**Name of Process:**
SP process (Sodium Powder Dispersion Dechlorination Process)

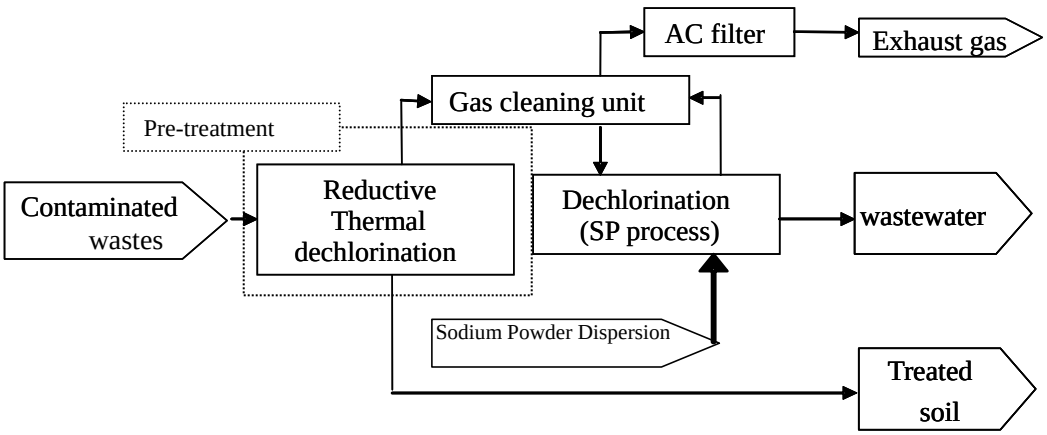
**Vendor:**
Web site: http://www. kobelco-eco.co.jp

**Applicable Pesticides and related POPs wastes:**
Pesticides such as BHCs, Dolins, PCNB, DDTs, are applicable.
POPs wastes such as PCBs, Dioxins, and related halogenated Organic chemicals are also applicable.
There are no concentration limits because it easily dilutes hydrocarbon solvents for complete dechlorination.

**Status:**
**SP process has been developed since 1997 based on the Powertech process, for the dechlorination of PCBs and Dioxins in the contaminated wastes to adopt Japanese regulatory standards, and approved by the treating technology evaluation committee of the government in 1999.**
**In 2002, 214kg of PCBs in capacitor was treated in Okayama prefecture, and other plants are now under construction.**
**The original process developed by Powertech has been conducted for treating PCBs in electric insulation oil for more than 15 years in Canada.**
**Pre-treating technology, RH-process(Reductive heating process) has also been developed in 2002 and approved 2004, in order to reduce the consumption of SP reagent, and now in the large scale demonstration test for the decontamination of POPs contaminated soil and sludge.**

**Technology description:**
SP process is composed of two systems One is pre-treatment process, RH-process, and another is SP process which is composed of a main dechlorination reaction process and a reaction product treating process.
In the pre-treatment process, POPs contaminated wastes is treated by indirect heating at a temperature ranging from 350 to 600°C in oxygen controlled atmosphere, and POPs are decomposed and evaporated from the wastes. The treated wastes become clean and discharged from the process.
The decomposed and evaporated POPs are collected via the oil scrubber, and at the same time evaporated water from the wastes is also condensed. The decomposed and evaporated POPs are dissolved in oil phase and the condensed water is accumulated at the bottom of the scrubber. The process gas from the indirect heating furnace via oil scrubber is exhausted through activated carbon filter.
Scrubbing oil dissolved POPs and their decomposed substance is treated by batch method, reacted with metallic sodium powder dispersion oil at a temperature about 90 °C for an hour. After the reaction, water is added to remove excess sodium to water phase and settled to separate treated oil and alkali solution. Separated treated oil is recycled to scrubbing oil

**Process diagram:**




Process diagram of this technology

**Performance:**

**Treatment efficiency**:

BHC, liquid Hydrocarbon, and Isopropanol are mixed for preparing BHC solutions. After this solution is heated from 50 to 60 , sodium dispersion reagent is added under the control of constant temperature. After 15 to 60 minutes from finishing to add the reagent, solution is sampled and the residual BHC concentration is analyzed. When the BHC decomposition is confirmed, solution is cooled to room temperature, and after water is added to hydrate the excess sodium in the solution brewed the $CO_2$ to neutralize the water, then solution is separated to liquid hydrocarbon and water. Through the reaction, $N_2$ is purged in the reaction vessel. Exhaust gas was passed through the active carbon filter.
As the large scale test, 30L reactor is used and reacted the 5% BHC solution (BHC;420g, Hydrocarbon;7.98kg) at 60 in one hour. Chlordane was also treated by same method.

**2L scale test result**
Result of 2L scale test is shown in Table.1. When the BHC concentration was from 3 to 10%, residual concentration of BHC was lower than the limit of quantification (<0.04mg/kg), and a decomposition rate was greater than 99.999%. When the concentration was higher than 10%, it was difficult to complete the reaction since BHC could not be dissolved completely.

Table.1 Result of 2L scale test

| Experiment No. | Concentration [wt%] | BHC [g] | Temperature [ ] | Residual BHC In Hydrocarbon [mg/kg] | Destruction Efficiency [%] |
|---|---|---|---|---|---|
| 1 | 3.0 | 10.0 | 60 | < 0.04 | > 99.9998 |
| 2 | 3.1 | 10.0 | 60 | < 0.04 | > 99.9998 |
| 3 | 5.1 | 16.0 | 60 | < 0.04 | > 99.99992 |
| 4 | 5.1 | 16.2 | 60 | < 0.04 | > 99.99992 |
| 5 | 10 | 25.1 | 50 | < 0.04 | > 99.99996 |

The GC/MS spectrum analysis showed no cyclohexene but benzene is detected in treated hydrocarbon.

**BHC decomposition rate**
The result of each BHC concentration for treated hydrocarbon, wastewater, process gas before passing activated carbon filter and a BHC balance is shown in Table 2.

Table.2 Result of BHC analysis and balance

| No. | Item | BHC | Tereaed Hydrocarbon | Wastewater | Exhaust gas before AC filter |
|---|---|---|---|---|---|
| 1 | Sample Amount | 420.61g | 7.4kg | 23.6L | 39.56L |
| | BHC Conc. | 98.32wt% | < 0.04mg/kg | < 0.004mg/L | 0.0722mg/$m^3$N |
| | BHC(mg) | 411350 | < 0.30 | < 0.096 | 0.0029 |
| | BHC(%) | 100 | < 7×10 | < 2×10 | 7×10 |
| | DEs(%) | | | | |
| | DREs(%) | | | | |
| 2 | Sample Amount | 420.85g | 8.8kg | 23.6L | 37.93L |
| | BHC Conc. | 98.32wt% | < 0.04mg/kg | < 0.004mg/L | < 0.002mg/$m^3$N |
| | BHC(mg) | 411350 | < 0.35 | < 0.096 | < 0.000076 |
| | BHC(%) | 100 | < 0.000085 | < 2×10 | < 2×10 $^{8}$ |
| | DEs(%) | | | | |
| | DREs(%) | | | | |

The residual BHC concentration decreased below the quantification limit of 0.04mg/kg after 30 minutes from the finish of sodium dispersion addition, and no BHC was detected in treated hydrocarbon and treated wastewater. Though 0.0722mg/$m^3$N of BHC was detected in exhaust gas before activated carbon treatment, no BHC was detected after activated carbon treatment. Total BHC

destruction efficiency showed larger than 99.9998%.

**Chlorine balance**

The result of chlorine analysis and Cl balance is shown in Table. 3.
From 96.1 to 100% of chlorine contained in BHC was recovered as inorganic chlorine in wastewater. Organic chlorine was not detected in treated hydrocarbon and wastewater.

Table.3 Result of chlorine analysis and Cl balance

| No. | Item | BHC | Treated Hydrocarbon | Wastewater |
|---|---|---|---|---|
| 1 | Sample amount | 420.61 g | 7.4 kg | 23.6 L |
| | Total Cl | 73.5 wt% | | |
| | Organic Cl | | < 1mg/kg | < 10 mg/L |
| | Inorganic Cl | | < 0.1mg/kg | 12600 mg/L |
| | Cl amount(g) | 309 | < 0.008 | 297 |
| | Cl rate(%) | 100 | < 0.003 | 96.1 |
| 2 | Sample amount | 420.85 g | 8.8 kg | 23.4 L |
| | Total Cl | 73.5 wt% | | |
| | Organic Cl | | < 1mg/kg | < 10 mg/L |
| | Inorganic Cl | | < 0.1mg/kg | 13200 mg/L |
| | Cl amount(g) | 309 | < 0.01 | 309 |
| | Cl rate(%) | 100 | < 0.003 | 100 |

**Dioxins**

The result of dioxins analysis of each treated hydrocarbon, wastewater, and exhaust gas is shown in Table. 4. Treated wastewater showed 0.0027pg-TEQ/L and this adapted the environmental water standard of 1pg-TEQ/L. The dioxins concentration of exhaust gas before activated carbon treatment showed 0.012ng-TEQ/$m^3$N. After activated carbon treatment, concentration showed 0.0020mg-TEQ/$m^3$N and is within the exhaust gas emission standard of 0.1ng-TEQ/$m^3$N.

Table 4 Analytical result of Dioxins

| No. | Item | | Treated oil | Treated wastewater | Exhaust gas | |
|---|---|---|---|---|---|---|
| | | | | | Before AC Filter | After AC Filter |
| 1 | T-DXNs | Observed | 750 pg/g | 22 pg/L | 23 ng/$m^3$N | |
| | | TEQ | 0.094 pg-TEQ/g | 0.0019 pg-TEQ/L | 0.012 ng-TEQ/$m^3$N | |
| | T-DXNs | Observed | 860 pg/g | 55 pg/L | | 20 ng/$m^3$N |
| | | TEQ | 0.11 pg-TEQ/g | 0.0027 pg-TEQ/L | | 0.0020 ng-TEQ/$m^3$N |

Table5 Results of treatment

| Input POPs | | DEs | DREs | exhaust gas | waste water | treated oil | residue |
|---|---|---|---|---|---|---|---|
| | | % | % | mg/$m^3$N | mg/L | mg/kg | mg/kg |
| BHC | 98.32 wt% | > 99.99990 | > 99.9999993 | 0.0722 | <0.004 | <0.04 | |
| BHC | 98.32 wt% | > 99.99989 | 100.0000000 | <0.002 | <0.004 | <0.04 | |
| Chlordane | 7.2 wt% | > 99.99979 | > 99.9999998 | <0.002 | <0.002 | <0.01 | |
| Chlordane | 7.2 wt% | > 99.99981 | > 99.9999998 | <0.002 | <0.002 | <0.01 | |
| BHC | 345900 mg/kg | > 99.99998 | 100.0000000 | <0.0019 | <0.0004 | <0.005 | 0.038 |
| Aldrin | 7100 mg/kg | > 99.99970 | 100.0000000 | <0.0001 | <0.0001 | 0.002 | <0.001 |

**Atmosphere of work area**

The result of BHC and dioxins concentration of atmosphere of work area showed that BHC was not detected (<0.002mg/$m^3$N) and dioxins concentration was 0.10pg-TEQ/$m^3$N, which is within the environmental standard (<0.6pg-TEQ/$m^3$N).

**Throughput:**
The throughput of this process is according to the plant capability. To date, we have three plants, one is 500L/batch and others are 100L and 30L/batch. The performance is owing to the pre-treatment, and when using reductive heating kiln it allows 200kg/hour throughput for the treatment of contaminated soil and related wastes.

**Wastes/Residuals:**
Wastes from the process are wastewater, treated oil(hydrocarbon liquid),and exhaust gas(N2). When neutralization treatment using acids is not employed, waste alkali(sodium hydroxide) is generated.

**Reliability:**
This technology is confirmed reliable by the actual PCBs dechlorination for more than 15 years at Powertech plant in Canada and 214kg of PCBs treatment experience in Japanese mobile Plant. In addition, several pilot scale tests were carried out under the control of Japanese government technical committee, and has been approved that this technology effective for POPs decomposition without forming secondary hazardous substance.

**Limitations:**
It can be applied to a broad spectrum of contaminants in a wide range of configurations.
However, some pre-treatment are appropriate; when treating contaminated wastes without hydrocarbon liquid state, such as reductive heating treatment for solid wastes like soil and sludge, and solvent extraction for wastewater is employed as pre-treatment for SP process.

**Transportability:**
We have basically designed this process as mobile type plant such as equipped in container or as skid.

**Detailed information:**
No Annex.

**Conclusion:**
The sodium dispersion method was applied for the decomposition of BHC, an organic halogenide agricultural chemicals using 30L scale reactor. For the reaction of 5% BHC concentration at 60 in 30 minutes, the decomposition rate of 99.9998% was obtained and BHC residue of treated hydrocarbon, wastewater, exhaust gas from activated carbon filter showed was not detected. and almost all chlorine was recovered as inorganic phase. Also the dioxins of wastewater and exhaust gas showed lower than wastewater standard (1pg-TEQ/L) and 0.1ng-TEQ/$m^3$N. This indicated that sodium dispersion method is effective as noncombustive method for the decomposition of BHC as one of the organic halogenides.

**Full Scale Treatment examples:**
In 2002, 214kg of PCBs in electric capacitors was treated in our group company in Okayama prefecture using on site plant, including extracting PCBs from capacitors and the dechlorination systems of 100L reactor.

In 2004, 2.5 tons of Dioxins contaminated wastes(soil) is treated via pre-treatment of rotary kiln type reductive heating processor.

**Vendor Contact details:**

**Murotani 1-1-4, Nishi-ku, Kobe, 651-2241**
**TEL:+81-078-992-6525, FAX:+81-078-992-6504**
**E-mail: t.kawai@kobelco-eco.co.jp**
**http://www.kobelco-eco.co.jp**

**Patents:**

Patents pending.

**References:**

1. T.KAWAI et. al., Dechlorination reaction of dioxins in electric insulation oil, soil, and wastewater using sodium powder-oil suspension, *J.Soc.of Powder Technology, Japan*,37(2000),442-448
2. T.KAWAI: Dechlorination of PCBs with sodium particle suspension, *Mineral processing* ,47(2000),63-70
3. http://www.kobelco-eco.co.jp

.