

# BIODEGRADATION OF OILS

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**Biodegradation** is a process of chemical breakdown or transformation of a substance caused by micro-organisms (bacteria, fungi) or their enzymes.

There are two extents of biodegradation of a substance:

- ☐ **Primary biodegradation** - modification of some physical and chemical properties of the substance caused by activity of micro-organisms.
- ☐ **Ultimate biodegradation** - total utilization of the substance resulted in its conversion into carbon dioxide (CO<sub>2</sub>) or methane (CH<sub>4</sub>), water (H<sub>2</sub>O), mineral salts and microbial cellular constituents (biomass).

## Biodegradability test

**Biodegradability** is the ability of a substance (oil) to biodegradation measured in a standard test procedure.

In the test a sample of the oil is incubated at 77°F (25°C) for 28 days. The biodegradation of the oil is induced by an inoculum of a mixed population of micro-organisms.

As an inoculum the test may use bacteria from sewage-sludge from a domestic sewage-treatment plant, from natural water, soil bacteria or their combination.

Common oil biodegradability tests are performed in the presence of Oxygen and water (aerobic aquatic biodegradation).

Primary biodegradation is measured by using infrared spectrometer.

Ultimate biodegradation is determined according to the evolution of carbon dioxide (CO<sub>2</sub>) from the tested sample over that produced in a blank, which contains inoculum only.

### Standard biodegradability tests:

- ☐ ASTM D-5864 Standard Test Method for Determining Aerobic Aquatic Biodegradation of Lubricants. The method is used for testing non-volatile oils, which are not inhibitory to the inoculum micro-organisms.
- ☐ CEC-L-33-A-94 of the Coordinating European Council (CEC). The method is applicable for determination of primary biodegradability. It is widely used for testing Engine oils.
- ☐ OECD 301B, or Modified Sturm Test of the Organization for Economic Cooperation and Development (OECD). The method determines only ultimate biodegradability by measuring evolving carbon dioxide.
- ☐ OECD 301D or Closed Bottle Test of the Organization for Economic Cooperation and Development (OECD).

The method is used when the oxygen concentration in the test oil is not the limiting factor for degradation.

- ☐ EPA 560/6-82-003 or Shake Flask Test of the US Environmental Protection Agency (EPA).

The tests determine the rate of the biodegradation:

- ☐ **Readily biodegradable** - at least 60-70% (depending on the test type) of the sample oil is degraded.
- ☐ **Inherently biodegradable** - 20-60% of the sample oil is degraded.
- ☐ **Persistent** - less than 20% of the sample oil is degraded.

## Biodegradability of some lubricants

Lubricant	Biodegradability, %
Mineral oil	15-35
White oil (highly refined mineral oil)	25-45
Vegetable lubricants	70-100
Polyalphaoleins (PAO)	5-30
Polyether	0-25
Polyisobutylene (PIB)	0-25
Phthalate & Trimellitate Esters	5-80
Polyol esters & Diesters	55-100

Source : [http://www.substech.com/dokuwiki/doku.php?id=biodegradation\\_of\\_oils](http://www.substech.com/dokuwiki/doku.php?id=biodegradation_of_oils)