Name of Process:
Supercritical Water Oxidation

Vendor:
Kurita Water Industries Ltd.
Web site: http://www.kurita.co.jp/
Komatsu Ltd.
Web site: http://www.komatsu.co.jp/

Applicable Pesticides and related POPs wastes:
BHC and Chlordane

Status:
A commercial scale 10 m3/day demonstration unit has been successfully operating with a variety of industrial, municipal and agricultural wastes at a facility of Kurita Water Industries Ltd., in Nogi, Tochigi, Japan.

A USA company have successfully demonstrated to destroy POP's related and warfare agents within a project of US Army using a 0.5 gpm pilot unit of the same origin technology.

Technology description:
Supercritical water oxidation (SCWO) is the destruction technology for organic compounds and toxic wastes using the unique properties of water in supercritical condition that is high temperature and pressure (above 374 degree C and 22 MPa). In supercritical water, organic materials, such as chlorinated organic compounds, are quickly oxidized and decomposed with oxidants. Carbon in the organic compounds is converted to carbon dioxide, hydrogen to water, and chlorine atoms to chloride ion.

Gases including oxygen and organic compounds are completely soluble in supercritical water and become a single phase. Such single phase contact under high density and high temperature allows rapid and almost complete oxidation reaction. Quite high destruction efficiencies for various compounds have been demonstrated using SCWO.

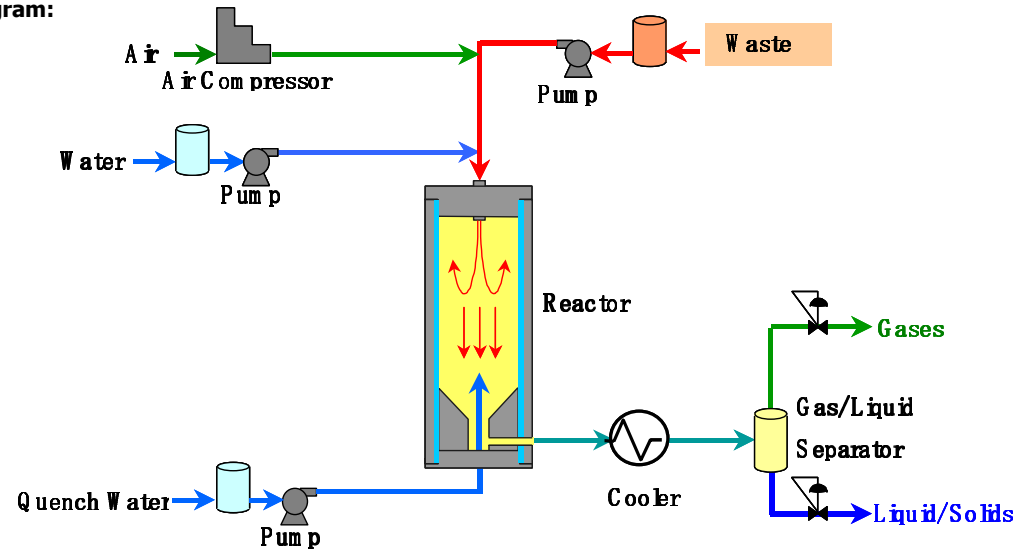
The reactor of Kurita/Komatsu SCWO system is a vertically oriented cylindrical vessel with a feed injection nozzle at upper end, an effluent outlet at bottom and an anticorrosion liner on the wall.

The treatment began by feeding the waste, water and air into the reactor that is under supercritical condition using starter fuel, air and water. The feed substances are injected continuously through the nozzle without preheating, and the feeds are quickly heated to be oxidized in the reactor. The reaction temperature and pressure for BHC and Chlordane treatments were set at 670 degree C and 23.4 MPa. Air is used as the oxidant for Kurita/Komatsu SCWO system.

The after-reaction fluid is cooled and neutralized at the bottom of the reactor by quench water including neutralizer such as sodium hydroxide. The effluent out from reactor is cooled by cooler and lead to the gas/liquid separator. The effluent gas and liquid are depressurized and discharged.

The reaction temperature is controlled by continuously adjusting the waste or water feed rates. The reaction pressure is generated by air compressor and high pressure pumps and is controlled by pressure let down valves. These controls are performed by the automatic operation control system.

Process diagram:



Performance:

Treatment efficiency:
Destruction tests of BHC and Chlordane were performed respectively using the commercial scale demonstration unit. The reaction temperature and pressure were controlled at 670 degree C and 23.4 MPa. The residence time of the waste stream in the reaction region in reactor was calculated as 35 seconds. The test results are summarized in Table 1.
Destruction test of BHC was performed simultaneously using the commercial scale demonstration unit. The reaction temperature and pressure were controlled at 670 degree C and 23.4 MPa. The residence time of the waste stream in the reaction region in reactor was calculated as 35 seconds. The test results are summarized in Table 2.

Table 1: Treatment Test Results

Material	BHC (powder reagent)	Chlordane (emulsion)
Total Tested Amount	1.6 kg	3.96 kg
Concentration in Feed	3.3 %	8.25 %
Concentration in Effluent		
Liquid Effluent:	< 1.6 ng/L	< 0.8 ng/L
Gas Effluent:	< 4 ng/m3N	< 2 ng/m3N
Destruction Efficiency	> 99.999999 %	> 99.999999 %
Destruction Removal Efficiency	> 99.9999998 %	> 99.9999993 %
Dioxin Analysis		
Material:	5100 pg-TEQ/g	0.64 pg-TEQ/g
Liquid Effluent:	0.0012 pg-TEQ/L	0.00008 pg-TEQ/L
Gas Effluent:	0.0036 ng-TEQ/m3N	0.0063 ng-TEQ/m3N
Working Atmosphere:	0.65 pg-TEQ/m3N	0.68 pg-TEQ/m3N

Table 2: Treatment Test Results

Material	BHC extraction
Total Tested Amount	60 L
Concentration in Feed	12000 mg/L
Concentration in Effluent	
Liquid Effluent:	< 0.0004 mg/L
Gas Effluent:	0.00056 mg/m3N
Destruction Efficiency	> 99.999942 %
Destruction Removal Efficiency	> 99.9999639 %
Dioxin Analysis	
Material:	48000 pg-TEQ/L
Liquid Effluent:	0.00074 pg-TEQ/L
Gas Effluent:	0.000014 pg-TEQ/m3N

Throughput:
24 kg/hr as organic feed solution (or emulsion) of material in fuel and/or solvent.

Wastes/Residuals:
In BHC or Chlordane treatment, the effluents from the system are gas and liquid.
In general, solid residuals come out with liquid effluent when water-insoluble inorganic compounds are contained in feed or such compounds are produced during reaction.

Reliability:
As a demonstration unit, the system has been operated successfully in many kinds of tests, however, no concrete reliability data is currently available.

Limitations:
Feed should be solution, emulsion or slurry that is transportable by high pressure feed pump. Pretreatment such as extraction or grinding may be useful to get the best destruction efficiency in the cases of solid-absorbed pesticides.

Transportability:
SCWO systems are transportable.

Detailed information:
No Annex

Conclusion:
Extremely high destruction efficiencies (> 99.999999 %) and very low dioxin concentrations in effluents were obtained in both BHC and Chlordane treatment tests using the commercial scale demonstration SCWO unit. The tests were performed with the throughput of 24 kg/hr as organic waste stream and stable operation continued during the test by automatic control system. No significant problem such as corrosion was found. The SCWO unit is designed as transportable.

Full Scale Treatment examples:
The demonstrations with a variety of wastes have been successfully performed with the commercial scale unit whose maximum throughput is 10 m3/day as total feed.

Vendor Contact details:

Kurita Water Industries Ltd.
Hiroshi Obuse
1-1 Kawada-Gochoyama, Nogi, Tochigi 329-0105, Japan
Ph: +81 280 54 1576
Fax: +81 280 57 2633
Email: hiroshi.obuse@kurita.co.jp

Komatsu Ltd.
Yasuhiko Hata
1200 Manda, Hiratsuka, Kanagawa 254-8567
Ph: +81 463 35 9275
Fax: +81 463 35 9285
Email: yasuhiko_hata@komatsu.co.jp

Patents: General Atomics LTD (D.A. Hazlebeck, et al., U.S. Patent #6,054,057 (2000)).
Kurita Water Industries Ltd and Komatsu LTD have another patents in Japan.

References:

1. Masaaki Wakita, Hiroshi Obuse, Kiyoyuki Kitano, Yasuhiko Hata, Down flow Supercritical Water Oxidation System, Evvironmental Management, Vol.39, No.4, 30(2003)
2. Masaaki Wakita and Kiyoyuki Kitano, Decomposition of organic wastes by down flow supercritical water oxidation system, Environmental Conservation Engineering, Vol.32, No.11, 17(2003)
3. Hirokazu Kaku, Satoshi Nakayama, Yasuhiko Hata and Kiyoyuki Kitano, Supercritical Water Oxidation of Sewage Sludge -Development of Down Flow Supercritical Water Oxidation System, Environmental Solution Technology, Vol.2, No.8, 22(2003).