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SUPERFUND INNOVATIVE TECHNOLOGY EVALUATION

# Emerging Technology Bulletin

## *Reductive Photo-Dechlorination (RPD) Process for Safe Conversion of Hazardous Chlorocarbon Waste Streams*

### *ENERGIA, Inc. of Princeton, New Jersey*

**Technology Description:** ENERGIA, Inc. of Princeton, New Jersey has developed a novel technology designated "Reductive Photo-Dechlorination" (RPD) for environmentally safe treatment of waste streams containing hazardous chlorinated hydrocarbons. This RPD process employs ultraviolet (UV) light in a reducing atmosphere and at moderate temperatures to efficiently convert chlorocarbon contaminants into valuable hydrocarbons such as methane, ethane, ethylene and acetylene and hydrogen chloride. The UV light promotes carbon-chlorine bond cleavage and long-chain radical reactions with the hydrogenous bath gas leading to the thermodynamically and kinetically favored hydrocarbon products at a conversion rate of 99%+.

The RPD process is schematically shown in Figure 1. The pilot-scale prototype consists of five main units: (1) Input/Mixer; (2) Photo-thermal Reactor; (3) Scrubber; (4) Separator/Storage; and (5) Recycling. Chlorinated waste streams can be introduced in one of three ways: liquid, vapor or adsorbates (to activated carbon). Chlorocarbon solvents are fed into a vaporizer, mixed with a reducing gas and passed into the Photo-thermal Reactor. Air laden with chlorocarbon vapors is first passed through a separator (condenser) which removes chlorinated materials as liquid. Chlorinated contaminants adsorbed onto activated carbon are removed as vapors by purging with a mildly heated reducing gas. Then the vapors are passed into the Photo-thermal Reactor.

The Photo-thermal Reactor is the heart of the RPD technology. Here the mixture is irradiated and heated. The UV light breaks the C-Cl bond and the temperature sustains long-chain radical reactions. After a suitable residence time, conversion and dechlorination are fully completed. Hydrogen chloride is scrubbed from the mixture which proceeds to the separator. After separation, excess reducing gas is recycled back to the Input/Mixer. Valuable hydrocarbon products are collected and sold. There is also an option for recycling a portion of the hydrocarbon products as an auxiliary fuel to heat up the Photo-thermal Reactor.

**Test Results:** 1,1,1-Trichloroethane is a representative chlorocarbon contaminant. Tests have demonstrated greater than 99% conversion and complete dechlorination. Figure 2, clearly shows the advantage of RPD (black bars) over Reductive Thermal (RT) (open bars) treatment under otherwise identical conditions. In both cases conversion is 99%+. However, while the RT is limited to 51%+ dechlorination, the RPD exhibits 99%+. It is apparent that the RPD process is capable of safe and efficient conversion of chlorinated hydrocarbon contaminants to valuable

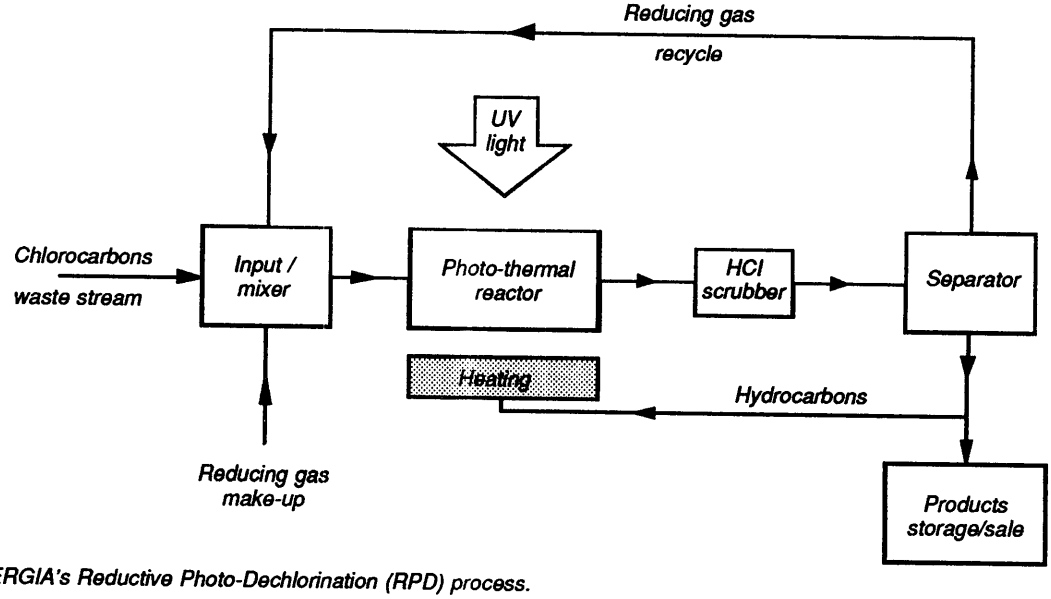


*Figure 1. ENERGIA's Reductive Photo-Dechlorination (RPD) process.*

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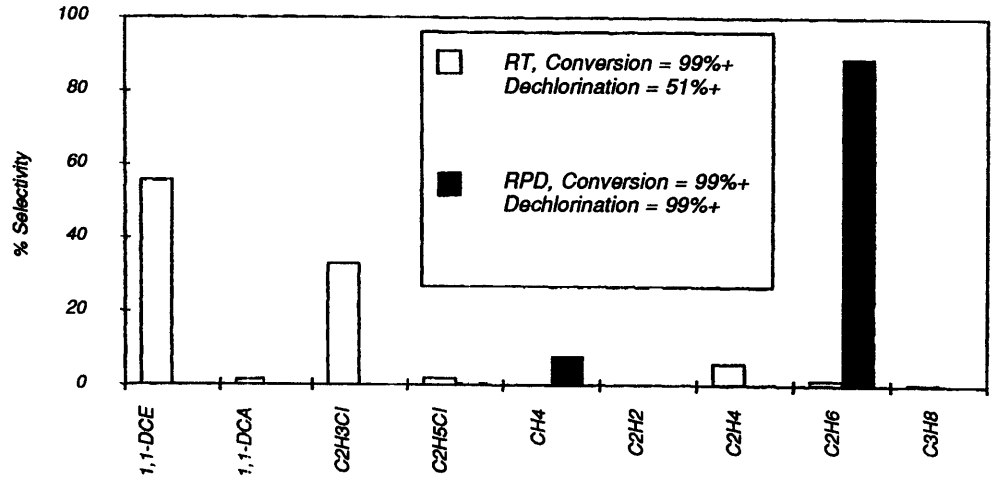


***Figure 2.*** *Product selectivity obtained during treatment of 1,1,1-TCA with Reductive Thermal (RT) and Reductive Photo-Dechlorination (RPD).*

hydrocarbon products (mainly ethane and methane). Similar favorable results have been obtained for other saturated and unsaturated chlorocarbons treated by the RPD process.

**Waste Applicability:** The RPD Process can be effectively applied to liquid or gaseous waste streams containing saturated and unsaturated chlorocarbons. It was tested for TCE, TCA, DCE, DCA, vinyl chloride, ethyl chloride, DCM, and chloroform. It may also be applicable to PCE, carbon tetrachloride, and chlorinated aromatics to be tested.

The RPD process is specifically cost-effective for the following on-site remedial operations:

(1) In-situ treatment of chlorinated wastes discharged from Soil Vapor Extraction (SVE).

(2) Direct treatment of Off-Gas streams containing chlorocarbons.

(3) On-site regeneration of Activated Carbon saturated with chlorocarbons removed by adsorption from waste streams.

(4) Pretreatment of waste streams entering Catalytic Oxida tion systems, reducing the chlorine content and thereby promoting oxidation and longevity.

(5) Small-scale, on-site remediations in R&D and testing laboratories, chemical hoods, clean rooms, etc.

**Status:** The RPD process has successfully completed the bench-top developmental stage and is the basis on which a pilot-scale prototype unit is being constructed. A demonstration SITE program will follow after which the RPD technology will be available for commercialization. Preliminary cost analysis shows that it is extremely competitive with other remedial processes. Its estimated cost is less than $1/lb. of treated chlorocarbon.

**Business Opportunity:** Energia is seeking a joint venture/industrial partner to cost-share the demonstration project, which will be funded, in-part, by EPA SITE program. Energia will consider granting an exclusive license for the emerging RPD technology in exchange for royalties.

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