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Watch out for water contamination

Mosaic uses Vaisala equipment in its turbine lubrication systems

Mosaic is the combination of two global leaders in the fertilizer industry, IMC Global and Cargill Crop Nutrition. It is one of the world's largest potash and phosphate mining and processing operations, providing an ever-expanding selection of products and services to enhance crop yield and livestock nutrition.

One of Mosaic's potash mining sites, the Belle Plaine plant in Regina, Saskatchewan, relies on two General Electric 20 MWe turbine generator sets for co-generated power and process steam, and three Westinghouse EL125 prime movers for process applications. A major consideration for any turbine operation is the development of a comprehensive preventive maintenance program for ensuring long service life.

Water contamination is an inevitable phenomenon that should be carefully managed.

One of the most destructive contaminants for a turbine's bearings and hydraulic system is water. Despite all the measures in place designed to prevent water ingression into a turbine's lubrication system, water contamination is an inevitable phenomenon that should be carefully managed. Sources of water ingression include the high pressure steam driving the turbine, condensation of water vapor in the head space of a lubrication reservoir, and failed bearing seals.

Take moisture problems by the throat

Troubled with continuous moisture problems, the Mosaic Technical Services

The Vaisala HUMICAP® Moisture and Temperature Transmitter for Oil HMP228 is inserted directly into the line with ball valve assembly. The unit is installed in a bearing return oil drain adjacent to the high pressure end turbine packing.

Group initiated a research project in 2005 to identify the sources of water contamination by actively measuring moisture levels in their turbine's oil and hydraulic systems.

Mosaic chose the Vaisala HUMICAP® Moisture and Temperature Transmitter for Oil HMP228 to provide in-line, continuous measurement. The instrument displays the reading locally and provides an analog output signal and fully adjustable alarm relays. It also directly measures a parameter called water activity (aw) which indicates a fluid's margin to saturation on a scale of 0 to 1, with 0 signifying a completely dry situation with no water present and 1 signifying full saturation.

Test your equipment

Before installing the device, Mosaic first needed to characterize the performance of the instrument as a function of temperature and water concentration (in ppm mass) as a variable of aw output. A test apparatus was created consisting of a steel drum placed on a heating plate with an agitator to circulate the oil.

The study comprised three different response tests:

Test #1:

Determine if the Vaisala transmitter would respond to the oils used in Mosaic's turbines at the Belle Plaine location. The two oils used for the test were Petro Can Superflow Turboflow Turbine Oil (virgin oil) and Shell VSI Circulating Oil 32 (water saturated oil). Each oil was placed into the test apparatus and heated to 115°F. The Vaisala transmitter was inserted into each oil and allowed to stabilize. The virgin oil measured water activity (aw) of 0.091 with the visual observation noted as "clear, transparent." The water saturated oil read an aw of 0.968 with a noted appearance of "foggy, cloudy, unable to see bottom of drum."

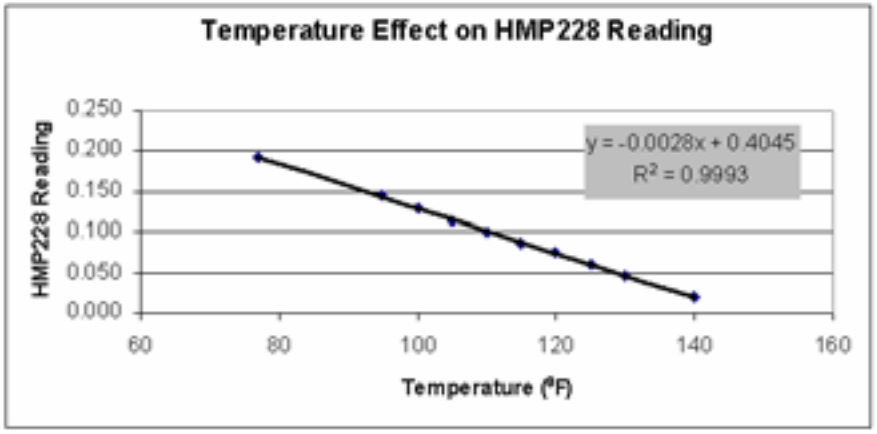
Test #2:

Determine how temperature affects the water saturation level of the virgin turbine engine oil. Using the test apparatus, the turbine oil was heated from room temperature to 140°F while water activity readings were recorded with the Vaisala transmitter. The data was plotted and a linear trendline was formatted. As expected, the water activity readings decreased as the oil temperature increased.

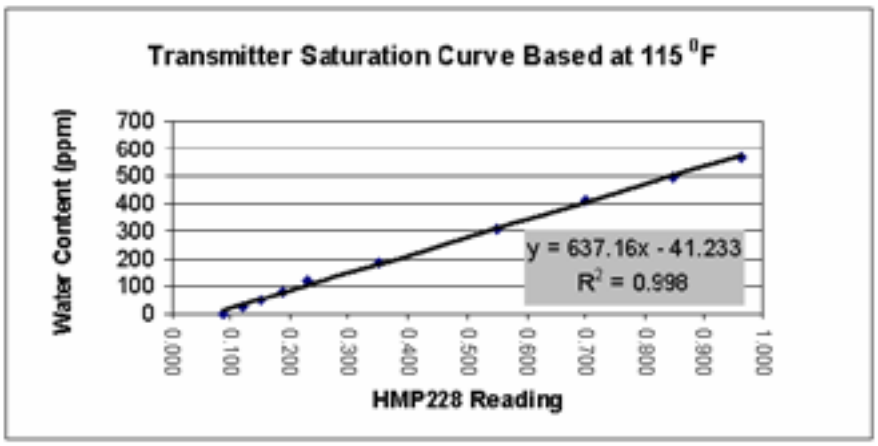
Results, test 1

Oil Type	Transmitter Reading (aw)	Temperature (°F)	Observations
Petro Can	0.968	115.3	
Shell	0.091	115.8	Oil looked clear. Transparent

Results, test 2



Results, test 3



Test #3:

Determine how the Vaisala transmitter responds to water content changes in turbine engine oil. Maintaining the turbine oil temperature at 115°F, known ppm volumes of water were added to the oil and water activity readings were recorded at each point. The data was plotted and a linear trendline was formatted. As anticipated, the water activity readings increased linearly as the water content of the oil increased.

A regression analysis was completed for both oils and a contour plot was developed to characterize water activity as a function of both temperature and water content. With the positive results of this analysis yielding correlation coefficients greater than 0.99, Mosaic installed the Vaisala equipment on both 20 MWe turbine generators.

Prevent hazards with reliable measurements

"Based on this good result, our intent is to alarm at 0.60 water activity. Both temperature and water activity will be used to calculate ppm water in oil within plant DCS systems. The ppm water calculation can be compared to oil analysis results. Corrective actions will be taken beyond 0.65 aw and can include external scrubbing, corrections to gland condenser systems, packing inspections, etc," states the Mosaic Technical Services Group.

After installing the Vaisala transmitter with the alarm relay function activated, Mosaic was alerted to a potentially destructive water ingression problem caused by water entering their oil system via a faulty bearing packing that was spilling steam into an adjacent bearing labyrinth seal.