

Application Note

Continuous monitoring of oil content in rolling and cutting oil

Aim of the measurement

Rolling oil: Oil used in hot- and cold-rolling of ferrous and non-ferrous metals to facilitate feed of the metal between the work rolls, improve the plastic deformation of the metal, conduct heat from the metal, and extend the life of the work rolls.

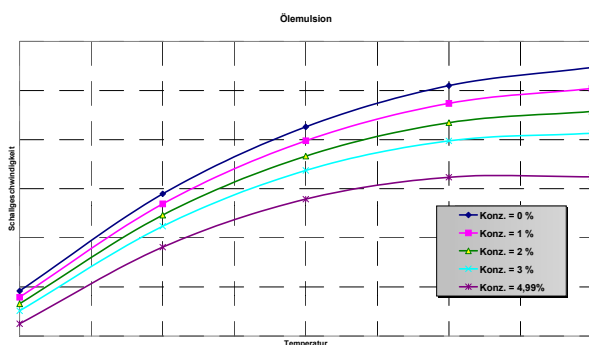
Oil content of the rolling oil emulsions typically ranges from 1.5 to 3% (other ranges 0.4 to 1%, and 7 to 15%) and has to be kept within tight limits ($\pm 0.1\%$ to 1%, depending on range). In addition to mineral or synthetic oils, the fluids contain emulsifiers.

Oil concentrations above target result in increased costs for purchasing and for removal of excess oil. Even carbonization of the surface may occur, resulting in reject product.

Oil concentrations below target cause poor surface quality, damaged surface and eventually also reject product.

Measuring method

The oil content directly relates to the sound velocity of the fluid. A change of 1% oil content brings about an increase of approx. 2 m/s. Examples of typical concentration/temperature



characteristics are shown in Fig. 1.

Fig. 1 Typical sound velocity curves for rolling oil emulsions of different concentrations at different temperatures

The measurement is done with a **sound velocity sensor SPR 4115** (fig. 2), connected to the **process control unit mPDS 2000V3**.

The oil concentration directly correlates with the sound velocity, concentration and temperature are continuously displayed on the screen of the process control unit.

Up to 255 different characteristics of oil emulsions can be stored in the processor of the control unit, each with its own target concentration and limit range.

A pressure measurement and compensation should be performed in case of large pressure fluctuations, as the sound velocity of the emulsions is influenced by pressure (compressibility of oil). Typical values for pressure influence: 0.15 m/s per bar.

Additional sources of uncertainty:

- formation of coating on the sensor
- abraded particles in the emulsion
- entry of other oils

The "A" version of the SPR sensor (robust DIN 11851 thread connection) is easily removed from the line for quick cleaning.

Depending on the oil type, cleaning of the sensor may be required once or twice a day to avoid drifting results. Simple wiping with a soft cloth will remove any coating.

Influence of abraded particles can be minimized by suitable installation site, preferably after a filter.

Other oils (morg oils, tramp oils) will also influence the sound velocity, greatly depending on the type of oil.



Fig. 2 SPRn 4115 sound velocity sensors for measurement of rolling oil



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Alternative methods

Refractive index with hand-held meters.
Inaccurate discontinuous method.

Laboratory method: evaporation in a drying cabinet, followed by weighing. Very time consuming.

Separation method: Acid is added to a sample, effecting the phase separation between oil and water. After complete separation, the oil content is read from a scale on a glass tube.

Density measurement using a vibrating tube: Accuracy similar to SPR method, but cleaning is more difficult.

Accuracy

Accuracy of oil concentration measurement +/- 0.2% (depending on oil type and impurities)

Measuring range

0 to 10 %

References

Sidmar N. W. (Belgium): Has used multiple SPR sensors for several years.

Stahlwerke Bremen (Steel works in Bremen, Germany)

Manufacturers of oils: Gerolub, Quaker, Fuchs Lubricants, etc.

Terminology

Morg oil: oil for bearings

Tramp oils: mixture of hydraulic oils, gear oils, morg oils and shipping oils of varying concentrations

Literature

<http://www.industrialheating.com/CDA/ArticleInformation/coverstory/BNPCoverStoryItem/0,2830,94032,00.html>

http://www.prod.exxon.com/exxon_productdata/lu/be_encyclopedia/rolling_oil.html

<http://www.ethosfr-media.com/RollingOil.pdf>

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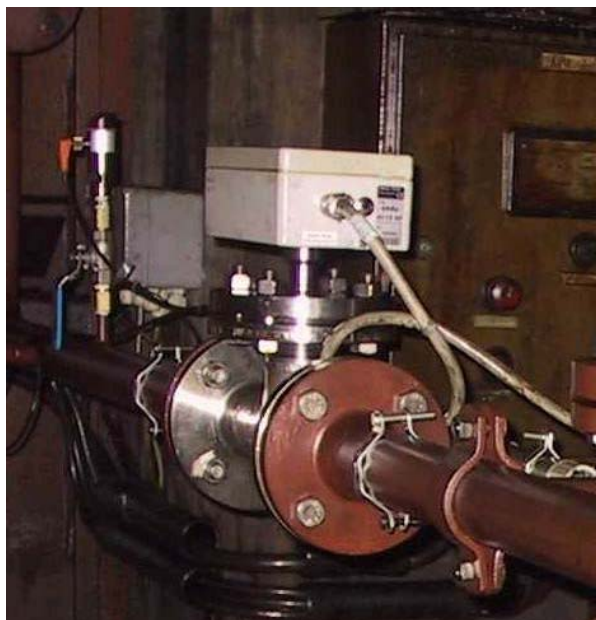


Fig. 3 Example of installation

Customers

Cold rolling mills

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