VAISALA News

160/2002

ABB Azipod® Propulsion Systems with On-Line Measurement of Moisture in Oil

Hand-held measurements

New Relative Humidity and Temperature Probes for MI70 Indicator

New technology for high accuracy measurements

Vaisala DM500 Precision SAW Hygrometer

Studying the Carbon Cycles of World's Ecosystems

VAISALA News

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Vaisala in Brief

– We develop, manufacture and market products and services for environmental and industrial measurements.

– The purpose of these measurements is to provide a basis for a better quality of life, cost savings, protection of the environment, improved safety and better performance.

– We focus on market segments where we can be the world leader, the preferred supplier. We put a high priority on customer satisfaction and product leadership. We secure our competitive advantage through economies of scale and scope.

The AMT100 Series Ammonia Detectors were launched a year ago. They have proven their reliability in both cold and warm environments. Demanding installation sites with different background odors and gases have shown that the AMT100 Ammonia Detectors have excellent ammonia selectivity, which is a key concern for many customers, for instance in the food processing industry.
PHOTO COURTESY OF INGMAN

Orion Pharma, the leading Finnish pharmaceutical company, has awarded a contract to Vaisala to support their operations. Vaisala's Humidity and Temperature Transmitters are used as part of a validated system that provides measurement data in Orion's manufacturing and storage facilities in Turku. The system follows strict Good Manufacturing Practice (GMP) guidelines.

The historic site of Mawson's Huts in the Australian Antarctic Territory boasts a rich cultural heritage but is located in very demanding environmental conditions. Supporting the effort to preserve the site, Vaisala equipment is used to monitor and study the environmental conditions.
PHOTO COURTESY OF STEVE MARTIN, STATE LIBRARY OF NSW

Vaisala supports the lifetime accuracy of the instruments by making regular calibrations easy and affordable. The calibration reminder and service program offers both standard and accredited calibrations, enabling customers to get the best possible performance out of their products.

Cover photo:
The ABB Azipod® Propulsion System is used in numerous types of vessel, such as cruise vessel Voyager of the Seas. Photo by Gero Mylius, © INDAV Ltd, Finland.

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+358 9 8949 2227

Internet:
http://www.vaisala.com

Design and Artwork:
Edita Oyj

Editors:
Bellcrest Language Services Oy

Printed in Finland by
Edita Oyj, Finland

ISSN 1238-2388

NORDIC ENVIRONMENTAL LABEL
441 002
Printed matter

President's Column

Vaisala's principles

We manufacture instruments for environmental measurement – using the term "environment" in its broadest sense. For us, the environment also includes closed research premises and production and process facilities. Concerning weather measurement applications we also provide total system solutions, while in industrial measurement applications our focus is on supplying instruments. In all its business operations, Vaisala subscribes to a few key principles, designed to achieve satisfied customers and create mutual, lasting benefit.

Vaisala is innovative. We are technology leaders in our own field. HUMICAP®, BAROCAP® and many other sensor technologies are examples of this. All our products are based on our own R&D activities. We do not copy or purchase licenses. We invest 12 percent of our turnover in R&D and have committed more than 250 people to this work. We hold numerous patents on the technologies we have developed. We also cooperate with the world's leading research institutes.

Vaisala is reliable. This applies both to us as a company and to our products. We want our products to operate faultlessly even in the most demanding conditions. Our products undergo many tests - often conducted in cooperation with key customers - before their market launch. Our in-house design rules have been formed through experience. Concerning measuring instruments, accurate calibration is of paramount importance. For this purpose we have an accredited calibration measurement standards laboratory which answers for traceability to primary standards. As a company, Vaisala is stable and financially sound. We follow strict ethical principles. We only promise what we know to be feasible and we keep our promises. We don't leave our customers without support.

Vaisala's products and customer relationships are long-lasting. We dimension our products for professional use and for demanding conditions. To the user, our products are investments which are expected to be in service for many years. We design our instruments to require recalibration as seldom as possible. But when needed, we provide recalibration. We supply spare parts and upgrades for our products. Our products do not become obsolete, even though needs may slightly change over the product lifecycle. The same objective characterizes our customer relationships. We believe that successful business is based on continuing customer relationships. They can be maintained only if the customers are satisfied with the products and the service they get. We want to serve our customers well, and not to maximize our own short-term interests.

Vaisala provides solutions. We do not sell our products through a product catalogue and leave the customer alone with their product selection. We familiarize ourselves with the applications where our products are used. This allows our experts to assist customers in the selection of instruments, and in their installation, use and maintenance. We want to serve customers well to ensure they get an appropriate, reliable and durable solution for their needs. We are not out there only to obtain orders and the customers' money, which would be shortsighted and foolish.

We have adhered to the above principles for a long time already. I believe that you have noticed it. Vaisala is an innovative and reliable solutions provider. ●

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Vaisala's AMT100 Series ammonia detectors celebrate their 1st Birthday

Vaisala Ammonia Detectors' successful first year

It was one year ago that we launched the AMT100 Series Ammonia Detectors. Vaisala's polymer thin film sensor, AMMONICAP®, has proven its reliability in both cold and warm environments (–40°C to +60°C). Demanding installation sites with different background odors and gases have shown that the AMT100 Series Detectors have excellent ammonia selectivity – thanks to the AMMONICAP® Sensor. Moreover, the low maintenance and short warm-up time of only 3 minutes have brought us many satisfied customers. This article summarizes some comments from our global customers and also gives information on AMT100 Series applications.

One of our customers is a company called KWH Freeze, who offer cold storage. Their CEO, Peter Lång, explains, "KWH Freeze rents refrigerated storage space to anyone who needs it, and also provides internal logistics. The quality of our services is a high priority for us as KWH Freeze is one of the biggest companies in this area in Finland. We chose Vaisala's AMT100 Series Ammonia Detectors for our new storage rooms because of their performance in cold temperatures and flexible interfacing. It can be connected directly to automation systems or to typical gas controllers."

Vaisala AMT100 Ammonia Detectors are highly ammonia specific, which reduces costly false alarms.

AMT100 Series entering the Japanese market

We have also been successful in introducing our AMMONICAP® sensor in a very important industrial nation, Japan. One of our ammonia detector customers, Nichirei, is a general processed food company based on storage operations. The company is a leader in the refrigeration warehousing industry and also the number one frozen food company in Japan. Mr. Norihiro Koishikawa, who works as team leader of the technical section delivery team, comments on their experiences with previous instruments: "We had been having problems with semiconductor type ammonia detectors, the main problem being false alarms caused by other gases such as hydrogen in the cold storage rooms. We then tested the AMT101 and found that it does not react to other gases." Mr. Koishikawa indicated that their alarm system is working well with AMT101 at -25°C (-13°F). He also appreciates the option of extra interchangeable probes for easy and fast maintenance even in critical situations.

Demanding users in the food industry

It is not difficult to find a demanding environment in the field of ammonia detection, the food industry offers excellent challenges, for example. The Apetit Group markets its products primarily in Finland, but has gradually expanded its market area to include the Baltic Rim. Apetit develops, produces and markets frozen foods, fish products, jams and marmalades, all from pure, carefully selected raw materials. Apetit meets the requirements of clean and safe food production in order to achieve sustainable development. Mr. Kyösti Lind, who works as a automation engineer in the maintenance department at Apetit Group, points out: "Apetit is Finland's market leader in frozen foods, as well as in jams and marmalades produced for retail. We have two production sites in Finland, one in Säkylä and another in Turku. When Vaisala launched their new AMMONICAP®-based Ammonia Detector, we saw a good opportunity to replace some old ammonia detectors in problematic places."

Enabling the production of high-quality ice cream

Within the food processing industry, ice cream factories are big users of ammonia. One of Vaisala's ammonia detector users

Ammonia is a common refrigerant in cold stores and the food processing industry. Despite its many advantages, ammonia is a hazardous chemical and must always be handled in a safe manner.

Antero Pasanen stresses the importance of high selectivity that the AMT100 Ammonia Detector offers.

is an ice cream facility located in the United States. This ice cream plant is using ammonia as a refrigerant in its facility, situated in a densely populated area. As a consequence, ammonia leak detection units are imperative for safety reasons. The plant has a very elaborate control system in order to monitor numerous parameters, including ammonia leak detection. They had a problem with the former ammonia sensor, a catalytic sensor, which was very inaccurate and required frequent maintenance. Because of the numerous odors at the ice cream facility and the temperature of the rooms, -31°C (-23°F) , the catalytic sensor would not function correctly. Annoyed by the inaccuracies of this sensor, the facility installed four Vaisala AMT101 Ammonia Detectors in its ice cream production rooms. With no false alarms and all detectors functioning correctly at such a cold temperature, our customer will be replacing all catalytic sensors in the facility with Vaisala AMT101 Ammonia Detectors in the future.

Another example of an ice cream manufacturer that uses Vaisala technology is the Finnish food industry group Ingman Foods, which is a wholly owned subsidiary of Ingman Group. The Group has been systematically developed over the years to become one of Finland's leading food manufacturers, with an important position in the dairy sector. The strategy of the Group is to concentrate on milk-based products and complimentary products that apply the same production technology. The products are safe and of a high quality. Fresh Finnish milk is the most important raw material, forming the basis of production. Ingman's main product groups are:

- chilled dairy products
- liquid milk products
- ice cream products
- cheese, butter and powder.

"Our production facilities in Sibbo, close to Helsinki, invested in a bigger +2°C storage room facility in 2002. Vaisala's Ammonia Detector was the obvious choice because of its high ammonia selectivity," comments Mr. Antero Pasanen, a technical manager in Sibbo Factory.

Ammonia detection without false alarms

In food processing industry there are numerous demanding measurement needs and ammonia detection is a very challenging field for manufacturers of measurement instruments. Controlled Environments Constructive, Inc. is a general contracting firm in Tustin, California. The company is involved in numerous applications, ranging from the pharmaceutical industry to cold storage warehousing. Within their organization they also specialize in control systems for these applications. Controlled Environments Constructive purchased six AMT101 units in the summer of 2001. Mr. Mark Smith, who works in the system controls and integration division, incorporated these units into a control system. In this system, temperature and defrost control were also monitored in a cold storage warehouse where ammonia was used as a refrigerant. He utilized the 4-20mA signal from the units, which was received on his control panel. There are 3 alarm levels programmed into the panel, which activate different actions within the facility depending on the level of ammonia that the AMT101 senses. The units have been placed outside in a docking station, in a machine room, in freezers, and also in an ice cream room. Mr. Smith comments: "I have been very pleased with the Vaisala AMT101 Ammonia Detectors. This is the first time I have not had any false alarms with an ammonia detector."

PHOTO COURTESY OF KWH FREEZE

These examples of customer comments are encouraging. Continuous co-operation with our customers is essential during the whole lifetime of products. Our aim is to continue intense work in the ammonia detection field and to develop even better instruments in the future - with the help of our customers. ●

New accessory for ammonia detectors

Vaisala is launching the new IP33 Box for AMT100 Series Ammonia Detectors. The IP33 Box has been designed for use in either outdoor or harsh indoor environments, where the unit may need extra protection from water. Continuous cleaning and washing with sprayed water sometimes causes extra coverage need for the ammonia detector body, especially at process sites in food processing industry.

The detector slides into the IP33 Box and the unit is then protected from falling water. The box protects the unit up to a maximum raining water angle of 60 degrees. ●

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New options for hand-held measurement

New Relative Humidity and Temperature Probes for MI70 Indicator

The family of new hand-held instruments for dewpoint and carbon dioxide measurements based on Vaisala MI70 Measurement Indicator was launched in 2001. A new member is now added to this product family: three new relative humidity and temperature probes in combination with HM70 Hand-Held Meter set further extend the selection of measurement parameters and applications.

Versatile indicator

The fully digital MI70 Measurement Indicator represents the latest generation of Vaisala hand-held indicators. The indicator has been designed to be robust and easy to use. A clear graphic display together with an intuitive menu-based interface makes it easy for the user to get accustomed with the indicator. The language of the user interface can be selected from six different alternatives: English, German, French, Spanish, Swedish and Finnish. Graphical trends enable the user to monitor the stabilization time of the measurement and in this way indicate when a reliable reading can be

The three new relative humidity and temperature probes, used together with the MI70 Measurement Indicator, form the HM70 family.

taken. Furthermore, a sophisticated Windows® software program is available to transfer data from the indicator to a PC, where it can be processed further and copied to other Windows® programs. With an analog output cable the measurement results can also be transferred to a chard recorder or to an external control system.

The MI70 Measurement Indicator automatically recognizes the connected probe and displays which parameters the probe is able to measure. This makes it easy to measure different parameters by simply changing the probe. Two probes can be connected to the MI70 simultaneously and three measurement parameters can be displayed and logged into the indicator memory at the same time.

Its durable and rugged structure, compact size and light weight make the MI70 suitable for a wide variety of applications.

HM70 Hand-Held Relative Humidity and Temperature Meter

The three new measurement probes for relative humidity and temperature which, together with the indicator, form the HM70 family, now further extend the application base of the MI70 Measurement Indicator. The probes are based on Vaisala's proven HUMICAP® technology. The HMP75 Humidity and Temperature Probe is suitable for general-purpose measurements. The HMP76 Humidity and Temperature Probe enables measurements in more demanding conditions. Its long stainless steel shaft enables even difficult places to be reached. The rugged probe structure can also take rough handling better than other models. The HMP77 Humidity and Temperature Probe is designed for high temperatures up to 180 °C. The probe has a 5-meter cable between the small sensor head and the handle, making it ideal for use in tight and difficult-to-reach areas and for the on-site calibration of Vaisala's process transmitters.

The HMP76 and HMP77 probes also have the parallel versions HMP76B and HMP77B, providing chemical purge and sensor pre-heat options. The chemical purge option makes the probes stable even in environments where high concentrations of chemicals or cleaning agents are present. In chemical purge, the sensor performance is returned to normal by evaporating the interfering chemicals from the sensor polymer. Chemical purge helps to maintain measurement accuracy between calibrations. Sensor preheat enables the installation of the probe in processes where high humidity exists at an elevated temperature. If the temperature of the humidity sensor during probe installation is lower than that of the process, dew is easily formed on the sensor and it may take a long time to evaporate in high humidity conditions. With the sensor pre-heat function the formation of dew can be prevented. In this way an unwanted delay in starting the actual measurements can be avoided.

The HM70 directly measures relative humidity and temperature. Based on the measurement of these parameters, the MI70 calculates dewpoint, absolute humidity and several other humidity parameters, which can then be displayed numerically or graphically and stored in the data logging memory.

Calibration of the HM70 is easy. The indicator provides a guided calibration procedure which can be used together with, for example, the HMK15 Calibrator. The probes can also be sent to a Vaisala service center which will provide a traceable calibration in several humidity points. The calibration can also be sealed making the HM70 a traceable humidity reference for even demanding applications.

Supporting the maintenance of Vaisala's transmitters

The HM70 effectively supports the maintenance of most of Vaisala's fixed relative humidity transmitters. Connection cables for both analog and digital humidity transmitters are available, enabling the comparison of transmitter readings with a calibrated reference probe. It is even possible to adjust the humidity output of the transmitter in application conditions without removing the transmitter from the installation site or disconnecting it from the monitoring or control system.

Wide selection of measurement parameters

With the new relative humidity and temperature probes the MI70 Indicator is now available as three different sets, HM70 for relative humidity and temperature measurements, DM70 for dewpoint measurements and GM70 for carbon dioxide measurements. Probes for different parameters are also available individually, enabling the same indicator to measure several different parameters. This makes the MI70 suitable for many multiparameter applications, such as greenhouse monitoring, health inspection, incubators, control measurements in building automation, etc. With Vaisala's stable and reliable HUMICAP®, DRYCAP® and CARBOCAP® sensor technology, innovative design and easy-to-use features, the MI70 and its several probes provides lifetime value and readings you can trust in all conditions.●

Main Features of HM70 Series

Measurement Indicator MI70

- Graphical trend display shows stabilization
- Multi-lingual user interface
- Programmable shortcut keys
- Measurements easily reported to PC using Windows software
- Two probes can be connected and measured simultaneously
- Rechargeable and alkaline battery versions available

HM70 Series of Humidity and Temperature Probes

- HMP75 basic humidity probe for relative humidity and temperature measurement.
- HMP76 rugged probe with a long stainless steel shaft. Preheat and Chemical Purge options available.
- HMP77 probe with a cable for industrial processes up to 180 °C. Preheat and Chemical Purge options available. ●

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Preserving our Antarctic Heritage -

Mawson's Huts

The historic site of Mawson's Huts in the Australian Antarctic Territory is the location of one of only six surviving complexes from the era of Antarctic exploration. The site's rich cultural heritage and demanding environmental conditions have been taken into account in the Conservation Management Plan being developed to manage the many constraints, issues and opportunities the site offers. Supporting the effort to preserve this site, CSIRO has chosen Vaisala equipment to monitor and study the environmental conditions.

PHOTO COURTESY OF STEVE MARTIN, STATE LIBRARY OF NSW

Latitude 67 degrees south, longitude 142 degrees east, pinpoints the bleak and inhospitable Cape Denison situated on Commonwealth Bay in the Australian Antarctic Territory.

Latitude 67 degrees south, longitude 142 degrees east, pinpoints the bleak and inhospitable Cape Denison situated on Commonwealth Bay in the Australian Antarctic Territory. The windiest place on earth at sea level, Cape Denison is home to a site classified as rare in a global context and unique in Australian history. It is the location of one of only six surviving complexes from the Heroic Era of Antarctic exploration… the historic site of Mawson's Huts.

Hurriedly constructed by the Australasian Antarctic Expe-

dition led by Sir Douglas Mawson in 1912, the site consists of four buildings - the Main Hut, Magnetograph House, Transit Hut and Absolute Magnetic Hut - and numerous scattered artefacts. Mawson remained there for two years, directing several arduous journeys of exploration from the site and conducting scientific experiments.

Many constraints, issues and opportunities have been taken into account in the Conservation Management Plan that is being developed to manage the site's significant cultural heritage.

The Historic Site - the "Home of the Blizzard"

The Mawson's Huts Historic Site and associated elements is a complex cultural landscape that illustrates, in its surviving form and setting, the isolation and harsh conditions encountered by the original expedition members. Foremost is the preservation of Mawson's Main Hut, a formidable task due to the location, environment and lack of accessibility. Cape Denison can only be reached by sea in the Australian summer between December and March – a duration of one week's sailing from Hobart, Tasmania.

The historic site and its buildings face an extremely demanding climate, with temperatures ranging from –20°C to occasionally over 0°C. The constant onslaught of abrasive snow and ice coupled with severe winds that average a daily maximum of 71 kph (82 km/h) is proving to be the greatest single long-term threat to the buildings.

Since the 1970s various proposals have been made as to how best conserve Mawson's Hut. These include covering the building with a transparent dome, over-cladding the original exterior timbers, dismantling the Hut for relocation to Australia, and sundry other options for removing the ice which has invaded the building over its many years of solitude.

Action plans

In 1997-98, based on previous heritage and condition assessments, AAP Mawson's Huts Foundation sent a conservation team to generally stabilize the buildings. The team spent seven weeks at the site to assess the condition. The Main Hut and the Magnetograph House had weathered their 89 years reasonably well, maintaining intact structures and cladding, whereas the Transit Hut and the Absolute Magnetic Hut were subsequently stabilized for conservation as "standing ruins".

Remedying the ice abrasion and ingress in the Main Hut has been the most frequently proposed conservation option, and its removal appears to be a fait accompli. However, prior to a commitment to any preservation strategy, it is crucial to gain a full understanding of the likely impact of action plans. Is the snow/ice inside the Hut helping the building to be more wind-resistant? If the ice is removed, will the temperature increase around the foundations thereby jeopardizing the Hut's anchorage? Will ice removal expose metal surfaces to increased contact with salt? Will it increase the humidity thereby exacerbating corrosion in the original bolts and nails and/or increasing mould and staining on artifacts still not fully documented?

Monitoring

CSIRO has been providing expertise in monitoring corrosion rates at Mawson's Hut since 1983. Although Antarctic temperatures do curb the two most important factors in timber deterioration - fungus and insects - the common belief that a freezing climate will prevent bio-deterioration and corrosion, thus giving perfect preservation, has been exposed as a myth.

To further understand the deterioration processes affecting the building structure and artefacts, equipment for monitoring

The Mawson's Huts Historic Site and associated elements is a complex cultural landscape that illustrates, in its surviving form and setting, the isolation and harsh conditions encountered by the original expedition members.

temperature and relative humidity, corrosion, salt deposition and erosion of timbers was installed in 1999. Data-loggers organized by the Consortium for Heritage Collections & Their Environment, which consists of CSIRO Department of Building, Construction and Engineering, the Australian Museum, the University of Canberra and the University of NSW, were positioned in the Main Hut and downloaded by a much-publicized couple, Jim and Yvonne Claypole.

A Campbell Scientific CR10X monitoring system was used, with eight combined Vaisala HM35A Relative Humidity Temperature Transmitters and 10 surface temperature thermocouple sensors variously placed from floor to ceiling height and from the outer walls to the center of the Hut to record differing conditions within the building.

The Claypoles also exposed low-alloy copper steel coupons on top of a research team building near the Main Hut for atmospheric corrosion study and analysis.

Revealing statistics

CSIRO's Wayne Ganther said that the immense volume of data collected over the 1999-2000 period revealed some incongruous statistics. The steel corrosivity samples indicated an atmospheric corrosion rate similar to that of suburban Melbourne and Sydney – 12.2 microns per year. The data collected from inside the Main Hut demonstrated that daily internal temperature and humidity peaks only occur when solar radiation is significant during the Antarctic summer. The temperature in the Main Hut did not rise above 0°C, except at the highest ceiling point, at any time during the year. Interestingly though, the relative humidity did not fall below 80% in the majority of locations throughout the Hut. Time of wetness (TOW), a major factor in corrosion study, was extrapolated against the International Standard 9223 and the newly christened "King" TOW criteria developed by King and Ganther from CSIRO-based work at Terra Nova Bay, Antarctica, 2000.

Research published in "Studies in Antarctica Help to Better Define the Temperature Criterion for Atmospheric Corrosion" by CSIRO scientists George King and Wayne Ganther, Janet Hughes from the National Gallery of Australia, and Paolo Grigioni and Andrea Pellegrini from ENEA Italian National Antarctic Research Program, revealed that the standard ➤

To further understand the deterioration processes affecting the building structure and artifacts, equipment for monitoring temperature and relative humidity, corrosion, salt deposition and erosion of timbers was installed in 1999.

benchmark ISO 9223 criterion for estimating time of wetness is incorrect and needs to be revised.

Utilizing King's alternative criteria, the recently calculated TOW data together with the deterioration of the metal artefacts observed on previous expeditions shows there is significant risk to the building. Previous studies have indicated that biodeterioration of timber is said to be possible above 20% equilibrium moisture content. The surface equilibrium moisture content in Mawson's Hut was measured as continually above 16% and above 20% more than 80% of the time. If decay is indeed possible at these temperatures then there is more than enough water available for it to proceed.

Despite the severe-site limitations, the collected data has demonstrated that the current state of the building offers some insulating effect. While it is initially surprising that these processes are occurring, it is worthy to note that it is incremental over a long period of time with significant intermissions during winter conditions. That being said, even sluggish processes become a major factor when considering the need to preserve historically significant buildings for future generations.

Ultimate responsibility for the conservation and management of Mawson's Huts Historic Site rests with the Australian Antarctic Division as custodian for the Australian Antarctic Territory on behalf of the Australian Government. The statutory context for this responsibility for both cultural and natural heritage conservation is provided by the Antarctic Treaty. ●

CSIRO Australia

CSIRO Australia is one of the world's largest and most diverse scientific research institutions. With a staff of more than 6000, CSIRO conducts some 10% of Australia's total R&D effort including about 12% of the R&D contracted out by industry.

Globally CSIRO is active in more than 70 countries, with over 700 current or recently completed projects. Almost a third of CSIRO's international activity is in collaboration with leading scientific organizations and firms in the USA. A further third of the international activity is with leading institutions and firms in Europe and Japan.

CSIRO Built Environment

CSIRO Built Environment offers leading science, technology, products and services to infrastructure and built environment industries, marketing its people, technology, products and services through three core science capabilities: Thermal & Fluids Engineering, Sustainable Materials Engineering and Infrastructure Systems Engineering. ●

CSIRO has been providing expertise in monitoring corrosion rates at Mawson's Hut since 1983. Although Antarctic temperatures do retard the two most important factors in timber deterioration - fungus and insects - the common belief that the freezing climate will prevent biodeterioration and corrosion, a la 'perfect preservation', has been exposed as a myth.

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Vaisala's Humidity Measurement in the Pharmaceutical Industry

Validated Data even in the Most Demanding Environments

Orion Pharma, the leading Finnish pharmaceutical company, has awarded a contract to Vaisala to support their operations. Vaisala's HMP233 and HMP243 Humidity and Temperature Transmitters are used as part of a validated system that provides measurement data in all manufacturing and storage facilities at Orion's premises in Turku. The system follows strict Good Manufacturing Practice (GMP) guidelines.

Orion Pharma is a research and development oriented pharmaceutical division of the Orion Group, the leading Finnish company specializing in healthcare products. Pharmaceutical R&D at Orion Pharma focuses on four therapy areas: Central Nervous System (CNS) disorders, Cardiology and Critical Care, Hormonal therapies, and Respiratory disorders. New innovative pharmaceutical products are discovered, developed, manufactured and marketed both for human and animal health.

In Scandinavia, which is Orion Pharma's home territory, company operations include a broad selection of human and veterinary preparations, as well as active pharmaceutical ingredients. In Finland, Orion Pharma is the leading supplier of pharmaceuticals with a 13% market share.

The research and development and production units of Orion Pharma are situated in several locations in Finland. Orion Pharma also has a research and development center in Nottingham, United Kingdom, which focuses on cardiovascular and CNS drug development. Moreover, subsidiaries in Denmark, Germany, the UK, France and Sweden have medical departments. In the US, ➤

Mr. Pasi Kollanus (right) and Mr. Jyrki Salminen from Orion Pharma's maintenance department in Turku.

Orion Pharma collaborates in clinical research projects with partners.

Validated system for production control

Orion Pharma's Turku premises have used Vaisala products for a decade to measure relative humidity and temperature, both indoors and outdoors. They are now building a separate, validated system to measure conditions in laboratories, production, packaging and storage rooms. In addition to humidity and temperature, other variables are also measured. Measured conditions vary from normal room conditions to more demanding environments.

GMP – Good Manufacturing Practice

The pharmaceutical industry follows Good Manufacturing Practice (GMP) regulations on safety and quality in manufacturing pharmaceutical preparations. According to the World Health Organization (WHO), Good Manufacturing Practice is a system for ensuring that products are consistently produced and controlled according to quality standards. GMP covers all aspects of production from raw materials, premises and equipment, to the training and personal hygiene of staff. Detailed, written procedures are essential for everything that could affect the quality of the finished product. There must be systems to provide documented proof that correct procedures are consistently followed at each step of the manufacturing process, every time a product is made.

"Compared to ISO9000 quality systems, GMP is much stricter," says Mr. Salminen from Orion Pharma's maintenance department. Orion Pharma's validated measurement system fulfils GMP regulations. The objective of the system is to provide proven information about the environment in Orion Pharma at all stages of production.

Superior accuracy and easy calibration

Vaisala was the clear winner when the supplier for new installations was decided upon, due to the superior performance of their instruments. "With Vaisala instruments we can always be sure the readings are true – if the signal is zero, it really means zero! This is a simple thing as such, but it was not so obvious with the other instruments we tested," points out Mr. Salminen.

Easy calibration was also found to be a clear advantage for Vaisala. "Each measurement instrument is calibrated and adjusted both in the sensor and as part of the measurement system. Because of the validated system, the measurement instruments cannot be dismantled for calibration. Vaisala could offer us the solution – the HMK15 Salt Bath Calibrator and the HMI41 Indicator with HMP45 Humidity and Temperature Probe - for on-site calibration and adjustment. We are extremely happy with it," says Mr. Kollanus, Maintenance Manager of Orion Pharma, Turku.

HMP243 for wash-down areas

Moreover, Vaisala's technology provided a solution for humidity measurements in spaces that are often washed. "Our production facilities are high pressure cleaned with water once or even twice a day. Traditional humidity transmitters show overscale for hours after washing due to water in the sensor. Vaisala's HMP243 with warmed probe recovers much faster from such humidities and we have therefore used them to equip our wash-down areas," says Mr. Salminen. ●

The manufacturing of drugs and other pharmaceutical products is strictly controlled by GMP guidelines.

Vaisala HMP233 Humidity and Temperature Transmitter for tight places

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 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 a local display.

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

The HMP233 is suitable for duct installations, tight spaces and outdoor installations.

Vaisala HMP243 Humidity and Temperature Transmitter - designed for use in high humidity

The Vaisala HMP243 Humidity and Temperature Transmitter is specially designed for reliable and fast dewpoint measurement at high humidities and/or rapidly changing temperatures, where condensing water vapor has been a problem. The HMP243 incorporates Vaisala's advanced HUMICAP® technology and a warmed probe head to guarantee accurate and reliable dewpoint measurement even in condensing environments.

The HMP243 works well both at lower humidities and in saturating conditions. In addition to industrial applications it is suitable for use in outdoor/meteorological applications where sudden temperature changes and windy conditions can occur. The HMP243 Transmitter is fully configurable and outputs dewpoint, relative humidity, ppmv and temperature.

Excellent Performance under High Humidity

Vaisala's unique warmed probe provides fast and reliable dewpoint measurements in environments where humidity almost reaches saturation. The sensor also recovers very fast from condensation in extreme conditions. As the probe is warmed, the humidity level inside the head stays below the ambient. With accurate temperature measurement the dewpoint of the ambient environment can be precisely calculated. ●

The HMP243 can be equipped with an optional temperature sensor for ambient temperature and relative humidity measurement.

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ABB Marine is a leading global electrotechnical partner with the marine industry. ABB supplies power plants and electric propulsion systems - including azimuthing electric propulsion, total automation systems and a wide range of other electrotechnical products and drive systems. ABB Marine has provided the world's shipbuilders with state-of-the art electric propulsion drives for luxury cruise vessels, ro-ro vessels, tankers and offshore and special purpose vessels for more than half a century.

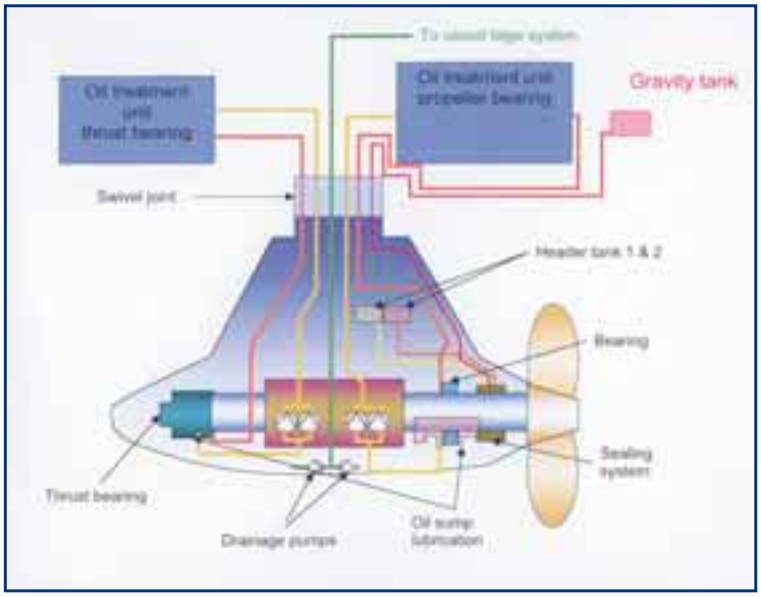
Azipod® Propulsion System – the world's leading propulsion system

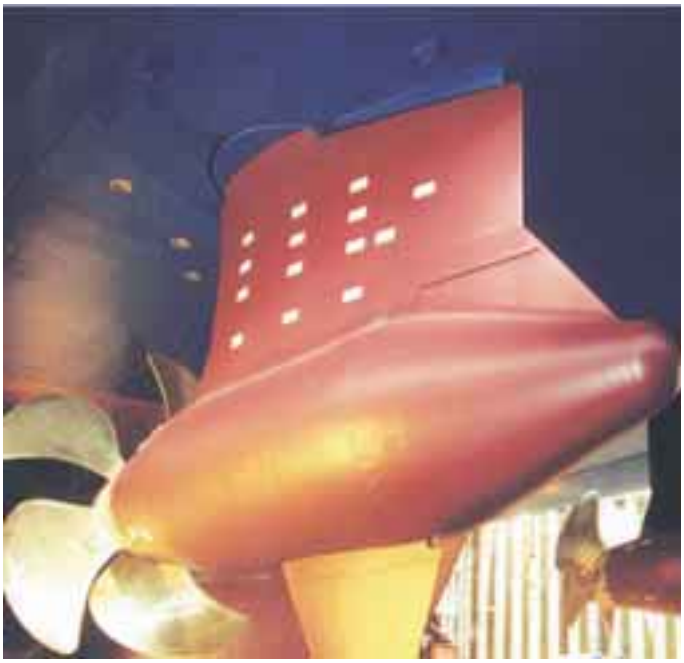
ABB introduced Azipod, the first azimuthing podded propulsion system on the market, at the beginning of the 1990s. The Azipod propulsion system combines the advantages of various conventional propulsion systems available today. The propulsion system provides the major benefits of excellent dynamic performance and maneuvering characteristics, hydrodynamic efficiency resulting in

HMP228 Moisture and Temperature Transmitter for Oil

On-line Measurement of Oil Gives up-to-date Information for Operators

The Propulsion Unit of ABB Marine and Turbocharging relies on Vaisala to measure the moisture in lubrication oil on-line. The Vaisala HMP228 Moisture and Temperature Transmitter for Oil is a standard feature in the ABB Azipod® propulsion system. The HMP228 provides fast, reliable and accurate measurements of moisture in oil in the circulation lubrication system of under-water propulsion motors.





The ABB Azipod® propulsion unit.

shorter harbor times, reduced fuel consumption and safer operation even in harsh weather, restricted passages and offshore environments.

The Azipod system is an azimuthing electric propulsion drive with a propulsion motor installed inside a submerged azimuthing (unlimited 360 degrees) pod, coupled directly to an extremely short propeller shaft. The variable speed electric (AC/AC) drive produces smooth torque over the entire speed range, including zero speed. ABB designs and manufactures Azipod propulsion units for all marine propulsion applications, with units available with powers of up to 25 MW.

Over 10 years marine experience

Azipod was first conceived in 1987. After several years of research and development, the world's first Azipod® propulsion system (1 x 1500 kW) was delivered in 1990 to the service vessel "Seili". This was followed by the first tanker application "Uikku" (1 x 11 400 kW) in 1993, the first icebreaker application "Röthelstein" (2 x 560 kW) in 1994, and the first cruise vessel application "Elation" (2 x 14 000 kW) in 1998. By 2002, 76 Azipod units had been delivered to a total of 36 ships, with 11 delivered to ice breaker applications. Azipod units now have more than 472,000 cumulative operating hours in the world's seas.

Vaisala HMP228 Moisture and Temperature Transmitters for Oil are being installed in Azipod propulsion systems to measure on-line the moisture in the oil in circulation lubrication. Each ship has from one to three propulsion units and each propulsion unit has its own HMP228 to control oil. HMP228 units have already been installed in over twenty Azipod systems. It is a standard feature in new propulsion units and retrofittings are also being done on old units. "The on-line detection of moisture in oil with HMP228 has raised a lot of interest and customers are really willing to have the HMP228 units in their ships, even as retrofittings," says Mrs Lundell, Production Engineer of ABB Marine and Turbocharging, Propulsion Units.

On-line measurement helps operators monitor oil quality

Water contamination reduces the performance of oil, increasing the risk of corrosion, overheating, machine malfunction and other problems. Measuring and controlling the moisture in lubrication systems is essential to avoid costly failures. Careful monitoring of the moisture in oil within lubrication systems helps to plan servicing and prevent unscheduled downtime, thus potentially cutting maintenance costs substantially. On-line detection is especially important in applications with a risk of water contamination, for example marine applications.

In the Azipod propulsion system the electric propulsion motors are located under water. Each motor has two bearings, a propeller bearing and a thrust bearing. The lubrication system circulates oil from bearings in the propulsion unit to inside the ship's machine room, where the HMP228 unit is located. The purpose of on-line detection of moisture in oil is to monitor oil quality and to secure the proper lubrication quality. "The amount of oil in the Azipod propulsion system is rather small -- only around 200 liters -- compared to traditional propulsion systems that have up to 4000 liters of lubrication oil," explains Mrs Lundell. "With such a small amount of oil even a small amount of water will reduce lubrication quality, therefore, the moisture in the oil in the lubrication system must not exceed certain limits. The HMP228 issues a warning immediately something has happened so that the oil can be changed or purified." ➤

Mrs Susanna Lundell, Production Engineer of ABB Marine and Turbocharging, Propulsion Units.

HMP228 provides flexible and easy measurement

The first system ABB used to detect moisture in oil was an optical measurement system. "Optical measurement was expensive and difficult to assemble," remarks Mrs Lundell. "After testing the HMP228 and finding it fast, reliable and accurate we decided to change to it for on-line moisture detection. Above all, the HMP228 is easy to assemble and use: just fix the ball valve and connect the cables and the HMP228 is ready to go!"

Oil type, age and temperature irrelevant

Measurement with the HMP228 is independent of oil type, age and temperature. The HMP228 Transmitter measures water in oil in terms of water activity (a_w). The water activity measurement indicates directly whether there is a risk of free water formation. With a relative scale from 0 (no water present) to 1 (oil is saturated with water) it gives a reliable indication of how close the saturation point is. Water in its free form has a water activity of 1. As the solubility of water in oil increases with rising temperature, the saturation point of oil pulls further away. Thus water activity decreases with rising temperature.

According to Mrs Lundell, using water activity as a unit is new in the marine industry: "We have become accustomed in this field to seeing water saturation expressed as ppm. ABB has therefore had a conversion diagram from aw to ppm made by the VTT Technical Research Centre of Finland. Water activity has certain advantages in its independency of oil type, age and temperature, but as long as our customers in the marine industry are more familiar with ppm than aw values we will use them too." ●

The on-line detection of moisture in oil is especially important in those applications with a risk of water contamination, such as marine applications.

A HMP228 unit installed in a ship's machine room. Installation is easy and convenient to perform through a ball valve.

The Vaisala HMP228 allows the on-line moisture measurement of oil

The HMP228 Moisture and Temperature Transmitter for Oil offers fast, reliable and accurate on-line detection of moisture in oil. The transmitter is especially designed for lubrication and hydraulic oil systems, such as paper machines, diesel engines and power plants.

The Vaisala HMP228 Transmitter measures water activity and temperature in oil. The water activity (a_w) measurement offers several advantages compared to the traditional ppm-measurement. The HMP228 provides reliable information on how close the oil is to its saturation point. Oil-specific calibration is not necessary, as water activity is not affected by the type or age of the oil. Moreover, the transmitter can be ordered with a ball valve set, allowing the probe to be installed and removed for calibration without needing to drain the oil system.

The HMP228 incorporates Vaisala's HUMICAP® capacitive thin film polymer sensor, known for its accuracy, reliability and long-term stability. ●

The HMP228 controls the lubrication oil of a propulsion unit's bearings.

The new radiation shields are used in outdoor installations to protect relative humidity and temperature measurement instruments from rain and sun radiation.

New Radiation Shield Models DTR502B and DTR503A

Vaisala has launched new radiation shield models which are available for vertical pole, horizontal beam or flat surface, such as wall, installation. The new radiation shield models are easy to install, maintenance free, and available separately as an additional accessory for the humidity instruments, to be integrated, for example, into HVAC application ventilation systems or a wide variety of weather stations and observing systems. The shields protect measurement instruments from scattered and direct solar radiation and rain, ensuring reliable measurement data.

The Vaisala DTR502B Radiation Shield is a naturally ventilated 9-plate radiation shield complete with accessories to allow easy installation of the sensor heads of HMP233 and HMP237 Humidity and Temperature Transmitters into the shield. In addition to the sensor head accessories, the mechanics for pole installation (i.e. vertical installation) is included.

The Vaisala DTR503A Radiation Shield is a naturally ventilated 12-plate radiation shield included with a similar vertical pole, horizontal beam or flat surface installation set to that of the DTR502B Radiation Shield. The DTR503A Radiation Shield offers an accessory for HMP45A/D Humidity and Temperature Probe mounting.

In both models, the plates of the shields are made of a special material that offers excellent thermal characteristics and UV stabilized construction. For maximum protection, the outer surfaces are white to reflect radiation and the insides are black to absorb accumulated heat thus eliminating the possible warming inside the shield and resulting in very good measurement results in outdoor applications. ●

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Moisture assessment in power transformers

Lessons Learned

The need to know the water content of paper accurately under all operating conditions is essential for the safe operation of transformers. To improve existing methods of determining the water content of paper, a concept of "water-in-paper activity" has been developed. The water solubility parameter is of paramount importance for the accurate evaluation of water content. A stand-alone software application, the Transformer Moisture Monitor (TMM), is recommended for moisture assessment. The development of a new classification procedure provides a means of ranking dry and wet transformers.

Water in transformers appears as an unwanted substance, decreasing insulation breakdown strength and shortening transformer life dramatically. High water content in paper may result in bubbling, the formation of free water and an increased risk of dielectric breakdown. Water also causes accelerated paper aging, corrosion of core/tank and progressive consumption of oil additives.

Water contamination in transformers comes from three main sources: residual moisture in the "thick structure elements", ingress from the atmosphere, and the aging decomposition of cellulose and oil.

Residual moisture in a new transformer after factory dry out, prior to transportation, is expected to be less than 1%, with a target value of 0.5%. Excessive residual moisture of 2-4% can remain in some thick insulation components, particularly plastics[1]. During service, this moisture gradually seeps into the oil, increasing the water content in the thin insulation structure[1].

Atmospheric water is the main source of transformer contamination. Three mechanisms are acting here: the absorption of water from the direct exposure of the insulation to the air (installation and repair works), the ingress of moisture in the form of molecular (Knudsen) flow due to the difference in the water concentration in the atmosphere and in the oil in the tank, and the viscous flow of wet air into the transformer caused by the difference between the atmospheric pressure and the pressure in the tank[1].

The molecular flow of moisture is practically negligible. The main mechanism of water penetration is the viscous flow of wet air through "poor sealing", i.e. through the sealing points of bushings, the explosion vent and the cooling circulation loop etc., due to the pressure gradient. Large amounts of rainwater can be pumped into the transformer in a very short period of time (just a few hours) if there is improper sealing and a rapid drop in pressure[1].

Methods and instrumentation for moisture measurement

The term "moisture" in the transformer industry is commonly used to indicate water which is absorbed in the paper or dissolved in the oil. Occasionally, the terms "water" or "water content" are used as an alternative way to describe the same substance.

Water in transformers can be found in different parts of the insulation system. It can accumulate in solid insulation, be dissolved in oil, or be found in the form of liquid water at the core or bottom of a transformer. Depending on the media, different methods and instrumentation are used for moisture measurement. For example, to evaluate water content in oil, polymer relative humidity/relative saturation sensors are frequently used. By measuring the relative saturation of oil one can easily determine its absolute moisture content expressed in parts per million (ppm). In this case the water solubility characteristic for the specific oil must be known in advance. Being a real-time effi-

cient on-line method, the moisture-in-oil measurement has attracted a lot of attention in recent years. A number of commercially available sensors have been tested in different conditions using the Monash test rig.

Another method for ppm determination is a technique based on the well-known Karl Fischer titration reaction. However, this method is not a real-time one and requires appropriate chemical instrumentation for its implementation. It is also prone to a high level of error and its results are often difficult to interpret. A timely and accurate measurement of the oil temperature should be made when obtaining the oil sample.

There is also a group of methods based on the measurement and analysis of dielectric properties of insulation. Diagnosis with these methods is based on the fact that paper and oil change their dielectric properties when moisture levels increase. Therefore, by measuring parameters such as the dissipation factor, polarization and depolarization currents (PDC) and return voltages (RVM) in the frequency and time domains, it is possible to relate these changes to water concentration in a paper-oil insulation system. However, with most of these methods it is difficult – if not impossible – to distinguish the effects of moisture on the insulation from the effects of aging caused by other processes. This creates a lot of confusion over the reliability of dielectric response methods. Interpretation of the results still remains more art than science.

Water content of paper insulation

One of the aims of the moisture assessment of oil-filled power transformers was to evaluate the water content of its paper insulation. The term "paper insulation" is a generic term that describes solid cellulose material, such as paper, pressboard, wood and cotton. Another term, "water content of paper (WCP)", is used to quantify the amount of water present in paper insulation. Traditionally, the term WCP refers to a ratio between the mass of water and mass of dry non-oily paper, expressed in a percentage. The mass of water is calculated from the difference between the masses of wet and dry paper. The paper is usually dried out in an oven prior to the measurement of the dry paper mass. The traditional term WCP gives a clear meaning for non-oil-impregnated paper.

For oil-impregnated paper the WCP can still be measured, in this case using the Karl Fischer titration method. Following the measurement of water mass in the Karl Fischer apparatus, the oily paper is degreased and only then placed in an oven for drying. To obtain an accurate measurement, the thickness of the piece of paper or strip of pressboard should not exceed a few hundred microns. However, for a paper-oil insulation system with both thin and thick paper insulation the situation for measuring the WCP is completely different.

In a study conducted at Monash University under an EPRI, USA sponsored project, a new method of moisture assessment in operating transformers was developed, based on a water-in-paper activity concept. The parameter of water-in-paper activity is used to access moisture conditions in both new and old transformer insulation systems. Another term, "active water content of paper (WCP_A)", was also introduced. The term WCP_A reflects the water available in the transformer insulation for exchange between paper and oil. A new moisture equilibrium chart (shown in Figure 1) relating the parameter of water-in-paper ➤

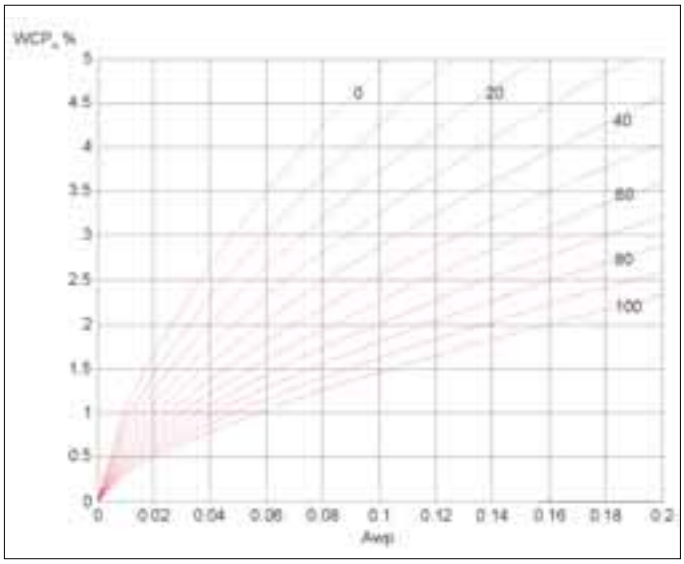

Figure 1. Moisture Equilibrium Curves relating water-in-paper activity to active water content of paper for temperatures from 0 to 100 °C.

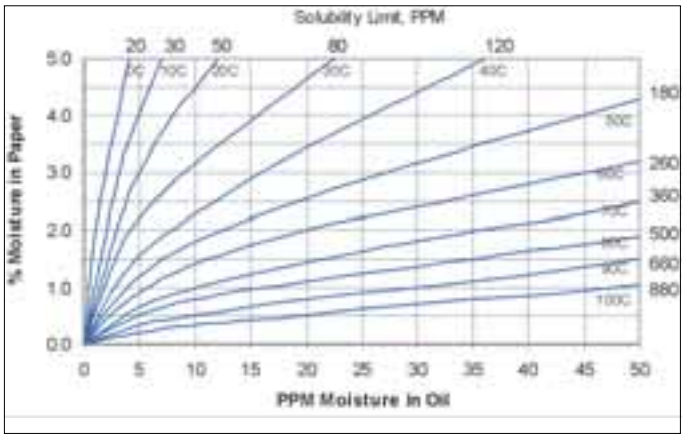

Figure 2. Moisture Equilibrium Chart as published in "Moisture Equilibrium Charts for Transformer Insulating Drying Practice".[2]

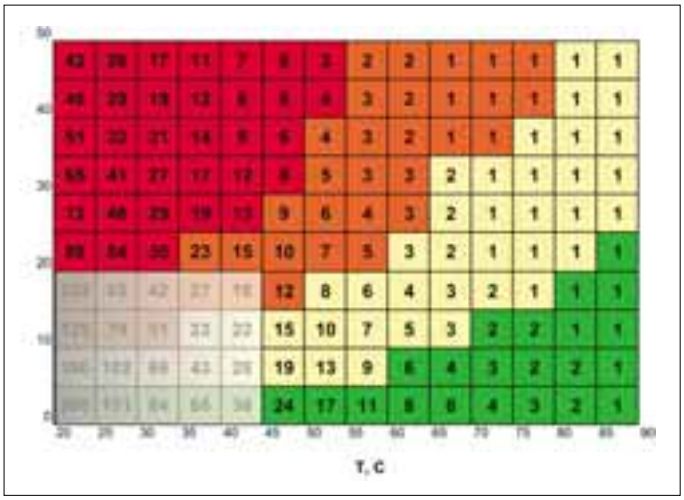

Figure 3. Chart for off-line moisture diagnostics of transformers containing new oil.

activity to the WCP_A was developed.

Numerically, water-in-paper activity (A_{wp}) is equal to the equilibrium percentage of relative saturation (RS_{eq}) divided by 100.

There are a number of ways to evaluate the WCP_A of paper insulation in a paper-oil insulation system. One of them is apparent from Figure 1. To use the curves of Figure 1 we need to establish equilibrium conditions in the system and measure the parameter of A_{wp} using a relative saturation (RS) sensor.

Another way to evaluate the WCP_A of paper insulation in a paper-oil insulation system is to use a moisture equilibrium chart, similar to the well-known moisture equilibrium chart published in 2 and shown in Figure 2.

The chart in Figure 2 gives the relationship between the water content of oil (WCO) expressed in ppm, the temperature and the "% Moisture in Paper", which, in fact, for thin paper insulation is equal to the WCP_A. Again, to evaluate the WCP_A, we need to establish equilibrium conditions in the system and then measure the WCO using the Karl Fischer apparatus. However, we must measure one more parameter in this case, prior to the evaluation of the WCP_A. This parameter is called the "water solubility of oil S(T)", or, as in Figure 2, the "Solubility Limit, ppm".

The moisture equilibrium chart in Figure 2 was developed for new oil. The figures around the chart show the water solubility parameter S(T) for new oil at temperatures from 0 to 100 °C in 10 °C intervals.

Assessment of moisture in an operating transformer

It is known that an operating power transformer is never in moisture equilibrium. Thus, the two moisture equilibrium charts in Figures 1 and 2 cannot be applied directly when assessing moisture in the field. To address this, a method for the moisture assessment of transformer insulation has been developed. The method is based on the Monash water-in-paper (WIP) algorithm, which incorporates the following three steps:

- Evaluation of true oil relative saturation in the transformer
- Evaluation of the water-in-paper activity (A_{wp}) for the transformer oil
- Evaluation of the active water content of paper (WCP_A) as a function of A_{wp} and temperature.

A software application, the Transformer Moisture Monitor (TMM), has been developed on the basis of the WIP algorithm. The TMM uses neuro-fuzzy computing to evaluate the consistency of the moisture sensor output, to access the WCP_A, and to alert the user when insulation conditions require attention. The TMM acquires data from the Vaisala HMP228 Humidity and Temperature Transmitter. The probe of the transmitter has both moisture and temperature sensing elements at its tip.

New classification procedure for off-line moisture diagnostics

The research conducted at Monash University has shown that, for the accurate moisture assessment of transformer insulation, the continuous monitoring of a number of parameters, including transformer load, temperature and oil relative saturation, is required. The measurement of water solubility characteristic of oil in the transformer is also required.

A utility may operate tens or even hundreds of transformers. However, not all of the transformers require continuous monitoring. How is it possible to identify a transformer with moisture concerns for further monitoring? There is a demand for a classification procedure, which would rank transformers by moisture levels.

A traffic light approach is the EPRI adopted way of ranking the health of plant equipment. Red, yellow and green colors would indicate the 'wet', 'requires attention' and 'dry' states of moisture in transformers.

A new classification procedure was developed to rank, from a population of power transformers, critical transformers in terms of moisture for further continuous monitoring. The new classification procedure aims to improve the effectiveness of the management of transformer life.

The new classification procedure is based on a method of moisture assessment that evaluates the WCP_A and was briefly described in the section above. It is available in the form of a chart, shown in Figure 3. Values of WCO in ppm represent the results of Karl Fischer (KF) measurements and values of the temperature T represent the temperature of the oil at the moment of oil sampling. In Figure 3, values of WCP_A are distinguished by color. Green corresponds to a WCP_A of less than 1%, yellow corresponds to a WCP_A of between 1% and 2% and red corresponds to a WCP_A of more than 2%. The numbers in the squares represent the diffusion time constant for moisture across a 1-mm pressboard plate exposed to oil from both sides. The 1-mm pressboard was chosen to reflect the approach of the water-in-paper activity applied to the transformer ranking and classification.

At an oil temperature below 45 °C and WCO of less than 20 ppm, the moisture diffusion time is too long for the reliable diagnosis according to the proposed procedure. To reflect this fact the bottom left corner of the graph in Figure 3 is shadowed.

The classification procedure chart in Figure 3 is valid for oil with a water solubility characteristic close to that of new oil. In the previous section of this paper it was demonstrated that the water solubility characteristic of new and aged oil can differ significantly. This means that for

the accurate ranking of aged transformers, evaluation of the oil's water solubility characteristic would be required.

In light of the new knowledge presented here, the traditional approach, which states: "If the WCO exceeds 20 ppm, the transformer requires further attention, if the WCO is less than 20 ppm no action is required," must be reconsidered. From Figure 3 it follows that at WCO=20-25 ppm a transformer with new oil would be considered "probably wet" if the oil sample was taken at a temperature of below 55 °C. However, if the oil sample was taken at a temperature of above 80 °C, with the same WCO=20-25 ppm, the transformer would be considered "probably dry". To prove or reject the conclusion, one more sample of oil should be taken in the number of hours shown in the related square on the chart. This example illustrates the importance of the measurement of oil temperature during the oil sampling, the importance of the second oil sampling, and the importance of the length of time between the two sampling events.

It is apparent that knowledge of the WCO only, gained from a single Karl Fischer measurement, is insufficient for the accurate assessment of transformer moisture condition. Knowledge of the temperature of the first oil sample, the dynamics of moisture and temperature gained from the second oil sample, and the water solubility of the oil are also required.

Conclusions

Oil type, age and flow rate contribute to the measurement and subsequent accuracy of moisture assessment in a paper-oil insulation system. Sensor positioning also contributes to the accuracy of moisture assessment.

The parameter of the water solubility of oil is required for the validation of the moisture sensor installed in the transformer. Water-in-paper activity was found to be a factor in determining the state of dryness in a power transformer.

A stand-alone software application called "Transformer Moisture Monitor" (TMM) is proposed for the moisture assessment of a transformer.

A new classification procedure that aims to identify critical units for further continuous monitoring is suggested for the ranking of power transformers by the level of moisture. Red, yellow and green colors would indicate the 'wet', 'requires attention' and 'dry' states of moisture in transformers. The classification procedure presented is only valid for oil with a water solubility characteristic close to that of new oil. For the accurate ranking of an old transformer, the water solubility characteristic of the transformer's oil would need to be evaluated. ●

The determination of moisture in oil is an essential part of a comprehensive transformer maintenance program.

HMP228 Moisture and Temperature Transmitter for Transformer Oil

The HMP228 Transmitter provides on-line measurement of moisture and temperature in transformer oil. The measurement gives continuous information and enables better maintenance against transformer failures.

Vaisala's microprocessor-based HMP228 Transmitter is accurate, reliable and fast. The basic model of the HMP228 Transmitter calculates the average water solubility in mineral transformer oil. The water solubility in oil is temperature dependent: water solubility increases as temperature raises. In addition to traditional ppm-output, the transmitter measures water activity. The water activity (a_w) indicates directly whether the oil is too moist. The a_w measurement is independent of the type, aging or temperature of the oil. ●

References:

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2. T. V. Oommen, "Moisture Equilibrium Charts for Transformer Insulating Drying Practice", IEEE Trans. on Power Apparatus and Systems, Vol. PAS-103, 10, 1984, pp.3063-3067

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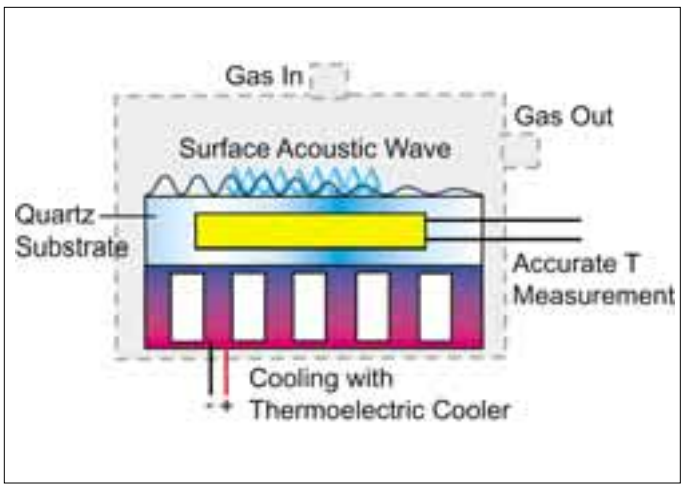
Vaisala's new DM500 Precision SAW Hygrometer has been specifically developed for applications where high accuracy is needed. The DM500 offers reliable measurements and ease of use, enhanced through additional product features, such as the graphical user interface. With excellent measurement performance and an easy-to-use product concept, the DM500 represents a new generation of high accuracy dewpoint measurement instruments.

New technology for high accuracy measurements

Vaisala's DM500 - Dewpoint Reference

The Vaisala DM500 Precision SAW Hygrometer offers excellent measurement performance with Surface Acoustic Wave (SAW) technology. The DM500 is the best choice for calibration laboratories and for use as a transfer standard. Due to the rugged sensing technology, the DM500 is also suitable for use in industrial applications, such as metal treatment processes. The innovative DEWCAP® SAW Sensor offers the advantage of high accuracy and reliable dewpoint measurement with excellent repeatability and fast response time. In addition, DEWCAP® technology can withstand particulate contamination and distinguish dew and frost directly.



With the DEWCAP® sensor condensation on the cooled surface is detected by a high frequency SAW signal which attenuates in dew or frost.

Product concept

The DM500 Precision SAW Hygrometer consists of a DMI500 User Interface Unit and a DMP501 Dewpoint Sensing Unit. The User Interface Unit includes display, keypad, power source and analog outputs. The Dewpoint Sensing Unit includes the SAW -based sensor and measurement and cooling elec-

The DM500 provides highly accurate dewpoint measurement with excellent repeatability.

Standard without a Mirror

tronics. Three different installations are available for the DM500: installation in a 19" rack, remote installation, and use of the DM500 as a desktop/portable instrument equipped with optional handle.

High measurement performance

The DM500 is an automatic, continuously controlling condensation hygrometer measuring dewpoint temperatures from -75 °C to +60 °C Td with ±0.2 °C traceable accuracy. For low frostpoint measurement, the DM500 has a connection for water cooling. In order to prevent condensation when measuring high dewpoints it is also equipped with an optional heated gas sampling system and a control for external pipeline heating.

Dew/frost determination

The DM500 detects the difference between dewpoint and frostpoint at dewpoint temperatures below 0 °C directly, without any additional cooling cycles. In traditional condensation hygrometers such as chilled mirrors the optical beam can not see the difference in the condensate. The problem exists when high accuracy measurement has an additional uncertainty factor in the typical range –30…0 °C Td. The presence of liquid condensation on the DEWCAP® sensor alters the signal in a repeatable way. Freezing the condensate causes a distinctly different signal change, thus enabling the determination of dew or frost on the DM500's sensor.

The DM500 has a high-quality LCD display with menu -based user interface.

Fast response time

The SAW signal is attenuated by dew/frost, which absorbs the energy of this micromechanical wave. The SAW detects very small amounts of condensate - as little as one-tenth of that required by an optical detection system. This means substantially faster response times, particularly at low frostpoints. ➤

Withstands contamination

The DM500 operates reliably even with substantial particulate contamination on the sensing element. The SAW signal is sensitive for condensate (dew/frost) but not for particulates.

Salt sensing

Hygroscopic dirt is a common source of error in conventional dewpoint measurement techniques as it can change water vapor pressure close to the sensor. The DM500 can detect the presence of salts or hygroscopic dirt on the sensor surface with its intelligent self diagnostics.

Chemically durable

Use of a quartz wafer as a sensor substrate gives excellent resistance to aggressive chemicals. Wetted parts are limited to stainless steel, silicone, tantalum, vectra polymer and quartz. All water absorbing materials are located downstream.

Various output variables

The DM500 displays user selectable hygrometric units, such as dewpoint/frostpoint temperature, relative humidity, partial pressure of water vapor, and humid air volume/dry air volume (ppmv). In addition, the DM500 can measure temperature, pressure and gas flow rate if the instrument includes the corresponding optional sensor.

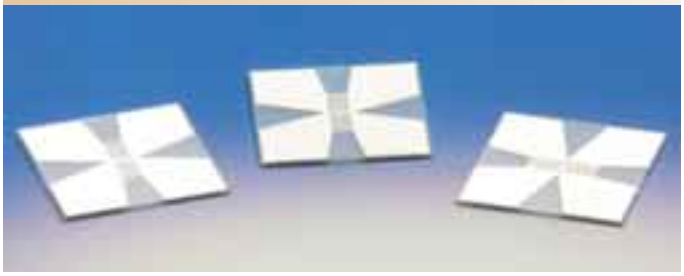
Wide variety of additional features

The DM500's display can be switched between numeric or graphical. The multi-lingual user interface is menu based and very easy to use. The DM500 also has data-logging capability and is equipped with the sophisticated MI70 Link Windows® software program for easy PC connection. ●

DEWCAP® Sensor and Surface Acoustic Wave (SAW)

Vaisala's DEWCAP® Sensor uses Surface Acoustic Wave (SAW) technology to usher in a new generation of condensation hygrometers. In Surface Acoustic Wave (SAW) technology the temperature controlled quartz sensor surface is cooled until dew or frost collects on the sensor surface. The presence or absence of condensation is sensed using the SAW instead of the traditional optical beam used in chilled mirrors. In measuring mode, the temperature of the DEWCAP® quartz surface is varied until condensation exists in equilibrium. When the equilibrium is reached, the temperature of the sensor surface is measured by a precision Pt-100 PRT. This measured temperature equals the dew/frostpoint temperature of the measured gas. ●

The DEWCAP® sensor is based on innovative SAW technology.



James Tennerman
Business Development Manager
Vaisala
Boston
USA

How to fully benefit from using the

Vaisala DM500 Precisi

Good planning is essential for achieving high performance measurement results with any metrology tool. Successful application of the Vaisala DM500 Precision SAW Hygrometer is best achieved with a three step planning approach. These steps can be described as evaluation, preparation, and execution.

Evaluation

Evaluation starts with an understanding of the intended use of the Vaisala DM500 Precision SAW Hygrometer. The results of evaluation include a "go" or a "no-go" decision as to the suitability of the instrument for the application. In the case of a "go," the correct product configuration will be evident. The following are critical things to consider during the evaluation:

What is the anticipated dewpoint or range of dewpoints to be measured?

- Identifies the correct sensor model and any possible need for external cooling,
- Identifies whether elevated dewpoints may cause condensation in the gas system, requiring the use of a heated sensor,

What is the pressure of the sample gas?

- Identifies the need for a pump option if pressure is ambient,
- Assures that maximum process pressure is within safe limits,

What is the temperature of the sample gas?

- High temperature gas should be cooled to ambient before measurement,

What is the composition of the sample gas?

- Assures material compatibility with the sensor,

What are the desired humidity parameters for display or output?

- For %RH, a temperature sensor option is required,
- For ppmv or other pressure

on SAW Hygrometer

The DM500 Precision SAW Hygrometer is an automatic, continuously controlling condensation hygrometer which is suitable for calibration laboratories and for use as a transfer standard.

sensitive parameters, a pressure sensor should be specified.

Preparation

When the suitability of the DM500 has been established, preparation takes into account the entire measurement scenario.

Filtration
If substantial particulate contamination is present in the gas sample, a non-hygroscopic filter should be installed in the sample line before the sensor. This minimizes the need for sensor cleaning and keeps the gas channel free of contaminants that may adversely effect measurement response time.

Fittings & tubing
Stainless steel tubing should be used for best results with dewpoint temperatures below –30°C. US users will typically want to use 1/4" tubing, compression fittings, and accessories that are equipped to be connected in this way. Other users will typically specify 6 mm tubing and fittings. Rubber and/or Tygon tubing should not be used for sampling!

Flow control
Samples at positive pressure will require some type of flow control downstream from the sensor for correct measurement of pressure dewpoint.

Physical location
The DM500 should be located in an environment consistent with the specifications. Access to the back of the sensor is required for gas and coolant connections. Appropriate line voltage should be available.

%RH measurements
Location of the temperature sensor is important. In general, the temperature sensor should be in the location where the user wants to know the relative humidity.

Execution
With the DM500 correctly specified and installed, all that remains is to operate and maintain the system.

• Cooling water should be circulating if installed; care should be taken to assure that condensation forming inside the sensor housing is drained.
• Response time is a function of the slew rate of the Peltier coolers and the rate of water vapor capture at the process dewpoint.
• Maintenance of the sensor should be performed as required. When liquid cooling is in use, sensor cleaning should only be done when the coolant temperature is above the ambient dewpoint.
• Maintenance of the cooling system and filtration components should be performed as required. ●

Meteorological dewpoint measurements from arctic conditions to hot deserts

National Weather Service Relies on Vaisala Instruments for Dewpoint Measurement

Jan Grönblad, M.Sc. (Eng.)
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Sensor Systems Division
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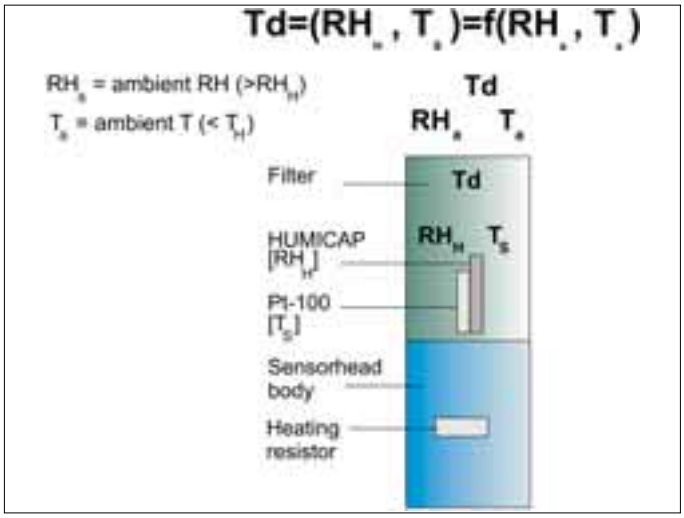
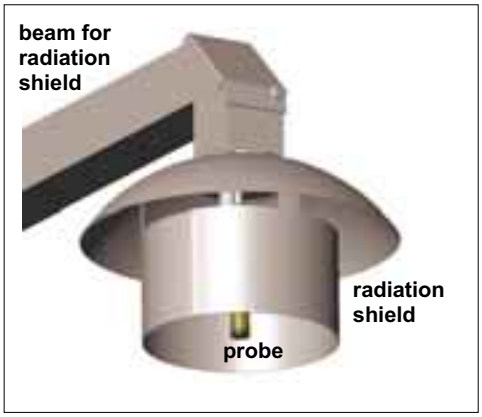
Finland

The National Weather Service (NWS) in the USA has started to update the dewpoint measurement in the ASOS (Automated Surface Observing System) network with Vaisala's HUMICAP® technology. The high measurement performance over a wide measurement range together with the long maintenance interval were among the most important factors considered when selecting the new-generation technology for the network. Vaisala's unique warmed sensor technology was finally chosen to satisfy the most demanding needs in humidity and dewpoint measurement.

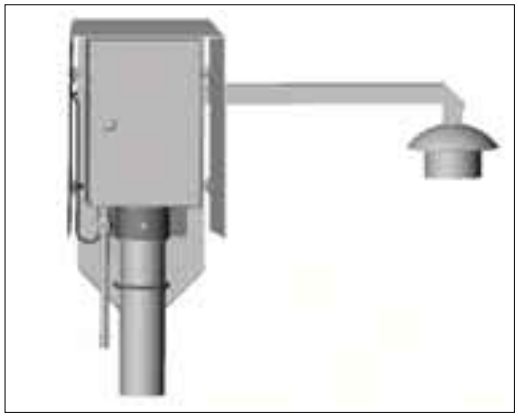
Vaisala's 30 years experience with capacitive humidity sensors has resulted in a sensor which satisfies one of the most demanding needs in humidity and dewpoint measurement.



The dewpoint measurement principle in the warmed sensor head. The temperature of the warmed HUMICAP® sensor is measured accurately in addition to the RH measurement. These values result in ambient dewpoint as dewpoint does not change although the temperature of the sensor rises.



The dewpoint probe in the specially designed radiation shield with open structure.



The dewpoint measurement in the ASOS network at NWS incorporates an installation kit for the sensor head together with an enclosure for the dewpoint transmitter and optical modem. The warmed probe of the transmitter is installed in a radiation shield with open structure.

After a long evaluation period the National Weather Service in the United States has started to replace its dewpoint measurement instruments with Vaisala's HUMICAP® technology throughout the ASOS (Automated Surface Observing System) network in the USA. This network covers the entire continent from Alaska to Texas, setting very high demands for the instrumentation in terms of environmental conditions, which range from arctic to hot desert. The sensors that are being replaced represent technology with a high need for maintenance, mainly due to the basic operation principle of the instruments. They utilized chilled mirror technology with optical dew detection which is known to be sensitive to dirt.

Reliable measurements with low maintenance needs

The new instrument for dewpoint measurement in the ASOS network is based on warmed HUMICAP® thin film polymer sensor technology, used in, for example, Vaisala HMP240 Series products. The measurement with capacitive thin film polymer sensor is itself very reliable and has a very low failure rate. For example, the MTBF value (mean time between failures) for the HMP243 Dewpoint Transmitter is more than 18 years (with 2σ confidence). The measurement technology is also not very sensitive to dirt and operates with the required accuracy over the specified wide temperature and humidity range.

Warming prevents the adverse effects of moisture

The advantage of warming is a reliable measurement even in situations where the humidity levels are close to 100%RH, i.e. the moisture in the air starts to condensate and dewpoint equals the ambient temperature. Warming ensures the sensor will not get wet which could result in incorrect humidity readings (too high) until the sensor dries up. In warmed sensor technology, the temperature of the HUMICAP® sensor is measured accurately in addition to the relative humidity measurement from which the dewpoint is calculated. The calculation results in actual ambient dewpoint, as dewpoint does not change although the temperature of the sensor rises.

Additionally, the long-term stability provided by HUMICAP® technology makes the final product concept unprecedented. It allows high-performance meteorological dewpoint measurements with minimal maintenance needs, meeting the exacting requirements of the NWS surface weather observing system. ●

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When direct dewpoint spot measurement is not possible

DSS70A Portable Sampling System

The Vaisala product family of portable dewpoint measurement instruments has now been enhanced with a sampling system option. The new DSS70A Portable Sampling System allows measurements to be made in applications where a direct measurement cannot be used. It also allows measurements to be made in the most demanding processes, with dusty and hot process gas samples.

The DSS70A Portable Sampling System, delivered in a carrying case, includes everything needed for sampling.

Compact design

The Vaisala DSS70A Portable Sampling System is a battery-powered system for portable dewpoint sampling applications. The DSS70A system enables dewpoint measurements to be made from places where direct measurement is not possible. The product is an option for the DM70 Hand-Held Dewpoint Meter family, but can also be ordered separately. This complete compact sampling system has been built around Vaisala's DM70 Hand-Held Dewpoint Meter.

The DSS70A is designed to provide the greatest amount of sampling flexibility. A battery-powered pump is used to extract a gas sample. The sample gas then passes through a filter to remove particulate contamination before measurement. Flow through the system is controlled and monitored with a needle valve and flow meter. The DSS70A is then simply connected to an appropriate sample point where tubing and measurement results can be monitored and analyzed with a Vaisala MI70 Measurement Indicator.

Demanding applications

The DSS70A is designed to work even in very demanding processes, for example in metal treatment processes, where the measured air sample is very hot and dirty. In plastic dryer applications a DM70 Hand-Held Dewpoint Meter together with a DSS70A Sampling System is an optimum tool to check the dryer is working properly.

Performance

- Wide measurement range – from -60 °C to +60 °C
- Fast response time between start-up from ambient conditions to low and high process dewpoints
- Standard process connections 1/4" SWAGELOK®
- Flow meter and needle valve to adjust sampling rate
- Changeable filter
- Clear battery indicator
- Rechargeable battery or AC usage
- Graphical trend display
- Sophisticated data collection functions including Windows® software

Measurement reports made easy

The Vaisala MI70 Measurement Indicator offers many handy features to analyze and collect data during measurement. The indicator has numeric and graphic display modes to follow the process trends. Measurement results can be stored in the memory and then later easily transferred to a PC at the office, using the optional Windows® software. ●

Mechanics Engineer Kari Bergman of Vaisala checks an injection moulding plastic dryer at Plastoco Oy.

Precision plastic injection moulding requires

Accurate Monitoring of Plastic Drying Process

In plastic production plants, dewpoint measurement is essential for monitoring the drying process. Tessy Plastics Corporation's state-of-the-art facilities have been equipped with Vaisala dewpoint measurement instruments for their drying units, with Vaisala technology also relied upon to cater for other measurement needs in their facility.

Tessy Plastics Corporation is a custom plastics injection molder headquartered in Elbrige, New York (USA). The company manufactures products for the medical, automotive and electronic industries, amongst others. Beside the plant in New York, Tessy Plastics Corporation has facilities in Virginia and China. The facility in Central New York houses a white room and a clean room, with post molding, engineering, design and tool building capabilities.

In order to be able to monitor the operation of plastic air dryers, Tessy Plastics use two Vaisala DM70 Hand-Held Dewpoint Meters. The DM70 measures dewpoint accurately in a wide measurement range, which is important in this application. The Advanced Manufacturing Facility Maintenance Supervisor, Todd Eaton, who is responsible for the maintenance of the plant production machinery, plant facilities, plant engineering and process improvement, stresses that the plastic dryers must operate with dewpoints below -40°F (-40°C) continuously for proper plastic drying. "Since the first DM70 unit was purchased in January 2002, additional instruments have been installed in our plant and in the drying systems," remarks Mr. Eaton.

The plant is also equipped with a DMT242 Dewpoint Transmitter that was purchased to upgrade one of the dryers. To monitor a dehumidification unit, a Vaisala DMP248 Dewpoint Transmitter is used. Moreover, a HMP233 with a radiation shield is used to monitor outside conditions, measuring the wet bulb and enthalpy of outside air. This instrument allows the maximization of free cooling potential using outside air. Additionally, the HVAC system at the plant is fitted with HMW40s that were recently installed.

Todd Eaton finds that Vaisala products offer excellent accuracy and repeatability. Moreover, the ability to be interfaced with PCs is important. "The instruments allow the recording and tracking of dewpoints and other measurements, which in turn allows us to operate our equipment more effectively and efficiently," Mr. Eaton explains. Vaisala instruments have performed very well and proven excellent for the company. ●

At Tessy Plastics, Todd Eaton uses Vaisala DM70 Hand-Held Dewpoint Meters to monitor the plastic dryers.

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The regulations for equipment used in hazardous areas where there is a risk of explosion vary slightly in different parts of the world. The Vaisala HMT360 Series Humidity and Temperature Transmitter used in hazardous areas has now received local approvals in three new countries. New approvals have been awarded to HMT360 by Factory Mutual in the USA, TIIS in Japan and Test Safe in Australia.

Safe measurements in hazardous areas

HMT360 Series Receives New Approvals

The HMT360 provides accurate measurements and safe operation on hazardous installation sites.

The Vaisala HMT360 Series Industrial Humidity and Temperature Transmitter was launched in 1999 with the European EEx approval for use in hazardous areas. However, global needs in this strictly controlled application area do not necessarily follow European regulations. This has caused the need to expand the range of local approvals for HMT360 Series Transmitters. In addition to the European approval ATEX100a from PTB (Physikalisch-Technische Bundesanstalt/Federal Institute of Physics and Metrology in Germany), the HMT360 series now has approvals from Factory Mutual in the USA, TIIS in Japan and Test Safe in Australia.

In industrial applications in the USA, Factory Mutual (FM) is an authority on approving instruments for use in potentially explosive atmospheres. Factory Mutual Research electrical equipment testing is based on Factory Mutual Research standards, American National Standards Institute (ANSI) Standards, and International Electrotechnical Commission (IEC) Standards.

In Japan, the Technology Institution of Industrial Safety (TIIS) has also approved the HMT360 Series. TIIS is a non-governmental, non-profit, self-sustaining organization which is recognized by the Ministry of Labor as a juridical incorporation. The objective of TIIS is to help reduce industrial accidents and contribute to the benefits of various industrial sectors in Japan.

TestSafe approval in Australia is the most recent approval for HMT360 Series Transmitters. TestSafe Australia is a safety testing and research facility which offers manufacturers and suppliers a comprehensive range of safety testing, certification, and approval services in the electrical, electronic, mechanical and personal protective equipment fields. Certificates and approvals at TestSafe are issued for conformance with Australian Standards and legislative requirements.

For hazardous areas the Vaisala HMT360 Series Humidity Transmitters are indispensable. They represent the latest measurement technology and fulfil safety requirements laid down in a wide variety of countries. The thorough studies made on the HMT360 Transmitter guarantee the safety of high-performance humidity and temperature measurements, even in installations with continuous exposure to the most easily ignited flammable gases. ●

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Major program to enhance national weather observation network

China Meteorological Administration Invests in Accurate Vaisala Barometers

China Meteorological Administration, CMA, is implementing a project around China called "Atmosphere Automatic Monitoring System". The objective is to set up a nationwide monitoring network of weather observation stations, in three different categories, to form a network.

According to its 10th five-year plan (2000–2004), China Meteorological Administration (CMA) has started to implement a project called Atmosphere Automatic Monitoring System, which extends over the entire country. The project aims to set up three classes of weather observation station and a monitoring network. The top-level stations, which are called national standard stations, will be the main weather observation bases in the monitoring network. Totaling more than one hundred, these stations will be equipped with the hardware needed to improve accuracy and long-term stability. The second grade of station are called basic stations and will be set up around China to raise the weather observation ability and the density of observations. The third category of station, so-called general stations, will total more than 1000. The general stations will perform observations to further increase network density and acquire more data. The automatic weather stations to be employed at these three classes of station will be manufactured in China. However, sub-assemblies and measurement instruments of foreign manufacture will be utilized, for instance for pressure measurement in the upper level stations.

The China National Meteorological Center which was responsible for the test is located in Beijing.

Extensive comparison of barometers

To improve the implementation of this project, the Department of Observations and Telecommunication of CMA, which is the topmost management office for meteorology in China, organized a comparison test for barometer performance. The Atmosphere Sounding Research Centre of China Meteorological Science Institute was responsible for the test design, setup, implementation and data collection. The comparison started with laboratory tests in 2000, with field tests then carried out from November 2000 to November 2001. They focused on the barometers' temperature stability and overall long-term stability.

The objective of the extensive test period was to choose which one or two pressure sensors would be most suitable for integration into the domestically manufactured automatic weather stations. Additionally, the aim was to improve the quality of air monitor prediction in China and to lighten the staff's workload, as well as to raise atmospheric forecasting accuracy and the level of automation in performing obser-

Barometers were tested on site for their stability,

vations in China. Some leading barometer manufacturers from around the world and China applied for participation in this trial and test.

Vaisala barometers participated

Vaisala sent 3 units of PTB210 and PTB220 Barometers to be assessed in the trial. The Vaisala PTB210 series of barometers are intended for direct outdoor installations. They operate in a wide temperature range, with the electronics housing protected to IP65 class against sprayed water. The PTB220 Series Digital Barometers cater for measurements in a wide environmental pressure and temperature range. Both the PTB210 and PTB220 series of barometers are used widely in, for instance, weather stations, data buoys and ships, and are based on the BAROCAP® pressure sensor. All six barometers showed very good performance during the trial and test. During the on site field tests trial, all barometers were installed in wind, rain, snow and shockproof test chambers under the same static pressure.

Comparison proved high performance of Vaisala barometers

The high reliability, accuracy and good stability of the Vaisala PTB210 and PTB220 Digital Barometers in this comparison proved once again that Vaisala products offer excellent quality. The good performance of the PTB series barometers was one of the most crucial factors for CMA in their selection and purchasing process. After comprehensive comparison and assessment CMA decided to purchase PTB220 barometers. Several hundred units have been delivered to CMA.

Extensive cooperation between CMA and Vaisala

CMA is one of Vaisala's most important customers in China. The various cooperation projects between CMA and Vaisala trace back to the founding of Vaisala's Beijing Representative Office in 1994. A set of MILOS 500 provided to CMA in August 1994 was much appreciated due to its advanced technology and long-term stability, proven in a 10-month test in western rural areas of Beijing. Since then Vaisala has also provided CMA with RS80-15G Radiosondes, RT20 Radiotheodolites, DigiCORA Sounding Systems with GPS wind finding, and a number of other weather observation products. In 1997 Vaisala provided the Qinghai province with key hardware for a project called Disaster Weather Monitoring Network, with the help of a loan from the Finnish government. Vaisala's Beijing office often arranges seminars on various topics to introduce state-of-art meteorological technologies. Vaisala also invites experts and officials of all levels to visit the production plant in Finland. Their high-performance products have proven that Vaisala is one of the world's best companies in the field of meteorology. Consequently, they have won the confidence of Chinese meteorological customers. ●

Vaisala's PTB220 Digital Barometers are designed for measurements in a wide environmental pressure and temperature range.

The PTU200MIK1 offers easy installation of equipment at an outdoor site.

The Vaisala SPH10 and SPH20 Static Pressure Heads are designed to minimize the errors in barometric pressure measurement caused by variations in wind speed and direction.

PTU200MIK1 Meteorological Installation Kit

Easy Measurements on Site

The Vaisala PTU200MIK1 Meteorological Installation Kit is a high-quality mounting kit for outdoor use of PTU200 Barometric Pressure, Relative Humidity and Temperature Transmitter. It allows meteorological measurements to be made on site, e.g. next to a GPS antenna. The PTU200 Transmitter belongs to recommended equipment of the SuomiNet network, an international network of GPS receivers.

The PTU200MIK1 Meteorological Installation Kit allows easy outdoor mounting and installation of the PTU200 Barometric Pressure, Relative Humidity and Temperature Transmitter. The kit consists of a protective transmitter box, support arm, a radiation shield, the SPH10 Static Pressure Head, pole attachment clamps, and a pressure hose. The kit can be attached to any pole with diameter of either 2" or 50 mm. The box offers IP65 (NEMA 4) protection for the transmitter. It is airtight and connected to the static pressure head with the pressure hose. The radiation shield protects the relative humidity and temperature probe of PTU200 and the SPH10 Static Pressure Head reduces the effect of wind on the pressure measurement.

Approved for SuomiNet

SuomiNet is an international network of GPS receivers, located primarily at universities. It generates near real-time estimates of precipitable water vapor in the atmosphere, total electron content in the ionosphere, and other meteorological and geodetic information. Each SuomiNet site has a dedicated meteorological measurement package (MET package) which records temperature, barometric pressure and relative humidity.

One of the approved MET instruments for the meteorological observations is the Vaisala PTU200 Barometric Pressure, Relative Humidity and Temperature Transmitter. The PTU200 Transmitter uses the very stable, silicon-based BAROCAP® pressure sensors and requires calibration only infrequently. The PTU200 central unit can be installed indoors with its display and keypad, or outdoors with the optional PTU200MIK1 outdoor installation kit. ●

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Finnish Meteorological Institute
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Finland

Surge in studies on

Carbon Cycles of the Ecosystems of the World

Interest in the global carbon cycle has grown greatly in recent years. Mankind is completely dependent upon primary production and interacts with the biota through different activities, such as agriculture, forestry and fish farming. The production of these basic resources will be very much affected by climate change and the growing human population.

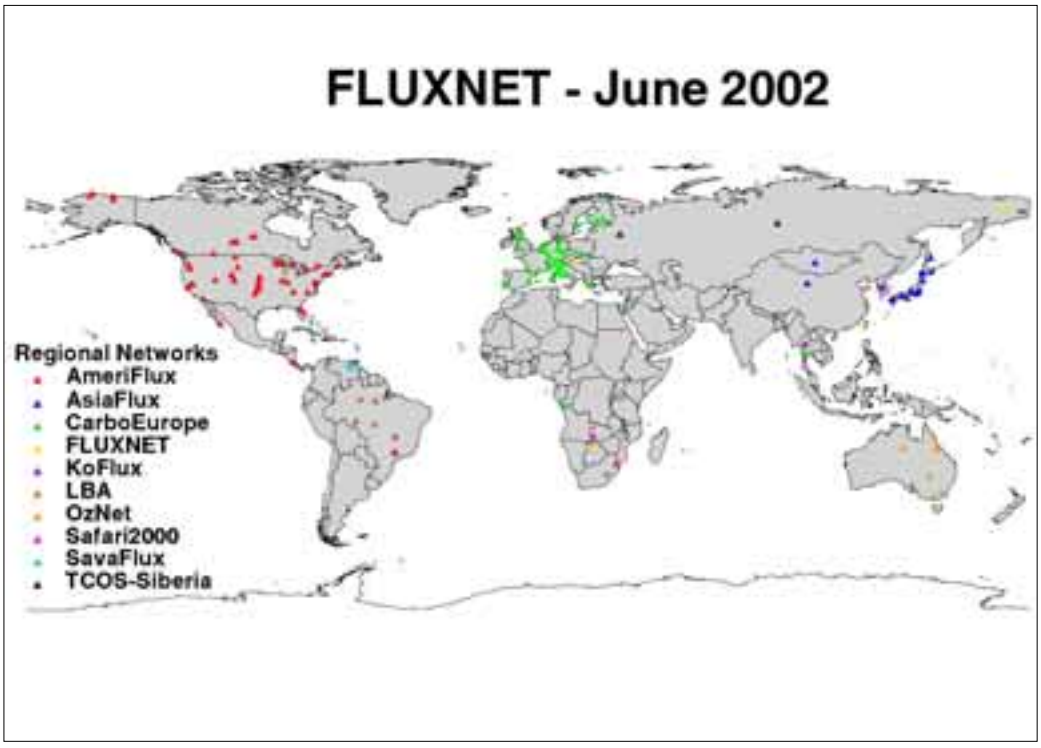

Figure 1. Most of the multiyear micrometeorological CO_2/H_2O flux sites have provided data to the FLUXNET-network, which has a Data and Information System unit at Oak Ridge National Laboratory, Tennessee.

In the 1990s, emissions of carbon dioxide from fossil fuel and cement production were, on average, 6.3 PgC (one PgC = one petagram of carbon = 1 billion tonnes of carbon) per year (IPCC, 2001)[1]. The rate of increase in atmospheric CO_2 concentration has been, on average, 1.5 ppm per year, which corresponds to 3.2 PgC per year in atmospheric storage. It is estimated that oceanic uptake is 1.7 PgC per year. To reach a balance, there has to be a net sink of atmospheric CO_2 to terrestrial areas that amounts to about 1.4 PgC per year. Land use changes, especially deforestation in tropical regions, cause a net CO_2 release to the atmosphere that was estimated to be about 1.7 PgC per year during the 1980s. From inversion modeling of atmospheric CO_2 concentrations and isotopic studies, we know that there is a large net sink (about 2 PgC per year) to the terres- ➤

Figure 2. Flux measurement site on a field at Jokioinen in southern Finland. The soil at this site is peat and one of the objectives of the study is to measure the decomposition rate of the peat and compare it to the carbon uptake by the cultivated plants. The sonic and inlet tube to the CO_2/H_2O monitor is mounted on a boom on top of the short mast. The monitoring and data acquisition computers are housed in a box on the ground. The other mast is equipped with meteorological sensors such as radiation components, temperature and humidity sensors. Also, soil temperature, moisture and heat flux to the soil are measured. During the growing season, CO_2 efflux from the soil uptake by plants is also measured by chambers to get data for ecosystem models.

trial biota, which is mostly located in temperate and boreal regions of the Northern Hemisphere. The reasons for this uptake are nitrogen deposition and increasing atmospheric CO_2 concentration, which act as fertilizers. Recent studies indicate that land use changes, especially the forestation of abandoned agricultural land, are also important contributors.

International cooperation to reduce emissions

To combat global warming, substantial reductions of fossil fuel emissions are needed. In Kyoto 1997, nations agreed upon an international protocol that aims at worldwide reductions of CO_2 emissions. To assist in reaching an agreement in negotiations, it was decided that additional terrestrial sinks might be partly used to compensate for anthropogenic emissions, i.e. human-induced emissions. The Kyoto Protocol remained on a rather general level. The negotiations thereafter, on how to define which biological sinks may be considered in the calculations, were long and difficult at many international conferences before the final text was approved in the Marrakech Accord in 2001.

Many nations would like to facilitate reduction of their emission burden through using carbon sequestration by vegetation. The problem is our insufficient knowledge of where the sinks are located and how they may change in the future. Our understanding is very much lacking in which land-use classes they are related and how forestry or agricultural practices may increase or decrease the sequestration. It is stated that the sinks should be verifiable, which is a normal condition in international agreements. However, it will be a very challenging task to develop the tools for carbon sequestration monitoring, because of different measurement approaches and the limited understanding of the processes.

Carbon dioxide budget measurements

There are several ways to study carbon balances at different scales, but all of them have severe limitations. The global CO_2 budget mentioned above is based on the very accurate atmospheric CO_2 concentration measurements, which are performed on global measurement networks. The Global Atmosphere Watch (GAW) network, coordinated by the World Meteorological Organization (WMO), and the network run by the CMDL group in the National Oceanic and Atmospheric Administration (NOAA) in the U.S., are the most important sources of this data. However, the network is too scarce to provide information on CO_2 balances at regional level. The calculations are based on inversion modeling, which has many limitations and relies on additional data.

Measurements of changes in stock of biomass are a direct way to monitor carbon uptake. It is a straightforward, though labor-intensive, task to measure the changes in tree trunk biomass every 5 years or so. Because most of the carbon is stored in the soil, it is a practically impossible task to measure changes in this carbon reservoir.

Micrometeorological flux measurement methods

Micrometeorological flux measurement methods offer an interesting way to study CO_2 fluxes in a scale that is comparable to the size of a typical ecosystem, for example 30 hectares. The core of a standard set-up is a fast-re-

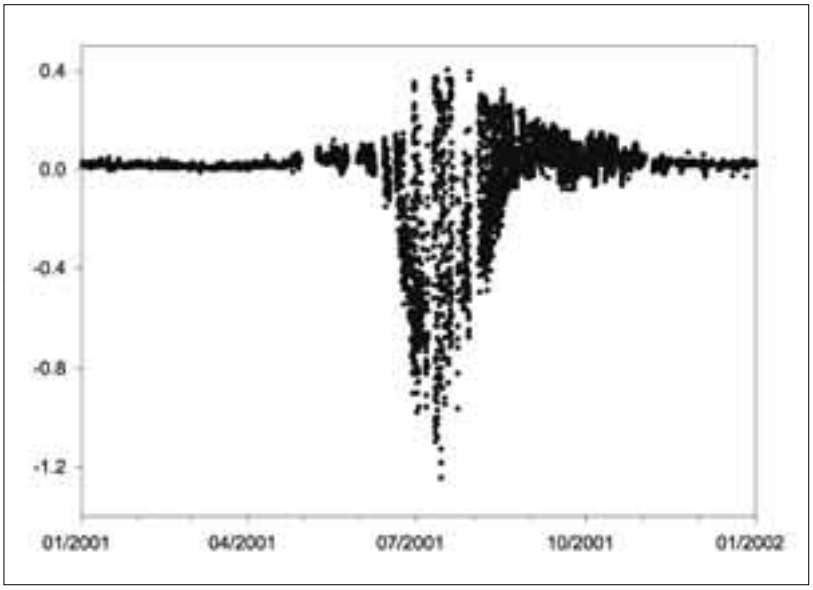

Figure 3. Annual cycle of CO_2 fluxes between the agricultural field at Jokioinen and the atmosphere in 2001. The half-hourly flux values in winter and spring show flux upward (positive numbers) when the peat is gradually decomposing. Barley was sown at the end of May and negative fluxes during the day (CO_2 uptake) appear in June reaching their maximum in mid-July. In August, the crop ripens and the CO_2 uptake gradually ceases. Harvest took place in September. Positive fluxes are highest during nights in summer when heterotrophic efflux from soil and autotrophic maintenance respiration from plants have their seasonal maximum. A typical feature of the micrometeorological observations is that the time series are not complete because of technical problems and an absence of turbulence during calm periods. These gaps have to be filled before long-term averages are calculated, which is one source of uncertainty. Outlayers typically result from non-ideal turbulent conditions. After gap filling the data, we can calculate the annual balances in 2001. This agricultural field on organic soil lost 200 g C m^{-2} to the atmosphere and 160 g C m^{-2} was transported away in harvest as grains, resulting in a total yearly carbon loss of 360 g C m^{-2}. We can estimate that during the growing season, carbon uptake by plants and respiration from soil were both about 550 g C m^{-2}.

sponse sonic anemometer and a fast-response (5-10 Hz) CO_2/H_2O monitor, which are located several meters above the ecosystem to be studied. Direct observation of the flux between the atmosphere and an ecosystem, including trees, undervegetation and soil, is obtained at 30-min. (half-hourly) resolution as a covariance between the vertical wind speed and gas concentration variations in a turbulent flow field.

A great advantage of micrometeorological measurements is that measured fluxes may be used in process studies and model verification. For example, temperature response of ecosystem respiration, light use efficiency of CO_2 assimilation or effects of drought on carbon balances, may be plotted from observations. Water vapor fluxes, which are measured in parallel, tie hydrological processes, evaporation and transpiration to the carbon fluxes. Micrometeorological flux measurement is the only tool to get daily and annual balances, which are obtained by summing up half-hourly observations. These measurements have provided a great deal of quite new information on the interannual variation of carbon fluxes and the factors behind these variations. The drawback of the method is the fact that to establish and run a station is not cheap. The costs for equipping a station lies at around 100 000 EUR and, usually, service visits are needed several times a week. In addition to flux measurements, measurements of other physical and biological parameters have to be conducted for a profound understanding of the functioning of the ecosystems. The instrumentation to obtain information on CO_2 fluxes of different components, leaves, stems, roots, ground vegetation and soil, are also needed for many applications. These are usually measured with different kinds of chamber systems.

Fluxnet for global measurements

After the development of field-proven instrumentation and data acquisition systems for flux measurements during 1990s, the network of permanent sites is expanding. The sites are usually run by research groups at universities as a part of their ecophysiological studies. Most of the multiyear sites are part of a global network FLUXNET (http://www-eosdis.ornl.gov/FLUXNET/). There are also regional networks such as CARBOEURO in Europe (http://www.bgc-jena. mpg.de/public/carboeur/) and AMERIFLUX in America.

The main task of these stations will be to act as reference sites to support the global endeavor to reach a better understanding of CO_2 fluxes and annual net balances. Remote sensing from space will be a central tool in the verification of the Kyoto Protocol. However, remote sensing measurements are entirely indirect and they have to be supported by extensive modeling activities and ground-based reference measurements if we aim to reach reliable net carbon balance estimates. ●

References:

1. IPCC, 2001: Climate Change 2001; The Scientific Basis, Cambridge University Press, Cambridge, 881 pp.

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Finland

GM70 Hand-Held Carbon Dioxide Meter

Versatile Carbon Dioxide Meter for Professional Use

The Vaisala GM70 Hand-Held Carbon Dioxide Meter measures carbon dioxide accurately and is available for several measurement ranges between 0...2000 ppm and 0...20% CO_2. The GM70 can be used in various spot-checking applications, including laboratories, greenhouses and mushroom farms, as well as HVAC applications. The GM70 incorporates Vaisala's advanced CARBOCAP® Sensor, which enables reliable and stable measurement.

The GM70 is small and lightweight, yet rugged. It is an ideal choice for even the most demanding of applications.

The Vaisala GM70 Hand-held Carbon Dioxide Meter is a versatile meter for measuring carbon dioxide gas concentration. The GM70 Hand-Held Carbon Dioxide Meter GM70 can be used in various spot-checking applications including laboratories, greenhouses and mushroom farms. The GM70 can also be used in HVAC applications. In addition, the meter can be used as a calibration check instrument for Vaisala's GM20 and GM220 Series fixed carbon dioxide instruments. The GM70 is small and lightweight, yet rugged, and therefore is an ideal choice for even the most demanding of applications.

The GM70 has a versatile easy-to-use menu based user interface, a clear graphical backlit LCD display and a data-logger function, all of which make handling measurement data easy. The GM70 is configurable and has a wide selection of measurement ranges, from low concentrations up to 20% of CO_2. Due to its short warm-up time, the GM70 is ideal for spot-checking measurements. The meter can also be used as a tool for checking Vaisala's fixed GM20 and GM220 Series CO_2 transmitters. In addition, the GM220 Series transmitters can be adjusted using the GM70. Optional, ready-to-use Windows® software provides an easy way to handle measurement data in a PC environment. A built-in power saving feature extends battery operation time during data-logging, making it possible to collect CO_2 data in locations without mains power.

The GM70 Meter uses the same interchangeable probes as Vaisala's GM220 Series industrial transmitters. By plugging different probes into the GMH70 Handle the user can easily change the measurement range from low concentrations to high concentrations. This feature makes the GM70 extremely suitable for various CO_2 measurement applications. ●

The calibration reminder program offers an easy-to-use calibration service with standard pricing.

Calibration reminder program helps to

Maintain Lifetime Measurement Accuracy

Besides providing high-performance products, Vaisala aims at supporting the lifetime accuracy of the instruments by making regular calibrations easy and affordable. The calibration reminder and service program offers both standard and accredited calibrations, enabling customers to get the best possible performance out of their products.

Measurement instruments must be calibrated regularly to ensure accuracy, since the physical and electrical properties of materials do not remain constant. Calibration means comparing the reading of an instrument to a valid reference value. If the reading is not in line with the reference value the instrument needs to be adjusted. In adjustment, the reading of the instrument is changed to correspond to the reference value. The calibration interval depends on the instrument, the required accuracy and the environment where measurement takes place.

Effortless but efficient calibration

The calibration reminder program allows customers who use Vaisala relative humidity, dewpoint, material moisture, barometric pressure, carbon dioxide and ammonia measurement instruments to easily have their instruments calibrated. After joining the program they get notification to remind them in advance of the approaching time for calibration.

There are many ways to join the calibration reminder program. All new instruments shipped from Vaisala include a registration card where the user can fill in product details and their contact information and return it to Vaisala. Customers can also register on the Vaisala website. Confirmation will be sent to those who register and then, when it's almost time for the recommended calibration, they will receive a reminder of the need to calibrate the instrument along with instructions on how to proceed. The instruments are sent to a Vaisala service center for calibration. To verify the results, customers receive two calibration certificates: one that is produced before the adjustment and one after. This allows for the monitoring of the instrument's performance. Calibrated products will also be marked with a sticker indicating the date of calibration and recommended date for the next calibration.

A service to meet customers' needs

Two levels of calibration service are available to cater for different customer needs: standard service calibrations and accredited calibrations from an accredited laboratory. Janne Kivilaakso of Vaisala, Sensor Systems Division, who is responsible for the service product line, says that in essence the calibration reminder program is about making customers' lives easier. They no longer need to worry about remembering calibration and instead can concentrate on their core operations. Using the Vaisala calibration service means they don't need to invest in the equipment or staff needed for calibration. The calibration reminder program offers an easy-to-use calibration service with standard pricing where costs are already known. Traceability to international standards is also easily available using the service. We are also offering optimized service contracts, including calibration and maintenance, to meet the needs of customers who use a large number of Vaisala products. ●

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C210020en 2002-09