

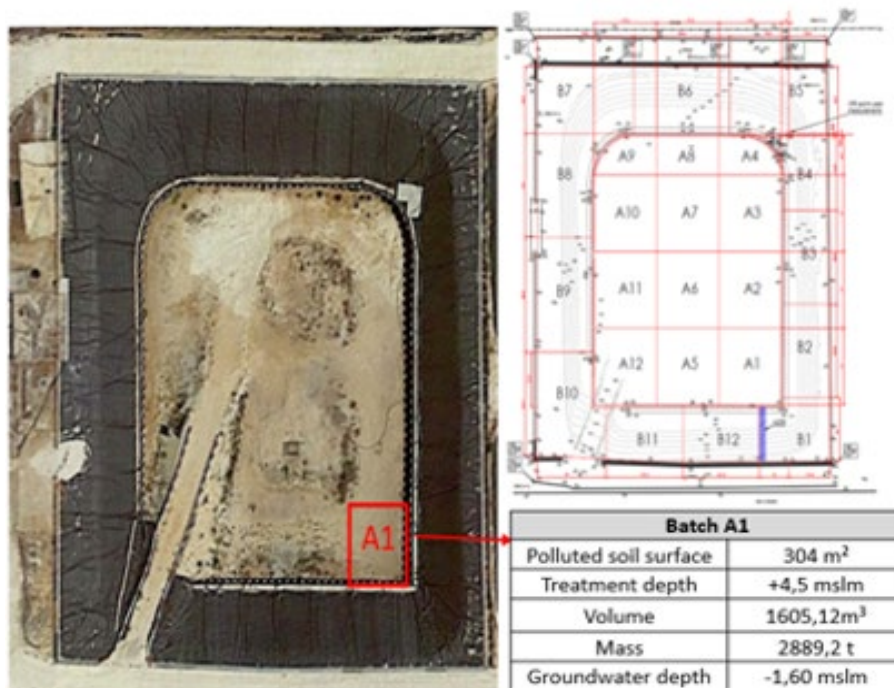
THERMAL DESORPTION WITH SMART BURNERS – CASE STUDY FOR THE IN-SITU TREATMENT OF UNSATURATED SOILS AT THE REFINERY OF GELA (ITALY)

K. PACELLA, H. SAADAOU, J. HAEMERS. HAEMERS Technologies ©

G. CACCAMO, A. BARABESI. Simam S.p.A., Servizi Industriali Manageriali Ambientali, Senigallia, Icaro Ecology S.p.A.

The site interested by the remediation process through the application of the In-Situ Thermal Desorption technology, located inside the Refinery of Gela (ENI Group), consists of former discharge for oil residues deposited in the past.

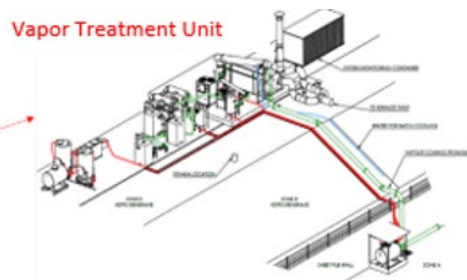
The contaminants are light and heavy hydrocarbons, benzene, polycyclic aromatic hydrocarbons, chlorinated compounds and mercury. The treatment area is divided into 24 batches: Zone A (12 batches of average surface area $\approx 290 \text{ m}^2$) and Zone B (12 batches of surface area between $\approx 400 \text{ m}^2$). The first batch (A1) was considered as pilot and its treatment started on 20 of September 2017 and ended on 13 December 2017.



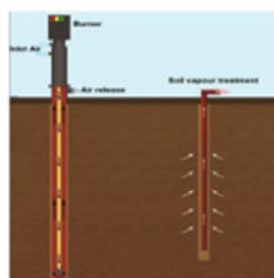
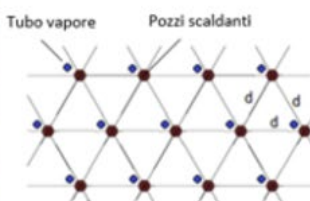
ISTD technology is an in-situ treatment method in which the contaminated soil is heated by thermal conduction. Once the evaporation point is reached, the volatile contaminants are aspirated through perforated extraction pipes creating a depression in the soil. Soil heating occurs by Smart-Burners, developed by Haemers Technologies. These burners are installed on vertical pipes, called heating wells. The technology can be applied to all types of pollutants with boiling point at atmospheric pressure not exceeding 550 °C.

Concerning the site of Gela, 143 burners were installed for the first batch, positioned on top of steel pipes. In correspondence of each heating element, perforated tubes have been installed in the most distant points (also called "cold points"), used for the extraction of the vaporized contaminants and then treated in an ad-hoc vapor treatment unit.

The soil monitoring includes points of measurement of the depression in the soil and the thermocouples located at different depths. The vapor treatment unit consists of vapor condensation and adsorption on activated carbon filters, zeolites and catalytic oxydation.



Smart Burners – Geometry of the heating elements



The soil temperature, soil pressure, recovery condensate and vapors extracted were the main parameters to understand the evolution of the remediation of the pilot batch.

The treatment was complete when reaching a temperature of 200°C at the cold points for 20 days or 250°C for 3 days.

In relation to this, based on the processing of data related to direct and indirect measurements during the treatment of the first batch and the final test verification (sampling and analysis of soils at different depths), the results showed the complete removal of contaminants in the soil matrix thanks to the concentration values recorded well below the target thresholds and almost always below the detection limit.

The final analysis also showed consistency with the monitoring data: when the target temperature was reached, the maximum extraction of the vapors and the complete removal of the contaminants was observed.

Contaminants	Objective concentration n mg/kg	BEFORE THE TREATMENT	AFTER THE TREATMENT		
		Contaminants concentration mg/kg	Contaminants concentration mg/kg (0-1 m)	Contaminants concentration mg/kg (2-3m)	Contaminants concentration mg/kg 4-5m)
HYDROCARBONS <=12	250	26600	<10	<10	<10
HYDROCARBONS >=12	750	130000	<40	48	<40
BENZENE	2	720	<0.02	<0.02	<0.02
ETILBENZENE	50	352	<0.05	<0.02	<0.02
STIRENE	50	140	<0.02	<0.02	<0.02
TUOLENE	50	680	<0.5	<0.5	<0.5
XYLENE	50	100	<1.5	<1.5	<1.5
TOTAL AROMATIC COMPOUNDS	100	2058	<0.2	<0.2	<0.2
BENZO (a) ANTRACENE	10	82	<1	<1	<1
BENZO (a) PIRENE	10	57	<1	<1	<1
BENZO (b) FLUORANTENE	10	33	<1	<1	<1
BENZO (g,h,i) PERILENE	10	9	<1	<1	<1
BENZO (k) FLUORANTENE	10	9	<1	<1	<1
CRISENE	50	74	<1	<1	<1
DIBENZO (a,e) PIRENE	10	3	<1	<1	<1
DIBENZO (a,h) ANTRACENE	10	5	<1	<1	<1
DIBENZO (a,h) PIRENE	10	1	<1	<1	<1
DIBENZO (a, i) PIRENE	10	2	<1	<1	<1
DIBENZO (a,i) PIRENE	10	4	<1	<1	<1
INDENO (1,2,3-cd) PIRENE	5	10	<1	<1	<1
PIRENE	50	196	<1	<1	<1
TOTAL IPA	100	485	<10	<10	<10
CHLOROMETHANE (METHYL CHLORIDE)	6,1	166	<0.02	<0.02	<0.02
VINYL CHLORIDE	1,3	29	<0.01	<0.01	<0.01
1,2-DICLOROETHANE (DCA)	0,46	730	<0.2	<0.2	<0.2
MERCURY	-	42	<0.02	<0.03	<0.03