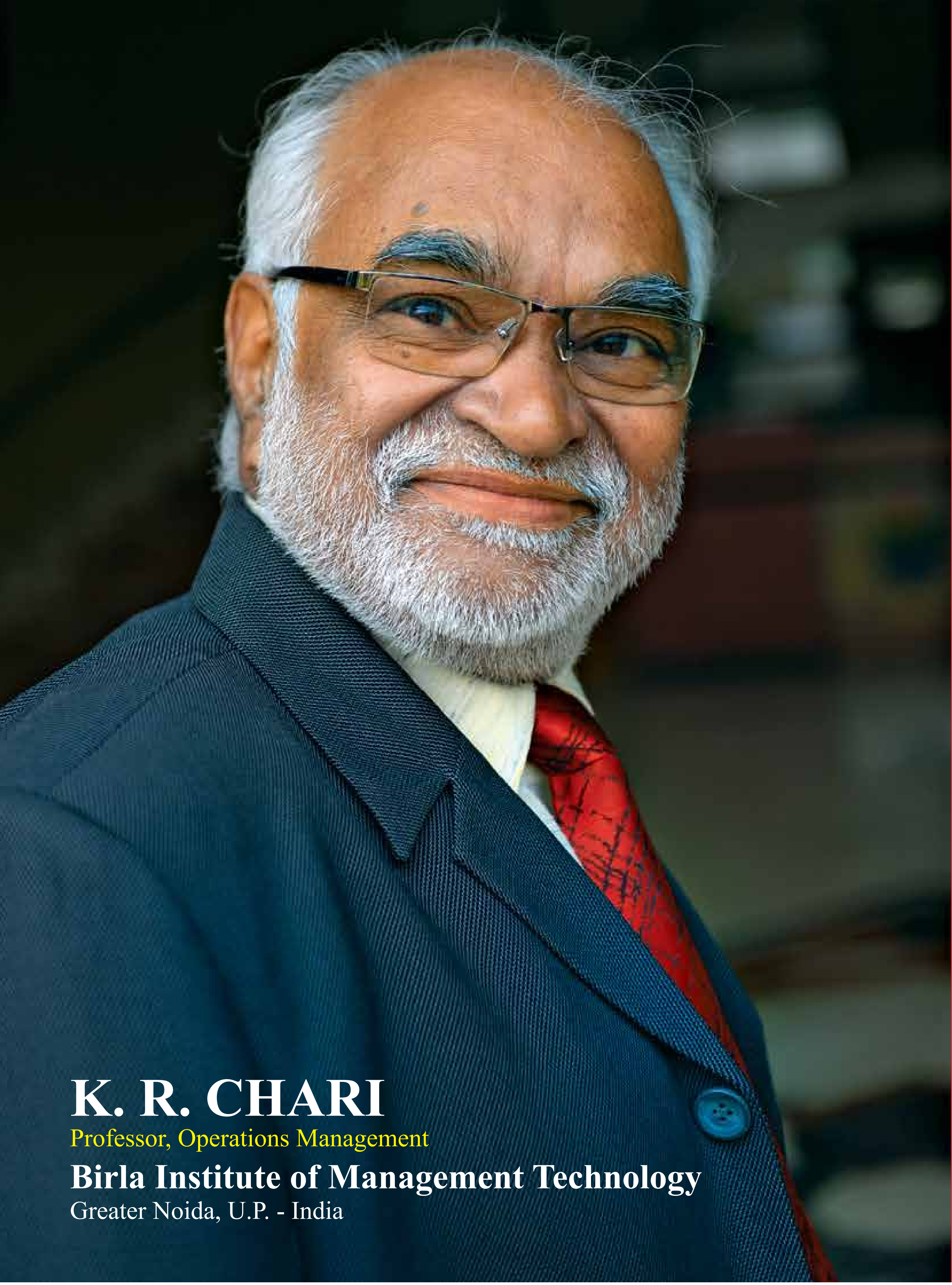

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Waste Oils/Lubricants

A GOLD MINE

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Management of waste oils is an issue of growing concern, particularly in industrial and urban areas. Generation of waste oils is closely linked with increases in the numbers of automobiles and industries. Most of these oils contain degraded additives which, along with other contaminants, render them hazardous. In many developing countries, some of these waste oils are recycled by means of primitive and obsolete technologies such as open boiling, the acid-clay method and so on, not only giving rise to toxic air emissions but also resulting in hazardous solid wastes. The market for low-grade recycled oils is usually limited and the remaining waste oils are either burnt in the open or indiscriminately disposed of, causing serious threats to both human health and the environment. Guidelines for management of waste oils have been prepared by entities such as the secretariat of the basel convention. However, these guidelines provide information on management of wastes in general and contain, at best, a generic description of destruction technologies. Local authorities and industry managers are increasingly in need of reliable information on various technology options for the safe treatment and disposal of waste oils.

Inspiring Statements

- "One gallon of used motor oil (waste oil) provides the same 2.5 quarts of lubricating oil as 42 gallons of crude oil." (The conversion ratio can be taken as 1 US gallon = 4 quarts, or we may say every litre of waste oil gives 0.63 litre of lubricating oil)
- The used oil from one oil change can contaminate 1 million gallons of fresh water—a years' supply for 50 people.
- Oils and fats are an essential part of every day for many people. It is an unfortunate fact that many people simply discard waste oil such as that used in cars.
- Waste oils come from more than petroleum sources; they also come from animals and plants. Recycling waste oils reduces society's impact on the environment and helps the economy.
- Re-refining used oil takes only about one-third the energy of refining crude oil to lubricant quality.
- One litre of waste oil processed for fuel contains about 9,300 Kcals of heat energy, and most important of all, assists in conserving crude reserves, while minimising unemployment through the building/construction of used lubricating oil recycling plants and eliminating used lubricants as a factor contributing to environmental pollution.
- Thus management of waste oils/re-refining has an economic advantage apart from being a solution for disposal with little or no effect on human health or the environment.

Sources: US EPA, Used Oil Management Program,

Recycling and Destruction Technologies for Waste Oils

Technologies for recycling, reprocessing and destroying waste oils are not widely available in developing countries. As a result, technology choices, when they are made, may not be well-informed, resulting in poor or uneconomic outcomes. The use of obsolete or inappropriate technologies also results in serious environmental issues due to toxic air emissions and discharges of hazardous solid wastes.

Mineral oils, whether extracted from crude oil or manufactured as synthetic oils, are used for a wide variety of purposes ranging from lubrication to heat and power transfer, metal cutting and so on. Depending upon the application and operating environment, these oils become contaminated and/or degraded and thus need to be discarded, resulting in the generation of waste oils (used oils). Such waste oils are classified as hazardous waste and under the Basel Convention fall under categories Y8 and Y9.

The management of waste oils is particularly important because of the large quantities generated globally through transport and industrial activities. These waste oils may have a detrimental effect on the environment, if not properly handled, treated or disposed of.

A large range of waste oils can be recycled and recovered in a variety of ways, either directly or after some form of separation and refinement. In keeping with the waste management hierarchy, the first option is to conserve the original properties of the oil, allowing for direct reuse. Other options include recovering its heating value and/or using in other lower-level applications. Certain types of waste oils, lubricants in particular, can be reprocessed, allowing for their direct reuse. After treatment, waste oils can be used either as a lube base stock comparable to refined virgin base oil or as clean burning fuel. Waste oils and residues from recycling processes which cannot be reused in any way need to be disposed of in an environmentally sound manner.

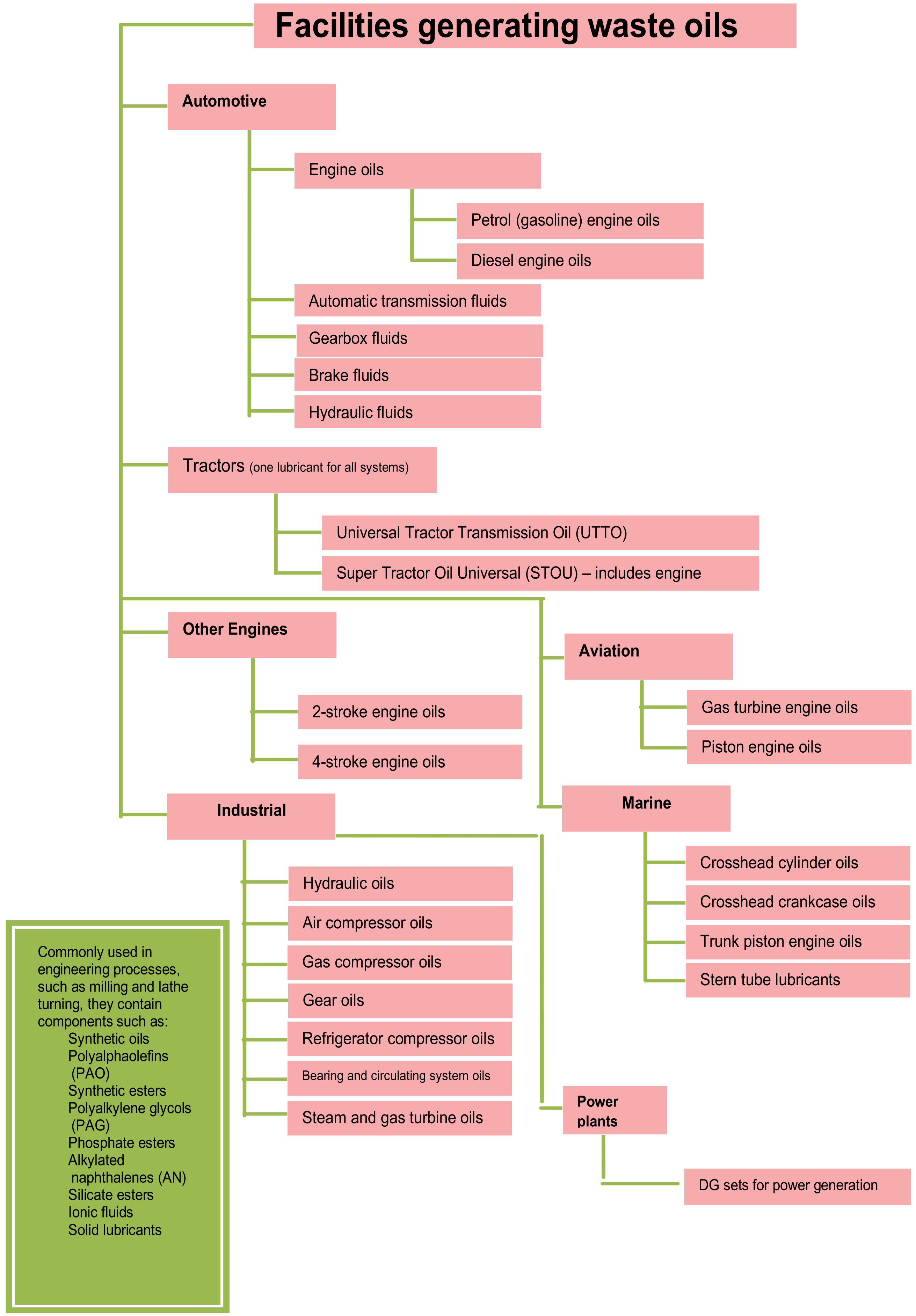
Impact of Waste Oils on Health and the Environment

The contaminants in waste oils have adverse impacts on both human health and the environment. The presence of degraded additives, contaminants and by-products of degradation render waste oils more toxic and harmful to human health and the environment than virgin base oils. Oil concentrations as low as 1 ppm can contaminate drinking water. For mammals and birds, harmful impacts include toxic contamination, destruction of food resources and habitats and impaired reproductive capability. In addition, oil vapors are toxic for some species and may damage their central nervous systems, lungs, and livers. Ingesting oil may also adversely impact the ability of animals to digest food and furthermore damage their intestinal tract. Oil reduces the insulating capacity of furs and the water repellency of feathers, which places some animals at the risk of freezing or drowning.

The recycling of used lubricants has been practiced to various degrees since the 1930s and particularly during the Second World War, when the scarcity of adequate supplies of crude oil encouraged the reuse of all types of materials, including lubricants. In the earlier part of the 20th century, lubricating oils contained few or no additives at all. Recycling these oils usually involved some basic and simple processes which were a combination of heating to remove volatile components; settling to separate water, dirt, and sludge; and centrifuging or filtering to remove most of the remaining insoluble contaminants. While this limited processing could not bring recycled oils to match the original oil quality, technological improvements now enable recycled oils to be at par with virgin oils in quality.

In recent years environmental considerations regarding the conservation of resources have further boosted interest in recycling. Recent developments, in particular the emphasis on waste recovery, have led to further renewed interest in recycling used oils. In some developed countries up to 50% of the countries' need for lubricating oil is met through recycled oils. There are different methods used by different countries for recycling used oils. It has been established that almost 85 to 90% of dehydrated waste oils can be converted into useful products, including base oils for further processing into lubricating oils or fuel.

Types of Facilities that Generate Waste Oils



Need for Regulations and Legislation

Legislation and regulations constitute an important part of the management of waste oils. Individual countries may design their own statutes in accordance with local needs, not withstanding the fact that the environmental impact of waste oils is a global and trans-boundary issue.

In designing appropriate regulations, it may be advisable to refer to some regulations and guidelines designed by various state and country agencies such as "A Guidebook for Implementing Curbside and Drop-off Used Motor Oil Collection Programs," written by the Washington Citizens for Recycling Foundation, February 1992, "A manual for community used oil recycling programs of the Pennsylvania (USA) Energy Office, or in the case of Australia, guidelines used by Transpacific, one of the largest waste oil collectors, which reprocesses waste oil collected from thousands of clients. They operate under an externally certified Integrated Management System meeting the requirements of key Australian standards for quality, environment and occupational health and safety.

In Europe, ATIEL is a body whose membership consists of various world-renowned lubricant manufacturers, namely BPCastrol, CEPSA lubricantes, Chevron, Eni, ExxonMobil, Fuchs, GALP, Kuwait Petroleum, Lotos Oil, LUKOIL, Neste Oil, ORLEN OIL, PETRONAS, REPSOL, Shell, SK Lubricants, Statoil Lubricants, Total, UEIL (Union Indépendante de I'Industrie Européenne des Lubrifiants) and Valvoline.

Legislation relating to lubricating oils has been reviewed at the European level and also within individual member states. This section examines existing legislation and the background to current developments, drawing heavily on the findings compiled in a 2009 report by the ATIEL Used Oil Technical Committee.

Waste Oil Management Programs

Various countries have designed their own systems for management of waste oils. The salient features and action points of such efforts in selected countries are depicted in Table below.

Features of waste oil management programs in various countries

Country	Features of the waste oil management program
France	78% collection of used oils; government-funded programs and fees are imposed on virgin lubes producers; 42% of used oil is re-refined by government directed re-refining associations.
Germany	94% recovered; high level of consumer interest in recycling, all used oils treated as hazardous waste; all oil marketers must provide collection facility near the retail establishment; retailers pay for used oil pick up; 41% of used motor oils are re-refined, 35% burned in cement kilns, and 24% processed and burned in other applications; recovering 48% of total lube oils sold.
Japan	No national level recycling program; no subsidies/funding; essentially no DIY market in Japan; high percentage of used motor oil is recovered, treated, and burned for heating value; re-refining is very limited.
Italy	Mandated use of re-refined oils in motor oils; six operating re-refining plants; funded by lube oil sales taxes; collectors and re-refiners both subsidised; only 10% of used oil can be directed to cement kilns. The collection efficiency of used oil has increased from 42.6% in 2008 to 48.7% in 2009. An incentive for recycling comes in the form of reduced excise duty. In Italy, re-refined product pays 50% of the excise duty applied to virgin lubricant. This tax advantage is granted only if the used oils for re-refining are collected in Italy. The EC has requested Italy to cease application of the ruling concerning used oil from outside of Italy. Also, it was estimated that the quantity of used oil collected by the COOU consortium is steadily over 95% of the collectible oil.
Australia	High subsidies for re-refining, low subsidies for low grade burning oils; none for reclaimed industrial oils; collecting 81% of available oil; $10M Australian funded by government to subsidise recycling; revising re-refining incentive downward; collecting 38% of total lube sold.
Canada (Alberta)	Focus on increasing collections; little emphasis on avoiding contamination; little emphasis on re-refining; funded by sales tax; recovering 51% of total lube oil sold.
United States	The United States has implemented a broad range of recycling programs; some states impose sales taxes to subsidise collections; some states classify used oil as hazardous waste to discourage illegal dumping; some local municipalities fund collection activities; signs of quick lube facilities growth which has produced positive results by reducing oil improperly disposed of by DIY oil changers; small re-refining industry; disposition of used oil as a fuel encouraged. The United States has no central coordinating body that focuses on used oil management similar to Europe, therefore industry statistics are not readily available. The U.S. does have a mandatory federal policy requiring the preferential purchase of re-refined oil and does promote the source reduction and recycling of materials over their treatment (including burning as a fuel) and disposal under the Resource Conservation and Recovery Act and the Pollution Prevention Act.
India	The Ministry of Environment and Forests (MoEF), GOI has licensed about 170 small to medium recyclers (352 MT per annum to 26,460 MT per annum) with a total licensed capacity of about 0.69 MMT of used and waste oil recycling capacity.

Waste oil generation, collection and re-refining cycle

RECYCLING AND DESTRUCTION TECHNOLOGIES FOR WASTE OILS

Waste oils are particularly suited for the adoption of preventive approaches. Most of these oils are discarded because of contamination/degradation. As the basic properties of lube oils remain by and large intact in most cases, the discarded waste oils can be properly collected and treated.

Basically there are two alternatives for the destruction/disposition of waste oils:

- Re-refining to produce lubricating base oils
- Burning as fuel

Recycled lubricating oil products are potentially suitable for all uses, including their original use, if given proper segregation, cleanup and additive treatment. Studies across the world have demonstrated that re-refined oils using modern technology produce a safe product, including consideration of carcinogenicity.

The principle of recycling waste oils utilises many of the following basic steps:

- Removal of water and solid particles by settling
- Sulphuric acid treatment to remove gums, greases, etc.
- Alkaline treatment to neutralise acid
- Water washing to remove "soap"
- Stripping to drive off moisture and volatile oils; vacuum distillation and/or solvent extraction
- Clay contacting to bleach the oil and absorb impurities
- Filtering to remove clay and other solids
- Hydrogenation to improve colour
- Blending to specification

Generic Technologies for recycling waste oils

Over time, the re-refining processes are advancing and thus improving, especially from the aspects of yield and reduced environmental impacts. The most common of the generic systems are:

- Acid-clay Re-refining
- Acid Activated Clay Technology
- Vacuum Distillation/Evaporation Technology
- Hydrogenation Based Technologies
- Ultra-Filtration Technology
- Extraction Based Technologies

Specific Technologies for Waste Oil Recycling

Based on the generic technologies referred to in the previous section, many companies have developed specific processes for recycling waste oils. Some of the more prominent and better known among them are detailed below. It may however be noted that the following technologies do not cover all those which have to date been tried and experimented with. Not all have found their way to the commercial markets. Another few have been tried but no plants exist that use these technologies commercially. They have been classified as "C" (commercially available), "R&D" (only researched and developed at the laboratory level) and "OD" (outdated and no longer in use).

1. KTI Process
2. Safety Kleen Technology
3. Axens/Viscolube (REVIVOIL) Technology
4. IFP Technology/Snamprogetti Technology
5. HyLube Process
6. UOP DCH Process
7. Probex Process
8. STP Process
9. Degussa Process (Transformer Oil Recycling)
10. Buss Luwa Vacuum Distillation/Clay Filtration Process
11. BERC/NIPER Hydrogenation
12. Phillips Petroleum Company PROP: Hydrogenation Technology
13. Entra Process
14. ORYX Process: Vacuum Distillation
15. CEP Process
16. Vaxon Process
17. MeinkenTechnology
18. Atomic Vacuum Distillation Technology
19. BlowDec Technology
20. Dunwell Process
21. Interline Re-refining Process

Advanced Waste Oil Recycling Technologies

1. Thermal Cracking Based
2. Springs Oil Conversion (SOC)
3. Great Northern Processing Inc. (GNP) Thermal Cracking Process (Propak Process)
4. Environmental Oil Processing Technology
5. EADIEMAC Process for Recycling of Used Lubricating Oils

Selection of Appropriate Technology

There is no single re-refining process that is perfect for every country. Much depends on the throughput and processing flexibility desired. However, it is worthwhile noting that current technology seems to be converging towards a two-step procedure, vacuum distillation of dehydrated waste oil, and subsequent hydrotreating of distilled stocks. Such technologies usually produce high-quality base oils and concentrate the contaminants in the distillation residue. Other re-refining technologies, for example, extraction based Interline technology and UOP Hylube, also show promise.

The criteria for selection of a particular re-refining technology are described in the following section. The users of this compendium are advised to consider the following important parameters before making a selection of any technology. For larger users, it would be perhaps necessary to undertake a comprehensive techno-economic evaluation of the project through an experienced consulting agency.

Issues Relevant to Developing Countries

In light of the realisation that waste oils have a high potential to cause air, water and land pollution, no distinction should be made between developing and developed countries when deciding whether or not to introduce environmentally sound technologies (EST). At the same time, a certain degree of leniency is worth considering in the case of developing countries. The regulations can be continuously strengthened as stringency is fortified gradually.

In developing/underdeveloped countries, there may be a lack of awareness among the general public or insufficient infrastructure to support a large or medium industry.

It is suggested that developing countries choose a simpler re-refining technology (e.g. vacuum distillation followed by clay treating), which has lower investment needs. The management of waste oils through such relatively less eco-friendly technologies may have a better effect than from not having any management system in place for waste oils.

Other generic technologies based on vacuum distillation and extraction followed by hydrogenation are capital intensive and are viable for lager capacities (say, above 10,000 MT per annum). Although waste oil may be available in large quantities, availability may be very thinly distributed over a larger geographic region, making it economically unviable to collect and transport. Most developing countries may not have enough raw material to support these large capacities. All hydrogen based technologies are out of context here as even some developed countries have not adopted these insofar as they are highly capital intensive and they also carry higher operating costs. Ultra-filtration based technologies at present have yet to gain a significant presence even in the developed world.

Socio-economic Implications of Recycling

As detailed in the following section, the destruction of waste oil has its own share of both brighter and darker sides. However, it must be said that notwithstanding the darker aspect of having to live with hazardous waste, recycling offers many times more advantages to individuals, communities and the globe as a whole. Though hazardous, the residues from all the processes can be dealt with by adopting appropriate routes and processes for handling them, including secured landfill as a last resort.

Underdeveloped countries definitely have an advantageous position compared to advanced countries, because the energy intensity (specific energy consumption for recycling) can be brought down through the use of manual labour in most of the operations, e.g. handling drums and barrels, loading and unloading the products, labelling, maintaining records and other administrative procedures and so forth, which account for a major portion of energy in the processes. Even some of the technical operations like operating the filter presses can be undertaken using manual labour, through minor modifications and appropriate leveraging as well as indigenous designs using local skills.

News Update...

LafargeHolcim

LafargeHolcim Receives Revised CCI Divestment Order from India

LafargeHolcim announced that it has received a revised order of the Competition Commission of India (CCI) for the divestment of its interest in Lafarge India, including three cement plants and two grinding stations with a total capacity of around 11 million tons per annum. The company also markets aggregates and is one of India's leading ready-mix concrete manufacturers. The proposed transaction is an alternate remedy for the merger of the Group's legacy companies and now forms part of the company's CHF 3.5 billion divestment target in 2016.

"We will operate in India through our subsidiaries ACC Ltd. and Ambuja Cements Ltd. with a combined cement capacity of around 63 million tonnes and a distribution network that extends across the entire country. We see opportunities to further build our business in India through our network of over 100,000 dealers and retailers, and by meeting the infrastructure needs of a country that is experiencing significant urbanization," said Eric Olsen, CEO LafargeHolcim.

The conditional clearance by the CCI for an earlier divestment proposal was received in April 2015; including the divestment of Jojobera and Sonadih plants in Eastern India with a cement capacity of 5.1 million tonnes. LafargeHolcim subsequently entered into a letter agreement with Birla Corporation Limited, subject to CCI approval, in August 2015. However, due to the current regulatory issues relating to the transfer of mining rights captive and critical to the two plants, LafargeHolcim was obliged to submit an alternate remedy to the CCI to ensure compliance with the order. As a result, LafargeHolcim will now launch a new divestment process for Lafarge India.