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Mineral oil – Origin, production and composition

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What is Mineral Oil?

	Wikipedia	IARC	Petroleum industry
Origin	non-vegetable (mineral)	prepared from naturally occurring crude petroleum oil	Obtained from crude oil
Production	a distillate of petroleum	Crude oil is distilled first at atmospheric pressure and then under high vacuum to yield vacuum distillates and residual fractions that can be further refined to mineral oils	The chemical composition is set by manufacturing processes to satisfy a range of performance, physical and toxicological properties
Apperance	colorless, odorless		
Hydrocarbon no range	15-30	>15	15-50
Boiling point range (°C)		300-600	
Molecular structures	mixtures of alkanes	complex and variable mixtures of straight and branched-chain paraffinic, naphthenic (cycloparaffinic), and aromatic hydrocarbons	Complex substances of hydrocarbon components; consists of alkanes (isoparaffincs), saturated cyclic alkanes (naphthenics), alkylated aromatics
Synonyms	imprecise, having been used to label many specific oils over the past few centuries. Other names, similarly imprecise, include white oil, liquid paraffin, and liquid petroleum. Baby oil refers to a perfumed mineral oil.	base oils, mineral base oils or lubricant base oils	Often considered as lubricant base oils or white oils

Mineral oil - definition

No clear definition

- **Petroleum industry:**
  - **The chemical composition is set by manufacturing processes to satisfy a range of performance, physical and toxicological properties**
  - **Obtained from crude oil**
  - **Complex substances of hydrocarbon components:**
    - **Consists of alkanes (isoparaffincs), saturated cyclic alkanes (naphthenics), alkylated aromatics**
    - **Carbon number ranging from C15 to C50**

Performance: Applications of mineral oils

- Fuel
- Heating
- Base oils
  - Electrical Industry: insulating medium for transformers
  - Lubricant Industry: main component
    - Metal working fluids
    - Lubricants and greases
  - Chemical Manufacturing Industry: component of a material and/or part of a process
    - Industrial Rubber
    - Adhesives
    - Printing Inks
  - Tyre Industry: fine-tune and adjust final performance properties of the tyre like rolling resistance and traction
  - Medicinal White Oils
  - Cosmetic applications
  - Pharmaceutical applications
  - Food applications

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Physical: Characterization of mineral oils

Charateristics	Diesel	Marine bunker fuel	Base oil
Cetane number	X	-	-
Ash	X	-	-
Viscosity	X	X	X
Hydrocarbon distribution	X	X	X
Colour	-	-	X
Sulfur	X	X	X
UV absorption	-	-	X
...			
...			

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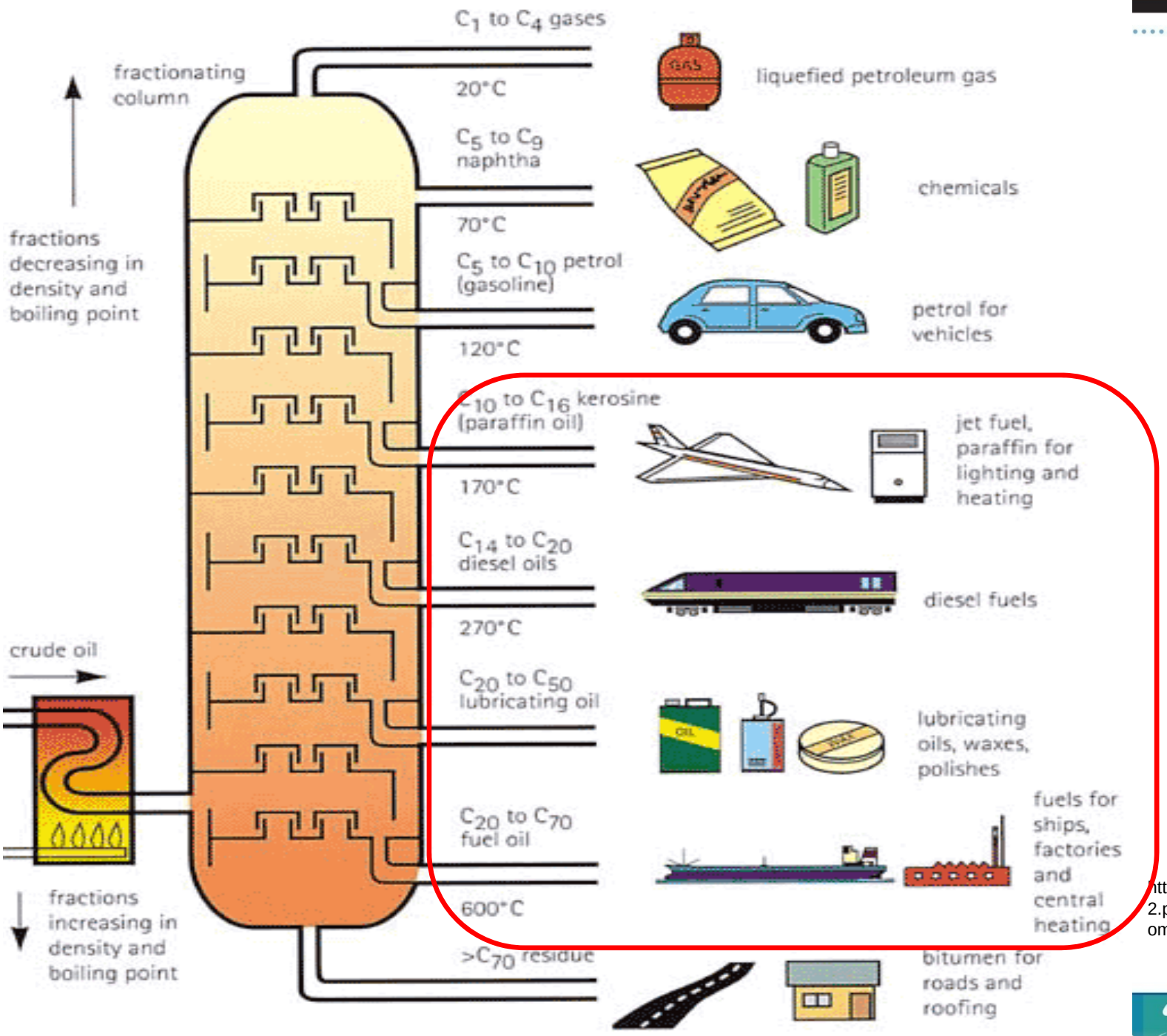
Refining - distillation



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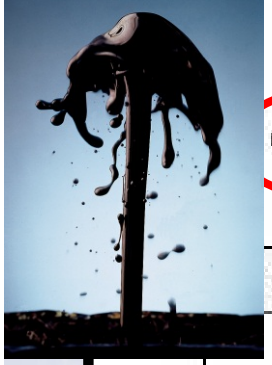

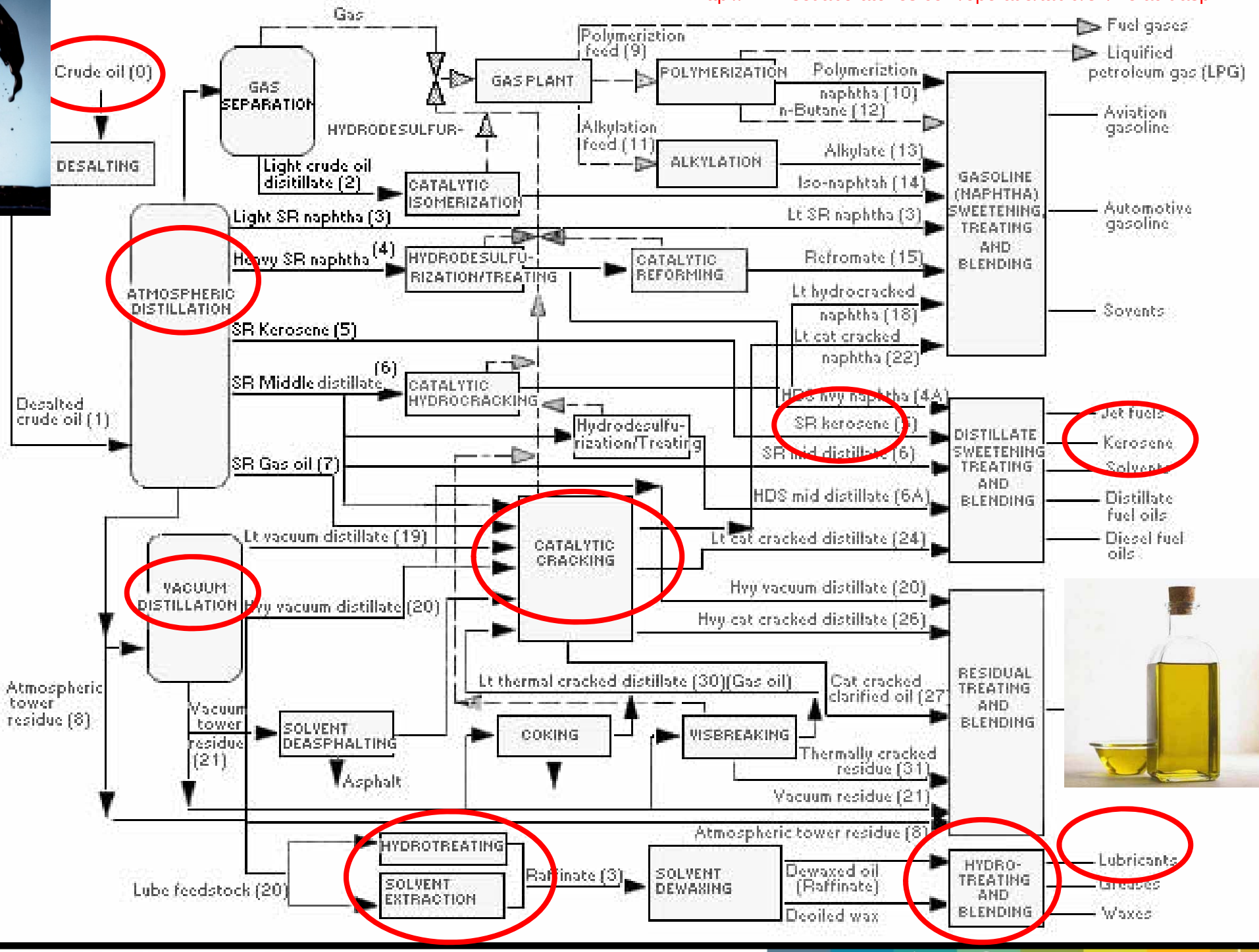

Refining – conversion: hydrotreatment

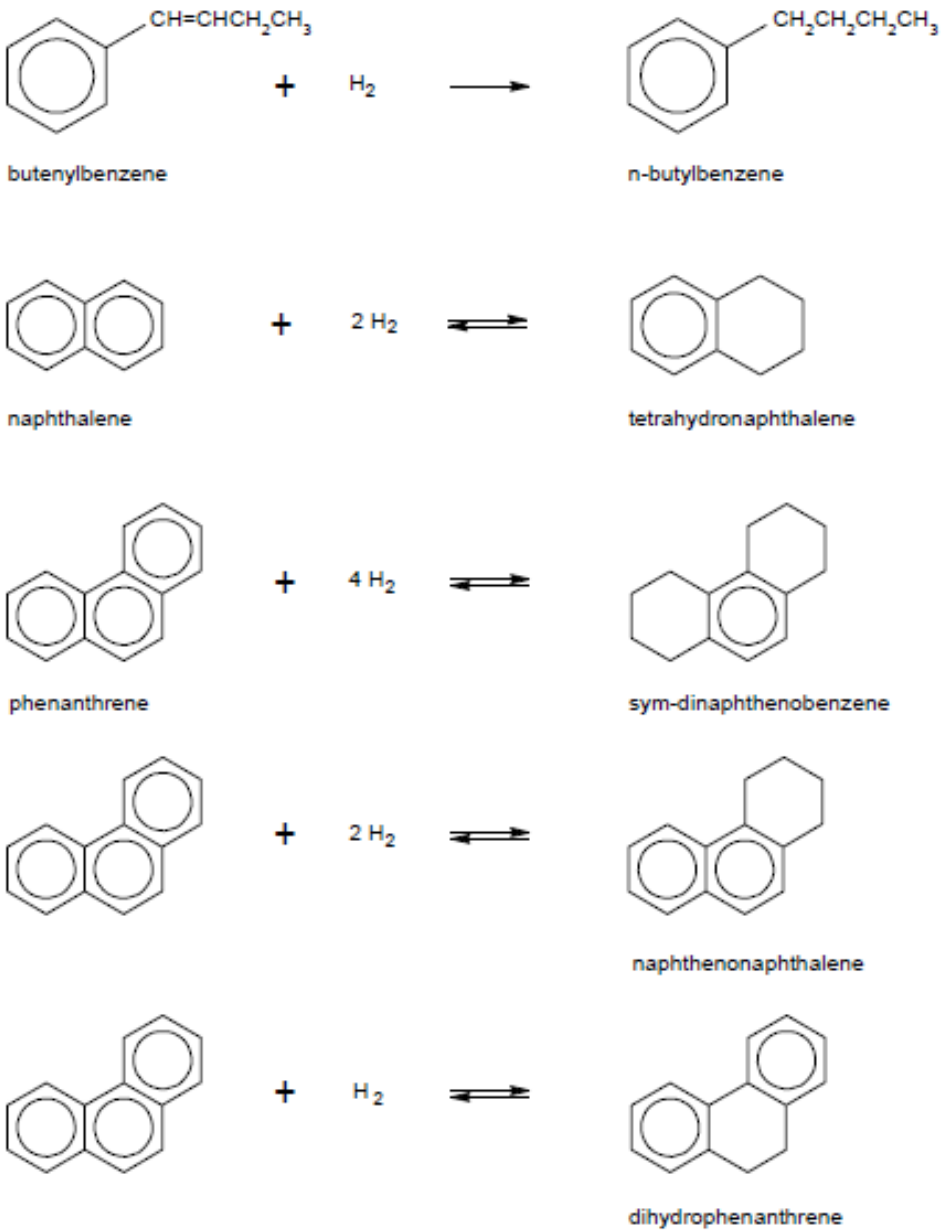

Figure 2. Saturation of butenylbenzene, naphthalene, and phenanthrene.

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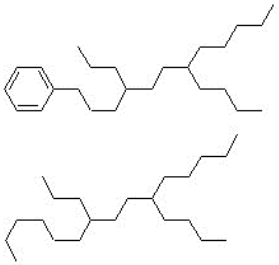
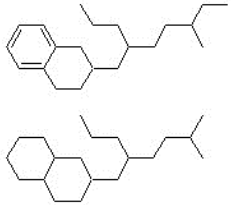
Mineral oil – molecular structure

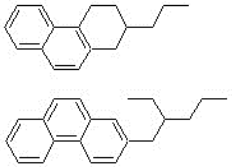
- Alkanes
  - (Iso)Paraffinic oils



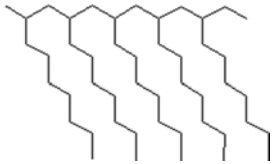
- Saturated cyclic alkanes
  - Naphthenic oils



- Alkylated aromatics
  - Aromatic oils



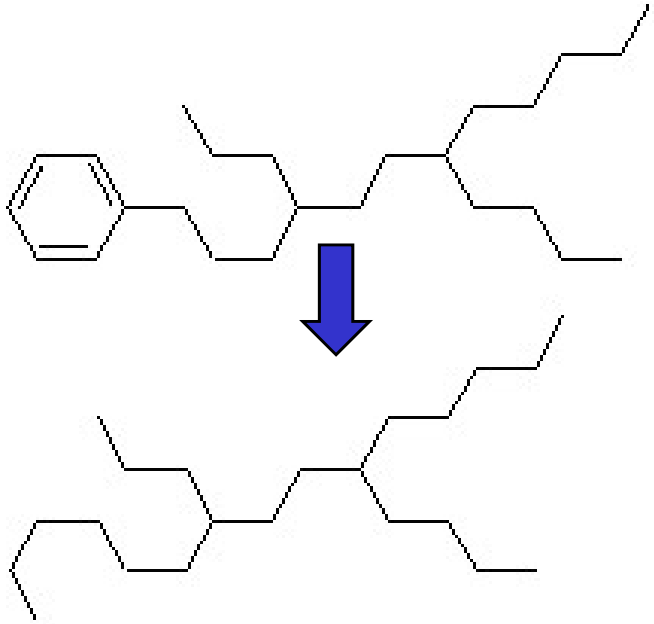
- (Poly Alfa Olefins (PAO))
  - Synthetic oils



Base oils

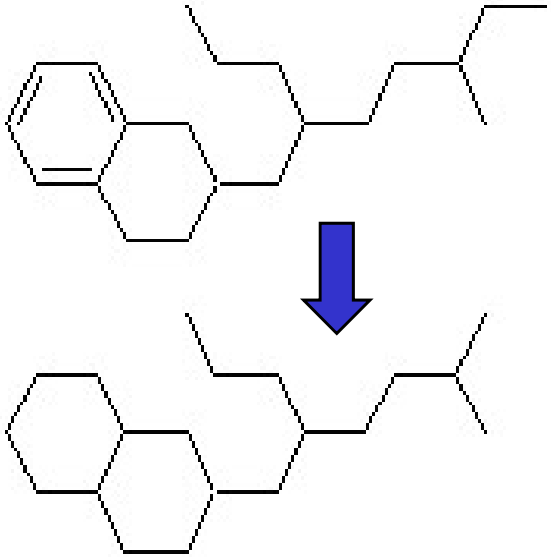
- **The more refined the less hazardous product**
- **From technical oil to medical white oil**

Typical paraffinic oil molecule



Paraffinic White Oil molecule

Typical naphthenic oil molecule



Naphthenic White Oil molecule

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Toxicological: Hazard characterization of base oils

- DMSO extraction, IP346
  - Analytical method to quantify extractable compounds in the mineral oil matrix by DMSO extraction
  - Correlated to carcinogenicity in vivo for mineral oils
  - Incorporated in current legislation on how to classify and label substances (CLP: 1272/2008) – to differentiate between carcinogenic and non-carcinogenic mineral oils
- Individual quantification of identified PAH
  - Chromatographic separation and quantification of individual PAHs

- Skin painting test
  - In vivo test to assess the development of skin cancer caused by dermal application to a population of mice
- Modified Ames Test, ASTM E 1687
  - In vitro test (hamster livers needed) to assess the mutagenic potential of the substance
  - Correlated to mutagenicity and indicator of carcinogenic potential of mineral oils

- The industry supply products that meet specifications
- Due to the number of petroleum products the industry have traditionally grouped the products and REACH allows for putting substances in categories:
  - 18 categories ranging from gasoline to bitumen
  - All data of these categories could be found in REACH dossier submitted in 2010.
  - The hazard of the category is always described as ”worst-case”, i.e. the most severe classification applies
    - *unless* some criteria could be met i.e. IP346 for base oils
- Rerefined / regenerated (from waste) products are ”excempt” from REACH since they should be the ”same” substance as the virgin product

Summary

- **Petroleum products**
  - originate from crude oil which is a complex combination of hydrocarbons extracted from the ground
  - composition is linked to refinery history
  - are refined to meet specification
  - are put in 18 categories, from gasoline to bitumen
- **Mineral oils**
  - have numerous definitions
  - are substances and by nature also complex being derived from crude oil
  - include many petroleum products and applications including fuel and medicinal white oils
  - can range be less refined (only straight-run) to highly refined (severely hydro-treated)
  - composition and toxicity depend on the refining history
- **Base oils are categorised as Lubricant Base Oils and Highly Refined Base oil**
  - **Toxicity is linked to degree of refining**