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Instituto Nacional de Seguridad y Salud en el Trabajo

Used engine mineral oils

CARCINOGENS AT WORK:
Know to prevent

Information about the substance and where it can be found

Used engine mineral oils are refined petroleum derivatives with chemical additives; they are used for lubrication and cooling of the moving parts of internal combustion engines as well as for the protection of metals against corrosion.

As with all other petroleum products, for lubricating oils to be place on the market as chemicals not classified as hazardous to health, they must comply with maximum allowable polycyclic aromatic hydrocarbon (PAH) content requirements. This is because the carcinogenic potential attributed to these products is related to their PAH content (Grimmer et al., 1982).

PAHs are a set of organic chemicals formed as a result of the combustion of organic matter, such as wood, oil, tobacco, food, etc. These compounds are considered carcinogenic, especially those with 4-6 carbon ring structures. The best-known for its carcinogenic and mutagenic potential is benzo(a)pyrene.

Unused mineral engine oils have are very low in PAH and are therefore not considered carcinogenic; however, when used in internal combustion engines, changes in their composition occur, mainly due to increased temperatures and the accumulation of unburned fuel residues and combustion products, along with the presence of air.

These changes in composition lead to a significant increase in PAH content, among other chemical species. The PAH content of used engine oils increases with the time the oil is used in the engine and also with the number of kilometres over which the oil is used (Badura, 2016).

Engine oils are used in all vehicles or machinery with internal combustion engines, such as cars and mopeds, diesel locomotives, boat engines, aircraft and portable machinery including chainsaws and lawnmowers. It is also found where waste from the maintenance of such engines is handled, either for processing and disposal or for reuse or recovery of the waste.

There are currently initiatives to use residues of used engine oil as an additive in the manufacture of cements and as a binder in crumb rubber asphalts for road construction.

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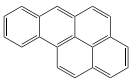
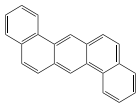
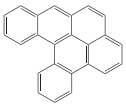
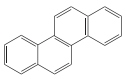
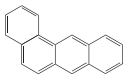
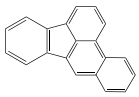
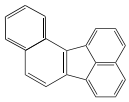
Table 1
IARC classification of the most important PAHs

Chemical agent	Chemical structure	IARC classification
Benzo[a]pyrene		1
Dibenz[a,h]anthracene		2A
Dibenzo[a,l]pyrene		2A
Chrysene		2B
Benz[a]anthracene		2B
Benzo[b]fluoranthene		2B
Benzo[j]fluoranthene		2B

Source: Spanish Agency for Food and Safety Nutrition Technical data sheet: Polycyclic aromatic hydrocarbons (HAP). September 2020.

Health effects

Used engine oils are classified as carcinogenic to humans (Group 1) by the International Agency for Research on Cancer (IARC) because of their potential to cause skin cancer. IARC includes this agent in the review of the carcinogenicity

of untreated or mildly treated mineral oils, to which the effect of used engine oils may be assimilated (IARC, 2012). The primary route of exposure, and the one to which the main pathologies or adverse effects are related, is the dermal route.

When skin is soaked in used engine oils, either directly or through contact with soiled clothing, irritation and allergic reactions can occur (Nowak et al., 2019). Effects such as eczema, oily skin and acne have also been observed. Moreover, as mentioned above, dermal exposure to used engine oils has been shown to cause skin cancer, as observed in the scrotum (CONCAWE, 1986; IARC, 2012).

The IARC (iarc.who.int) is an autonomous agency of the World Health Organization of the United Nations. It seeks to promote international collaboration in cancer research. It runs studies that are widely recognised for their quality and independence.

Scrotal cancer is a rare disease, associated only with occupational exposures. It was the first occupational disease to be described and associated with chimney sweeping (Brown and Thornton, 1957). Mortality associated with this type of skin cancer is low; however, it can be fatal if not diagnosed early (Azike et al., 2009).

Being chemical substances released by a process, used engine oils do not fall within the scope of Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures (CLP Regulation). However, they do fall within the scope of RD 665/1997 on the protection of workers from the risks related to exposure to carcinogens at work, following the inclusion in Annex I of works involving dermal exposure to mineral oils that have been used before in internal combustion engines to lubricate and cool the moving parts within the engine, by RD 427/2021 of 15 June. Likewise, this mixture of agents was assigned the Notation "skin" in Annex III of the Royal Decree, given the substantial contribution to the total body burden of via dermal exposure.

Where the exposure can take place

The workers most likely to be exposed to used engine oils are those involved in the maintenance, repair or adjustment of these engines. In particular, the profession of car mechanic or mechanic working with any other equipment with a combustion engine, and operations involving draining engine oil or contact with impregnated parts, will be the most compromised.

Other occupations at risk from dermal exposure to used engine oils are those involved in the recovery, regeneration or recycling of vehicle waste, such as scrap yard workers, waste managers collecting used engine oils or those involved in decontamination.

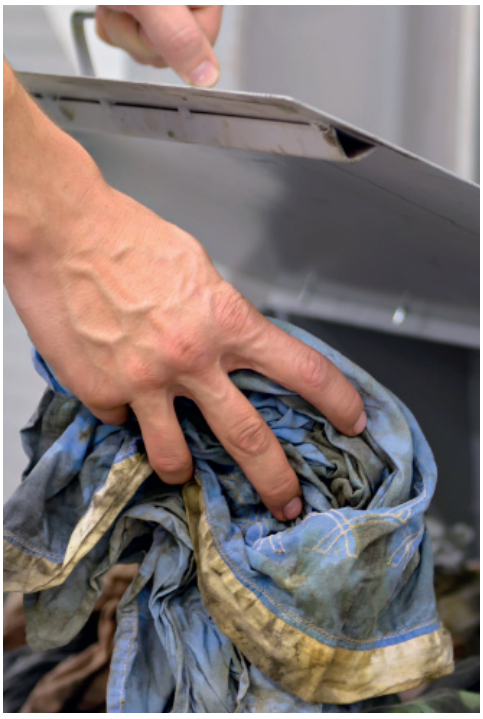
As mentioned, in the field of waste reuse or recycling, there are initiatives in which these oils are used as a binder in asphalts modified with tyre rubber crumb and as additives in the manufacture of cements, among others. There are also companies that regenerate used oils so that they can be reused as lubricants by applying physical-chemical treatments to remove heavy metals and other hazardous contaminants. Anyone who may come into contact with untreated waste oils or with parts or surfaces contaminated with waste oils may be exposed to this carcinogen.

Finally, skin contamination by used engine oil mists may occur during use of open two-stroke engines, such as those in chainsaws and other portable machines used in agriculture, forestry, gardening and other sectors (Nowak et al., 2019). However, this possibility, a priori, is remote if the engines are well protected with casings preventing the escape of these mists to the outside.

The notation "skin" given to this agent in the directive on carcinogens and mutagens indicates the importance of this route of entry into the body, either directly or by contact with soiled clothing. Moreover, soiled clothing may increase the risk of exposure to people in the worker's environment through contact with the soiled clothing or with surfaces contaminated by the soiled clothing.

Regulatory references:

Used engine oils, being chemical substances released by a process, do not fall within the scope of the CLP Regulation. However, they do fall within the scope of RD 665/1997, following the inclusion in Annex I of works involving dermal exposure to mineral oils that have been used before in internal combustion engines to lubricate and cool the moving parts within the engine, by RD 427/2021 of 15 June.



Exposure assessment

Once the risk from exposure to this agent has been identified, it shall be eliminated or exposure avoided, as a priority, in the activity conception and design phases. For those risks which cannot be eliminated, a risk assessment shall be performed to determine the nature, degree and duration of workers exposure. The risk assessment will provide information about the preventive measures to be implemented to reduce exposure to a level as low as technically possible.

Occupational exposure to hazardous chemical agents via the dermal route can be determined using quantitative methods, which estimate the quantity of chemical agent to which workers are exposed by taking samples using different techniques, or by using qualitative methods that estimate this exposure by using hazardousness data of the chemical agent and its use. Semi-quantitative methods have also been developed that do not require measurements, such as DREAM (*Dermal Exposure Assessment Method*).

In these cases where the exposure cannot be assessed using measurement, since there is no benchmark, qualitative and semi-quantitative methods are particularly useful. For dermal exposure, various methods can be used, among which the following can be highlighted:

- Simplified chemical risk assessment methodology. Institut National de Recherche et de Sécurité (INRS). It assesses dermal exposure taking into account the exposed body surface area, the frequency of contact and the hazard of the agent.
- Guidance for risk assessment and risk management of occupational dermal exposure, developed in the EU project "Risk assessment of occupational dermal exposure" (RISKOFDERM). It has a toolkit in which the user answers questions about local and systemic hazard and the characteristics of the exposure.
- The Stoffenmanager® tool, developed by the Dutch authorities, makes it possible to assess exposure via the dermal route.
- Semi-quantitative DREAM (Dermal Exposure Assessment Method), which allows an initial exposure assessment to be made, strategies to be adopted if sampling is chosen and appropriate preventive measures to be taken in each case.

Further information about methodologies for dermal exposure assessment of chemical agents can be found in the Technical Notes on Prevention number: 895, 896 and 897.

Table 2
Main sampling techniques applicable to dermal exposure. Source: NTP 895.Dermal exposure to chemicals: measurement methods

Sampling technique	Sampling method
Skin replacement technique	Patches
	Full body
	Absorbent gloves
Pollutant removal technique	Hand washing
	Solvent cleaning
	Removal of the contaminant with adhesive tape
In situ recovery technique	Video image
	ATR – FTIR
	Light probe
	PXRF
Surface sampling technique	Vacuuming of surfaces, solvent cleaning, determination of detachable leaf residue, etc.

In the specific case of used engine oils, exposure depends to a large extent on whether or not good handling and personal hygiene practices are adopted, therefore attention must be paid to compliance with measures, as the assessment of the risk of exposure is highly dependent on the application of safe procedures as well as the correct selection and use of protective equipment.

Controlling exposure

Exposure prevention and control measures should be prioritised according to their effectiveness. The first option should always be substitution; where this is not possible, the possibility of working in a closed system should be explored; where this is also not possible, it should be ensured that the level of exposure of workers is reduced to as low a level as is technically possible, and finally, where the above measures are not sufficient, personal protective equipment (PPE) must be used.

1. Substitution

The priority measure, and mandatory whenever it is possible, when working with carcinogens or mutagens, is always substitution with another agent or process not dangerous or is less dangerous. This measure is the most difficult to implement, especially when a production process is already in place, and many variables must be taken into account, but it must be planned and implemented whenever feasible, even if it is more costly, and it is necessary to keep up to date with technological advances in each sector.

In this case the substitution of the agent is complex as it is not the original product, engine oils, that is carcinogenic, but the carcinogenicity appears after use in internal combustion engines. Some studies have suggested that engines using biodiesel as a fuel have a much lower PAH content at the end of their useful life (Peacock et al., 2010). However, this fuel presents other, mainly environmental problems, related to the use of the land used to produce it.

2. Closed system

It consists of preventing the dispersion of the agent into the air where the worker is located by placing the process within a closed system with air evacuation, and a system of the treatment and evacuation to a safe environment to prevent the agents from harming the environment or public health.

For the most common engine maintenance tasks, the option of the closed system is impractical as manual intervention by the person performing the tasks is required. However, funnel systems can be used to collect oil residues from a location in close proximity to the outlet, preventing splashing onto skin, eyes, clothing or nearby surfaces. Containers in which used oil is collected must also be designed such that no leakage or splashing can occur.

Prioritisation of preventive measures for carcinogens:

1. Substitution
2. Closed system
3. Reduction of exposure to as low a level as is technically possible.
4. Personal protective equipment

Resources for substitution:

More practical experiences of risk substitution or elimination can be found in the following links:

- Solutions, examples of substitution and good practice for carcinogens, from the Roadmap on carcinogens initiative.
https://roadmaponcarcinogens.eu/solutions/good-practices/

- SUBSPORT Substitution Support Portal.
https://www.subsportplus.eu/

- OECD Substitution Toolkit Portal.
http://www.oecdsaatoolbox.org/

- INRS Substitution Fact Sheets.
http://www.inrs.fr/actualites/nouvelles-far-fas.html

Used engine oils used in industrial processes, provided they have not been pre-treated to reduce their PAH content, should be used in closed systems to avoid contact with the workers.

3. Reduction of exposure to as low a level as is technically possible.

The aim is to implement technical and organizational measures such that exposure is reduced as much as possible according to the state of the art.

Royal Decree 665/1997 establishes the obligation to adopt all necessary measures as set out in article 5.5. In general, these requirements are in line with the requirements of Royal Decree 374/2001 on the protection of the health and safety of workers from the risks related to chemical agents at work.

Premises at which used engine oils are treated for subsequent use as a base for new oils or in other recycling or recovery processes for these wastes must be designed and have processes in place to avoid contact of the agent with workers and surfaces in order to prevent indirect contamination.

If there is a possibility of mist or droplet generation, systems should be provided to collect and extract the mist at source and prevent it from being dispersed into the working environment. It should be recalled that the use of closed systems is a priority for this measure.

Since this is an agent where dermal exposure is important, implementing and supervising safe handling procedures, both for the compound itself and for the impregnated parts, soiled absorbent rags or papers and containers holding the residues, is of particular importance. Among other aspects, the following should be considered:

- Persons working with used engine oils should avoid any direct contact with the oil.
- Implementing decontamination protocols so that, in the event of accidental staining of work clothes with used oil, they are removed immediately and any soiled skin is washed with soap and water. The clothing that is worn makes the surface area of skin that can be exposed very large, thus considerably increasing the exposure.
- Time plays an important role in this case. Experimental studies have shown that the risk decreases considerably when the oil used is washed out within one hour from the time of contact (Drexelius et al., 1999).

Royal Decree 679/2006 of 2 June 2006 regulates the management of used industrial oils and sets out measures to prevent the environmental impact of industrial oils and to reduce their production after use or, at least, to facilitate their recovery.

What is done with used oil?

Once recovered, the oil is analyzed and, depending on its properties, it is then processed in one of the following ways:

Regeneration: this consists of removing water and impurities to obtain a base and manufacture new lubricating oil. This is the preferred option.

- Energy recovery: decontamination for subsequent use as an industrial fuel to produce energy, instead of using fuels such as fuel oil.

- Recycling: used oil is used to produce other materials such as asphalt bitumen, which is then used for road surfacing, paints, inks, fertilisers, etc.

- Barrier creams are available that can be used to facilitate subsequent hand washing and to prevent absorption of the agent through the skin. However, they should not be used as the only measure, since they do not form a completely waterproof barrier.
- Avoid storing rags or absorbent paper soiled with used oil in pockets.
- Containers with the waste must be labelled and stored in appropriate places and have buckets or trays to collect any leaks.
- If a leak or spillage occurs on the ground, it must be collected immediately, using absorbent granular material, swept up and deposited in the waste store in a properly labelled and suitable container, awaiting management as hazardous waste.

4. Personal protective equipment

As a general rule in prevention, PPE should be used as a last resort, only when all priority prevention measures have been implemented and are not sufficient. However, in the case of used engine oils, as in any other case where a hazardous chemical agent is assigned the notation 'skin', the use of PPE to protect the skin that may be exposed to the agent is particularly important.

Whenever manual operations are to be performed where skin contact with used oil may occur, such as routine maintenance of vehicles when removing the sump cap, protective gloves and goggles must be worn, as a general rule, and depending on the specific techniques used and as determined by the risk assessment.

Gloves must be made of an agent-impermeable material such as vinyl or nitrile and cover the entire surface of the hand with the material. In principle, disposable gloves would be sufficient, although consideration should be given to whether other hazardous products are handled or if it is necessary to protect against other risks such as burns, cuts, punctures, etc.

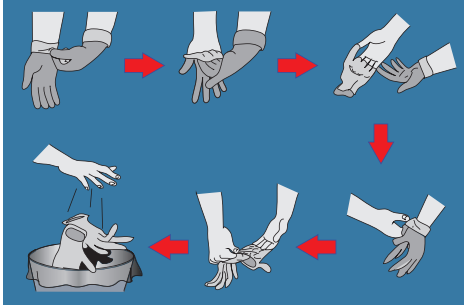
If gloves are single-use gloves, they must be disposed of each time the worker removes them. If the glove is reusable, it must be properly washed before removal, to avoid staining the hands on removal and subsequent re-application of the glove to contaminated skin, which would increase dermal exposure.

For maintenance work where the vehicle needs to be lifted to access the underside, goggles are required to protect workers' eyes from splashes. Face shields could also be used.

Personal hygiene measures for the use of gloves:

- Put them on clean, dry hands.
- Do not wear the same gloves for too long.
- Fold the edge of the cuff so that it can be removed without touching the skin of the arm.
- Clean gloves before reuse.
- Remove the gloves without touching the outside surface.
- Use protective cream after use of gloves.
- Before reuse (if reusable), allow them to dry inside.
- Reuse gloves only if there are no defects, cracks or tears.

More information at: Put in your hands the skin protection.



For all other activities where this agent is handled or where there is a risk of contact, the possibility that various parts of the body may be exposed through direct contact, indirect contact with soiled surfaces or through splashes should be considered and the results of this risk assessment shall determine what protective equipment or clothing needs to be put in place. Other risks that may coexist, such as the mechanical risk when handling parts impregnated with these oils, must also be considered.

Hygiene measures

Hygiene measures are of particular importance in the prevention of dermal exposure to used engine oils. These measures have several objectives:

- Prevent the agent from penetrating through the skin in case of accidental contact.
- Avoid the extent and duration of exposure by contact with soiled protective clothing or equipment.
- Avoid secondary exposure of others who may come into contact with soiled clothing or surfaces.

Article 6 of Royal Decree 665/1997 sets out the personal hygiene and personal protection measures to be taken by the company, including the following:

- Prohibit eating, drinking and smoking in risk areas.
- Provide protective or other appropriate clothing.
- Have separate storage places for working clothing and for street clothes.
- Have a designated place to store PPE and ensure that it is cleaned and checked for proper functioning.
- Provide appropriate and adequate washing and toilet facilities.

The same article states that workers identified as exposed must be allowed time for personal cleanliness, with a maximum of 10 minutes before lunch and a further 10 minutes before leaving work. In the case of workers exposed to used engine oils, it is known that the best protective measure is to wash the skin whenever there is contact with the oil, and to remove and replace clothing with clean clothing whenever it becomes soiled.

Regulatory references:

Royal Decree 1154/2020, amending Royal Decree 665/1997 on the protection of workers from the risks related to exposure to carcinogens at work, specifies that the time devoted to personal hygiene of workers identified as exposed, before lunch and before leaving work, may not accumulate or be used for other purposes.

The employer must also be responsible for washing and decontaminating work clothes, and it is forbidden for workers to take that clothing home for that purpose. If the clothing is sent to a specialised company for cleaning, it should be labelled such that the personnel of the company can identify the risk.

Penetration of chemical agents through the skin is highly dependent on the condition of the skin. If it is dehydrated, with cracks or other types of alterations, entry through this route will be more likely. Therefore, after hand washing, it is necessary to replenish the skin's protective layer by applying a suitable moisturiser.

Health surveillance

Cancer is generally characterised by long latency periods. Thus, Royal Decree 665/1997 establishes a right for workers who have been exposed to these agents to the extension of health surveillance beyond the end of the exposure or of the employment relationship.

In order for the health surveillance programme to be adjusted to the risks arising from the presence of chemical agents in the workplace, the employer must provide information about these risks to the basic health unit (BHU). In the absence of specific guidelines and action protocols, this USB, based on the risk assessment and the effects of used engine oils, will draw up a protocol and document the method and criteria used for the aforementioned health surveillance.

The protocol for specific health surveillance of occupational dermatoses, published by the Ministry of Health, contains a generic protocol, which must be adapted by the health professional responsible for health surveillance, depending on the results of the risk assessment and the characteristics and circumstances of the worker. It also includes guides by effect or disease, including cancer, which provide information about how to complete the generic protocol.

It is also recommended that workers frequently examine their skin and notify their supervisors and the medical service if they find eczema, warts or other changes that could indicate that the skin is not being adequately protected and that preventive and protective measures need to be reviewed.

Regulatory references

The table of occupational diseases, approved by Royal Decree 1299/2006, lists premalignant skin lesions and squamous cell carcinoma of the skin, caused by the action of polycyclic aromatic hydrocarbons (PAHs), mineral oils and residue products of these substances (among other carcinogenic agents), as occupational diseases. Activities listed in the table for these diseases include motor vehicle drivers, engine assemblers, mechanics (vehicle repair work), car park workers and work on combustion units (boilers), among other occupations that could be linked to exposure to used engine oils.

Other preventive measures

At works involving the risk of exposure to used engine oils, another series of measures set out in Royal Decree 665/1997 must be complied with concerning:

- Accidental and non-regular exposures (article 7).
- Obligation with regard to documentation (article 9).
- Information for the competent authorities (article 10).Consultation, information and training workers (articles 11 and 12).

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NIPO (en línea): 118-23-040-5