UPM-Kymmene, Finland’s largest forest industry company and paper manufacturer, relies on a new Vaisala concept to measure the water content in the lubrication system of its paper machines. This method is based on the measurement of a simple and unambiguous parameter: $a_w$.

Supporting the new measurement principle, Vaisala’s HMP228 transmitter is designed for convenient installation through a ball valve and easy calibration against salt solutions.

**A major paper manufacturer**

UPM-Kymmene’s forest industry traditions date back more than 100 years. Measured by its turnover, the UPM-Kymmene Group is Europe’s largest forest industry company and one of the biggest in the world. Its forest industry operations are organized under seven divisions.

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UPM-Kymmene’s total paper-making capacity is eight million tons a year. The company’s mills have undergone major expansions and modernizations in recent years, and today they account for a total chemical pulp production capacity of two million tons a year. The Group owns 940,000 hectares of forest in Finland. Annual wood consumption exceeds 20 million cubic meters. At the end of 1997, the UPM-Kymmene Group had a total of 33,814 employees, including 23,200 in Finland.

The UPM-Kymmene mill in Tervasaari produces high-quality sack papers, shaded envelope papers and special industrial papers, release and label papers for self-adhesives, and semi-alkaline pulp (SAP). The Tervasaari mill marked a major milestone in May 1998, when it produced its 7 millionth ton of paper.

A Vaisala HMP228 transmitter has been installed in Tervasaari’s paper machine to measure the water content of the lubrication system. Mr. Heikki Kataja and Mr. Markku Sironen handle the preventive maintenance of the mill’s paper machine. Mr. Kataja, who has overall responsibility for preventive maintenance, has used the HMP228 for more than a year. As he reports, it has improved the quality of maintenance ever since it was installed in March 1997.

**HMP228 enables on-line moisture measurements**

By measuring the moisture in the oil of a paper machine’s lubrication system, mills can significantly reduce maintenance costs and prolong the machine’s service life. Vaisala’s new HMP228 transmitter, a microprocessor-based instrument for moisture measurement, is ideally suited to measuring the water activity in these lubrication systems.

The operation of the sensor is based on capacitance changes as the thin polymer film absorbs water molecules. Water activity ($a_w$) measurement offers several advantages over the traditional parts per million (ppm) measurement used in Karl Fischer’s titration.

**Flexible measurement concept**

The HMP228 transmitter measures water in oil in terms of water activity ($a_w$), which can be determined as follows: water...
activity indicates the amount of water in the oil on a scale from 0 to 1 \( a_w \). On this scale, 0 \( a_w \) indicates that the oil is completely water free, while 1 \( a_w \) indicates that the oil is fully saturated. Water occurs in free form as \( a_w \) is 1.

The most important feature distinguishing the measurement of water activity (\( a_w \)) from traditional measurements of absolute water content (in ppm) is the capability to detect the saturation point regardless of the oil type, aging of the oil, additives used, etc. Other advantages of the HMP228 include easy installation through a ball valve and on-line measurement capability.

As Mr. Kataja explains, water is an undesirable substance in the lubricating system of a paper machine. It causes corrosion, absorbs or consumes additives in the oil and shortens bearing life and the service life of the entire machine.

**HMP228 offers easy calibration and reliable measurements**

Karl Fischer’s titration (see Fig. 1) is the ‘de facto’ standard for measuring the water content of oil, says Mr. Kataja. “Even though Karl Fischer’s titration is a reliable method, we are very pleased with the benefits offered by the HMP228 transmitter and Vaisala’s new concept. The instrument is easy to calibrate against salt solutions, and no reference oils are needed.” Water activity is a reliable measure of the safety margin to the saturation point.

“The amount of water in the lubrication system is one of the main concerns in preventive maintenance,” Mr. Kataja explains. “Although there is always some water in the system, our challenge is to keep the water content at an acceptable level. With the HMP228, this is now very easy.”

**Components of the oil lubrication system**

The lubrication system of a paper machine typically consists of an oil tank, circulation pump and separator or purifier. The separator is only able to remove water that is in free form. In addition to the separator or purifier, there is also an air dryer in the reservoir tank to remove humidity from the air in the tanks.

In modern paper machines, there are usually two separate lubrication systems, one in the wet end and one in the dry end. Each system contains from 10 to 30 cubic meters of oil. It is not unusual to remove from 20 to 40 liters of water from the system every week. The risk is that this moisture will come into contact with the machine bearings. Leaks in the bearing sealings, especially when the machine is being washed at high pressure, are the most common reason for the presence of water. The oil is changed approximately every seven years.

In paper machines, the oil absorbs the water while lubricating the bearings and then releases it for subsequent collection in a reservoir. From the standpoint of the bearings, the main objective is to avoid exposure to oils with a high water content. This is crucial during production breaks because the risk of water saturation increases as the oil temperature decreases.

**Experience at UPM-Kymmene’s Tervasaari mill**

Citing the following example (Fig. 2), Mr. Kataja demonstrates why the Tervasaari mill uses the HMP228 in all its lubrication systems.

As shown in this figure, the ‘normal’ \( a_w \) value for this modern machine is from 0.3 to 0.5. When the bearing sealings caused a leak in the system, the \( a_w \) value jumped to approximately 0.9. “The benefits of the HMP228 are clear. It provided an immediate alarm that something had happened. The oil had become saturated with water, and it took some time before the situation returned to normal. The point is that we were able to start troubleshooting immediately,” says Mr. Kataja.

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*Figure 1: Relationship between water content and \( a_w \).* This figure illustrates Vaisala’s new measurement concept. When the ppm (parts per million) values are used to measure water content, the type of oil and aging must be taken into careful account. For example, 200 ppm in one oil can indicate that it is saturated with water (the water is in a free form); with another type of oil, this level can be far from saturation. Instead of measuring ppm values, Vaisala’s concept provides real-time information about the presence of water in the oil (whether it is old, new, used, cold or hot).

*Figure 2. Bearing sealings leak when the machine is being washed.*