

Wärtsilä designed and delivered power plant in Turkey.



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21st century 4-stroke engine based **power plants rely** on Vaisala humidity measurement

Modern power plants equipped with Wärtsilä 4-stroke engines are designed to run efficiently while simultaneously minimizing emissions.

Power plant emissions (especially nitrogen oxides) can be controlled by monitoring the humidity content of the engine charge air. An accurate and reliable ambient humidity measurement provides the data needed to control and optimize the engine operation in different ambient conditions while at the same time avoiding water condensate in the plant's generating sets (gensets).

Power plants are located all over the world, including areas of extreme weather conditions from arctic Siberia to the tropics. Utilities and independent power producers use the plants to generate power to the grid, and industrial customers generate power for their own operational needs.

Wärtsilä power plants are designed for optimal performance in power production for peaking, intermediate, and baseload applications, flexibly meeting the actual electricity demand and thus providing the power plant owner with real operational flexibility. The plants typically run on natural gas, heavy fuel oil, or liquid biofuels.

Depending on prevailing needs, the power generation capacity of the plants can vary from a few megawatts to hundreds. Power plants typically have 1–40 turbocharged gensets in the size range from 1 to 23 MW per unit, with all necessary auxiliary equipment.

Emissions and efficiency

In countries all around the world, power plant operations are regulated by strict rules and legislation concerning emissions. In fact, reducing emissions has come to be one of the most important trends in the power market today. However, reducing emissions is not always compatible with operational efficiency, and therefore compromises are needed to achieve optimal results.

Moisture in charge air beneficially affects burning temperatures in the engine cylinder by lowering the peak temperature where the formation of thermal NO_x emissions of the engine takes place. The humidity measurement of inlet air is used to optimize

engine control parameters and to maintain engine efficiency and emissions at optimal levels.

Turbocharger and charge air cooler

Engine turbocharger is a gas compressor, which compresses ambient air to the engine cylinders using the engine's own exhaust gases as power. The charge air temperature also increases during the charging process and needs to be cooled before it enters the cylinders.

Cooling of the charge air is achieved using a water-cooled heat exchanger called a charge air cooler. The cooling water process is a closed system where the hot water from the engine is cooled in the engine auxiliary system and then returned to the cooler at the correct temperature and flow. The control of the cooling water temperature is affected by the charge air dew point temperature; to avoid condensation in the charge air cooler and the resulting losses in cooling efficiency, the cooling water temperature needs to be above the dew point temperature of the air. Condensation in the cooler also causes a risk of corrosion of the cooling fins.

Back then - a product catalog

Several years ago plant designers decided to use ambient air humidity as one of the plant monitoring elements. At that time products were ordered on the basis of data given in product catalogs. The product they chose was Vaisala HMP231.

When the new generation of Vaisala HMT330 humidity transmitters was launched, a suitable replacement for the HMP231 was discussed at length, and the product's direct successor HMT331 was selected as such. However, it was already then clear that in some plant locations the outdoor conditions are so harsh that the more advanced version HMT337 should be used.



A Wärtsilä 20V34SG gas engine.

As knowledge of the effect of humidity on genset performance increased over the years, it became evident that humidity affects not only emissions but also the efficiency of the charger. Thereafter humidity and air dew point has been used as one of the engine's controlling parameters. When any parameter is used for controlling purposes, it is essential that the most reliable measurement is in use to achieve optimal efficiency, the best quality and the lowest overall operating costs.

Today - close teamwork

As the importance of the humidity signal increased it was also recognized that the whole installation is just as essential as the measurement instrument itself. Power plants in general are designed as standard installations, but there are variations in power plant set-ups and even more in their locations and ambient conditions. Also the installation technicians may differ from one installation to another.

Considering the variations between projects it came apparent that giving unambiguous instructions for humidity sensor installation would prove to be very challenging. A target was set to develop a humidity monitoring set-up that is standardized and

simple to order and deliver. It would also need to have a fault-free installation process - i.e. just a 'plug-in', at its simplest.

After deep discussions between Vaisala and Wärtsilä's power plant development engineers a factory assembled unit was developed. It includes an HMT337 transmitter equipped with a warmed humidity measurement probe, a separate temperature probe, a radiation shield and a shield for the humidity probe as well as all necessary installation accessories. The unit is preassembled to the extent that the electricians at the power plant installation phase only need to connect the wires of the plant controlling system to the transmitter and fix the assembly on the standard installation bars on the plant's north-facing gable wall.

End result: optimized measurement solution...

The measurement set-up's radiation shield prevents direct sun light and heat from the plant heat sources from affecting the temperature measurement. The shield of the humidity probe protects the sensor from rain and snow and other unwanted outdoor phenomena, ensuring that the sensor is always in sharp measurement condition.



Wärtsilä power plant with multiple generating sets ensuring flexible power generation.

The humidity sensor also features a purge function that frequently evaporates any chemical contaminants that might have been absorbed into its sensing area, such as gaseous air pollutants. The purge cleans the sensor internally, improving its stability and measurement accuracy.

With the warmed probe the user can always be confident that even after condensing (100%RH) hours during the night time, especially in the tropics, the sensor gives accurate readings as soon as the air starts to dry below 100%RH. Probe warming also prevents condensation formation onto the sensing element, thus minimizing any particulate contamination, which would and affect the measurements.

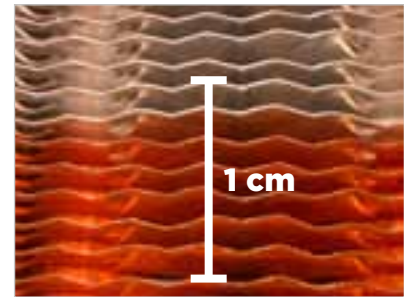
The probe warming and the chemical purge function together secure the required long-term stability for the humidity measurement. As a result of the close

teamwork, the HMT337 set-up offers a reliable way to conduct the essential measurements for process calculations, used to control the power plants engine operation to achieve the levels of efficiency and emissions the engines are designed to reach.

... and prompt deliveries

Gensets and power plant auxiliaries are nowadays mainly delivered in containers that include everything needed for commissioning the whole plant at once. All items to be shipped are gathered at a central shipping location and packed into containers for tightly scheduled shipping. Depending on the final destination, the containers are transported either by ship, truck or train - or in extreme cases even by aircraft.

To ship the project as scheduled, it's essential that all items are the correct ones and present on site



The copper cooling fins of the charge air cooler.

at the appointed time for packing. Together with Wärtsilä, Vaisala has developed a factory assembled and calibrated measurement set-up, including installation accessories, ensuring that the delivery can be made promptly in accordance with the plant owner's schedule. As the whole set-up is standardized, exactly the same unit is used in all plants, allowing plug-in and pre-designed installation at every plant location.