



## Laurent Jouanneau

Global Specialties Product Line Advisor,  
ExxonMobil

Mineral oils can be split between Lube Base Oils (LBOs), mainly used in the formulation of finished lubricants, and HRBOs, also called white mineral oils. Highly Refined Base Oils (HRBOs), are made of medicinal or pharmaceutical white oils, very pure products used in particular in pharmaceutical, cosmetics and food-contact applications, and of Technical white oils, that do not meet pharmacopeia purity level but can be used in food grade lubricants, rubber extender oils, textile oils, and petroleum jellies.

Paraffin waxes are made from mainly n-alkanes, long straight chains of saturated hydrocarbons, separated from mineral oils during the solvent dewaxing process. They are solid at ambient temperature, and vary in consistency from mostly brittle and hard to sometimes soft and plastic.

Mineral oils and wax originate from crude oils but typically account for less than 10% of total production in refineries. Crude oils are a complex matrix of naturally occurring hydrocarbons that can be mainly grouped in 3 families: paraffinics (alkanes), naphthenics (cyclo-alkanes), and aromatics. These various types of hydrocarbons have diverse and well-known performance characteristics and toxicological properties. Refining will select the desired molecules to set the final chemical composition (and properties) of the mineral oils:

- Distillation separates molecules by boiling range, and determines the boiling/carbon/molecular weight range of the final oil.
- Solvent extraction or hydrocracking or hydrogenation determines the total aromatics content and removes most of Polycyclic Aromatic Compounds (PACs) down to IP346<3%. It is a critical step to ensure mineral oils and wax are non-carcinogenic. It is key to remember that what is important for toxicological properties is the level of polyaromatic compounds, not the total amount of aromatic molecules.
- Solvent or iso-catalytic dewaxing removes or converts solid waxy hydrocarbons (n-paraffins and some isoparaffins) from mineral oil. Solvent Dewaxing also creates Wax as a co-product.
- Hydrocracking or moderate hydrotreatment or Acid Treatment removes most aromatics (to typically 0.5-5% level), and polyaromatics to below ppm level, and produces Technical White Oils.
- Severe hydrogenation or Acid Treatment removes nearly all remaining aromatics (to ~0.1% level), and brings polyaromatics to ppb level or below; It produces

# Manufacture of Mineral Oil and Wax - Composition and Specifications

## Medicinal/pharmaceutical White Oils

- After its creation by separation from the oil, slack wax can be further refined to ensure higher purity and allow use in more demanding applications
  1. Solvent deoiling produces paraffin wax and petrolatum with less than 1% remaining oil content
  2. Hydrogenation or clay treatment removes additional polyaromatic and polar Compounds, to reach purity level suitable for pharmaceutical, cosmetic, and food contact applications of food grade wax and microcrystalline wax.
- Petroleum jellies, also called vaselines, are a blend of paraffin wax, microcrystalline wax and mineral oil, that can go through a purification step depending on purity of raw materials, and on the application (e.g. food contact, pharmaceuticals).

A set of specifications has been developed to tightly control mineral oil composition, ensure performance in intended application, and absence of Health and Safety concern. These specification tests are simple and quick to be run on each production batch:

- Volatility or Flash point control adequate initial boiling point.
- Viscosity or GC distillation control carbon range and average molecular weight.
- Pour point or solid paraffin test ensure removal of solid n-paraffins.
- CaCpCn by ASTM D2140 or density or viscosity Index control right aromatic vs naphthenic vs paraffinic hydrocarbons balance.
- Aromatics % by ASTM D2007 or Aromatics ppm in White oil by direct UV test relate to remaining total aromatics content.
- PAC in mineral oils by IP 346 ensures products are not carcinogenic, and low level of PAC in white oil, wax and petroleum jelly is controlled by UV DMSO test.

Also, synthetic wax or oils can be obtained using the Fischer Tropsch process (also called "Gas To Liquids" process), plus a final purification step by hydrogenation for some food contact or cosmetic applications.

## In conclusion:

- Refining selects the molecules from the crude oil in a controlled manner to set the final chemical composition (and properties) of the mineral oil and wax
  - Removal of undesirable molecules obtained through various refining units
  - Product Specifications tightly control mineral oil and wax composition
    - to ensure performance in application and no safety concern for consumer
    - tests shall be simple and quick to be run on each production batch
- PACs are removed at desired level
  - Absence of carcinogenicity is controlled by IP346 <3.0% and known refining history
  - Mineral base oils: Total aromatics can be in the 0-50% range, but PAC % are only a very small part of these total Aromatic hydrocarbons.
- White mineral oils, wax and petroleum jellies: removal of PAC to level suitable for the application is controlled by UV-DMSO test.
- Total aromatics content (like could be measured by a so called "MOAH" test) is not a correct safety indicator.

