ENVIRONMENTAL CONTAMINANTS ENCYCLOPEDIA

OIL, NEW (UNUSED MOTOR OIL) ENTRY

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Like a library or many large databases (such as EPA's national STORET water quality database), this document contains information of variable quality from very diverse sources. In compiling this document, mistakes were found in peer reviewed journal articles, as well as in databases with relatively elaborate quality control mechanisms [366,649,940]. A few of these were caught and marked with a "[sic]" notation, but undoubtedly others slipped through. The [sic] notation was inserted by the editors to indicate information or spelling that seemed wrong or misleading, but which was nevertheless cited verbatim rather than arbitrarily changing what the author said.

Most likely additional transcription errors and typos have been added in some of our efforts. Furthermore, with such complex subject matter, it is not always easy to determine what is correct and what is incorrect, especially with the "experts" often disagreeing. It is not uncommon in scientific research for two different researchers to come up with different results which lead them to different conclusions. In compiling the Encyclopedia, the editors did not try to resolve such conflicts, but rather simply reported it all.

It should be kept in mind that data comparability is a major problem in environmental toxicology since laboratory and field methods are constantly changing and since there are so many different "standard methods" published by EPA, other federal agencies, state agencies, and various private groups. What some laboratory and field investigators actually do for standard operating practice is often a unique combination of various standard protocols and impromptu "improvements." In fact, the interagency task force on water methods concluded that [1014]:

> It is the exception rather than the rule that water-quality monitoring data from different programs or time periods can be compared on a scientifically sound basis, and that...
>
> No nationally accepted standard definitions exist for water quality parameters. The different organizations may collect data using identical or standard methods, but identify them by different names, or use the same names for data collected by different methods [1014].

Differences in field and laboratory methods are also major issues related to (the lack of) data comparability from media other than water: soil, sediments, tissues, and air.

In spite of numerous problems and complexities, knowledge is often power in decisions related to chemical contamination. It is therefore often helpful to be aware of a broad universe of conflicting results or conflicting expert opinions rather than having a portion of this information arbitrarily censored by someone else. Frequently one wants to know of the existence of information, even if one later decides not to use it for a particular application. Many would like to see a high percentage of the information available and decide for themselves what to throw out, partly because they don't want to seem uniformed or be caught by surprise by potentially important information. They are in a better position if they can say: "I knew about that data, assessed it based on the following quality assurance criteria, and decided not to use it for this application." This is especially true for users near the end of long decision processes, such as hazardous site cleanups, lengthy ecological risk assessments, or complex natural resource damage assessments.

For some categories, the editors found no information and inserted the phrase "no information found." This does not necessarily mean that no information exists; it simply means that during our efforts, the editors found none. For many topics, there is probably information "out there" that is not in the Encyclopedia. The more time that passes without encyclopedia updates (none are planned at the moment), the more true this statement will become. Still, the Encyclopedia is unique in that it contains broad ecotoxicology information from more sources than many other reference documents. No updates of this document are currently planned. However, it is hoped that most of the information in the encyclopedia will be useful for some time to come even without updates, just as one can still find information in the 1972 EPA Blue Book [12] that does not seem well summarized anywhere else.

Although the editors of this document have done their best in the limited time available to insure accuracy of quotes or summaries as being "what the original author said," the proposed interagency funding of a bigger project with more elaborate peer review and quality control steps never materialized.

> The bottom line: The editors hope users find this document useful, but don't expect or depend on perfection herein. Neither the U.S. Government nor the National Park Service make any claims that this document is free of mistakes.

The following is one chemical topic entry (one file among 118). Before utilizing this entry, the reader is strongly encouraged to read the README file (in this subdirectory) for an introduction, an explanation of how to use this document in general, an explanation of how to search for power key section headings, an explanation of the organization of each entry, an information quality discussion, a discussion of copyright issues, and a listing of other entries (other topics) covered.

See the separate file entitled REFERENC for the identity of numbered references in brackets.

HOW TO CITE THIS DOCUMENT: As mentioned above, for critical applications it is better to obtain and cite the original publication after first verifying various data quality assurance concerns. For more routine applications, this document may be cited as:

> **Irwin, R.J., M. VanMouwerik, L. Stevens, M.D. Seese**, and **W. Basham.** 1997. Environmental Contaminants Encyclopedia. National Park Service, Water Resources Division, Fort Collins, Colorado. Distributed within the Federal Government as an Electronic Document (Projected public availability on the internet or NTIS: 1998).

Oil, New (Unused Motor Oil, New Crankcase Oil, Motor Oil)

Brief Introduction:

Br.Class: General Introduction and Classification Information:

In general, a motor oil is an oil suitable for use in an engine crankcase. This term also can sometimes apply to oils used to lubricate electric motors. Motor oil is one of the hundreds of different lubricant products that are made by many refineries and compounders [637]. Motor oil is used to lubricate the parts of an automobile engine, in order to keep everything moving smoothly. Crankcase oil consists of virgin lubricating base oil and additives; it is used in the crankcase as a hydrodynamic lubricant to reduce friction, as a coolant, and to form a compression seal. Before they are used, crankcase oils consist of a base lubricating oil (a complex mixture of hydrocarbons, 80 to 90% by volume) and performance-enhancing additives (10 to 20% by volume) [752]. Most engine oils are petroleum based materials comprised primarily of saturated hydrocarbons [497].

The most important characteristic of a lubricating oil for automotive use is its viscosity. For example, the common SAE viscosity number "10W30" used in most automobiles corresponds to specific ranges of viscosity at 0 degrees F and 210 degrees F [637].

According to the US Coast Guard Emergency Response Notification System (ERNS), unused motor oil is one of the most commonly spilled petroleum products the U.S [635]. Private vehicles use approximately 75% of the crankcase oils sold for gasoline engines, and light commercial vehicles that run on gasoline or propane use the remaining 25%. Heavy, commercial on-road vehicles use 70% of the crankcase oils sold for diesel engines, and industrial off-road vehicles use the remaining 30%. About half of the volume of crankcase oil used in the automotive sector is burned and released from exhaust during engine use and lost from crankcase leaks into the environment. It is estimated that direct oil emissions in the exhaust of engines in perfect technical condition range from 0.1 to 0.25 L/1000 km [752].

Lubricating oils are relatively heavy products. Petroleum distillates in order of decreasing volatility include [363]:

1. Petroleum ether or benzine
2. Gasoline

3. Naphtha
4. Mineral spirits
5. Kerosene
6. Fuel oils
7. Lubricating oils
8. Paraffin wax
9. Asphalt or tar.

Br.Haz: General Hazard/Toxicity Summary:

New motor oil contains a higher percentage of fresh and lighter (often more volatile and water soluble as well as lighter) hydrocarbons that would be more of a concern for short term (acute) toxicity to aquatic organisms, whereas used motor oil contains more metals and heavy polycyclic aromatic hydrocarbons (PAHs) (some partly the result of combustion processes) that would contribute to chronic (long-term) hazards including carcinogenicity. Although the concentration of several PAHs is much higher in used oil than in (fresh) lubricating oil [519], new lubricating oils do nevertheless contain many hazardous PAHs [519].

> Above text reprinted with permission from Environmental Toxicology and Chemistry, Volume 12(11), C. Upshall, J.F. Payne, and J. Hellou, "Induction of MFO Enzymes and Production of Bile Metabolites in Rainbow Trout (Oncorhynchus mykiss) Exposed to Waste Crankcase Oil." Copyright 1993 SETAC].

New lubricating oils are relatively heavy petroleum products [363] which would be expected to have a greater percentage of PAHs than many of the lighter products.

Long-term potential hazards of the some of the lighter, more volatile and water soluble compounds (such as benzenes, toluene, xylenes) in new oils would include contamination of groundwater. Long-term water uses threatened by spills include potable (ground) water supply.

Long-term effects are also a potential problem associated with PAHs, alkyl PAHs, and alkyl benzene (such as xylene) constituents of new oils. Although PAHs do not make up as large percentage of new oils by weight, there are some PAHs in new lubricating oils [519]. Due to their relative persistence and potential for various chronic effects, PAHs, (and particularly the alkyl PAHs), can contribute to long term (chronic) hazards of new oils in contaminated soils, sediments, and groundwaters. Chronic effects of some of the constituents in new oils (benzene, toluene, xylene, naphthalenes, alkyl benzenes, and various alkyl PAHs) include changes in the liver and harmful effects on the kidneys, heart, lungs, and nervous system. Increased rates of cancer, immunological, reproductive, fetotoxic, genotoxic effects have also been associated with some of the compounds found in new lubricating oils.

Used motor oil is more hazardous than new, and additional human health issues related to used mineral-based crankcase oil have been summarized by ATSDR [961].

See also: PAHs as a group entry.

Br.Car: Brief Summary of Carcinogenicity/Cancer Information:

The 4- to 7-ring PAHs have been especially implicated in the carcinogenic effect of used oil [519]. Many of these same PAHs are found in new oil, although in lower concentrations [519].

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The debates on which PAHs and alkyl PAHs in complex mixtures such as this product to classify as carcinogens, and the details of exactly how to perform both ecological and human risk assessments on the complex mixtures of PAHs typically found at contaminated sites, are likely to continue. There are some clearly wrong ways to go about it, but defining clearly right ways is more difficult. PAHs usually occur in complex mixtures rather than alone. Perhaps the most unambiguous thing that can be said about complex PAH mixtures is that such mixtures are often carcinogenic and possibly phototoxic. One way to approach site specific risk assessments would be to collect the complex mixture of PAHs and other lipophilic contaminants in a semipermeable membrane device (SPMD, also known as a fat bag) [894,895,896], retrieve the contaminant mixture from the SPMD, then test the mixture for carcinogenicity, toxicity, and phototoxicity (James Huckins, National Biological Service, and Roy Irwin, National Park Service, personal communication, 1996).

See also: PAHs as a group entry.

Br.Dev: Brief Summary of Developmental, Reproductive, Endocrine, and Genotoxicity Information:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

More information is available about used motor oil, see Oil, used motor oil entry.

See also: PAHs as a group entry.

Br.Fate: Brief Summary of Key Bioconcentration, Fate, Transport, Persistence, Pathway, and Chemical/Physical Information:

The concentration of several PAHs is much higher in used oil than in (fresh) lubricating oil [519]. For example, Grimmer et al. reported concentrations of dibenz(a,c)-anthracene, 4-methylpyrene, fluoranthene, benz(a)anthracene, benzo(e)pyrene, benzo(g,h,i)perylene, and benzo(a)pyrene, respectively, 36, 49, 253, 720, 1,112, 4,770, and 7,226 times higher in "used" compared to "fresh" oil [519].

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More information is available about used motor oil, see Oil, used motor oil entry. See also: PAHs as a group entry.

Synonyms/Substance Identification:

Lubricating Oil (Virgin Crankcase Oil) [560]
Transmission Oil [560]
Motor Oil [560]
Crankcase Oil [560]
10W30 [560]
5W30 [560]
Auto Lube (new) [856]
Motor Oil Composite, unused [607]

Associated Chemicals or Topics (Includes Transformation Products):

See also individual entries:

Oil, Used Motor Oil
Petroleum, General

PAHs as a group

Water Data Interpretation, Concentrations and Toxicity (All Water Data Subsections Start with "W."):

W.Low (Water Concentrations Considered Low):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

W.High (Water Concentrations Considered High):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

W.Typical (Water Concentrations Considered Typical):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

W.Concern Levels, Water Quality Criteria, LC50 Values, Water Quality Standards, Screening Levels, Dose/Response Data, and Other Water Benchmarks:

W.General (General Water Quality Standards, Criteria, and Benchmarks Related to Protection of Aquatic Biota in General; Includes Water Concentrations Versus Mixed or General Aquatic Biota):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

W.Plants (Water Concentrations vs. Plants):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

W.Invertebrates (Water Concentrations vs. Invertebrates):

Acute toxicity of motor oils to Artemia. These fluorescence tests were older Canadian methods using only the product indicated and would be only roughly comparable to other fluorescence values. Fluorescence methods are not particularly desirable when unknown or mixed oil products are of concern (ranges in parentheses) [684]. The following tables show that new motor oil has more potential for acute (short term) toxicity than used motor oil; however, these findings do not relate to overall hazard since used motor oil contains more metals and heavy PAHs that would contribute to chronic (long-term) hazards including carcinogenicity. See also the "Petroleum, General" entry for comparison with 21 other refined and crude oils.

OIL	48-HR EC50 (Measured by fluorescence in MG/L)
Auto Lube (New)	0.08 (0-1.51)
Auto Lube (Used)	>12.8

OIL	48-HR LC50 (Measured by fluorescence in MG/L)
Auto Lube (New)	0.44 (0.1-0.79)
Auto Lube (Used)	>12.8

Acute toxicity of motor oils to Daphnia magna. Data from all valid replicates were combined (ranges in parentheses) [684]. Same remarks apply as for the table above. See also the "Petroleum, General" entry for comparison with 21 other refined and crude oils.

MOTOR OIL	48-HR EC50 (Measured by fluorescence in MG/L)
Auto Lube (New)	0.3 (0.25-0.34)
Auto Lube (Used)	4.65 (3.36-5.97)

MOTOR OIL	48-HR LC50 (Measured by fluorescence in MG/L)
Auto Lube (New)	0.38 (0.32-0.44)
Auto Lube (Used)	4.87 (3.36-5.97)

W.Fish (Water Concentrations vs. Fish):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

W.Wildlife (Water Concentrations vs. Wildlife or Domestic Animals):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

W.Human (Drinking Water and Other Human Concern Levels):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

W.Misc. (Other Non-concentration Water Information):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Sediment Data Interpretation, Concentrations and Toxicity (All Sediment Data Subsections Start with "Sed."):

Sed.Low (Sediment Concentrations Considered Low):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Sed.High (Sediment Concentrations Considered High):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Sed.Typical (Sediment Concentrations Considered Typical):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Sed.Concern Levels, Sediment Quality Criteria, LC50 Values, Sediment Quality Standards, Screening Levels, Dose/Response Data and Other Sediment Benchmarks:

Sed.General (General Sediment Quality Standards, Criteria, and Benchmarks Related to Protection of Aquatic Biota in General; Includes Sediment Concentrations Versus Mixed or General Aquatic Biota):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Sed.Plants (Sediment Concentrations vs. Plants):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Sed.Invertebrates (Sediment Concentrations vs. Invertebrates):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Sed.Fish (Sediment Concentrations vs. Fish):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Sed.Wildlife (Sediment Concentrations vs. Wildlife or Domestic Animals):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Sed.Human (Sediment Concentrations vs. Human):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Sed.Misc. (Other Non-concentration Sediment Information):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Soil Data Interpretation, Concentrations and Toxicity (All Soil Data Subsections Start with "Soil."):

Soil.Low (Soil Concentrations Considered Low):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Soil.High (Soil Concentrations Considered High):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Soil.Typical (Soil Concentrations Considered Typical):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Soil.Concern Levels, Soil Quality Criteria, LC50 Values, Soil Quality Standards, Screening Levels, Dose/Response Data and Other Soil Benchmarks:

Soil.General (General Soil Quality Standards, Criteria, and Benchmarks Related to Protection of Soil-dwelling Biota in General; Includes Soil Concentrations Versus Mixed or General Soil-dwelling Biota):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Soil.Plants (Soil Concentrations vs. Plants):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Soil.Invertebrates (Soil Concentrations vs. Invertebrates):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Soil.Wildlife (Soil Concentrations vs. Wildlife or Domestic Animals):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Soil.Human (Soil Concentrations vs. Human):

No information found on this complex and variable mixture. See Chem.Detail section for chemicals found in this product, then look up information on each hazardous compound. Some individual compounds found in petroleum products have low-concentration human health benchmarks for soil (see individual entries).

Soil.Misc. (Other Non-concentration Soil Information):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Tissue and Food Concentrations (All Tissue Data Interpretation Subsections Start with "Tis."):

Tis.Plants:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Plants:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

B) Body Burden Residues in Plants: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Tis.Invertebrates:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Invertebrates:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

B) Concentrations or Doses of Concern in Food Items Eaten by Invertebrates:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

C) Body Burden Residues in Invertebrates: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Tis.Fish:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Fish (Includes FDA Action Levels for Fish and Similar Benchmark Levels From Other Countries):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

B) Concentrations or Doses of Concern in Food Items Eaten by Fish:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

C) Body Burden Residues in Fish: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Tis.Wildlife: Terrestrial and Aquatic Wildlife, Domestic Animals and all Birds Whether Aquatic or not:

A) As Food: Concentrations or Doses of Concern to Living Things Which Eat Wildlife, Domestic Animals, or Birds:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

B) Concentrations or Doses of Concern in Food Items Eaten by Wildlife, Birds, or Domestic Animals (Includes LD50 Values Which do not Fit Well into Other Categories, Includes Oral Doses Administered in Laboratory Experiments):

From RTECS [607]:

Chemical name: motor oil composite, unused Substance investigated as: Primary Irritant, LD50/LC50 - Lethal dose/conc 50% kill, rat: LD50; Route: Oral; Dose: 22 gm/kg; Reference: Acute Toxicity Data. Journal of the American College of Toxicology, Part B 1:146, 1990.

C) Body Burden Residues in Wildlife, Birds, or Domestic Animals: Typical, Elevated, or of Concern Related to the Well-being of the Organism Itself:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Tis.Human:

A) Typical Concentrations in Human Food Survey Items:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

B) Concentrations or Doses of Concern in Food Items Eaten by Humans (Includes Allowable Tolerances in Human Food, FDA, State and Standards of Other Countries):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

C) Body Burden Residues in Humans: Typical, Elevated, or of Concern Related to the Well-being of Humans:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Tis.Misc. (Other Tissue Information):

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Bio.Detail: Detailed Information on Bioconcentration, Biomagnification, or Bioavailability:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Interactions:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Uses/Sources:

No information found; see Chem.Detail section for compounds in this product, then see applicable individual compound entries for summaries of information on individual components of this mixture.

Forms/Preparations/Formulations:

The typical composition of automotive crankcase oil [753]: Well-fractionated and refined cuts from paraffin-base, mixed-base, or cycloparaffinic crudes; best grades from paraffinic or solvent-refined mixed-base crudes; contain a variety of additives, (oxidation inhibitors, pour depressants, viscosity builders, detergents, antiwear compounds, etc).

Chem.Detail: Detailed Information on Chemical/Physical Properties:

> Caution: Every individual petroleum product has a unique "fingerprint," or distinct set of constituents most commonly identified by a gas chromatograph analysis. Due to the varying properties of the same general category of a petroleum product (each source and weathering stage of a unused motor oil has a unique gas chromatograph "fingerprint"), careful assessment of the toxicity, specific gravity, and other physical characteristics of each individual oil must be taken into consideration to determine the exact effects of the product on the environment. Therefore, the below comments on unused motor oils are to be considered as representative, but not absolute values typical of every batch of the product with the same name.

Since PAHs are important hazardous components of this product, risk assessments should include analyses of PAHs and alkyl PAHs utilizing the NOAA protocol expanded scan [828] or other rigorous GC/MS/SIM methods.

The concentration of several PAHs is much higher in used oil than in (fresh) lubricating oil [519]. For example, Grimmer et al. reported concentrations of dibenz(a,c)-anthracene, 4-methylpyrene, fluoranthene, benz(a)anthracene, benzo(e)pyrene, benzo(g,h,i)perylene, and benzo(a)pyrene, respectively, 36, 49, 253, 720, 1,112, 4,770, and 7,226 times higher in "used" compared to "fresh" oil [519]. Nevertheless, all of the above-listed compounds are also found in new oil [519].

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Physicochemical information from Environment Canada [560]:

> NOTE: In this section, for properties with more than one value, each value came from its own source; in other words, if API Gravity at 60 F was measured several times and several different answers were obtained, all of the answers are provided [560]:

API GRAVITY (60/60 degrees F)

NOTE: Created by the American Petroleum Institute (API), API gravity is an arbitrary scale expressing the gravity or density of liquid petroleum products [637]. This scale was created in order to compare the densities of various oils. API gravity = (141.5/specific gravity [60/60 degrees F]) - 131.5, where specific gravity [60/60 degrees F] is the oil density at 60 degrees F divided by the density of water at 60 degrees F.

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DENSITY (g/mL)

For temperatures of oil (T) between 0 and 30 C:
Density = 0.97871 - 0.000710 T

NOTE: The densities of crude oils and oil products are dependent on the temperature and degree of weathering. The following density values are at "0% Weathering Volume" - in other words, fresh motor oil.

Temp(C)	Density (at 0% Weathering Volume)
0	0.8892
15	0.8784 0.89 (10W30) 0.88 (5W30)
20	0.9004 (estimated)

SOLUBILITY

Aqueous Solubility (mg/L): The solubility of oil in water can be determined by bringing to equilibrium a volume of oil and water, and then analyzing the water phase. Oil's aqueous solubility is expressed as the cumulative concentration of the individually dissolved components. Solubility is significantly reduced by weathering.

	No temp reported	22 C
Fresh Water	0.99	0.2
Seawater	1.43	

HYDROCARBON GROUP

NOTE: The main constituents of oil are generally grouped into the below categories. Asphaltene content increases with increasing weathering, as does wax content.

Hydrocarbon Group Analysis (Weight %):

Saturates	73.7
Aromatics	25.4

Polars	0.9
Asphaltenes	0

VISCOSITY

NOTE: The viscosities of crude oils and oil products are dependent on the temperature and degree of weathering. The following viscosity values are at "0% Weathering Volume" - in other words, fresh motor oil.

Dynamic Viscosity (mPa.s or cP):

Temp(C)	Dynamic Viscosity (at 0% Weathering Volume)
-28.9	20000 to 30500
-17.8	1200 to 4100
0	727.4
15	224.5

Kinematic Viscosity (mm2/sec or cSt):

Temp(C)	Kinematic Viscosity (at 0% Weathering Volume)
0	818.0
15	255.6
37.8	79 to 86
98.9	9.6 to 12.9
100	10.40 (5W30) 10.30 (10W30)

Pour Point (degrees C):

Pour point is the lowest temperature at which an oil sample is observed to flow when cooled under prescribed conditions. It is affected by weathering.

-37
-39 (10W30)
-42 (5W30)

INTERFACIAL TENSIONS

NOTE: Interfacial tension is the force of attraction between molecules at the interface of a liquid. These tensions are essential for calculating the spreading rates and the likely extent to which the oil will form oil-in-water and water-in-oil emulsions. The interfacial tensions of crude oils and oil products are dependent on the temperature and degree of weathering. The following tension values are at "0% Weathering Volume" - in other words, fresh motor oil.

Air-Oil (mN/M or dynes/cm):

Temp(C)	Air-Oil Tension (at 0% Weathering Volume)
0	30.2
15	29.9

20	36 to 37.5

Oil-Seawater (mN/M or dynes/cm):

Temp(C)	Oil-Seawater Tension (at 0% Weathering Volume)
0	18.2
15	16.6

Oil-Water (mN/M or dynes/cm):

Temp(C)	Oil-Water (at 0% Weathering Volume)
0	19.8
15	18.6
20	33 to 54

EMULSION

NOTE: Water-in-oil emulsions are stable emulsions of small droplets of water incorporated in oil. Termed "chocolate mousse," these stable water-in-oil emulsions can have different characteristics than the parent crude oil. Emulsion characteristics of crude oils and oil products are dependent on the temperature and degree of weathering. The following typical values are at "0% Weathering Volume" - in other words, fresh motor oil. In general, motor oil is likely to form emulsions.

Emulsion Formation Tendency (in the VERY LIKELY range):

Temp(C)	Fraction of oil that forms an emulsion (f initial)
0	1.0
15	1.0

Emulsion Stability (in the VERY STABLE range):

Temp(C)	Fraction of oil in the emulsion that remains after settling (f final)
0	1.0
15	0.89

Water Content of Emulsion (volume %):

Temp(C)	Water Content (at 0% Weathering Volume)
0	58.6
15	72.2

DISPERSIBILITY

Natural Dispersibility (% Dispersed):

Temp(C)	Naturally Dispersed
0	4.7
15	0

FIRE AND REACTIVITY

Flash Point (C):

199 (C.C)
188 (C.C)
200 (C.C) (5W30)
200 (C.C) (10W30)
149

DISTILLATION

NOTE: Distillation data provides an indication of an oil's volatility and relative component distribution. Distillation data is reported as volume % recovered.

Distillation (C):

(Vol%)	Liquid Temp	Vapor Temp
IBP	377	157
5	397	336
10	400	351
15	402	355
20	404	356
25	405	358
30	407	360
35	409	361
40	411	362
45	414	363
50	417	364
55	419	365
60	422	366
65	426	367
70	430	368
75	434	369
80	439	370

Boiling Range (C):

290 to 325 (5W30)
284 to 615 (10W30)

NON-METAL CONTENT

Sulphur (Weight %):
0.37

SENSATION

Color
3.0
4.0

OTHER

Reid method Vapor Pressure (kPa):

Temp(C)	Pressure
37.8	0.689 (estimated)

Fate.Detail: Detailed Information on Fate, Transport, Persistence, and/or Pathways:

As was stated in the Brief Introduction:

> New motor oil contains a higher percentage of fresh and lighter (often more volatile and water soluble as well as lighter) hydrocarbons that would be more of a concern for short term (acute) toxicity to aquatic organisms, whereas used motor oil contains more metals and heavy PAHs (some partly the result of combustion processes) that would contribute to chronic (long-term) hazards including carcinogenicity.
>
> About half of the volume of crankcase oil used in the automotive sector is burned and released from exhaust during engine use and lost from crankcase leaks into the environment. It is estimated that direct oil emissions in the exhaust of engines in perfect technical condition range from 0.1 to 0.25 L/1000 km [752].

Laboratory and/or Field Analyses:

Recent (1991) studies have indicated that EPA approved methods used for oil spill assessments (including total petroleum hydrocarbons method 418.1, semivolatile priority pollutant organics methods 625 and 8270, and volatile organic priority pollutant methods 602, 1624, and 8240) are all inadequate for generating scientifically defensible information for Natural Resource Damage Assessments [468]. These general organic chemical methods are deficient in chemical selectivity (types of constituents analyzed) and sensitivity (detection limits); the deficiencies in these two areas lead to an inability to interpret the environmental significance of the data in a scientifically defensible manner [468]. A great deal of uncertainty remains in the use of dose-response relationships based on crude oil as a whole mixture [734].

The relative proportions of hazardous compound constituents present in petroleum-based oil contamination is typically quite variable. The lab analyses most appropriate for measuring different types of oil contamination depend upon the type of oil involved and the reason for measuring the contamination. The farther one progresses from lighter towards heavier oils (the general progression from light towards heavy is the following: Diesel, No. 2 Fuel Oil, Light Crudes, Medium Crude Oils, Heavy Crudes, No. 6 Fuel Oil, etc.) the greater the percentage of PAHs and other semi-volatiles (many of which are not so immediately toxic as the volatiles but which can result in long term/chronic impacts). These heavier oils thus need to be analyzed for the semi volatile compounds which typically pose the greatest long term risk, PAHs and (especially) alkylated PAHs. Used motor oil typically has much higher concentrations of PAHs than new motor oil [40,519].

See also: PAHs as a group entry.

Crude oil consists of thousands of individual compounds. The major groups include the saturated alkanes, alkenes, benzene, alkylated and aryl benzenes, polynuclear aromatics, heterocyclic aromatics, and hetro-atom substituted alkanes, alkenes and aromatics [783]. Some of the more toxic compound classes are: low molecular weight aromatics (such as benzene, toluene, xylene, other monocyclic aromatics), and polynuclear aromatic hydrocarbons (PAH) [713, 745]. Due to the presence of light aromatics and PAHs in fuel crude oil, we recommend the following decision tree:

Decision Tree (dichotomous key) for selection of lab methods for measuring contamination from midrange to heavy crude oils, number 6 and heavier fuel oils, bunker C, motor oils, and all other oils considered to be heavy):

1a. Your main concern is biological effects of petroleum products..2

1b. Your main concern is cleanup or remediation but no ecological or human resources are at risk............3

2a. The resource at risk is primarily humans via a drinking water pathway, either the contamination of groundwater used for drinking water, or the fresh* or continuing contamination of surface waters used as drinking water, or the risk is primarily to aquatic species in confined** surface waters from a fresh* spill, or the risk is to surface waters re-emerging from contaminated groundwater resources whether the spill is fresh* or not; the medium and/or pathway of concern is water rather than sediments, soil, or tissues. Note: although heavy products have a lower percentage of BTEX and other relatively soluble compounds which typically threaten drinking water, ground water, or water column organisms, some heavy oils including crudes do contain some of these water soluble compounds, so they cannot be ignored........................4

2b. The resource at risk is something else......................5

3a. The spilled substance is a fresh* oil product of known composition: If required to do so by a regulatory authority, perform whichever Total Petroleum Hydrocarbon (TPH) analysis specified by the regulator. However, keep in mind that due to its numerous limitations, the use of the common EPA method 418.1 for Total Petroleum Hydrocarbons is not recommended as a stand-alone method unless the results can first be consistently correlated (over time, as the oil ages) with the better NOAA protocol expanded scan*** for polycyclic aromatic hydrocarbons (PAHs) and alkyl PAHs. If not required to perform an EPA method 418.1-based analysis for TPH, instead perform a Gas Chromatography/Flame Ionization Detection (GC/FID) analysis for TPH using the spilled substance as a calibration standard. GC/FID methods can be sufficient for screening purposes when the oil contamination is fresh*, unweathered oil and when one is fairly sure of the source [657]. If diesel 1D was spilled, perform TPH-D (1D) using California LUFT manual methods (typically a modified EPA method 8015) [465] or a locally available GC/FID method of equal utility for the product spilled. However, no matter which TPH method is used, whether based on various GC/FID or EPA method 418.1 protocols, the investigator should keep in mind that the effectiveness of the method typically changes as oil ages, that false positives or false negatives are possible, and that the better Gas Chromatography-Mass Spectrometry-Selected Ion Mode (GC/MS/SIM) scans (such as the NOAA expanded scan***) should probably be performed at the end of remediation to be sure that the contamination has truly been cleaned up. Another option for fresh oil: in cases where an inexpensive screening scan is desired, consider using an HPLC/Fluorescence scan method for sediment or bile metabolite samples. Such scans are available from laboratories at Texas A. and M., Arthur D. Little, and the NOAA lab in Seattle. This scan is not much more expensive, and less prone to false negatives and various other problems than some of the more common screening methods (TPH-EPA 418.1 and Oil and Grease). Screening measures the total fluorescence of oil components while GC/MS measures individual aromatic compounds [521]. Thus, HPLC/fluorescence screening allowed detecting lower concentrations of petroleum-related aromatic compounds in samples contaminated by Prudhoe Bay Crude Oil than did analysis by GC/MS [521].

3b. The spilled product is not fresh* or the contamination is of unknown or mixed composition.......................6

4. Analyze for Benzene, Toluene, Ethyl Benzene, and Toluene (BTEX) compounds in water as part of a broader scan of volatiles using EPA GC/MS method 8240. The standard EPA GC/MS method 8240 protocol will be sufficient for some applications, but the standard EPA method 8240 (and especially the less rigorous EPA BTEX methods such as method 8020 for soil and method 602 for water) are all inadequate for generating scientifically defensible information for Natural Resource Damage Assessments [468]. The standard EPA methods are also inadequate for risk assessment purposes. Thus, when collecting information for possible use in a Natural Resource Damage Assessment or risk assessment, it is best to ask the lab to analyze for BTEX compounds and other volatile oil compounds using a modified EPA GC/MS method 8240 method using the lowest possible Selected Ion Mode detection limits and increasing the analyte list to include as many alkyl BTEX compounds as possible. Also analyze surface or (if applicable) ground water samples for polycyclic aromatic

hydrocarbons (PAHs) and alkyl PAHs using the NOAA protocol expanded scan*** modified for water samples using methylene chloride extraction. If the contaminated water is groundwater, before the groundwater is determined to be remediated, also analyze some contaminated sub-surface soils in contact with the groundwater for BTEX compounds (EPA GC/MS method 8240), and PAHs (NOAA protocol expanded scan***). The magnitude of any residual soil contamination will provide insight about the likelihood of recontamination of groundwater resources through equilibria partitioning mechanisms moving contamination from soil to water.

5a. The medium of concern is sediments or soils.................6

5b. The medium of concern is biological tissues.................7

6. Perform the NOAA protocol expanded scan*** for polycyclic aromatic hydrocarbons (PAHs) and alkyl PAHs. If there is any reason to suspect fresh* or continuing contamination of soils or sediments with lighter volatile compounds, also perform EPA GC/MS method 8240 using the lowest possible Selected Ion Mode (SIM) detection limits and increasing the analyte list to include as many alkyl Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) compounds as possible.

7a. The problem is direct coating (oiling) of wildlife or plants with spilled oil product..................................8

7b. The problem is something else...............................9

8. Perform NOAA protocol expanded scan*** for polycyclic aromatic hydrocarbons (PAHs) and alkyl PAHs and/or GC/FID fingerprinting of the coating oil only if necessary to identify the source or exact oil. If the source is known and no confirmation lab studies are necessary: dispense with additional chemical laboratory analyses and instead document direct effects of coating: lethality, blinding, decreased reproduction from eggshell coating, etc., and begin cleaning activities if deemed potentially productive after consolations with the Fish and Wildlife Agencies.

9a. The concern is for impacts on water column organisms (such as fish or plankton)..10

9b. The concern is for something else (including benthic organisms)...11

10. If exposure to fish is suspected, an HPLC/Fluorescence scan for polycyclic aromatic hydrocarbon (PAH) metabolites in bile may be performed to confirm exposure [844]. The HPLC/fluorescence scan looks for the presence of metabolites of PAHs: naphthalene, phenanthrene, and benzo[a]pyrene. The technique does not identify or quantify actual PAH compounds, but subsequent gas chromatography analyses can be done to

confirm the initial findings. Even the semi-quantitative Total Scanning Fluorescence (TSF) done inexpensively by labs such as GERG are a better measure of PAH contamination than GC/FID, which measures less persistent and less hazardous aliphatics. For bottom-dwelling fish such as flounders or catfish, also analyze the bottom sediments (see Step 6 above). Fish which spend most of their time free-swimming above the bottom in the water column can often avoid toxicity from toxic petroleum compounds in the water column, but if fish are expiring in a confined** habitat (small pond, etc.), EPA GC/MS method 8240 and the NOAA protocol expanded scan*** for PAHs could be performed to see if Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX), naphthalene, and other potentially toxic compounds are above known acute toxicity benchmark concentrations. Zooplankton populations impacted by oil usually recover fairly quickly unless they are impacted in very confined** or shallow environments [835] and the above BTEX and PAH water methods are often recommended rather than direct analyses of zooplankton tissues.

11a. The concern is for benthic invertebrates: analyze invertebrate whole-body tissue samples and surrounding sediment samples for polycyclic aromatic hydrocarbons (PAHs) and alkyl PAHs using the NOAA protocol expanded scan***. If the spill is fresh* or the source continuous, risk assessment needs may also require that the sediments which form the habitat for benthic invertebrates be analyzed for Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and other volatile compounds using EPA GC/MS method 8240 or modified EPA method 8240 in the Selected Ion Mode (SIM). Bivalve invertebrates such as clams and mussels do not break down PAHs as well or as quickly as do fish or many wildlife species. They are also less mobile. Thus, bivalve tissues are more often directly analyzed for PAH residues than are the tissues of fish or wildlife.

11b. The concern is for plants or for vertebrate wildlife including birds, mammals, reptiles, and amphibians: polycyclic aromatic hydrocarbons (PAHs) and other petroleum hydrocarbons break down fairly rapidly in many wildlife groups and tissues are not usually analyzed directly. Instead direct effects are investigated and water, soil, sediment, and food items encountered by wildlife are usually analyzed for PAHs and alkyl PAHs using the NOAA protocol expanded scan***. If the spill is fresh* or the source continuous, risk assessment needs may also require that these habitat media also be analyzed for Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and other volatile compounds using EPA GC/MS method 8240 or modified EPA method 8240 in the Selected Ion Mode (SIM). Less is known about plant effects. However, the same methods recommended above for the analyses of water (Step 4 above) and for sediments or soils (Step 6 above) are usually also recommended for these same media in plant or wildlife habitats. If wildlife or plants are covered with oil, see also Step 8 (above) regarding oiling issues.

* Discussion of the significance of the word "fresh": The word "fresh" cannot be universally defined because oil breaks down faster in some environments than in others. In a hot, windy, sunny, oil-microbe-rich, environment in the tropics, some of the lighter and more volatile compounds (such as the Benzene, Toluene, Ethyl Benzene, and Xylene compounds) would be expected to disappear faster by evaporation into the environment and by biodegradation than in a cold, no-wind, cloudy, oil-microbe-poor environment in the arctic. In certain habitats, BTEX and other relatively water soluble compounds will tend to move to groundwater and/or subsurface soils (where degradation rates are typically slower than in a sunny well aerated surface environment). Thus, the judgement about whether or not oil contamination would be considered "fresh" is a professional judgement based on a continuum of possible scenarios. The closer in time to the original spill of non-degraded petroleum product, the greater degree the source is continuous rather than the result of a one-time event, and the more factors are present which would retard oil evaporation or breakdown (cold, no-wind, cloudy, oil-microbe-poor conditions, etc.) the more likely it would be that in the professional judgement experts the oil would be considered "fresh." In other words, the degree of freshness is a continuum which depends on the specific product spilled and the specific habitat impacted. Except for groundwater resources (where the breakdown can be much slower), the fresher the middle distillate oil contamination is, the more one has to be concerned about potential impacts of BTEX compounds, and other lighter and more volatile petroleum compounds.

To assist the reader in making decisions based on the continuum of possible degrees of freshness, the following generalizations are provided: Some of the lightest middle distillates (such as Jet Fuels, Diesel, No. 2 Fuel Oil) are moderately volatile and soluble and up to two-thirds of the spill amount could disappear from surface waters after a few days [771,835]. Even heavier petroleum substances, such as medium oils and most crude oils will evaporate about one third of the product spilled within 24 hours [771]. Typically the volatile fractions disappear mostly by evaporating into the atmosphere. However, in some cases, certain water soluble fractions of oil including Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) compounds move down into groundwater. BTEX compounds are included in the more volatile and water soluble fractions, and BTEX compounds as well as the lighter alkanes are broken down more quickly by microbes than heavier semi-volatiles such as alkyl PAHs and some of the heavier and more complex aliphatic compounds. Thus after a week, or in some cases, after a few days, there is less reason to analyze surface waters for BTEX or other volatile compounds, and such analyses should be reserved more for potentially contaminated groundwaters. In the same manner, as the product ages, there is typically less reason to analyze for alkanes using GC/FID techniques or TPH using EPA 418.1 methods, and more reason to analyze for the more persistent alkyl PAHs using the NOAA protocol expanded scan***.

** Discussion of the significance of the word "confined": Like the word "fresh" the word "confined" is difficult to define precisely as there is a continuum of various degrees to which a habitat would be considered "confined" versus "open." However, if one is concerned about the well-being of ecological resources such as fish which spend most of their time swimming freely above the bottom, it makes more sense to spend a smaller proportion of analytical funding for water column and surface water analyses of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and other volatile or acutely toxic compounds if the spill is in open and/or deep waters rather than shallow or "confined" waters. This is because much of the oil tends to stay with a surface slick or becomes tied up in subsurface tar balls. The petroleum compounds which do pass through the water column often tend to do so in small concentrations and/or for short periods of time, and fish and other pelagic or generally mobile species can often swim away to avoid impacts from spilled oil in "open waters." Thus in many large oil spills in open or deep waters, it has often been difficult or impossible to attribute significant impacts to fish or other pelagic or strong swimming mobile species in open waters. Lethality has most often been associated with heavy exposure of juvenile fish to large amounts of oil products moving rapidly into shallow or confined waters [835]. Different fish species vary in their sensitivity to oil [835]. However, the bottom line is that in past ecological assessments of spills, often too much money has been spent on water column analyses in open water settings, when the majority of significant impacts tended to be concentrated in other habitats, such as benthic, shoreline, and surface microlayer habitats.

*** The expanded scan protocols for polycyclic aromatic hydrocarbons (PAHs) and alkyl PAHs have been published by NOAA [828].

End of Key.

Other Detailed Discussion:

Contaminants data from different labs, different states, and different agencies, collected by different people, are often not very comparable (see also, discussion in the disclaimer section at the top of this entry).

As of 1997, the problem of lack of data comparability (not only for water methods but also for soil, sediment, and tissue methods) between different "standard methods" recommended by different agencies seemed to be getting worse, if anything, rather than better. The trend in quality assurance seemed to be for various agencies, including the EPA and others, to insist on quality assurance plans for each project. In addition to quality control steps (blanks, duplicates, spikes, etc.), these quality assurance plans call for a step of insuring data comparability [1015,1017]. However, the data comparability step is often not given sufficient consideration. The tendency of agency guidance (such as EPA SW-846 methods and some other new EPA methods for bio-concentratable substances) to allow more and more flexibility to select options at various points along the way, makes it harder in insure data comparability or method validity. Even volunteer monitoring programs are now strongly encouraged to develop and use quality assurance project plans [1015,1017].

At minimum, before using contaminants data from diverse sources, one should determine that field collection methods, detection limits, and lab quality control techniques were acceptable and comparable. The goal is that the analysis in the concentration range of the comparison benchmark concentration should be very precise and accurate.

It should be kept in mind that quality control field and lab blanks and duplicates will not help in the data quality assurance goal as well as intended if one is using a method prone to false negatives. Methods may be prone to false negatives due to the use of detection limits that are too high, the loss of contaminants through inappropriate handling, or the use of inappropriate methods. Inappropriate methods are commonly used for oil products.

Although EPA method 418.1: Petroleum Hydrocarbons expressed as Total Petroleum Hydrocarbons (TPH), is recommended by many State agencies, some consulting firms, and some laboratories for certain regulatory and screening applications (often leaking underground storage tanks), this method is not well suited to crude oil contamination or to the more persistent hazardous constituents in oil. Low values tend to give the mistaken impression that a site is clean when it really isn't (a false negative). For example, a field test of bioremediation of soils contaminated with Bunker C (a heavy fuel) at a refinery in Beaumont, Texas, utilized oil and grease data, which (although the data was quite variable) seemed to indicate bioremediation was taking place [728]. A comparison of the oil and grease data at this site with TPH data at this site suggested the same thing, that the data was quite variable but if anything, the oil was being slowly being cleaned up by bioremediation (Bruce Herbert, Texas A. and M., Department of Geology, personal communication, 1995). However, a later study of the same site utilizing the expanded scan for PAHs [828] (a modified EPA 8270 including alkyl homologues and lower detection limits), indicated that very little bioremediation of hazardous alkyl PAHs and multi-ring PAHs was actually taking place [727]. Thus, utilizing either oil and grease or TPH analyses would tend to lead one to the faulty conclusion that the harmful compounds were being naturally cleaned up at an acceptable rate. This is partly because the TPH and oil and grease methods tend to favor the lighter and less alkylated PAHs, whereas many of the carcinogenic and longer lasting PAHs are the heavier multi-ringed and alkylated compounds.

One author reported concentrations of dibenz(a,c)-anthracene, 4-methylpyrene, fluoranthene, benz(a)anthracene, benzo(e)pyrene, benzo(g,h,i)perylene, and benzo(a)pyrene, respectively, 36, 49, 253, 720, 1,112, 4,770, and 7,226 times higher in "used" compared to "fresh" oil. The 4- to 7-ring PAHs have been especially implicated in the carcinogenic effect of used oil [519].

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Payne, and J. Hellou, "Induction of MFO Enzymes and Production of Bile Metabolites in Rainbow Trout (Oncorhynchus mykiss) Exposed to Waste Crankcase Oil." Copyright 1993 SETAC].

In cases where a less expensive screening scan is desired, consider using an HPLC/Fluorescence scan method for sediment or bile metabolite samples. Such scans are available from laboratories at Texas A. and M., Arthur D. Little, and the NOAA lab in Seattle. This scan is less prone to false negatives and various other problems than some of the more common screening methods (TPH-EPA 418.1 and Oil and Grease). HPLC/Fluorescence is less expensive than some of the more rigorous scans. The HPLC/fluorescence scan can be used for analyses of fish bile: the scan looks at bile directly for the presence of metabolites of PAHs: naphthalene, phenanthrene, and benzo[a]pyrene. The technique does not identify or quantify actual PAH compounds, but subsequent gas chromatography analyses can be done to confirm the initial findings. Even the semi-quantitative Total Scanning Fluorescence (TSF) done inexpensively by labs such as GERG are a better measure of PAH contamination than GC/FID, which measures less persistent and less hazardous aliphatics.

TLC Patterns for Engine Oil [497]:

> Most engine oils are petroleum based materials comprised primarily of saturated hydrocarbons. Their thin-layer chromatography (TLC) pattern, using hexane as the eluting solvent, will show one main oval-shaped spot at an Rf of 0.9, visible with iodine staining. There may also be a faint tail stretching from Rf 0.9 to the origin Rf 0.0. Specific additives may also show up as individual spots on the thin-layer chromatography (TLC) plate.

For additional details on protocols, including field collection protocols, see the Oil Spills entry.