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Remediating Oil-Contaminated Soil and Groundwater

The kinds of oil and how contamination works, plus a comparison of chemical oxidants and bioremediation

BioRangers

• Overview

Overview

Although we speak of "oil" as a single thing, it is in fact a mixture of many different components. This article explains the kinds of oil, why oil contamination is a problem, the differences between domestic and overseas environmental standards, how soil and groundwater contamination occurs, and compares chemical oxidants and bioremediation as remediation methods.

Oils of concern **mineral oils (gasoline, kerosene, diesel, heavy oil, machine oil, etc.)**	Remediation methods **chemical oxidants / bioremediation**
Advantages of bioremediation **low environmental impact; remediation possible even on land with buildings**	Triggers for remediation **contamination of neighbouring land, facility oil leaks, land sale, business withdrawal, etc.**

• Kinds of oil

There are many kinds of oil

At a refinery, petroleum is separated into gasoline, kerosene, diesel, heavy oil and other products, but none of these is a single molecular structure; each is a mixture of hydrocarbons with similar molecular structures gathered together. Animal and vegetable oils are oils too, and like the EPA and DHA in fish oil, they differ structurally from petroleum hydrocarbons and are readily biodegradable. The oils that become a problem as soil and groundwater contamination when they leak are the "mineral oils" such as gasoline, kerosene, diesel, heavy oil, machine oil and lubricating oil.

• Why it matters

Why oil contamination is a problem

Oil can contain substances recognised as carcinogenic or hazardous, such as PCBs, benzene and polycyclic aromatic hydrocarbons. Even when stored with great care, oil can still leak, and leaving contaminated soil untreated risks adverse effects on human health and the environment later on. For example, if oil-contaminated land becomes a park, children's health could be harmed. In the case of groundwater contamination the oil spreads over a wide area, so prompt remediation of both soil and groundwater is desirable.

• Standards

Environmental standards at home and abroad

In many countries, including the United States, Europe, China and parts of Southeast Asia, standard values are set broadly not only for benzene but also for components such as toluene, xylene and ethylbenzene. In Japan, by contrast, apart from specific hazardous substances such as PCBs and benzene, the individual components of oil are not designated as regulated environmental substances, and the reality is that their effects on the environment, on plants and animals, and on human health are not adequately considered. As a result, remediation in Japan tends to be carried out in order to eliminate the discomfort and unease caused by foul odours and oil sheens.

• Common cases

Common examples of oil-contamination remediation in Japan

In Japan, remediation is carried out mainly for reasons such as: oil contamination of leased or neighbouring land, oil leaks at public facilities, exceedance of a company's own standards, social responsibility after withdrawing from a business, and contamination discovered at the time of a land sale. The kinds of oil that become a problem differ by facility, as follows.

Facility	Oils of concern
Gas station	benzene, gasoline, kerosene, diesel, etc.
Factory	heavy oil for boilers, cutting oil for parts, machine lubricating oil, etc.
School	kerosene and heavy oil for heating
Hospital	kerosene and heavy oil for heating and hot water, heavy oil for emergency generators

• Soil & groundwater

Soil contamination and groundwater contamination

Soil contamination is the state in which oil has soaked into the soil; groundwater contamination is the state in which oil has reached the groundwater. In Japan almost every site has groundwater, and the depth of the groundwater and the degree to which the oil has soaked in determine whether the contamination remains soil contamination or progresses to groundwater contamination. There are two types of soil-contamination remediation: transporting the contaminated soil to another location, and in-situ remediation, which cleans it up on the spot.

Because oil is lighter than water, when it reaches the water table it spreads sideways into wide-area contamination, and as the groundwater rises and falls with the seasons the contamination also extends into a vertical band. Groundwater contamination is mainly addressed by in-situ remediation, but when a large amount of oil has accumulated on the water table, physically recovering that oil is effective.

• Comparison

Comparing chemical oxidants and bioremediation

Oil remediation with chemical oxidants is a chemical method. It is difficult to use in ponds, rivers and seas where aquatic life is present; because it makes the land acidic, its use on farmland is also restricted; and because it corrodes metal, it can affect metal buildings and structures. The reaction also lasts only for the instant of contact, so if there is too little, additional dosing is required, and because it reacts with organic matter other than oil, the amount used increases in soils rich in organic matter.

Bioremediation is a method that uses the power of microorganisms to break down oil. Although the remediation rate varies with the condition of the microorganisms, making the timeline hard to predict, it has low environmental impact and can remediate even land with buildings on it. Above all, as long as the microorganisms remain alive they continue to break down the oil in that land — the major difference from chemical oxidants.