

## Thermal desorption and safety and health measures

*Beside the explanation of the process of soil remediation and thermal desorption, the paper contains elaboration of the assessed hazards and risks in those processes. The appropriate measures for safe and healthy work are established and prevised accordingly. A systematic approach, the basic principles of behavior at work and the structure of the risk and possible consequences are presented also.*

**Key words:** contaminated soil, risk, thermal desorption

### 1. INTRODUCTION

Soil remediation is the process by which performs cleanup of soil contaminated with oil or other chemical pollutants. This process has, due to the growing demand due to pollution and the use of various technologies in the world, advanced to a great extent and is increasingly used [1–3].

One of the procedures for cleaning contaminated soil that has been accepted by many countries (notably the European Union) is the thermal treatment of soil contaminated with oil, which is called thermal desorption. The procedure and measures for occupational health and safety will be discussed in more detail below [3–5].

### 2. THERMAL DESORPTION, THE CONCEPT AND PROCESS DESCRIPTION

Thermal desorption is a process that carries out thermal treatment of soil contaminated with oil and other hydrocarbons. For treatment of the contaminated media a variety of technologies is used. Organic contaminants can range from highly volatile solvents such as trichloroethylene and seething medium compounds such as organ chlorine pesticides, to extremely low corrigible compounds such as PCBs, dioxins and pentachlorophenol, then solids include soil, sediment, sludge lagoons from the filtering process and similar solids.

The process uses direct thermal treatment method for cleaning contaminated soil by hydrocarbons. The system uses heat from around 400–900 °C for thermal removal of contaminants from the soil [1].

To ensure proper operation, the plant for thermal desorption must include equipment for continuous control emissions, monitor emissions and flue gas temperature to control the process.

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Received for Publication: 10. 06. 2013.

Accepted for Publication: 23. 08. 2013.

Regardless of the methods used in this process, the procedures must be capable of detecting the most severe levels of pollution and need to protect ground-water quality, air quality and other environmental receptors.

Disposal of treated soil must be acceptable to the required limit values of characteristic parameters set forth in applicable laws and regulations.

To fulfill the requirements above it is necessary, at a minimum, to provide the following:

- Adequate equipment for the process of thermal desorption;
- Additional combustion for destruction of organic compounds;
- Air pollution control system and the methodology of the same;
- System of continuous monitoring of air emissions from thermal treatment processes, as well as any other information subsequently requested by official institutions.

It should be noted that from the zone of thermal treatment all facilities and equipment must be removed before the appropriate facility is installed.

### 3. THERMAL DESORPTION PLANT

Plant for the thermal desorption must use the technology to the satisfaction of the required limits and relevant rules for disposal of treated mass in the soil, air and water. Thermal treatment of land includes all land contaminated by Aliphatic and aromatic compounds.

Concentrations of contaminants and allowable concentrations must be specified in the project soil remediation using thermal desorption. Thermal treatment does not include land that is contaminated with heavy metals.

Plant for thermal treatment must be placed on a waterproof surface (geotextile sheeting etc..) with a drop of 1%, which must also include the dump for contaminated and treated soil. Pool resistant to storm

water to collect potentially contaminated rainwater from the surface containing the contaminated land. Plant for thermal treatment is connected to the mains, and oil or natural gas is used for the burner. Water is used for cooling the treated soil [2].

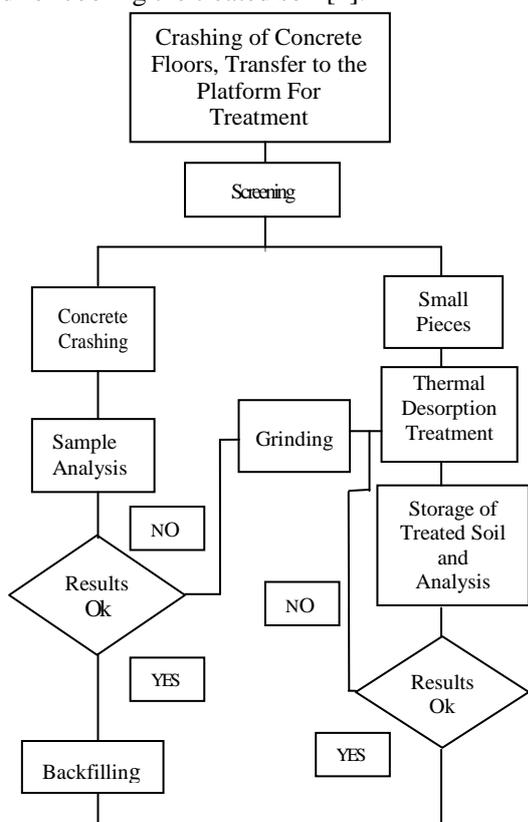


Figure 1 – Thermal desorption algorithm

4. SAFETY AND HEALTH AT WORK

Head of Works and Process technologist at the plant for thermal desorption are responsible for the safety of workers and equipment during operation. They must provide the work in accordance with the rules and operations that are defined in its manual labor. A copy of the record of safety and health at work of the plant must be communicated to all employees at the plant for thermal desorption of contaminated soil. Shift manager, or head of staff, take all necessary measures to ensure the safety and health of employees during work [3].

Person for safety and health at work does continuous control and monitoring of the operation in terms of safety and health of employees at work and taking care of all the necessary measures to ensure the continued health and safety of employees during work..

Measures of health and safety at work involve, primarily following:

- prevention of potential hazards;
- informing and training of the underlying business.

Organizers of work are required to monitor the implementation of these measures and to adapt them according to the changing situation in order to prevent potentially dangerous situations.

The purpose of safety and operational guidelines and warnings is to reduce the risk of incidents, and are based on the following principles [4]:

- Avoiding risks;
- Assessment of risks which can not be avoided in the workplace and reducing the effects of;
- Adjustment of the working environment for the employee;
- Evaluation techniques;
- Replacement of dangerous technological processes or methods harmless or less hazardous;
- Giving priority to collective over individual safety measures health and safety;
- Giving appropriate instructions to employees.

Basic instructions and information on health and safety at work in the process of thermal desorption is shown in the following tables:

Table 1 - Basic instructions and information for the use of protective equipment

Wearing protective equipment is a must!		
Activity	Equipment	Designation
All activities	Protective boots	
All activities	Personal firefighting suit	
All activities	Helmet	
Positions exposed to noise	Ear protectors	
All activities	Protective gloves	
At positions where is worked at a high temperature	Protective gloves resistant to high temperatures	
Positions subjected to volatilization of hydrocarbons	Mask A2B2E2K1 Hg P3	
At the work with the oxidizer	Protective mask with ventilation	
The part of the work that has been exposed to dust	Mask with dust filter	
The part of the work that has been exposed to some splashing	Safety goggles	
The positions that are located at a height	Safety belt	

Table 2 - Different types of masks Charge (evaporation)

Type/Standard	Basic use
A - EN 141	Organic vapors (boiling point > 65 °C)
AX - EN 371	Organic vapors (boiling point < 65 °C)
B - EN 141	Inorganic vapors (eg Cl <sub>2</sub> , Hcn)
E - EN 141	Sulfur Dioxide
K - EN 141	Ammonia
Hg - EN 141	Mercury vapor

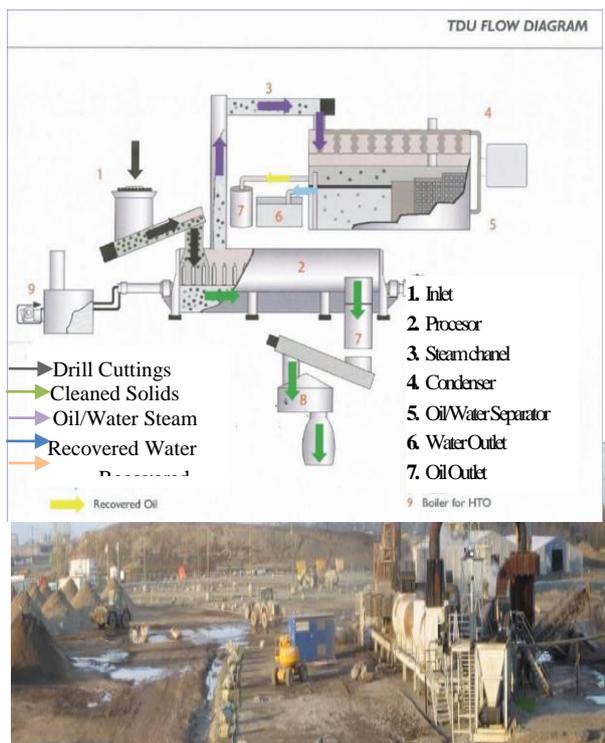


Figure 3– One of the thermal desorption plant in service

Table 3 - List of hazards/risks and their sources

Source of risk	Risk
Fans, motors	Traumatic and irritating noise
Transport	Traffic accident
Containers for waste disposal	
Heated area	Burns
Hot particles	
Using of burners	
Steam	
Soda repository	
Dust	Poisoning
Toxic fumes	
Intervention within indoor	Suffocation

Evaporating hydrocarbon	Fire / explosion
Reservoir hydrocarbon	
Reservoir volatiles	
Natural Gas	
Lack/absence of el.insulation	Electric shock
Heavy burden	Back pain and back injury
Work at height	Falling from a height

## 5. DESCRIPTION OF POTENTIAL RISKS AND MEASURES FOR THEIR ELIMINATION

*Explosion may arise from two sources:*

- Natural gas or fuel to run the plant. The risk is limited by standard measures, control and good governance protective equipment.
- Hydrocarbons from treated land, this risk is limited to the instructions on the operation and work with it.

*Electric shock:* it comes with power seats that are not or poorly insulated. Measures to prevent an electric shock in a periodic check of electrical equipment and installations by authorized persons (examinations are performed only when the unit is off) as well as the handling of the same and of appropriate health and safety (rubber boots and gloves).

*Blows to the head:* possible during work on the installation and maintenance of the plant, so it is necessary to wear safety helmets.

*Injuries-collisions:* may occur between transport vehicles on site during the inspection, loading the thermal disorder crusher, disposal of treated soil, and the like. It is therefore a detailed plan and schedule of the movement of soil and means of transport, and the same emphasis on the visible place, possess the relevant licenses to drive by employees, wearing vests for identification, using sirens and alarms for going back and slow motion at the site. Injury can occur on any part of the equipment: dryers, transmitters, transmission belt and others.

*Burns:* Risk of burns can occur in contact with any hot surface, or in contact with a hot dust and particles. Using protective clothing, helmets and goggles is mandatory to prevent injury. Wearing protective gloves is also mandatory when working with highly heated parts of the plant. In every part of the plant where it is worked at high temperatures must be a reservoir of water.

*Suffocation:* can occur when an employee is engaged in the areas of installation for drying, oxidation, cyclones, heat exchangers and filters. Thorough ventilation of these spaces and the use of protective

masks to reduce the risk. Before any work in these areas, concentrations of oxygen, carbon monoxide, hydrogen sulfide, etc. must be measured.

*Poisoning:*

- *Poisoning and dust particles:* when working Plant for the thermal desorption there is a large amount of dust, so for the work near the plant it is necessary to wear protective masks. Also at the exit of the dryer water is sprayed in order to suppress dust. The control room, which is nearby, must be isolated and controlled.
- *Poisoning very volatile organic compounds and hydrocarbons:* gas masks with ABEKP3 charge are required for all employees.

*Noise:* a potential hearing damage can occur close to the thermal desorption plant, therefore the employees are required to wear ear protectors, Class 3, and carrying the same sign must be prominently displayed at the facility. The control room must be equipped with double insulation to keep them safe from the noise.

*Back injuries:* are possible if a heavy burden is being lifted from the wrong position, so the presence of other persons during the execution of these actions is obligatory. Using a variety of machines and cranes and forklifts reduces this risk.

*Falls from height:* can be reduced by using protective barriers and baskets that are commonly found on the control platform. The presence of other people while doing this operation is necessary, as well as training for working at height.

It should be noted that for the effective functioning of the process of remediation of soil by thermal desorption, the existence of an appropriate integrated information system process management, plant maintenance, quality management and environmental protection systems is necessary.

It is also necessary to find an adequate profile of staff and form a team to work on such a technological system and provide continual training of employees.

## 6. CONCLUSION

Work on the plant for thermal desorption is a work with increased risk. Operators of the plant, in addition to professional qualifications, must be trained in safe and healthy work. Therefore, they must be familiar with all safety procedures in the operation and maintenance of plant and act upon them.

Also, while working on the plant, employees must use the prescribed personal protective equipment. The constant presence of the site manager and person for safety and health is very important.

*Acknowledgements*

*The research presented in this paper was funded by the Ministry of Education and Science of the Republic of Serbia, project TR 35041.*

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## IZVOD

### TERMALNA DESORPCIJA I MERE BEZBEDNOSTI I ZDRAVLJA NA RADU

*U radu je uz objašnjenje procesa remedijacije zemljišta i termalne desorpcije izvršena procena opasnosti i rizika na tim procesima. Prema utvrđenim rizicima predviđene su i adekvatne mere za bezbedan i zdrav rad. Prikazan je sistemski pristup, osnovni principi ponašanja na radu, struktura rizika i moguće posledice.*

**Ključne reči:** kontaminirano zemljište, rizik, termalna desorpcija

Stručni rad

Primljeno za publikovanje: 10. 06. 2013.

Prihvaćeno za publikovanje: 23. 08. 2013.