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Vaisala Humidity Transmitters Help to Preserve the Royal Warship Vasa

Creating the Right Climate

Saving the famous 17th century Swedish warship, Vasa, from further environmental damage in its purpose-built museum has been achieved by technical improvements to its air conditioning system. Central to the new system, which became operational in 2004, are a large number of humidity transmitters from Vaisala.

Scandinavia's most visited museum, the Vasa Museum is located in Stockholm, the capital of Sweden. First opened in 1990, it is built around the royal warship Vasa, the world's only preserved 17th century wooden ship. Since the summer 2000 the warship Vasa has suffered from a serious acid attack caused by oxidizing sulfur stored in ship's wood. Researchers are working to stop the sulfuric acid corrosion – work which requires both long-term and short-term solutions.

The critical requirement for the preservation is to maintain a stable climate in the ship hall. For sustainable humidity and temperature conditions, the museum had to have its air conditioning system updated. The new system relies on Vaisala HUMICAP® Humidity and Temperature Transmitter HMP233s.

The royal warship Vasa was the most expensive and richly ornamented naval vessel built in Sweden in the 17th century. When the Vasa sailed forth on her maiden voyage, Stockholmers stood along the shore to wish her good luck. They were eyewitnesses to the disaster. The Vasa capsized and sank inside Stockholm harbour. After 333 years on the seabed, the Vasa ship was salvaged. Nowadays the ship is on view in the Vasa Museum, Stockholm.

Demanding air conditioning under the Vasa's conditions

The Vasa is housed in her own specially constructed museum, but despite the continued preservation, the ship is extremely fragile. Therefore, there has always been paid special attention to create a suitable climate, a sort of an air curtain to protect the Vasa ship from surrounding stressful conditions that may cause further damage. The system works with re-circulated air that is either cooled or heated, dried or humidified, depending on the temperature and relative humidity values.

The new era in the battle to preserve the royal warship Vasa for future generations started in summer 2000. Due to a period of warm and humid weather, large-scale sulfur problems was triggered in the ship's wood. By July 2003, the warship Vasa suffered around 1,500 areas of acidified wood and visible deposits of sulfates. It appears that large quantities of elemental sulfur had built up within the surface layer of the wood. The sulfur oxidizes catalytically into approximately 100 kg sulfuric acid every year. It is estimated that the wood now contains around two tonnes of sulfuric acid and a further five tonnes or so may build up once all the sulfur has oxidized.

This acid attack on the Vasa addressed that the original air conditioning system of the museum was inadequate to cope with the large number of museum visitors. Variations in climate around the ship influence on the rate of acid formation. Therefore, air should be kept at 55% relative humidity and temperature +18.5 °C. The maintenance of stable conditions is chal- ➤

A Right Royal Disaster

In the early 17th century, Sweden was building its empire around the Baltic Sea in northern Europe. During 1620, Sweden was at war with Poland. Then, in 1625 the Swedish king Gustavus Adolphus ordered new warships. Among them was the Vasa.

By 1628 the Vasa ship was ready. It was the mightiest warship in the world, armed with 64 guns on two gundecks and 300 soldiers. When the Vasa set off for its maiden voyage on Sunday August 10, the beaches around Stockholm were filled with spectators, among them foreign diplomats.

The Vasa set sail and fired a salute. But only after a few minutes of sailing the ship began to keel over. She righted herself slightly but keeled over again. Water started to gush in through the open gunports. And, to everyone's' horror and disbelief, the glorious and mighty warship suddenly sank! Of the 150 people on board, 30-50 died in the disaster.

Why did the Vasa sink?

In the 17th century it was not uncommon that warships keeled over and sank. Due to lack of scientific methods of calculating a ship's stability, the ship builders used so called reckonings, which recorded certain ship-measurements. Therefore, the underlying cause of the Vasa's demise was insufficient theoretical know how of the period. At the time, the Vasa was something new – a military experiment.

The reckonings used in building the Vasa were intended for smaller ships with only one gundeck. The Vasa was built differently: she had two gundecks with heavy artillery. Vasa's builders did provide 130 tons of stone as ballast to give the ship stability. Unfortunately, the ballast was not enough as counterweight to the guns, the upper hull, masts and sails of the ship, resulting in the ship capsizing.

Shipbuilders learned from their mistakes and improved later designs. After the Vasa, many successful ships were built with two, three and even four gundecks.

Salvaging the ship

The Vasa ship was not discovered until 1956 when a private shipwreck-specialist Anders Franzén finally located it lying 30 meters beneath the surface in Stockholm. After careful planning, the Vasa ship was lifted slowly to the surface. On April 24 1961 the proud royal warship Vasa broke the surface.

The salvaging of the Vasa initiated intensive archeological excavation and preservation. The ship and all the findings were preserved, which was an effort of gigantic proportions. The Vasa is the biggest single object that has ever been preserved. Some 14,000 individual pieces of wood were brought up to surface, including around 700 sculptures and ornaments that decorated the warship, not to mention the sails. The ship, as well as all the objects found, were preserved using polyethylenglycol (PEG). It replaces water in wooden objects to prevent them from shrinking when dried. The preservation work continued for 17 years. The ship was located at the time in a temporary Vasa Museum, the Wasavarvet.

It was in 1990 that the permanent Vasa Museum was inaugurated. The museum is built in the heart of Stockholm, right next to the site where the Vasa was originally built during the years 1625-1628, and only few hundred meters to the spot where the Vasa sank. The purpose of the museum building is dual: to maintain the ship and other salvaged objects by creating and keeping suitable levels of temperature and relative humidity, and to give possibility to preferably as many people as would wish to see the Vasa in order to share the history. ●

Vaisala HUMICAP® Humidity and Temperature Transmitter HMP233 as mounted on the Vasa ship. The instrument is a part of the updated climate monitoring system that protects the ship against climatic stress.

Emergency acid neutralization is being carried out on the Vasa with a solution of bicarbonate and soda. The level of acidity on visible surfaces of the wood often shows a temporary improvement after treatment, but the acid tends to return gradually after a few months.

lenging because of seasonal changes, variations between day and night as well as day to day differences such as the number of visitors that all have an effect on air quality. Also the height of the ship (max. 52.5 m) causes its own problems. The museum's air circulation system handles 90,000 m^3/h of air, distributing it through displacing outlets situated on the keel level but there is also a distribution system inside the Vasa ship. The source of air distributed around the hull is situated on the keel level, which means that there is a temperature gradient that, in its turn, creates a gradient of relative humidity.

Renovating the air conditioning system

The renovation of the Vasa museum's climate control started in autumn 2002. The owner of the museum, the National Property Board (SFV) of Sweden, scheduled the work in close cooperation with the Vasa Museum's specialists. As Mr. Jacob Jacobson, Assistant Head of the Vasa Museum says, "We at the Vasa Museum knew very well what was wrong with the old system and we knew exactly what we wanted from the new one."

TAC, a supplier of integrated systems for building automation, was chosen to design and build up a new integrated climate monitoring system for air conditioning. TAC had already been involved with the planning and realization of the old air conditioning system when the Vasa Museum was being built in 1988. TAC has also took part in similar projects in other National Property Board's premises, such as the National Museum of Ethnography, Sweden, and Moderna Museet, the Swedish Museum of Modern Art.

The new TAC Xenta® system that was delivered relies on several tens of Vaisala HUMICAP® Humidity and Temperature Transmitter HMP233s. "The museum wanted accurate and reliable measurement instruments. Therefore, Vaisala was an obvious choice based on our

Vaisala HUMICAP® Humidity and Temperature Transmitter HMP233

The HMP233 is a versatile and easy-to-use transmitter for demanding industrial and air conditioning applications. The transmitter measures relative humidity and temperature, and also outputs dewpoint and wet bulb temperature as calculated variables, mixing ratio and absolute humidity.

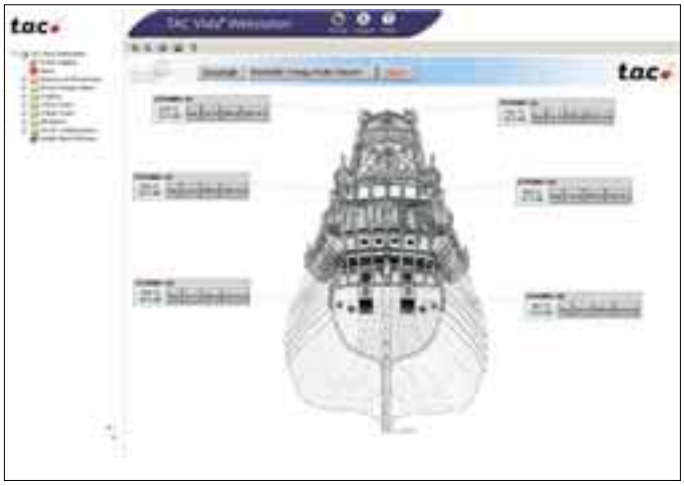
The HMP233 incorporates the Vaisala HUMICAP® Sensor. This humidity sensor provides accurate and reliable measurement with excellent long-term stability over the whole measurement range. The sensor is also immune to particulate contamination and most chemicals.

The sensor head in the HMP233 transmitter is small and fits into tight spaces. It can be equipped with two different cables: one is for lower temperatures of up to +80 °C and the other is for temperatures up to +120 °C.

The HMP233 transmitter can be configured to the customer's requirements on the production line; configuration and parameters can also be set by the user. Both analog and serial outputs are available as

well as several other options: different cable lengths, power supply modules, serial interface modules and local display. ●

Assistant Head Jacob Jacobson from Vasa Museet, Project Manager Fred Sörensen and Project Engineer Fredrik Söderberg from TAC Sweden, and Sales Manager Dragan Morovic from Vaisala Malmö visiting the Vasa ship. According to Mr. Jacobson, seamen spent most of their times on board in dark, damp, cold and crowded conditions on the battery deck.



The Internet based user interface shows graphically the position and status of each measurement point.

previous experience," says Mr. Fred Sörensen, Project Manager from TAC Sweden. The Vaisala transmitters are installed inside the Vasa ship, in the museum hall, and in air conditioning ducts. In the ship alone there is altogether 32 measurement points that provide on-line temperature and relative humidity information.

All the transmitters are equipped with a display in order to make the field check easy. The transmitters have a 10 meters probe cable, which enables flexible mounting. "We wanted to minimize the amount of electronics and cabling inside the Vasa ship," says Mr. Jacob Jacobson. The long probe cable enables the electronics housings to be installed either on the deck or in the support cradle. The measurement probes are distributed all over the ship in different elevations to measure the conditions inside the protective air curtain that surrounds the ship.

Tailor made user interface

The relative humidity and temperature data is being reported for both National Property Board's personnel as well as Vasa Museum conservators. Due to the large number of users with different needs, TAC has developed an easy-to-use Internet based user interface for the Vasa Museum. The TAC Vista® user interface has many advanced features. It displays the measurement data inside the museum as well as outside, shows graphically the position and status of each measurement point, determines the average readings on set interval, as well as draws the graphical trends based on measured data. "Our conservators are quite happy. In the previous system we did not have a reporting tool like this. Instead, we had to make our own using spreadsheet programs. With this system following the status and reporting is much faster and easier," says Mr. Jacob Jacobson from the Vasa Museum. The TAC system also enables alarms with different priorities, which can be sent for example to mobile phones.

The new climate monitoring system has been designed to have a capacity to cope with up to 1,500 visitors in the museum at any time. It is has been up and running since early summer 2004. ●

BEVARA VASA

Preserve the Vasa

The Preserve the Vasa Charitable Foundation was founded in spring 2003 by the Friends of the Vasa Museum. The foundation collects money for research and other activities that aim for preserving the Vasa ship. The benefactor of the fundraising campaign is Carl XVI Gustaf, king of Sweden.

If you want to support the preservation of the Vasa, please give your donation to following account:

In Sweden:
Preserve the Vasa's Postgiro account number is 90 1628-8

Outside Sweden:
The name of the receiver: Insamlingsstiftelsen Bevara Vasa (or Preserve the Vasa Charitable Foundation)
Address: Postgirot, 105 06 Stockholm, Sweden
BIC/SWIFT code: NDEASESS
Account number: 90 1628-8
IBAN: SE95 9500 0099 6042 0901 6288

Further information about the Preserve the Vasa fundrising: maria.sandstrom@maritima.se. ●