Oil Sentinel – Theory of Operation

Oil Sentinel

Technology Brought To You By

Voelker Sensors Inc. CINCINNATI

Industrial Series Sensor System

Water Contamination and Oxidation Measurements in base oils & hydraulic fluids

U.S Patents: 5,435,170 5,777,210, 5,789,665
Eur. Patent: pending

Theory of Operation

VOELKER SENSORS INC.

Methodology:

The Oil Sentinel Sensor System uses an innovative approach to oil condition monitoring that utilizes the electrical properties of an insoluble polymeric bead matrix to measure oil wear. Charged groups attached to the beads serve as the conducting medium. The method operates by correlating a relative change in the electrical properties of the beads with a relative change in the solvent properties of an oil, i.e., the interactions between the charged groups adjust as the oil moves from a nonpolar (clean) condition to a polar (oxidized or water contaminated) condition.

Individual chambers with distinct bead formulations allow water contamination and oxidation to be measured independently. Water can be detected as droplets, as an emulsion, or fully dissolved. The method does not require standards or external calibration, is independent of an oils viscosity, and is compatible from 20 – 70°C (as measured in the reservoir).

The Sensor System Consists of:

•A Sensing Element
The sensing element (a consumable due to irreversible contamination by degraded oil) is composed of a nonconductive housing having two holes covered by wire mesh screen that contain a separate formulation of an insoluble polymeric bead matrix.

•A Mechanical Interface
The sensing element is secured to an oil reservoir by a mounting plate that serves as the mechanical interface. The sensing element connects to a preamp board that protrudes through the mounting plate and connects to the signal conditioning unit by means of a cable.

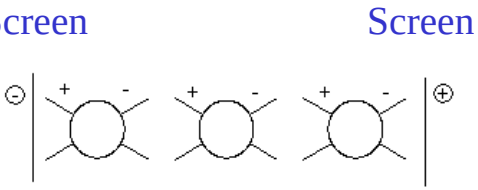
•A Signal Conditioning Unit
The electronics consist of a simple circuit board with microprocessor that conditions the signal from the sensing element. A series of LED's display individual readings for water contamination, oxidation, level, and over-temperature and report oil quality as: good, fair, and change.

Operation of the Sensing Element

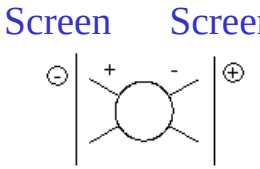
Sensing Element
(Fits in oil reservoir)

Thermistor

Bead Matrix Behavior



For clarity, only a single monolayer of the charged bead matrix is shown.



Measurement Type

Oxidation – multiple beads connected electrically to three chambers

Water Contamination – individual beads connected electrically to a single chamber

Water Contamination & Bead Matrix Behavior

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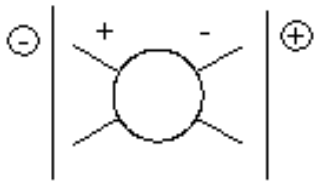
SRH* < 100%

oil + water ⇌ oil - water

water held as a complex

Without "free" Water



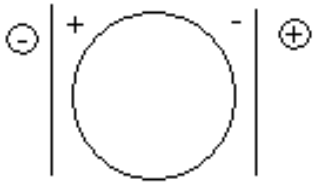
Relative Low Conductivity

SRH > 100%

oil + water ⇌ oil - water

excess "free" water

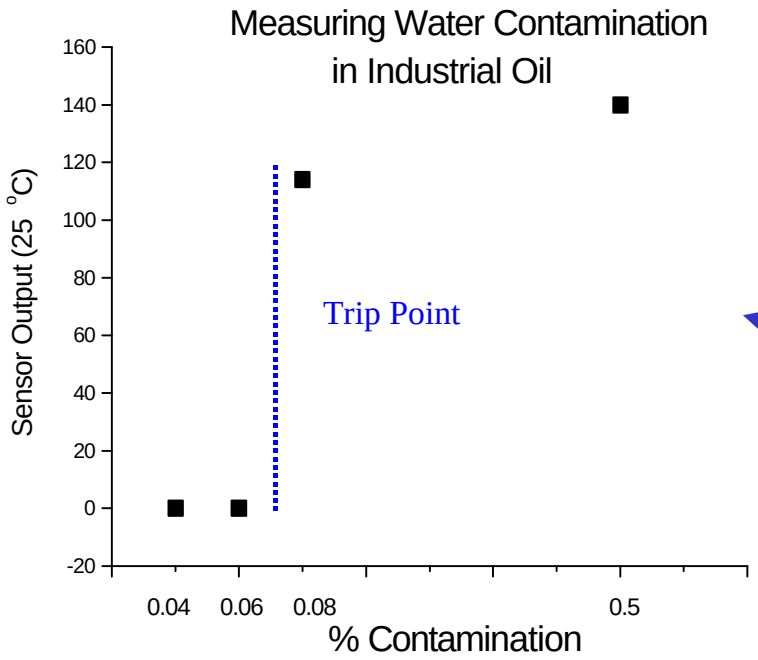
With "free" Water



Relative High Conductivity

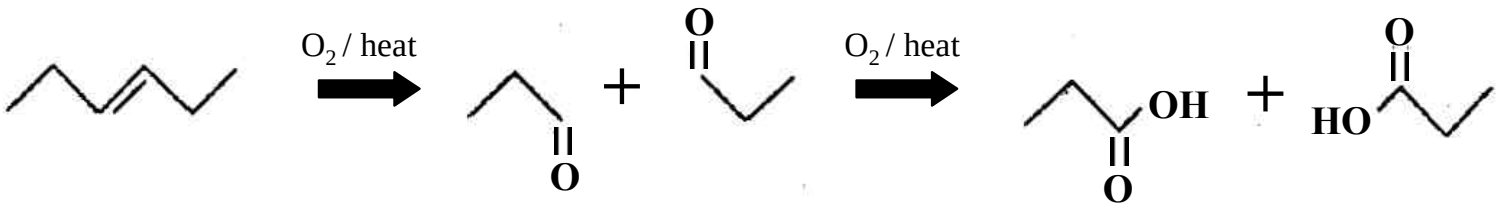
*Saturated relative humidity (SRH)

Measuring Water Contamination



- Oxidation / Water contamination independently measured
- Water contamination measured as low as 0.08%, by volume

Oxidation & Bead Matrix Behavior

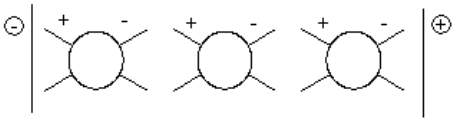


Clean oil
(non polar / non conductive)

Partially Degraded oil
(polar / conductive)

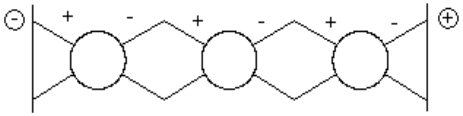
Degraded oil
(more polar / more conductive)

Nonpolar (clean) Oil



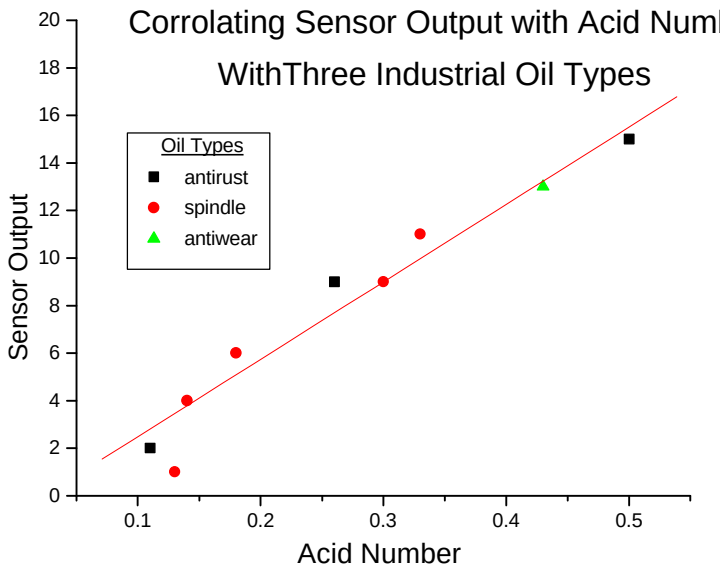
Relative Low Conductivity

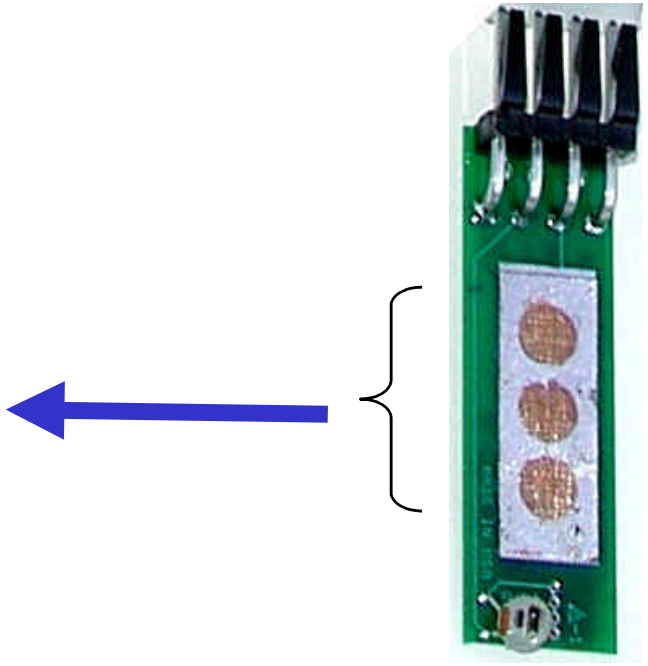
Polar (degraded) Oil



Relative High Conductivity

Measuring Oxidation





- Oxidation / Water contamination independently measured
- Oxidation provides a direct correlation with the TAN (total acid number)