ADDITIVES as seen previously

Active
- Anti-Wear
- Extreme Pressure Additive
- Friction Modifier
- Detergent
- Oxidation Inhibitor
- Corrosion Inhibitor
- Dispersant

Inactive
- Pour Point Depressant
- Tackifier Component
- Viscosity Modifier
- (De)Emulsifiers
- Biocide
- Foam Inhibitor
- Solubiliser
- Component
- Friction Modifier
ADDITIVES grouping by Rudnick

 Deposit Control Additives
- Oxidation Inhibitor
- Detergent
- Dispersant

 Film Forming Additives
- Friction Modifier

 AW/EP Additives
- Anti-Wear
- EP Additive

 Viscosity control Additives
- Pour Point Depressant
- Viscosity Modifier

 Misc. Additives
- Foam Inhibitor
- Biocide
- Corrosion Inhibitor
- Tackifier
- (De) Emulsifiers
- Solubiliser
## ADDITIVES OF LUBRICANTS (examples)

<table>
<thead>
<tr>
<th>Active substances</th>
<th>Area of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkyl-phenols, BHT</td>
<td>Automotive and ind. oils</td>
</tr>
<tr>
<td>Amines</td>
<td>Metalworking fluids</td>
</tr>
<tr>
<td>ZDDP</td>
<td></td>
</tr>
<tr>
<td>Overbased sulphonates</td>
<td>Engine oils</td>
</tr>
<tr>
<td></td>
<td>Compressor oils</td>
</tr>
<tr>
<td></td>
<td>Metalworking fluids</td>
</tr>
<tr>
<td>Polyalkyl succinimides</td>
<td>Engine oils and transmission fluids</td>
</tr>
<tr>
<td>Graphite, MoS$_2$</td>
<td>Greases</td>
</tr>
<tr>
<td>Esters, amides</td>
<td>Gear oils</td>
</tr>
<tr>
<td></td>
<td>Metalworking fluids</td>
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<td>ZDDP</td>
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<td></td>
<td>Metalworking fluids</td>
</tr>
<tr>
<td>Polysulphides</td>
<td>Greases</td>
</tr>
<tr>
<td>Dithiocarbamates</td>
<td>Gear oils</td>
</tr>
<tr>
<td></td>
<td>Metalworking fluids</td>
</tr>
<tr>
<td>Iso-alcohols</td>
<td>Metalworking fluids</td>
</tr>
</tbody>
</table>
## Additives of Lubricants (Examples)

<table>
<thead>
<tr>
<th>Active Substances</th>
<th>Area of LUB Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMA, Polymethacrylates</td>
<td>Automotive and Industrial Oils</td>
</tr>
<tr>
<td>PAMA</td>
<td></td>
</tr>
<tr>
<td>OCP, Olefin Copolymers</td>
<td>Engine Oils</td>
</tr>
<tr>
<td>Styrene-Based</td>
<td>Engine Oils</td>
</tr>
<tr>
<td>Organomodified Siloxanes</td>
<td>Engine Oils, Hydraulic Oils, Circulation Oils, Metalworking Fluids</td>
</tr>
<tr>
<td>Hydroxyethyl-triazine Formaldehyde-condensates</td>
<td>Metalworking Fluids</td>
</tr>
<tr>
<td>Alkylamines, Borates (Fe)</td>
<td>Metalworking Fluids</td>
</tr>
<tr>
<td>Benzotriazole (Cu)</td>
<td>Metalworking Fluids</td>
</tr>
<tr>
<td>Nitrates, Nitrites (Al)</td>
<td>Metalworking Fluids</td>
</tr>
<tr>
<td>PIB</td>
<td>Greases, Slideway Oils</td>
</tr>
<tr>
<td>Etoxylated Alcohols</td>
<td>Metalworking Fluids</td>
</tr>
<tr>
<td>Alkyl Succinic Acid Derivatives</td>
<td>Metalworking Fluids</td>
</tr>
<tr>
<td>Alkyl-Benzene</td>
<td>Hydraulic Oil, Circulation Oils</td>
</tr>
</tbody>
</table>

**Pour Point Depressant**

**Viscosity Modifier**

**Foam Inhibitor**

**Biocide**

**Corrosion Inhibitor**

**Tackifier**

**Emulsifiers**

**Demulsifiers**

**Dehumidifiers**
NATURE OF ADDITIVES: anti-oxidant single effect utilized in multiple industries

INDUSTRY
- Lubricants
- Plastics
- Food
- Cosmetics

EFFECT / FUNCTION
- Oxidation Inhibitor
- Radical scavenger

CHEMICAL STRUCTURE
- 2,6-di-tert-butyl-4-methylphenol a.k.a. BHT (butylated hydroxytoluene)
NATURE OF ADDITIVES: AW additive multiple effects targeting a single industry

INDUSTRY

Lubricants

EFFECT / FUNCTION

Oxidation Inhibitor
Anti-Wear
EP Additive
Corrosion Inhibitor

Radical scavenger
Surface absorption of thermal degradation products

CHEMICAL STRUCTURE

ZDDP
Dimer, trimer, tetramer, etc.
More on FM/EP/AW additives

Lubricating regimes

**Boundary**
- Surfaces in contact
- Chemistry-dependent

**Mixed**
- Partial fluid film
- Chemistry and viscosity-dependent

**Hydrodynamic / elastohydrodyn.**
- Full fluid film
- Viscosity-dependent
- No wear

Source: Lubrizol
ADDITIVE ASSETS OF MOL-LUB

- Lubricating grease and additive plant
  - Grease plant
  - Additive plant
    - Pilot plant
      - Dithiocarbamate plant
    - Succinimide plant
      - Mono- and bissuccinimides
    - Polysuccinimide plant
    - Surfactant plant
      - Surfactants
    - RALOX plant
      - ALIP system
      - RALOX system
GROUP OF MOLECULES: BACK TO CHEMISTRY

- Dithiocarbamate (Szhb plant)
  - Oxidation Inhibitor
  - Anti-Wear
  - EP Additive
  - Corrosion Inhibitor

- Polyalkyl-Succinimides
  - Dispersant
  - Viscosity Modifier

- Vegetable oil amide surfactant
  - Emulsifiers

- Aluminum-oxo-stearate
  - Grease thickener
EP/AW: DITHIOCARbamate production
at pilot plant szazhalombatta

CS2-based synthesis (toxic ingredients)

Dibutylamine + Carbon disulphide + Dichloromethane → Methylene-bis(dibutyl-dithiocarbamate)

+ water + NaCl

Intermedier: N-subst. dithiocarbamic acid sodium salt

Ashless multifunctional additive

EP/AW
Antioxidant
Corrosion inhibitor
DISPERSANTS: SUCCINIMIDE PRODUCTION
FOR SITE VISIT: SUCCINIMIDE AND POLYSUCCINIMIDE PLANT

THERMAL TECHNOLOGY (DISPERSANT ONLY):

**Maleic-acid-anhydride + Poly-iso-butylene → Polyisobuteryl-succinic anhydride**

\[
\text{CH}_2\text{C} = \text{CH}_2 + \text{CH}_3\text{CH} = \text{C} = \text{CH}_2 \rightarrow \text{CH}_2\text{C} = \text{CH}_2 = \text{CH}_2 \text{CH} = \text{CH}_2
\]

- Maleinsavanhid \( M_{\text{MSA}}=98 \)
- Poli(izo-butilén) \( M_{\text{PIB}}=950 \)
- Poliizobutenil-borostánkősavanhidrid \( M_{\text{PIBBA}}=1048 \)

**Acylation:**

\[
\text{PIBSA} + \text{polyamines} \rightarrow \text{mono- or bissuccinimide + water}
\]

\[
\text{PIBBA} + \text{H}_2\text{N} - \left(\text{C}_2\text{H}_4 - \text{NH}\right)_4\text{H} \rightarrow \\
\text{CH}_3\text{CH} = \text{C} = \text{CH}_2\text{CH} = \text{CH}_2\text{CH} = \text{CH}_2\text{CH} = \text{CH}_2
\]

- PIBBA \( M_{\text{PIBBA}}=1048 \)
- Tetraetilén-pentamin \( M_{\text{TEPA}}=189 \)
- mono-szukcinimid \( M_{\text{mono}}=1219 \)
- Víz \( M_{\text{víz}}=18 \)

}\end{document}
SOLVENT TECHNOLOGY

- Catalytic addition (PIB + MSA + DTBP (cat.) + Xylene)
- Vacuum solvent release
- Dilution, filtration
- Acylation

\[
\text{ahl: } U = -CH_2-CH_2-(NH-CH_2-CH_2-)_x \\
x \geq 0 \\
m, n, p, q > 1
\]

**Polysuccinimide**

\text{poliszukcinimid}
**Surfactant mixture additive**

- **Field of application:** Enhanced Oil Recovery together with a polymer (macroemulsion)

- **Non-ionic component:** vegetable oil amide

- **Anionic component:** (proprietary patented by Pannon Univ.)
**SPECIAL ADDITIVES: GREASE THICKENER**

For site visit: RaloX Plant

- Greases can be classified based on their thickeners as well (Li, LiX, CaS, CasX, AlX, polymer, etc.)

- Aluminum-complex grease thickener manufacturing
  - Grease precursor (intermedier)
  - Two stage process:
    - Al-isopropoxide (ALIP)
    - Al-oxo-stearate
  - Complex formation is finalized during grease manufacturing with benzoic acid

- Marketable product as an intermedier for grease manufacturers (35% market share in EU)
THE FUTURE OF ADDITIVES

Additives are vital components for modern lubricants

Additive development is applied science and chemistry:
  - Application focused
  - Experiment-based
  - …with dead-ends

MOL- LUB places strong focus on its additive product portfolio development according to its Strategy 2030
BACKUP Technology
SUCCINIMIDE-TYPE OF ADDITIVES

SUCCINIMIDE AND POLYSUCCINIMIDE PLANT

🔥 THERMAL TECHNOLOGY:

- Diluting oil
- MSA
- PIB
- Reaction
- MSA
- Dilution, Filtration
- Acylation
- Filtration agents
- Vacuum
- Amines
- Szukcinimid
SUCCINIMIDE-TYPE OF ADDITIVES

SUCCINIMIDE AND POLYSUCCINIMIDE PLANT

SOLVENT TECHNOLOGY

- Catalytic addition (PIB + MSA + DTBP + Xylene)
- Vacuum solvent release
- Dilution, filtration
- Acylation

\[
\text{Polysuccinimide: } U \equiv CH_2-CH_2-(NH-CH_2-CH_2-x \geq 0 \\
m, n, p, q \geq 1}
\]
PRODUCTION OF LUBRICATING GREASE THICKENER
RALOX PLANT

ALIP PRODUCTION SYSTEM
PRODUCTION OF LUBRICATING GREASE THICKENER
RALOX PLANT

❤️ RALOX PRODUCTION SYSTEM