Cooling lubricants
About us…

ZET-CHEMIE GmbH
Established: 1989
CEO: Jürgen Zimmerhackl
Office: Heisenbergstraße 3 und 7
Employees: 25
Production and sale: 8.000.000 liter
Product range:
- Lubricants for metal working
- Corrosion protection fluids
- Industrial lubricants
- Cleaners
- Greases

*But we do not just sell, we …*
About us…

… make the service around the product in our own laboratory.

- RFA
- IR
- Rancimat
- Salt spray test
- Microtap
- Particle counter
About us…

… we transport the ordered goods to you, we take back the empties and we also supply bulk products.

- Own truck fleet
  3 trucks with EURO V standard
- Shipment with shipping companies
- Parcel service
About us…

… we dispose by waste codes and offer you a complete fluid management.

Disposal according to the European Waste Catalogue:
No: 12 01 09  halogenfree machining emulsions and -solutions
No: 13 02 05  non-chlorinated machine, gear and lubricating oils based on mineral oil
No: 14 06 03  solvents and solvent mixtures

For more information visit www.zet-chemie.de/en/
An important element in the process of machining

- Classification
- Requirements
- Structure
- Maintenance and monitoring
## Classification of lubricants

<table>
<thead>
<tr>
<th>Water Miscible</th>
<th>Non Water-Miscible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emulsifiable based on</td>
<td>Based on</td>
</tr>
<tr>
<td>- mineral oil</td>
<td>- mineral oils</td>
</tr>
<tr>
<td>- ester</td>
<td>- synthetic oils</td>
</tr>
</tbody>
</table>

- Emulsions
- Water soluble based on
  - glykols
- Solution
- Cutting oils, grinding oils, honing oils, deep-drawing oils, punching oils, broaching oils, lapping oils
Emulsions

… are finely dispersed oil droplets in water. The oil droplets remain stable in water with the help of an emulsifier.

The emulsifier has an oil-loving and an water-loving part and thus keeps the oil droplets finely dispersed in the water.
Other components of an emulsion

- oil
- emulsifiers
- bactericide
- fungicide
- defoamers
- corrosion protection
- wear protection
- EP additives
- inhibitors

A ready-mixed emulsion in the machine consists of:

approx. 90 – 95 % water (main ingredient)
5 – 10 % emulsion concentrate
Water-miscible *cooling* – *lubricant*

<table>
<thead>
<tr>
<th></th>
<th>cooling</th>
<th>lubricant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water cools</td>
<td></td>
<td>Oil and EP lubricates</td>
</tr>
<tr>
<td>content</td>
<td>90 – 95 %</td>
<td>5 – 10 %</td>
</tr>
<tr>
<td>specific heat capacity</td>
<td>4,2 c</td>
<td>1,8 c</td>
</tr>
<tr>
<td>thermal conductivity</td>
<td>0,6 k</td>
<td>0,1 k</td>
</tr>
</tbody>
</table>
Requirements für modern water-miscible cooling lubricants

- easy machining of the workpiece
- easy miscibility
- positive medical and toxic properties
- compliance with standard requirements and laws
- material compatibility with machine parts
- good corrosion protection
- less of foam
- good residue behavior
- storage stable
Various product requirements result in a variety of product types.

There are 3 basic types:

1. boric and amine-containing 70 % market share
2. boron-free and amine-free 20 % market share
3. boron-free and amine-containing 10 % market share

Each type has its authorization.

All types have advantages and disadvantages.

THE perfect cooling lubricant is not yet developed!
1. Type boric and amine-containing

**Advantages:**
- biostable
- pH-stable
- good corrosion protection
- good for single filled machines
- requires little maintenance
- long emulsion life
- bactericides are often not necessary (especially useful when grinding with high aerosol formation)
- low foaming

**Disadvantages:**
- In rare cases, the pH-value may cause skin problems
- degreasing can cause problems in CHC / HC systems
- since June 2015 in the material safety data sheet under section 3 the classification H360FD

H360FD – May damage fertility. May damage the unborn child
2. Type boron- and amine-free

**Advantages:**
- low pH-value
- kind to the skin
- good at critical aluminium and non-ferrous metal alloys
- light degreasing
- good flushing properties
- free of bactericides

**Disadvantages:**
- less low foaming
- not very biostable, light bacterial contamination possible
- more monitoring is necessary
- more maintenance effort
- worse corrosion protection
- formation of residues
- phenolic compound as biostat *(Bosch Listed)*
- problems with nitrite and nitrosamine
3. Type boron-free and amine-containing

<table>
<thead>
<tr>
<th>Advantages:</th>
<th>Disadvantages:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• more pH-stable than boron- and amine-free</td>
<td></td>
</tr>
<tr>
<td>• less foam than boron- and amine-free</td>
<td></td>
</tr>
<tr>
<td>• light degreasing</td>
<td></td>
</tr>
<tr>
<td>• inexpensive</td>
<td>• always with bactericide</td>
</tr>
<tr>
<td></td>
<td>• pH-value drops faster than a boric cooling lubricant</td>
</tr>
<tr>
<td></td>
<td>• not as biostable as a boron-containing cooling lubricant</td>
</tr>
</tbody>
</table>
A solution is a homogeneous mixture consisting of two or more substances. The base is a glycol, a water-soluble oil.

**Advantages:**
- very biostable
- excellent thermal conductivity
- rapid separation of tramp oil.

**Disadvantages:**
- poor corrosion protection
- possibility of water soluble sticky residues

The main application is grinding
Based on these 3 basic tapes, each manufacturer produces various products of these types. Every single type varies in its group with different characteristics. ZET-CHEMIE examples:

<table>
<thead>
<tr>
<th>1. boric and amine-containing</th>
<th>2. boron- and amine-free</th>
<th>3. boron-free – amine-containing</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZET-cut 8404</td>
<td>ZET-cut 4100</td>
<td>ZET-cut 9700</td>
</tr>
<tr>
<td>universal</td>
<td>kind to the skin</td>
<td>universal for all</td>
</tr>
<tr>
<td>low of foam</td>
<td>bactericidal free</td>
<td>materials.</td>
</tr>
<tr>
<td>47 % mineral oil</td>
<td>low of odor</td>
<td>pH stable</td>
</tr>
<tr>
<td>ZET-cut 1310</td>
<td>45 % mineral oil</td>
<td>40 % mineral oil</td>
</tr>
<tr>
<td>universal</td>
<td>ZET-cut 4108</td>
<td></td>
</tr>
<tr>
<td>low priced</td>
<td>kind to the skin</td>
<td></td>
</tr>
<tr>
<td>45 % mineral oil</td>
<td>especially for</td>
<td></td>
</tr>
<tr>
<td>ZET-cut 8950</td>
<td>non-ferrous metal</td>
<td>ZET-cut 9100</td>
</tr>
<tr>
<td>aluminium machining</td>
<td>50 % mineral oil</td>
<td>for aluminium, steel</td>
</tr>
<tr>
<td>much EP</td>
<td></td>
<td>and cast</td>
</tr>
<tr>
<td>50 % mineral oil</td>
<td>ZET-cut 9008+</td>
<td>much EP</td>
</tr>
<tr>
<td>ZET-cut 3770</td>
<td>low of foam</td>
<td>ZET-cut 9008+</td>
</tr>
<tr>
<td>low of foam</td>
<td>good for grinding</td>
<td>for non-ferrous metal</td>
</tr>
<tr>
<td>0 % mineral oil</td>
<td></td>
<td>65 % mineral oil</td>
</tr>
</tbody>
</table>
Mix with water

Quality characteristics of the mixing water:
• water should have drinking water quality
• pH-value approx. 7
• electrical conductivity up to 1000 ys/m
• water hardness 10 –15 °dH
• low chloride and nitrate content, maximum 50mg/l

Mixing process:
• mix concentrate with therefor developed mixing equipment
• if no mixer is available, first submit the water
• then stir in the concentrate
Examination of the cooling lubricant by the user.

The client can detect 90% of all important parameters in 2 minutes:

- **daily concentration**: datasheet \(\pm 1\)
- **weekly pH-value**: 8,5 – 9,2
- **weekly nitrite content**: 20ppm

The TRGS 611 prescribes appropriate measurements and documentation.
Examination of the cooling lubricant in the laboratory

Every customer of ZET-CHEMIE has the possibility to send emulsion samples to our laboratory for examination for free:

- **bacteria**: maximum $10^4$
- **bactericide (formaldehyd content)**: 50 – 100 ppm
- **conductivity**: maximal 6000 yS/m
- **drain / foreign oil**: maximum 1 %
- **dissolved metals**: as little as possible, typical are copper/cobalt
- etc…
Measures and care

if concentration deviates → replenish water or concentrate
pH-value drops → add „ZET-PH plus“
bacteria → bactericide
fungi or yeasts → fungicide
foam → defoamers
solids → deposition by suitable filter
foreign or leak oil → run skimmer
nitrite value >20ppm → ask your cooling lubricant consultant

Parallel to all measures,
always look for the cause of the problem.
Bacterial infection during use can not be prevented!

The lower the pH-value, the more contamination, at too low concentration, the faster bacterial infections are formed.

This results:

**Odor**

**Material problems**

**Corrosion**

**Skin problems**

The main groups:

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Escherichia coli/ Pseudomonas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fungi</td>
<td>Fusarium / Penicillum</td>
</tr>
<tr>
<td>Yeast</td>
<td>Candida / Trichosporan</td>
</tr>
</tbody>
</table>

**pH-value**: is the measure of the alkalinity of aqueous cooling lubricants

- **pH < 7** sour e.g. pH 0-3 vinegar
- **pH = 7** neutral e.g. pH 4-6 beer, wine
- **pH > 7** alkaline e.g. pH 7 distilled water
e.g. pH 8-10 cooling lubricant, soap
e.g. pH 11-19 caustic soda
Changing of the water-miscible cooling lubricant

Should a change be required, it shall proceed according to the following instructions:

1. Fill machinery container as high as possible
2. Fill in 2 - 3% ZET-Systemreiniger and run it for at least 24 hours
3. Empty machine container completely.
4. (rinse with clear water and 2 - 3% ZET-Systemreiniger)
5. (rinse with clear water and ZET-Fungizid) and empty it after.
6. Refill the machine according to the instructions of the coolant.
What the future holds…

- Strong limitation of bactericides due to the authorization cost.
- Reduction of chemical substances due to REACH.
- Boric limit fixed at 5.5 %
- VSI – limit list e.g. phenoxyethanol, copper
Non-water-miscible cooling lubricants

Cutting oils
Grinding oils
Honing oils
Drawing oils
Punching oils
Lapping oils
Broaching oils
Bio oils
MQCL

The base of all is mostly a base oil having clearly predominant proportions. In this base oil then come aggregates which provide the required properties.
Structure of non-water-miscible cooling lubricants

**Base oil**
- **Mineral oil:** hydrocarbon compounds with different shape, structure and nature
- **Hydrocracking oils:** refined oils with higher purity and improved structure.
- **Polyalphaolefine:** synthesis products with straight hydrocarbon compounds
- **Ester oils:** vegetable or synthetic fatty oils

**Additive**
- **EP (extrem pressure):** fatty oils from 120°C
- **AW (anti wear):** (chlorinated paraffin) from 150°C
  - sulfurized products from about 300°C
  - (zinc)phosphate from about 700°C
  - calciumsulfonat physically
- **Other:**
  - defoamers
  - anti mist additives
  - non-ferrous metal inhibitors
  - antioxidants (aging additives)
Advantages and disadvantages of non-water-miscible colling lubricants. The user makes the decision by himself…

**Advantages:**
- better lubrication
- easy monitoring
- better machinery maintenance
- longer service life of the filling
- disposal costs low

**Disadvantages:**
- poorer cooling
- higher cost of initial filling
- more oil mist
- more pollution of the parts and thus increased cleaning efforts
Based on the different types of base oils the manufacturer produces different types of products by adding different additive packages. These product types vary in their group with different characteristics.

**Typical applications and features**

- **Cutting oils**: Viscosity approx. 10-40 mm²/s, simple to highly sophisticated oils depending on the material
- **Drawing oils**: Viscosity approx. 10 mm²/s, active + inactive sulfur, much lipid and phosphorus compounds
- **Gearing**: Viscosity approx. 20 mm²/s, active sulfur and phosphorus compounds
- **Broaching**: Viscosity 15-30 mm²/s, active sulfur and phosphorus compounds
- **Honing**: Viscosity 3-25 mm²/s, high fatty share
- **Grinding**: Viscosity 2-10 mm²/s, little fatty share, easily filtered, oil mist reduced
- **Thread grinding**: Viscosity 12-30 mm²/s, active and inactive sulfur and phosphorus compounds
- **Punching oil**: Viscosity 2-500 mm²/s, set fast or slow evaporating, fats, calcium sulfonats, active + inactive sulfur
- **MQCL**: mostly biodegradable products, fatty alcohols, ester oils
Types with different characteristics (ZET-CHEMIE examples):

1. Cutting oil
   - ZET-cut 611 universal, carbon steel, aluminium, non-ferrous metal
   - ZET-cut 620 powerful, steel
   - ZET-cut 630 very powerful, high-alloy and hard and tough steel

2. Drilling oil
   - ZET-cut 678 heavy greased, steel, unsuitable for non-ferrous metals

3. Gearing and broaching oil
   - ZET-cut 683 very high alloyed, for difficult to machine ferrous materials

4. Honing oil
   - ZET-cut 668 heavy greased, aluminium, non-ferrous metals
   - ZET-Hon 669 very fluid, for short and long stroke honing

5. Grinding oil
   - ZET-cut 643 thin grinding oil, good heat dissipation, oil mist reduced
   - ZET-cut 645DK special oil for grinding of carbide, steel, non-ferrous metals and aluminium

6. Punching oil
   - ZET-stanz 57/2 fast evaporating, for complicated stamping operations
   - ZET-stanz 57/4 fast evaporating, leaves a corrosion protection film

7. MQCL
   - ZET-cut 609 stabilized vegetable oils
   - ZET-cut 906/40 full synthetic cutting concentrate for reaming, threading and grooving
Testing of non-water-miscible cooling lubricant in the laboratory

Viscosity: \( \text{mm}^2/\text{s} \)

Density: \( \text{g/cm}^3 \)

Flashpoint: open cup °C

Evaporation: measurement in cup (after Noak)

Copper corrosion: strip with color evaluation

Reichert/Brugger: wear activity \( \text{N/mm}^2 \)

Microtap: pressure carrying capacity \( \text{N/mm}^2 \)

Solids: particle count as per DIN
Skin protection – skin care

Skin diseases are with about 16 percent the most common diseases in metalworking companies.

Healthy skin provides effective protection against damaging influences. A lack of fat makes the skin brittle and cracked; the barrier function decreases. Particularly harmful is the frequent contact with water, grease, oil and chemicals.

Skin Care is therefore an essential need and consists of hand cleaning – skin protection – skin care

What supervisors should know in order to avoid health hazards for employees!

BGI 658
Skin protection in metal companies
BGI 504-24
Skin diseases
BGR 143
Activities with cooling lubricants
BGR 195
Use of protective gloves
BGR 197
The use of skin protection
TRGS 401
Risks resulting from skin contact
Skin care yes, but how?

Proper application

- Give skin protection and skin care to the cleaned and well dried hands and skin parts.

Procedure:

- Apply a small amount on the back of one hand (approx hazelnut size)
- Distribute as evenly as possible with the back of both hands
- Then rub between fingers, nail folds and fingertips carefully
- Massage the remaining rest with wash movements into the skin.
### Hautschutzplan für metallbearbeitende Betriebe

<table>
<thead>
<tr>
<th>Skin problems</th>
<th>Skin protection</th>
<th>Skin cleansing</th>
<th>Skin care</th>
</tr>
</thead>
<tbody>
<tr>
<td>by aqueous agents e.g.</td>
<td>Before work and after each break.</td>
<td>Before each break and at the end of work, in-between only when visibly soiled. [1]</td>
<td>At the end of the work, in-between only as needed (e.g. extreme dry skin)</td>
</tr>
<tr>
<td>- coolants</td>
<td>Pre wa sens ZET-CHEMIE Art.-No 3390</td>
<td>ZET-FIX ZET-CHEMIE Art.-No 3422</td>
<td>Apre sens ZET-CHEMIE Art.-No 3392</td>
</tr>
<tr>
<td>- water-miscible oils</td>
<td>Application: rub in</td>
<td>Application: rub in, rinse, dry</td>
<td>Application: rub in</td>
</tr>
<tr>
<td>- acids</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- alkalis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>by not-water miscible agents e.g.</td>
<td>Before work and after each break.</td>
<td>Before each break and at the end of work, in-between only when visibly soiled. [1]</td>
<td>At the end of the work, in-between only as needed (e.g. extreme dry skin)</td>
</tr>
<tr>
<td>- mineral oils</td>
<td>Pre ol sens ZET-CHEMIE Art.-No 3391</td>
<td>ZET-FIX ZET-CHEMIE Art.-No 3422</td>
<td>Apre sens ZET-CHEMIE Art.-No 3392</td>
</tr>
<tr>
<td>- metal processing oils</td>
<td>Application: rub in</td>
<td>Application: rub in, rinse, dry</td>
<td>Application: rub in</td>
</tr>
<tr>
<td>- fat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- cold cleaners</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- benzene</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- hydrochlorofluorocarbons</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>through strong skin-adhesive agents e.g.</td>
<td>Before work and after each break.</td>
<td>Before each break and at the end of work, in-between only when visibly soiled. [1]</td>
<td>At the end of the work, in-between only as needed (e.g. extreme dry skin)</td>
</tr>
<tr>
<td>- waste oil</td>
<td>Pre ol sens ZET-CHEMIE Art.-No 3391</td>
<td>ZET-FIX ZET-CHEMIE Art.-No 3422</td>
<td>Apre sens ZET-CHEMIE Art.-No 3392</td>
</tr>
<tr>
<td>- graphite</td>
<td>Application: rub in</td>
<td>Application: rub in, rinse, dry</td>
<td>Application: rub in</td>
</tr>
<tr>
<td>- metal dust</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[1] Note: frequent hand washing will damage the acid mantle of the skin. It should only take place if this is necessary or required (e.g. in cases of obvious contamination, before breaks and after completion of work). Dry hands thoroughly after washing.

ZET-CHEMIE GmbH - Heisenbergstraße 3 - 89584 Ehingen - Telefon 07391/7008-30 - www.zet-chemie.de

Stand 07.2015

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Any questions?
Please contact us!

Thank you for your attention!