



KRÜGER

Soil remediation you can trust In Situ Thermal Desorption



The real ISTD



Solutions & Technologies



Testing the efficiency

Our pilot ISTD system is easy and ready to use if a client wants to do a pilot scale test before entering a full-scale remediation.

The test system is built in a 20' container and consists of 6 heater circuits including a complete SCADA system to survey all important parameters. The unit is complete with 2 x 90 KVA transformers, making it compatible to almost any pilot sites ranging from 10-1.300 m³ of soil.

We also offer a laboratory treatability test before heating untested contaminants. By heating soil core samples to different temperatures and for different periods of time we can design the optimal target treatment temperature and duration.

ISTD

- ★ High remediation efficiency:
Concentration reductions of >99.9 %
- ★ Very short operation time: 3-4 months
- ★ Insensitive to geological inhomogeneities
- ★ Treats low-permeable sediments and bedrock
- ★ Remediates underneath buildings or close to residential areas
- ★ Unlimited according to the depth of the contamination
- ★ Remediates every volatile and semi-volatile compounds
- ★ No excavation needed
- ★ Applicable below water table





Technology you can trust

ISTD is a robust, proven and patented technology for heating the subsurface to remediate soil and groundwater. ISTD shows an unbeaten record of site closures.

ISTD is recommended for:

- ★ All organic contaminants
- ★ All soil types
- ★ Remediation above and below the water table
- ★ Inside buildings, near infrastructure
- ★ In fractured rock

For professional results

The success of ISTD is based on conductive heating. The thermal conductivity for the range of known soils varies by a factor of

less than five. This means that ISTD is not limited by soil type or heterogeneity like other techniques based on fluid conductivity.

Conductive heating ensures a uniform heating with a sweep efficiency of nearly 100% even in tight clay soils.

Years of experience

All projects are carried out in cooperation with the American company TerraTherm Inc. specialized in soil and groundwater remediation by thermal in situ treatment. www.terraetherm.com

The ISTD technology is developed and patented by Shell.

We offer a full range of remediation services, from turnkey solutions, partnering projects and supply of heating systems.



Benefits of heating the soil

1. Vapor pressure of the contaminants increases significantly driving it from the absorbed to the gas phase.
2. Heating drives the contaminants dissolved in the water to the gas phase by increasing the Henry's law constant.
3. A significant amount of contaminants are destructed in situ in the high temperature zone adjacent to the heaters.
4. When heating the soil to 100 °C in situ, steam stripping occurs.
5. VOC's are treated at a temperature of approximately 100 °C. Typically 30% of the pore water is vaporized resulting in a 500 time steam flush even in tight clay soils.
6. Conductive heating is the only major remediation technology capable of achieving soil temperatures significantly above 100 °C and hence enabling the treatment of higher boiling compounds such as PAH, PCB, Dioxins etc.





A Wide Range of Uses

Beneath or near buildings

ISTD can be used beneath or near buildings. Because no soil is excavated, neighbours and on-site workers will not be exposed to odors, noise, dust, and truck traffic often associated with excavations.

- ★ Several references from the US and EU
- ★ Very low impact on environment
- ★ Environmentally safe
- ★ Prevents fugitive emissions by applying vacuum to the treatment zone



Saturated and unsaturated zones

ISTD technology is applicable below the water table as long as the designated target treatment temperatures can be reached

- ★ Chlorinated solvents do not require treatment temperatures higher than 100 °C and can be treated simply by steam distillation below groundwater
- ★ Contaminants such as PAHs, dioxins and PCBs require treatment temperatures higher than the boiling point of water
- ★ Boiling off the water within the treatment zone allows heating up the soil to the designated treatment temperatures
- ★ A hydraulic barrier may have to be installed to control recharge into the treatment zone

On-site treatment

The ISTD technology can also be used for above ground treatment of contaminated soil to eliminate the need for off-site disposal. The In-Pile Thermal Desorption (IPTD) process is designed to allow effective within-the-soil remediation.

- ★ Soil piles are insulated, covered and equipped with heaters
- ★ The IPTD soil pile is designed for inexpensive emptying and refilling for quick batch change-out
- ★ Reuse of heaters and electrical connections/piping is facilitated, as well as efficient utilization of off-gas treatment equipment





V-Survey

See the results for yourself

Documentation is the key to validate the results of any in situ remediation process and is therefore visible at all times. Advanced software enables online display of the progress of the soil heating and treatment processes.

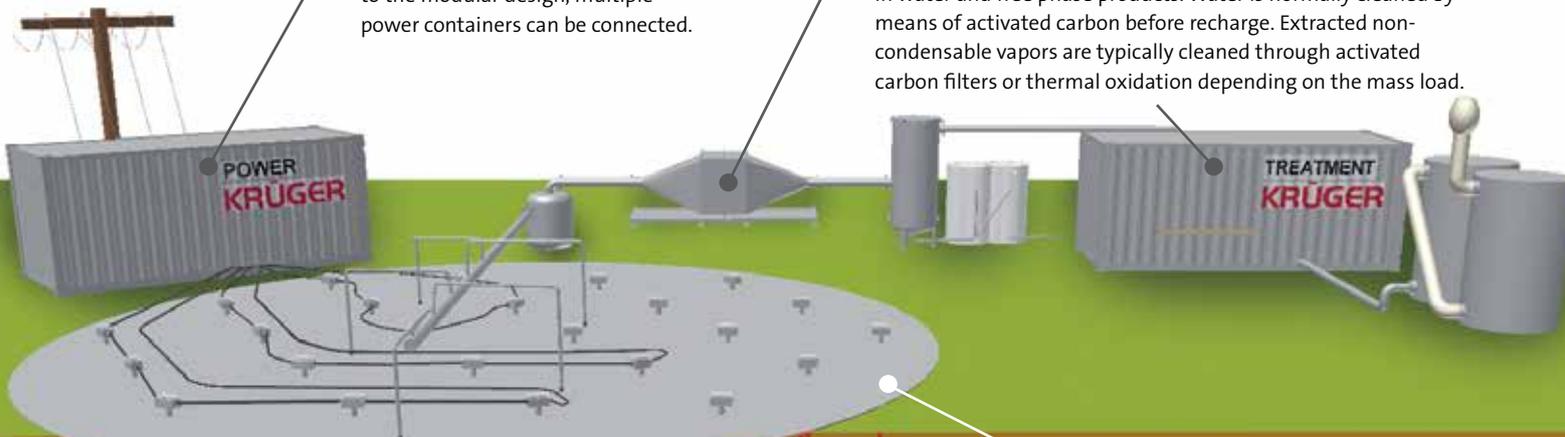
Continuously real time data of:

- ★ Soil temperature (often in the range of 80–300 monitoring points)
- ★ Process temperature (main pipes, cooling system, carbon vessels)
- ★ Pneumatic control
- ★ Process pressure (vacuum pumps, main pipes)
- ★ Flow (extraction, condensate, cooling water etc.)
- ★ Energy consumption
- ★ Heater well temperatures
- ★ Off-gas concentration
- ★ Operation efficiency (hours of operation)
- ★ Energy and mass balance
- ★ Field data such as PID readings, RH, lab analysis, etc.



Power: The “Power” containers supply and regulate power to the heater circuits from the grid. Due to the modular design, multiple power containers can be connected.

Off-gas treatment: A vacuum pump connected through a manifold to the venting wells collects produced vapors and prevents pressure build-up. Collected vapors are condensed and separated in water and free phase products. Water is normally cleaned by means of activated carbon before recharge. Extracted non-condensable vapors are typically cleaned through activated carbon filters or thermal oxidation depending on the mass load.



Vapor cap: The purpose of the lightweight concrete cap is to collect vaporized contaminants, minimizing heat loss to the atmosphere and to protect cooling rainwater from entering the heated zone.

Heater wells: Heaters are placed in 4” casings. The power of a heater well is typically approximately 1 kW pr. m well.

Target treatment zone: The volume to be heated to the target temperature is penetrated with numerous 4” heating wells and venting screens placed either vertically, horizontally or both. Contaminants vaporize and withdraw. Also, in situ destruction such as pyrolysis, hydrolysis and oxidation plays a significant part.

Outstanding Capabilities

As of 2012 more than 50 thermal projects using ISTD have been undertaken.

All projects were completed within time, budget and cleanup criteria.



North Adams, US

ISTD recovery of coal tar containing benzo(a)pyrene and naphthalene



Richmond, US

ISTD recovery of chlorinated solvents in former tank farm area



Edison, Alhambra, US

ISTD recovery of PAH and dioxins in former poleyard

Treatment of various contaminants

The data listed below are typical performances. Please do not hesitate to call us for more details on the projects and the teams involved.

See more references at www.veoliawaterst.com/istd

Site name	Contaminants of Concern	Mean Pre-treatment Concentration (mg/kg)	Mean Post-treatment Concentration (mg/kg)	Remedial goal (mg/kg)
Skuldelev, DK	PCE	DNAPL	0,02	5
Odense, DK	PCE	DNAPL	0,51	5
Reerslev, DK	PCE	78,3	0,038	1
Tåstrup (Alba), DK	PCE	122	0,0056	1
Confidential Site, Midwest, US	PCE	1,5	0,070	1
	TCE	99,8	0,045	1
	1,1,1-TCA	31,9	0,368	1
North Adams, US	Benzene	2.068	0,35	9
	Benz(a) pyrene	20	0,33	0,3
	Naphtalene	679	5,7	10
Richmond, CA, US	PCE	510	0,044	2
	TCE	6,5	<0,02	2
	VC	6,5	0,024	0,23
Alhambra, CA, US	PAH	2.306	0,059	0,065
	PCP	58	1,25	2,5
	Dioxins	0,018	0,00011	0,001



Reerslev, Denmark
 ISTD recovery of chlorinated solvents in residential area and cemetery



Odense, Denmark
 ISTD recovery of PCE under dry cleaning facility in operation



Skuldelev, Denmark
 ISTD recovery of PCE in residential area

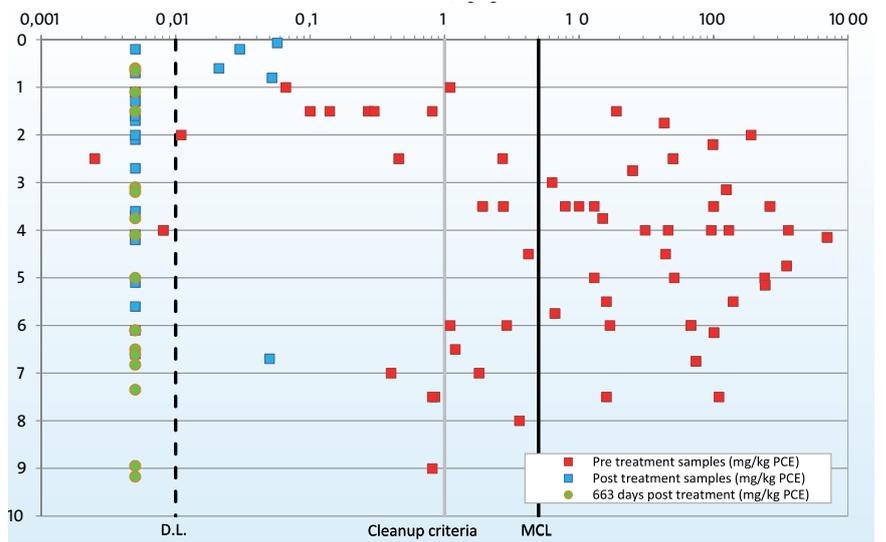


Gladsaxe, Denmark
 Pilot test: ISTD recovery of xylene at paint factory



Taastrup, Denmark
 ISTD recovery of chlorinated solvents beneath an industrial drycleaner

Soil concentrations Reerslev, Denmark (mg/kg)



Confirmative soil sampling is done by the means of intact soil core sampling. These hold both soil, water and poregas and by this clearly show that no rebound does occur.

MCL: Maximum Contaminant Level
 D.L.: Detection Limit

Is Thermal Soil Remediation right for my site?

You are always welcome to contact us if you have a contaminated site and we can help you evaluate if thermal soil remediation would be an option.

First, we do a screening of the site. Then, based on your site information we do a preliminary conceptual design and a cost indication.

To get an evaluation go to our website and fill out the questionnaire or contact us directly by e-mail in-situ@kruger.dk.

Based on this, the design work can be undertaken as well as the final pricing of the remediation.



A strong team you can trust

Krüger is committed to give the client the best service and value for money. We believe this requires excellence in all phases of a project from design to execution and management. The thermal remedy is designed by our thermal experts in Krüger in Denmark in close cooperation with our US partner TerraTherm Inc. – the global leader in thermal soil remediation.



Being part of Veolia Water Solutions & Technologies we gain access to the broad range of unique treatment technologies in the company network (water and off gas treatment). We work closely together with our sister companies in Europe ensuring the right management team and understanding of local customer needs.



Visit our ISTD website:

www.veoliawaterst.com/istd

E-mail: in-situ@kruger.dk

Want to learn more?

We truly believe that thermal remediation makes a difference thanks to its capabilities to succeed. If you are curious to learn more about in situ thermal remediation and to find out if the technology suits your site:

- Visit our website www.veoliawaterst.com/istd
- Request more information, brochures, references, case studies
- Ask for a presentation at your office or a video conference

If you are a consultant and want to tailor your own “seminar” for your clients, see our presentation guide on our website where you can read a summary of the different presentations along with their duration. Just select presentations and combine them into your program.