

CASE STUDY | KLOZUR® CR**APPLICATION OF KLOZUR® CR ACHIEVES TREATMENT GOALS FOR HYDROCARBONS, BTEX AND MTBE AT A FORMER PETROLEUM STATION IN ITALY****SITE OVERVIEW**

KLOZUR® CR is a combined remedy treatment technology consisting of KLOZUR® SP (sodium persulfate) and PERMEOX® Ultra (extended release calcium peroxide). This technology was successfully applied at a site in a densely populated urban area in Bologna, Italy and which was contaminated with various toxic contaminants. The site, a dismantled former petroleum station, was impacted by the storage of fuels which resulted in groundwater contamination including hydrocarbons (C<12 ~ 2000 µg/L), benzene (~ 500 µg/L), ethylbenzene (~ 380 µg/L) and methyl tert-butyl ether (MTBE) (~ 13000 µg/L).

Two injection events were carried out fifteen (15) months apart with a total of 4800 kg of KLOZUR® CR (25% by weight aqueous slurry) applied at the site. Eighteen (18) months following the first application, the concentrations of contaminants had decreased below the remedial goals in all monitoring piezometers in the treatment area. Total petroleum hydrocarbons were reduced by greater than 80 percent while MTBE was reduced by greater than 90 percent. Monitoring data confirmed that elevated oxidation-reduction potential (ORP) and dissolved oxygen (DO) levels were sustained to support continued enhanced aerobic bioremediation.

SITE INFORMATION**Site Type**

Confidential Former Petroleum Station

Location

Bologna City Center, Italy

Contaminants

Total Petroleum Hydrocarbons (TPH) ~2000 µg/L

Benzene ~500 µg/L

Ethylbenzene ~380 µg/L

MTBE 13000 µg/L

Soils

Silty sands to silty clays

Application

Solid slurry Injection

Results

Remedial goals obtained for all contaminants

TPH > 80% Reduction

MTBE > 90% Reduction

THE APPROACH

Monitoring data from 2017 suggested that the total contaminated area of the site was approximately 350 m² (Figure 1). The groundwater at the site was initially observed at a depth of approximately 3.8 m below ground surface (bgs), flowing in a northerly direction at a low rate of approximately 4 meters / year. Treatment with KLOZUR® CR targeted a 5 m vertical interval of saturated contaminated soil, between depths of 4 m and 9 m bgs. The soil consisted of backfill (gravel in a sandy matrix) up to a depth of 3.5 m bgs, below which were found silty sands, sandy loam, and silty clay lenses, at an effective porosity in the saturated zone of 15% and a hydraulic conductivity of about 10⁻⁴ cm/second.

The KLOZUR® CR technology was selected by the design engineers for groundwater remediation to sequentially promote:

- ISCO, In Situ Chemical Oxidation, via alkaline activated sodium persulfate,
- Enhanced aerobic bioremediation, due to slow-release oxygen in bio-available form (PERMEOX® Ultra),
- Enhanced anaerobic bioremediation (anaerobic oxidation), due to the interaction of sulphate and residual hydrocarbons in groundwater.

The remediation goals were calculated through industry standard risk analysis (AdR) corresponding to the sitespecific risk threshold concentrations (CSR) (Table 1).



Figure 1. Site location

Table 1. Site-specific risk threshold concentration remediation goals

Contaminant of Concern	Remediation Goals (CSR) (µg/L)
Benzene	18.24
Toluene	6.85
Ethylbenzene	53.04
p-Xylene	2.31
Total Hydrocarbons	350 (*)
MTBE	74.66
*CSR=CSC (Contamination threshold Concentration D.Lgs.152/06)	

FIELD APPLICATION

Two injection events were carried out in February 2018 and April 2019, with 2380 kg and 2400 kg of KLOZUR® CR used, respectively. The KLOZUR® CR was injected, as a 25% slurry, through 18 injection points (Figure 2) which were distributed with a regular triangular mesh of about 5 m side (sphere of influence ~ 2.5 m) in the region of the source area. The thickness of saturated treatment area was 5 m, between depths of 9 m and 4 m bgs (bottomup application with injective step approximately every 30 cm).

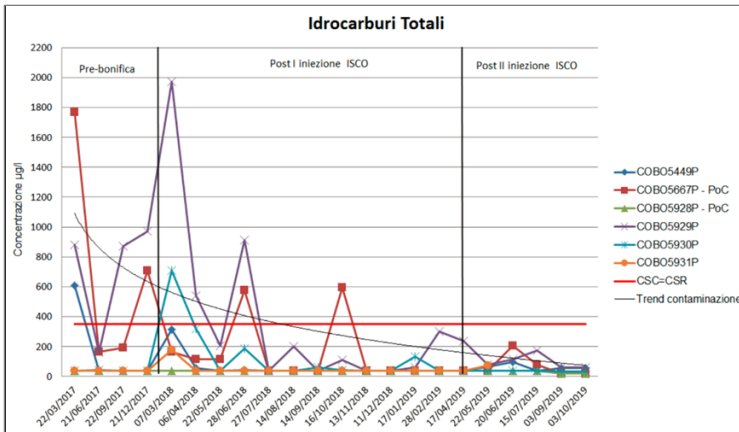
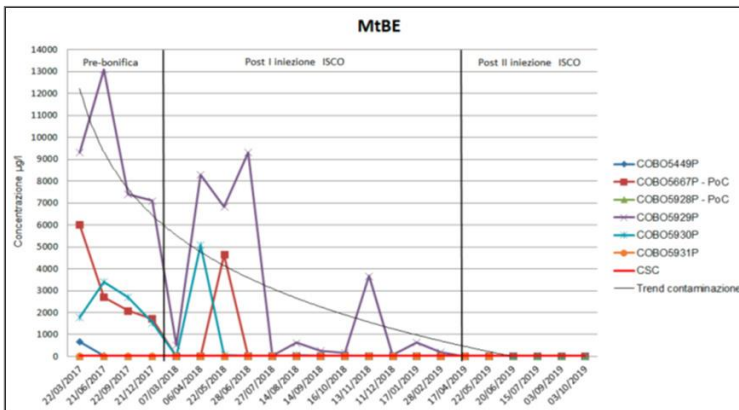
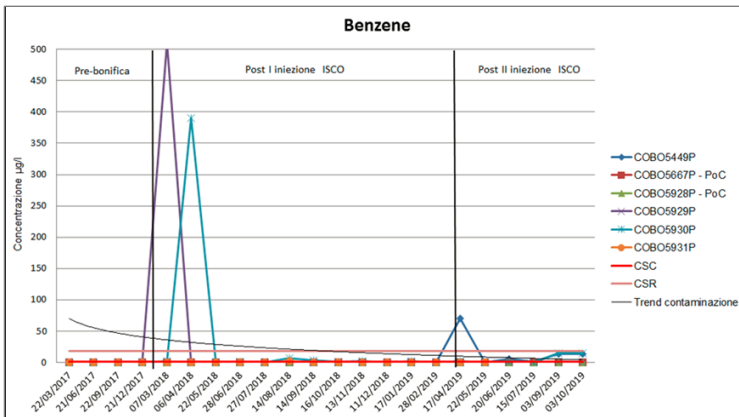


Figure 4. Total hydrocarbon, benzene and MTBE concentrations in groundwater before and after KLOZUR® CR treatment



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