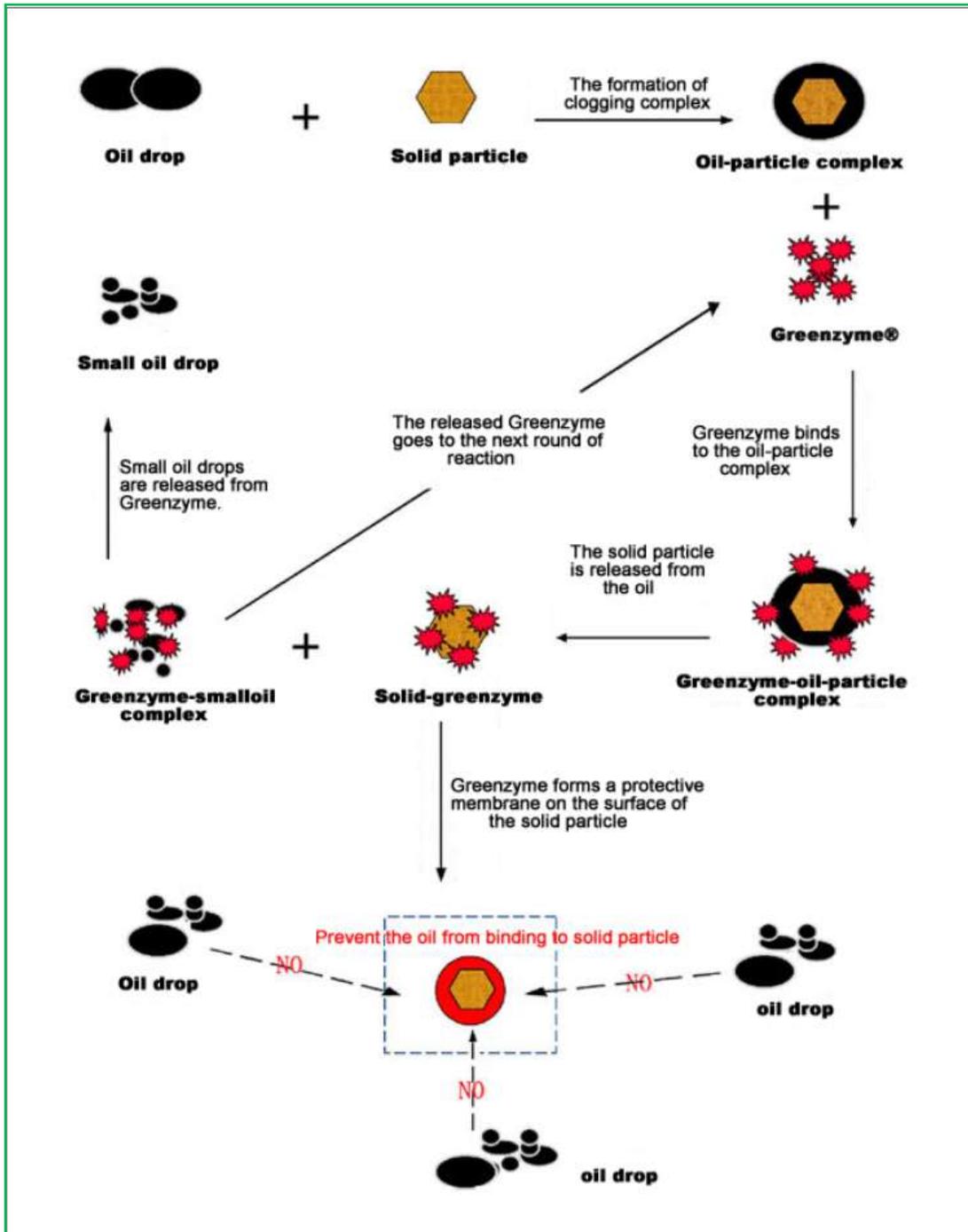


Q. By what mechanism does GreenZyme® perform rapid release of hydrocarbon oil from the surface of solid waste?

A. The attached schematic diagrams will briefly describe the biological mechanisms for the GreenZyme® reaction, please see explanation on the following pages.



Q. How can I perform a simple jar test, to determine if GreenZyme® is effective for cleaning my hydrocarbon contaminated and lightly weathered solid waste?

A. You can perform a simple jar test for your waste sample as follow:

- a) From GreenZyme® sample, which should be regarded as 100% concentrate for your testing purpose, prepare a 10% GreenZyme® solution by simply diluting with water.
- b) Scoop one part [by volume] of solid waste sample into a wide mouth glass jar. Then add three parts [by volume] of 10% GreenZyme® into the same jar.
- c) Close the cap of the jar, and then shake the jar vigorously for one minute or more. Make sure you have good thorough mixing between the solid waste and the GreenZyme® solution.
- d) Open the cap of the jar, and then add another 4 parts [by volume] of water into the jar. Close the cap. Hand shakes the jar vigorously for another one minute of time.
- e) Let the jar rest on a bench top for one hour and then observe. If GreenZyme® is effective in cleaning this solid waste, a top layer of hydrocarbon oil should be observed, this oil will be floating on top of the amber colored enzyme solution, i.e. a hydrocarbon oil and GreenZyme® interface exists. You will also see polished and cleaned solid sediments resting at the bottom of the jar.
- f) Notice that both the immiscible hydrocarbon oil and the GreenZyme® can be easily separated by using Apollo oil-water separator.
- g) The bottom solids, which can be further polished by GreenZyme® if necessary, can be easily separated from the liquid layers using a solid-liquid separator.

Q. If my company has its own soil washing process, can we incorporate GreenZyme® to improve our process?

A. Yes, We can sell your company only the GreenZyme®, which can dramatically improve your own soil washing process.

Q. Does Apollo Separation Technology Inc have technologies to treat different types of hydrocarbon contaminated waste?

A. Yes, we have several advanced and proprietary technologies, which can be used to treat both hydrocarbon contaminated solid waste and liquid waste.

Q. How does GreenZyme® work on hydrocarbon contaminated and heavily weathered solid waste?

A. For a heavily weathered solid waste, before applying GreenZyme®, a light hydrocarbon solvent should be chosen and added first in a pre-mixing process.

There are many kinds of light hydrocarbon solvents available, the common ones are hexane, kerosene, and diesel.

Typically the ratio of solid waste to solvent addition is 2:1. After the solvent pre-treatment process, a diluted **GreenZyme®** solution is applied directly to the pre-treated solid waste, again in a vigorous mixing process. The biological reaction usually completes within a few seconds.

Q. How does **GreenZyme® work on hydrocarbon contaminated and lightly weathered solid waste?**

A. For a lightly weathered solid waste, diluted **GreenZyme®** can be applied directly to react with the solid waste, usually in a vigorous mixing process. No other chemical additives are required.

Typically the biological reaction, i.e. the reaction to release all hydrocarbon oil from the surface of all solid wastes, can usually be completed within a few seconds.

Q. How does industry classify the types of hydrocarbon contaminated solid waste?

A. Basically there are two major types of hydrocarbon contaminated solid waste, namely:

a) Lightly weathered solid waste.

For example: this is a solid waste which still retains most of its light-end hydrocarbon components. Typically this type of waste has lower viscosity and a strong odor.

b) Heavily weathered solid waste.

For example: this is a solid waste which has lost most of its light-end hydrocarbon components, mainly due to both natural evaporation process and bacterial action for an extended period of time. Typically this type of waste is highly gummy and viscous in nature, with less pungent odor. A good example is tar ball found on sandy beaches.

Q. What are major methods for detoxifying hydrocarbon contaminated solid wastes?

A. There are several major methods to detoxify hydrocarbon contaminated solid wastes, namely:

a) Detoxification of solid waste using strong detergent chemicals.

For example: toxic soil washing by soap detergent.

b) Detoxification of solid waste using light hydrocarbon solvents.

For example: toxic soil washing by diesel.

c) Detoxification of solid waste using biological enzymes.

For example: toxic soil washing by **GreenZyme®**.

d) Detoxification of solid waste using live microbes.

For example: cleaning of toxic solids inside an aerobic or anaerobic digester. Another process involves land-farming of toxic solid waste using live microbes, nutrient chemicals and other supplements.

- e) Detoxification of solid waste using thermal extraction equipment.
For example: roasting of toxic solid waste inside a rotary evaporator, with the purpose of evaporating all hydrocarbon oil into a vapor phase.
- f) Detoxification of solid waste using high temperature incinerator.
For example: process involves a near complete burning of toxic solid waste inside a rotary kiln, using a high temperature heating source, usually in excess of 1800° F or higher.

Q. What are other applications and uses for GreenZyme®?

- A. **GreenZyme®** can be used in many solid and liquid decontamination applications.

Typical examples are as follow:

- a) Cleaning of rust protective oil from the surface of steel plates.
- b) Surface oil removal and cleaning of metal components and electronic boards.
- c) Cleaning of tank bottoms from railway tanker cars and chemical tank trucks.
- d) Cleaning of ballast tanks from river-going barges, ocean-going barges, and ocean-going ships.
- e) Decontamination of Above Ground Storage Tanks (AST) and Below Ground Storage Tanks (BST).
- f) Surface cleaning for: transportation vehicles, such as buses and container cars; airport runways; controlled oil-spills in airport fire drills; fire station drills; and other land-based oil spills.

Q. How can GreenZyme® be used for solving solid-based pollutant problems?

- A. **GreenZyme®** has an exceptionally high capacity to release toxic hydrocarbon oil from the surface of solid particles.

For example: in BTEX laden solid application, if **GreenZyme®** is added to react with these toxic solid wastes, all BTEX will be released from the surface of all solid particles immediately.

Both the BTEX hydrocarbon and the **GreenZyme®** solution can be easily separated by Apollo Oil-Water Separator, the **GreenZyme®** can be totally recycled and reused again.

The solid sediments, after repeated washing and polishing with additional **GreenZyme®**, can meet legal discharge for landfill, rather than being sent to expensive incinerating process.

Q. What are some examples for solid-based pollutants?

- A. Solid-based pollutants are mainly due to the mixing of hazardous wastes, such as toxic hydrocarbons and heavy metals, with soil and other solid sediments.

Typical examples are: Superfund sites on the EPA lists; pesticides and BTEX

(i.e. benzene, toluene, ethyl-benzene, and xylene) laden soil found in abandoned manufacturing sites; lagoon and tank bottom sediments found in waste treatment plants.

Q. How can GreenZyme® be used for solving liquid-borne pollutant problems?

A. GreenZyme® has a very high capacity to release hydrocarbon oil from the surface of all solid particles, usually in a few seconds of time.

For example: in a slop oil application, where hydrocarbon wastes exist with water and solid sediments, if GreenZyme® is added inside a well mixed and agitated slop oil tank, then GreenZyme® will release all hydrocarbon oil from the solid surfaces instantly.

Since GreenZyme® is totally soluble in water and insoluble in hydrocarbon oil, a phase separation occurs immediately. In other words, GreenZyme® does not form a chemical emulsion with most hydrocarbon oil. This will cause all hydrocarbon oil to float on top of the Greenzyme layer; the remaining solids will be free of oil and settled at the bottom of GreenZyme® layer.

At this stage, an Apollo Oil-Water separator can be used to easily separate the hydrocarbon oil from the GreenZyme® solution. The bottom solids can be separated from the liquid layers using a simple solid-liquid separator. These solids can be further polished by repeated washing with GreenZyme® to meet legal discharge permit.

During this process, the hydrocarbon oil can be totally recovered and reused, if there is any marketable value. As for the GreenZyme®, after the oil-water separation, it can also be totally recycled and reused again.

Q. What are some examples for liquid-borne pollutants?

A. Liquid-borne pollutants are mainly due to liquid hydrocarbon by-products coming into contact with water, sometimes with trace amount of solid particles.

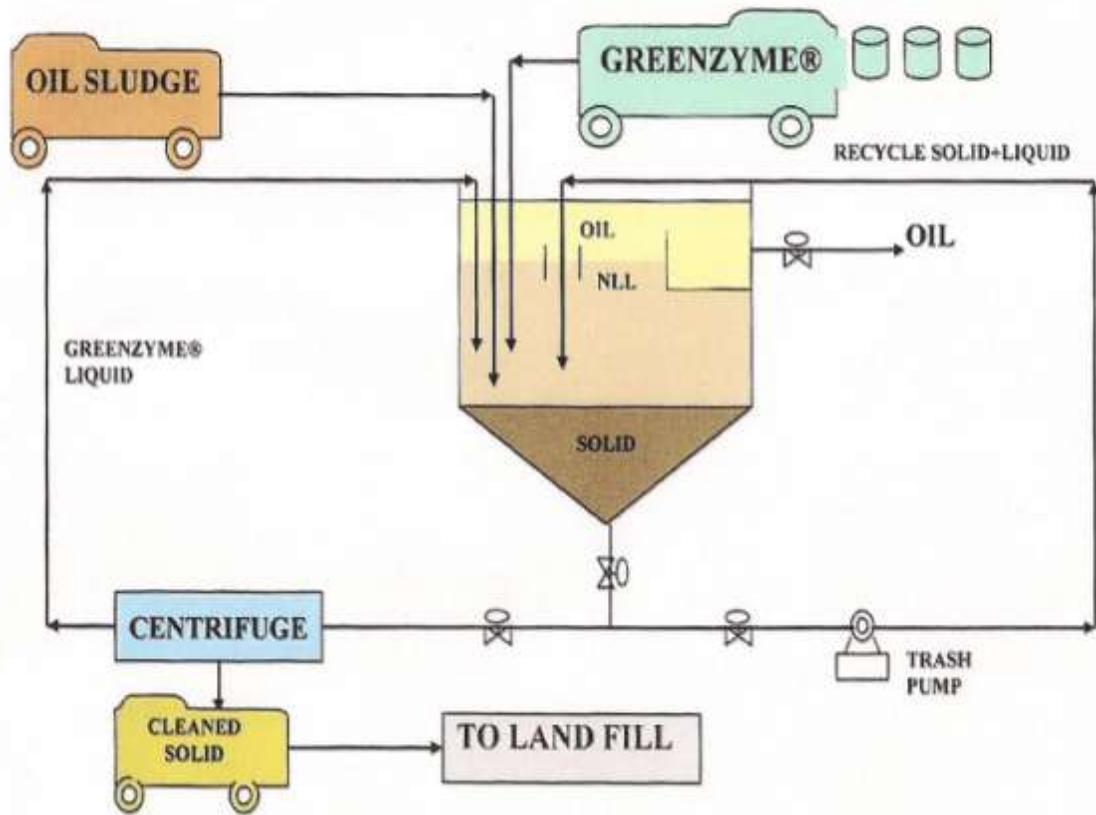
Typical examples are: produced water from crude oil production; waste hydraulic and lubricant oil from machine and metal industries; slop oil from petrochemical plants and waste disposal facilities; waste washing fluid from surface cleaning applications; and water impoundment found in manufacturing plants for rain water run-off, etc.

Q. What are the applications for using GreenZyme®?

A. Modern industries typically generate three types of pollutants, namely: air-borne pollutants; liquid-borne pollutants; and solid-based pollutants. GreenZyme® can be used to solve problems associated with both the liquid-borne and solid-based pollutants.

Most Apollo processes include the use of Apollo bioreactors, Apollo high efficiency oil-water separators, as well as other solid and liquid handling equipment.

OIL-SLUDGE PROCESS USING GREENZYME®



GreenZyme® is registered trademark of Apollo Separation Technologies Inc., Houston, Texas, USA.