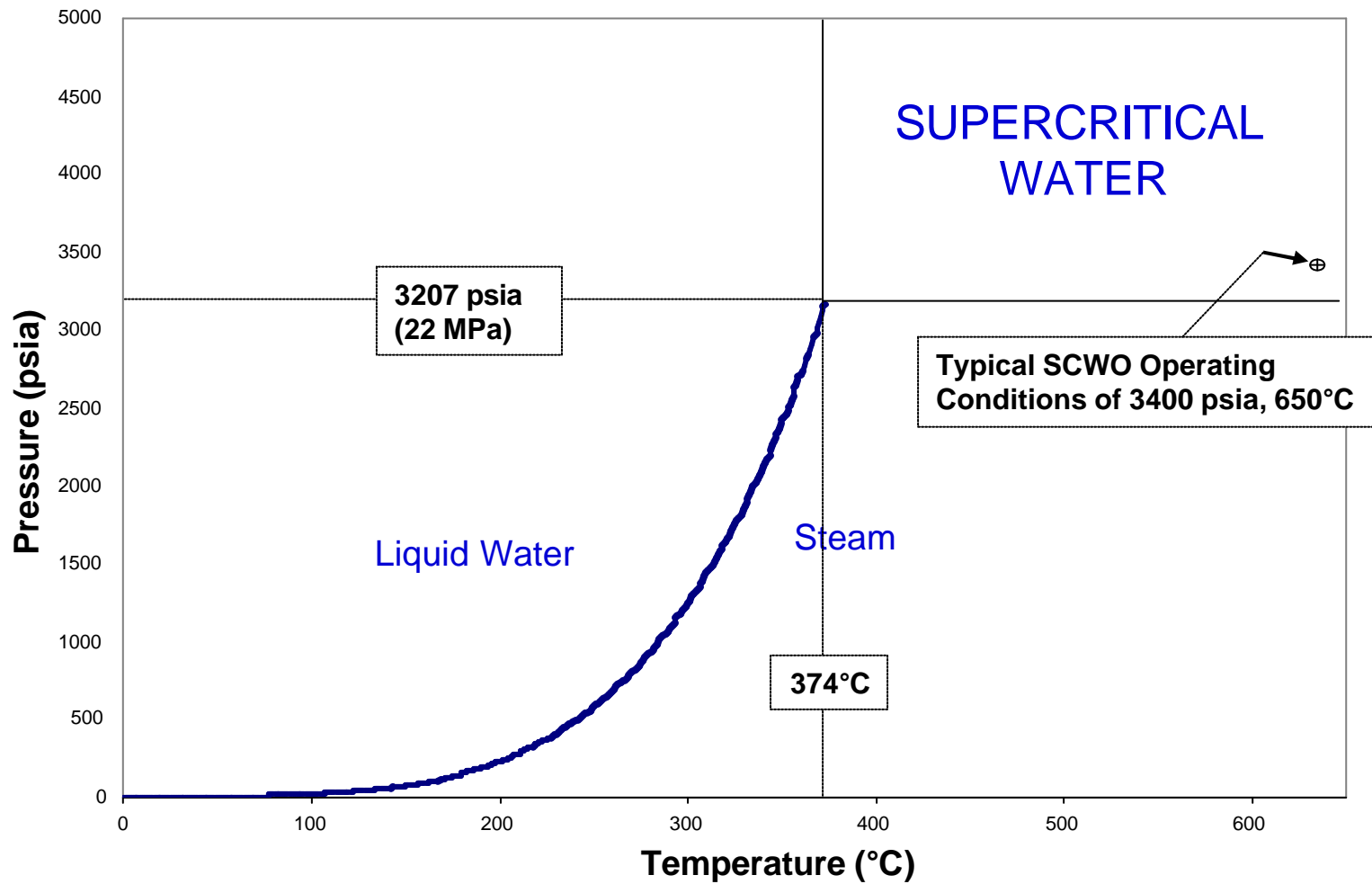
# PRESENTATION TOPICS

- SCWO basics
- Applicable testing
- Blue Grass Chemical Agent-Destruction Pilot Plant (BGCAPP) SCWO
- Industrial SCWO (iSCWO) for obsolete pesticide application
- Conclusions/summary

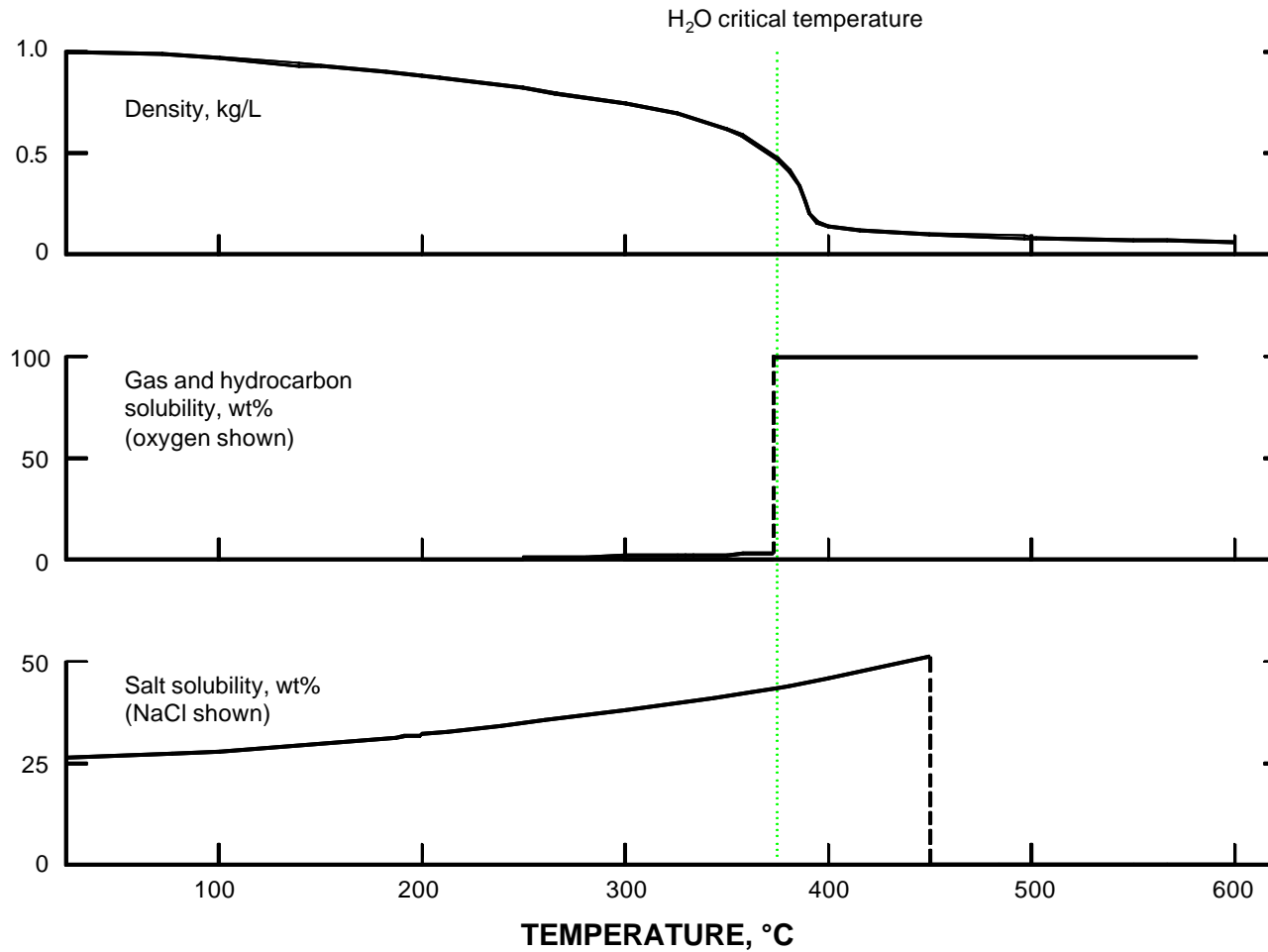
***SCWO offers significant environmental advantages for the destruction of hazardous materials such as pesticides.***

# SCWO BASICS

# WHAT IS SUPERCRITICAL WATER (SCW)?

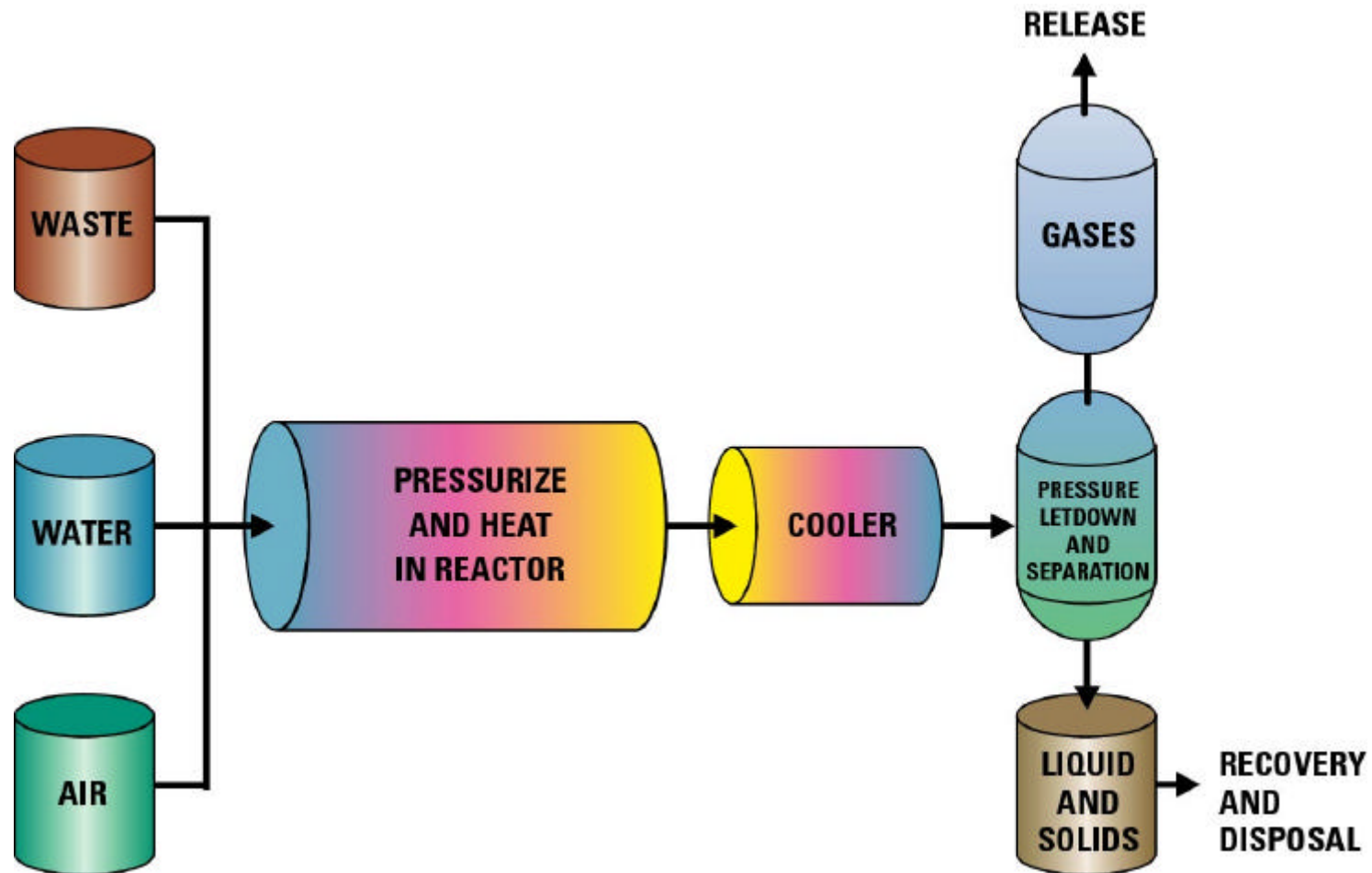


# SCW PROPERTIES



PRESSURE = 25 MPa

# CONCEPTUAL PROCESS FLOW OF A SCWO SYSTEM



# SCWO HAS SIGNIFICANT ATTRIBUTES

- **SCWO Efficiently Oxidizes Organic Wastes**
  - Above the critical point, hydrocarbons and gases are miscible with supercritical water – leads to very rapid, very thorough destruction of organics
  - Complete oxidation to  $\text{CO}_2$ ,  $\text{H}_2\text{O}$ , and salts
  - No acid gases or particulates
  - Low  $\text{NO}_x$ ,  $\text{SO}_x$ , and CO
  - No pollution abatement equipment required

# APPLICABLE TESTING



# WIDE RANGE OF APPLICABLE WASTES TREATED VIA SCWO

- >18,000 hr of testing
- Destruction of over 200 organic compounds demonstrated, including:
  - Hydrolysis products of GB and VX nerve agents (nerve agents are organophosphates similar to a major class of pesticides)
  - Dioxins and Furans
  - PCBs
  - DDT
  - Numerous similar compounds and mixtures (see handout)

# SCWO TO DATE AIMED PRIMARILY AT CHEMICAL AGENT NEUTRALIZATION PRODUCTS

- **~8,000 hr of testing**
  - GB hydrolysate
  - VX hydrolysate
  - Mustard hydrolysate
  - Energetics hydrolysate
- **Pilot plant feed rates up to 350 lb/hr (~160 kg/hr)**
- **Complete destruction – total organic carbon (TOC) concentration in liquid effluent of <1 ppm.**
- **The use of removable/replaceable liners and control of process chemistry ensure reliable, continuous operation**

## VX HYDROLYSATE TEST FACILITY



## VX Hydrolysate Drum Storage

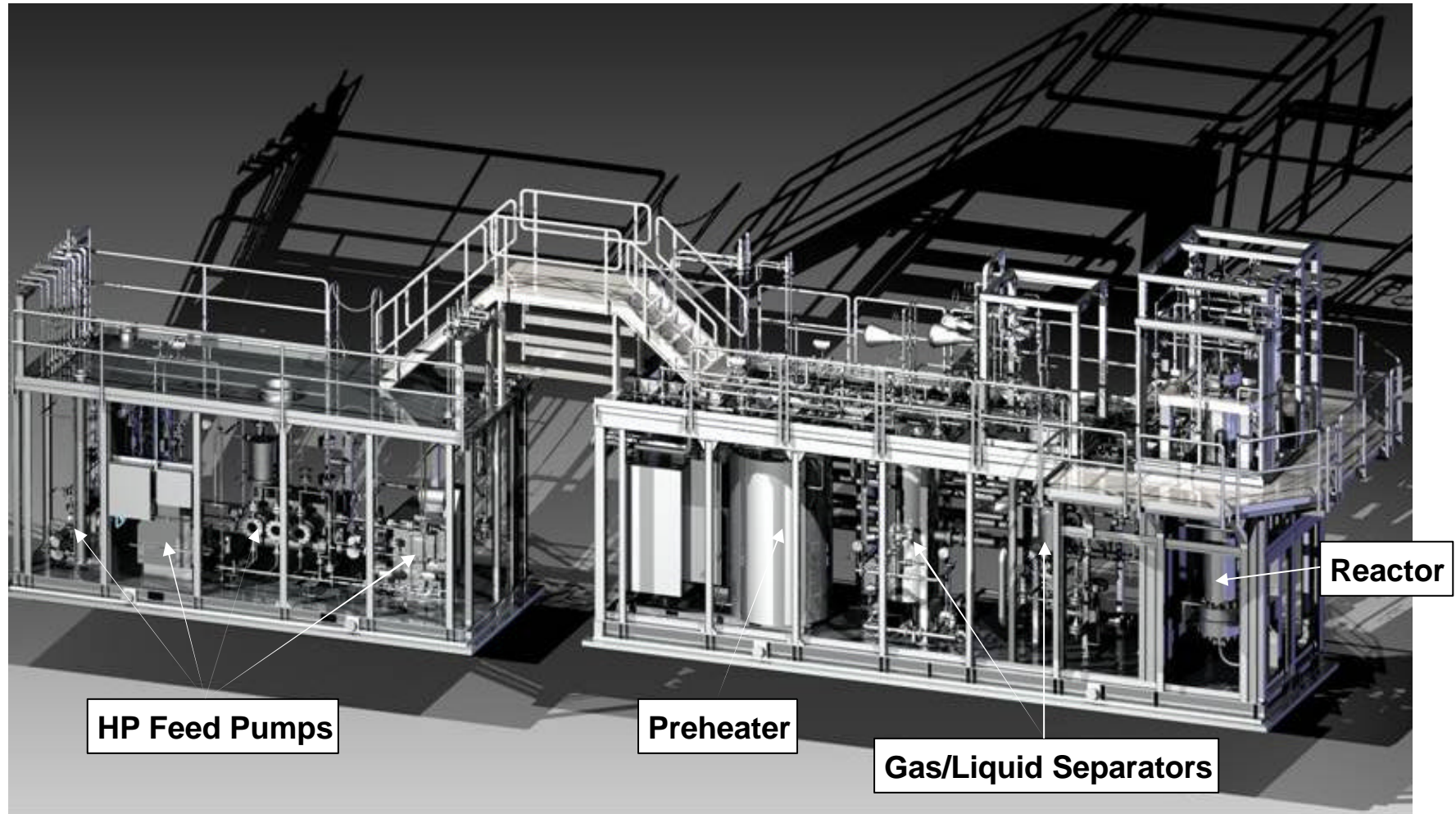


# **BLUE GRASS CHEMICAL AGENT- DESTRUCTION PILOT PLANT (BGCAPP) SCWO**

# BGCAPP SCWO OVERVIEW

- General Atomics is part of the Bechtel Parsons team responsible for design, construction, operation, and closure of a facility to dispose of the chemical munitions inventory at the Blue Grass Army Depot
- Agent/energetics destruction technology being implemented is neutralization followed by SCWO
- Three SCWO units rated at 1000 lb/hr (450 kg/hr) to be supplied for treatment of the neutralized agent and neutralized energetics waste streams

# BGCAPP SCWO UNIT FOR AGENT HYDROLYSATE AND ENERGETICS HYDROLYSATE DESTRUCTION





# INDUSTRIAL SCWO (iSCWO)

# THE iSCWO SYSTEM

- Simplified, robust design targeted at specific industrial and military applications
- Modular and portable
- Low capital cost
- Small footprint
  - 8 ft x 20 ft (2.4 m x 6.1 m) for main skid
  - 6 ft x 20 ft (1.8 m x 6.1 m) for compressor skid)
- Minimal personnel requirement

*The iSCWO design would be used for the destruction of obsolete pesticides.*



# INDUSTRIAL SCWO (iSCWO)



# iSCWO HP AIR COMPRESSOR



# SCWO REACTOR

- Downflow plug reactor
- Made from high-strength corrosion-resistant materials
- Code approved and stamped by American Society of Mechanical Engineers (ASME)
- Fitted with a removable liner that can be fabricated from a variety of corrosion-resistant materials (e.g., titanium)



# SCWO REACTOR AND ENCLOSURE



# SCWO PROVIDES EFFICIENT AND COMPLETE ORGANIC DESTRUCTION

Pollutant	Incinerator Limit	SCWO	Improvement Factor
Dioxins and Furans, TEQ ng/dscm	<0.2	<0.006	> 30 x
Particulate Matter, mg/dscm	<34	<4	> 8 x
HCl, ppmv	<21	<0.4	> 50 x
CO, ppmv	100	0.1	1,000 x
NOx, ppmv	variable	<10	N/A
Hydrocarbons, ppmv	<10	<0.03	300 x

***No Pollution Abatement System (PAS) required.***

# iSCWO SYSTEM UTILITY AND SUPPORT REQUIREMENTS

- 480 VAC, 3 ph, ~1200 amp service
- Water @ 30-50 psig (2.1-3.4 bar) supply, 18 gal/min (gpm) (~70 liter/min)
- Instrument air
- Propane (natural gas) – 1000 st ft<sup>3</sup>/h (2500 st ft<sup>3</sup>/h)  
28 st m<sup>3</sup>/h (71 st m<sup>3</sup>/h)
- Calibration gases – O<sub>2</sub> and CO
- NaOH
- Tanks – feed and effluent collection
- Low sulfur, diesel fuel

## ESTIMATED COSTS FOR 3-GAL/MIN (11.4 LITER/MIN) iSCWO SYSTEM

- **Capital Cost – \$1.7M U.S. (1.2M Euro)**
  - SCWO unit and HP air compressor
  - Assumes site provides feed and effluent tankage and any required feed pre-treatment
- **Operating Cost – \$0.15 to \$0.35 per pound  
(230-540 Euro per metric ton)**

# PESTICIDE PRETREATMENT SCENARIOS

- **Feed must be pumpable to SCWO**
  - Slurry with water
  - Dissolve in solvent (preferably a waste also requiring disposal)
  - Dissolve in water (if sufficiently soluble)



# SOLID WASTES CAN BE SHREDDED AND/OR SLURRIED, AND PROCESSED VIA SCWO

## WOOD SHREDDER



Micronized  
Wood

## PLASTIC/RUBBER SHREDDER



Micronized Plastics/Rubber

## HYDROPULPER SLURRIES WASTES FOR FEED TO SCWO



Slurry

Slurried and  
ready  
for feed to  
SCWO

# CONCLUSIONS/SUMMARY

# CONCLUSIONS/SUMMARY

- SCWO is an exceptionally clean waste destruction process fully capable of destroying all classes of obsolete pesticides
- SCWO to be implemented soon for major waste destruction project in the U.S. – chemical agent destruction facility at Blue Grass
- The iSCWO system is a simple and robust commercial version of SCWO that provides hazardous waste treatment/disposal at an affordable cost

## CONCLUSIONS/SUMMARY (CONT'D)

- **iSCWO is being implemented at several sites in the U.S.**
  - 3 gal/min (11 liter/min) unit for U.S. Air Force/commercial company in Alaska – *fabrication complete and awaiting shipment to site*
  - 3 gal/min (11 liter/min) unit for Tooele Army Depot – *delivered to site and awaiting installation*
  - 10 gal/min (38 liter/min) unit for Blue Grass Army Depot (non-chemical agent wastes) – *in design/procurement phase*