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COSA XENTAUR

REAL-TIME
GAS ANALYZERS

APPLICATION NOTE

Hygrometer Applications Electric Power Transmission & Distribution (Substations)

Featured Product
Xentaur HDT

Table of Contents

A. Opportunity

One of the best and easiest opportunities to sell Xentaur hygrometers exists at your local electric utility substation maintenance facility. We dominate the market place, and are indisputably the best product for this application.

B. Background

Electricity is generated in all sorts of different ways: fossil fuel burning power stations, hydroelectric dams, nuclear power plants, solar, wind turbines etc. The electricity generated has to be transmitted and distributed for end use. The transmission and distribution of electric power is completely separate from the generation function of the utility companies and is treated as such. Electric power generators have nothing to do with transmission and distribution; and similarly substation maintenance personnel have nothing to do with electric generating. Even though a great many applications for Xentaur hygrometers exist at the energy producers (for instrument air, electric generator hydrogen cooling gases and others), in this document we will address only the applications relating to substations.

Substations are located all over the world and are easy to identify. They are groupings of transformers, circuit breakers, switches and other electrical components surrounded by locked chain link fences with barbed wire around the top and “Keep Out” “Danger” and “High Voltage” warning signs posted all over the place. You see these substations in neighborhoods, cities, towns, everywhere electricity is used. Substation maintenance crews routinely visit these substations to test the electrical equipment contained within.

The substation maintenance facilities, **normally where you would make your sales call**, are easy to identify as well. These are fairly large facilities where you see truck maintenance bays; the yard is filled with transformers and breakers, large spools of wire, telephone poles and all sorts of other electric handling equipment are scatted around.

Keep in mind that the larger utilities are sometimes split into two departments. There is a separate contact for the circuit breaker group and for the transformer group. American Electric Power (AEP), one of our better customers is a perfect example. They have separate over-all corporate contacts of the substation maintenance groups for transformers and for circuit breakers. They have over five substation maintenance facilities covering over eleven states. All of these represent potential contacts for dewpoint meter purchase.

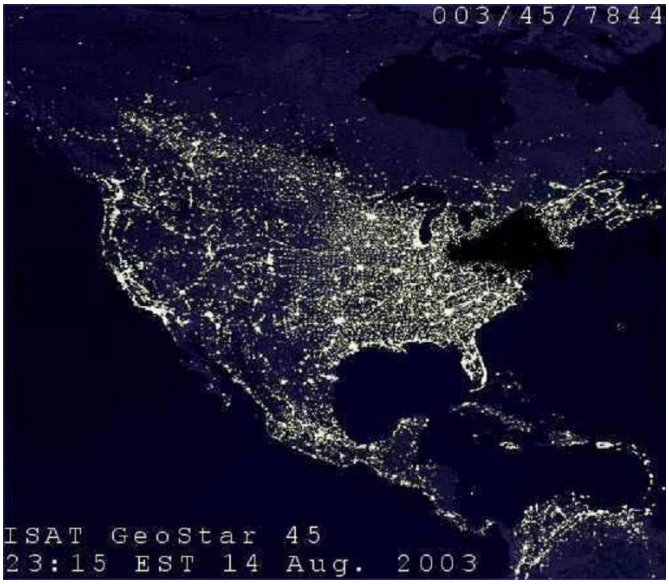
To find the utilities in your territory go to: http://www.utilityconnection.com/page2b.asp

C. Applications

There are basically four separate hygrometer applications in substation maintenance. Measuring moisture in:

1) Sulfur Hexafluoride (SF_6) filled circuit breakers and switches.
2) Nitrogen (N_2) filled transformers.
3) Air and N_2 during commissioning or re-commissioning of transformers.
4) Transformer Oil.

All electrical handling equipment is filled with some sort of insulating medium: Air, SF_6, N_2 or Oil. Insulators have to be bone-dry, as we all know that high voltage electricity and water don't mix. Moisture in electrical handling equipment can cause failures, outages, explosions and very expensive maintenance procedures. The satellite picture on the right is a reminder of the North-East United States power outage in the summer of 2003.



C.1 – SF_6 in Breakers and Switches

- High dielectric strength – The breakdown voltage of SF_6 is nearly three times higher than air at atmospheric pressure, rendering SF_6 an excellent insulator.
- Excellent arc quenching properties – An electric arc is rapidly extinguished in an environment of SF_6 gas.
- Good heat transfer characteristics – SF_6 provides performance that is comparable to or better than air under most conditions.
- Good thermal stability at high temperatures – SF_6 is nonflammable and does not decompose in the gas phase at temperatures below 500°C.
- Low chemical reactivity – SF_6 does not react with most other insulating or conducting materials at temperatures up to 200°C. Carbon or other conductive deposits are not produced as a result of arcing.
- Relatively nontoxic – The threshold limit value (TLV), an occupational standard for exposure of industrial workers, is 1,000 ppm by volume (0.1 percent) for SF_6, comparable to that of argon and other inert gases.
- Self healing in a discharge – Arc byproducts do not significantly degrade the dielectric strength of SF_6. Furthermore, disassociated molecules that have split apart due to arcing efficiently reform to SF_6. (Also, arc byproducts are removable by filtering.)
- Easily liquefied under pressure at room temperature – This characteristic allows for compact storage of SF_6 in metal cylinders.

SF_6 Filled Circuit Breaker

The mechanical switches in circuit breakers and transformers must be insulated with transformer oil or SF_6 gas to protect the electrical current routing through them from arcing or "flash over." The higher insulating value of SF_6 permits circuit designers to position switches closer to the walls of the enclosure and other components, resulting in smaller, lighter, and less costly switches. An SF_6-insulated substation can require as little as 10 percent of the volume of an air-insulated substation. Its excellent arc quenching ability and self healing properties make SF_6 ideal for use in high-voltage circuit breakers that generate an arc when opened or closed. Its chemical properties enhance the safety of SF_6 equipment and result in low maintenance requirements.

However, if moisture migrates inside the enclosure, it contaminates the SF_6, creating decomposition and toxic effects. And this is where moisture measurement becomes important.

Sulfur Hexafluoride is considered to be a fully fluorinated compound (FFC). Since FFC's have atmospheric lifetimes of up to 50,000 years, these potent greenhouse gases could contribute significantly and, essentially permanently to global warming if emissions continue to grow. For example, let's compare the global warming potential of CO_2 and SF_6. CO_2 has a global warming potential of 1, whereas SF_6 has a global warming potential of 24,900!! Also, over the past year or so, the price of new SF_6 gas has increased in price by as much as 600%!! Xentaur's model XPDM offers significant advantages over other dewpoint measurement instruments because of its speed, portability, and minimal gas consumption.

C.1a – Use of SF_6 in Generation of Electricity

Because of the relatively low voltages found in a generating station, the electric generation process has few applications for SF_6-insulated equipment and is responsible for very little use of SF_6 compared to the amount used in the transmission and distribution sector of the industry.

Potential applications in generating stations include gas-insulated transmission lines and gas-insulated transformers. These applications are primarily found in Asia where confined space requirements tend to increase the use of such equipment. Very little SF_6-insulated equipment is used in generating plants in the U.S.

Refer to Generating Station application literature for details on opportunities for our products.

C.1b – Use of SF_6 in Transmission of Electricity

This is the primary target area for portable dewpoint measurement. Our products are the industry standard for theses measurements, essentially we have no competition in this area, there is no need to discount even when multiple instruments are sold. Often utilities purchase multiple instruments, up to five is common even with small utilities, and larger utilities have purchased 30 to 50 instruments. see section F for references, refer to section D for more details.

SF_6-insulated equipment is used primarily in high-voltage transmission systems, which carry electricity from generating stations to the customer load center. Power generating stations are typically located long distances from the load center at sites where plentiful water is available and fuel is accessible or can be received via rail or other conveyance. A utility's transmission system is composed of all of its electric transmission lines in a network of related equipment and facilities that interconnect with neighboring transmission systems to transmit power to major customer load centers.

In addition to transmission lines and supporting towers, transmission-related equipment includes:

- High-voltage circuit breakers – These SF_6-insulated switching devices can be closed or opened to start or interrupt the flow of current.
- Disconnectors / ground switches – These switching devices can be used to isolate a portion of a circuit. They are similar to circuit breakers, but current flow must be stopped (using a circuit breaker) before they are switched on or off. These can use SF_6.
- Power transformers – These large transformers are used to step up or step down voltage in power circuits. These can use SF_6.

Electricity is transmitted at the highest practical voltage to reduce energy loss in the transmission system. At higher voltage, less current is required to transmit a given amount of energy. Because energy losses in transmission are proportional to the square of the current, utilities transmit at high voltage, reducing the current as much as possible, thus saving on energy loss in transmission. In the United States, transmission system voltages range from 115 kV to 765 kV, voltages of 345 kV and higher are classified as extra high voltage (EHV).

In the electric utility industry, SF_6-insulated equipment is used predominantly in transmission systems to manage the high voltages in use. The largest use of SF_6 in the overall electric power system is in high-voltage circuit breakers. Such breakers are capable of opening or closing to permit or interrupt current flow in a circuit. In addition to its good insulating properties, the ability of SF_6 to quench the arc that forms when an energized circuit breaker is opened or closed makes SF_6 an ideal substance for this application. Older two-pressure circuit breakers can contain up to 2,000 pounds of SF_6, while more modern breakers contain less than 100 pounds of SF_6.

Disconnectors and ground switches use SF_6 for insulation, and individually, they contain only slightly less SF_6 than a circuit breaker. However, because there are many fewer disconnectors and ground switches in use compared to the population of circuit breakers, they represent a much smaller category of SF_6 use than do circuit breakers. These devices are used to isolate portions of the transmission system where current flow has been interrupted.

Gas-insulated substations (GIS) use a significant amount of SF_6. There are currently more than 120 GIS installations in the U.S. in the 145 – 800 kV range. World wide, however, there are more than 1,700 GIS installations, the first GIS in the U.S. was installed in 1970. The primary advantage of a gas-insulated substation is its compact size. Gas-insulated substations house SF_6-insulated circuit breakers, bus bars, and monitoring equipment.

Other gas-insulated devices, such as gas-insulated transmission lines and transformers, are less commonly used in the transmission sector of the electric power industry of the U.S. They account for a relatively small percentage of the SF_6 now in service in domestic gas-insulated equipment.

C.1c – Use of SF6 in Distribution of Electricity

A utility's distribution system serves as the interface between the high-voltage transmission system and the customer. The distribution system incorporates the facilities used to transform power from the transmission system to commercial, industrial, residential, and other retail and wholesale customers. Transmission line voltage is stepped down to lower levels at main substations. These lower voltage levels range from about 34.5kV to 138kV. Distribution substations further step the voltage down to distribution voltage level which is in the range of 5kV to 34.5kV. Comparatively small amounts of SF_6 are used in this sector of the industry.

Distribution lines are often underground, especially in urban areas. The distribution system basically ends at the customer's meter, which measures the amount of electricity that each one uses. The dividing line between transmission and distribution is not as consistently distinguishable, nor is it determined solely by voltage level. A power line of intermediate voltage may be classified as either transmission or distribution depending on its function.

SF_6-insulated equipment is less commonly used in distribution equipment due to the lower voltages used compared to transmission system equipment. Up to voltages of 15 kV, vacuum-insulated circuit breakers dominate the U.S. market. SF_6-insulated distribution equipment has demonstrated advantages in size and maintenance in medium- voltage applications above 15 kV. Advantages of SF6-insulated distribution equipment include:

- Reduced breaker dimensions and weight.
- Reduced maintenance requirements; 10,000 to 20,000 operations before maintenance or change out. Furthermore, units may be sealed for life and maintenance free.
- Ease of installation.

Applications for this equipment include distribution substations, cogeneration facilities, industrial facilities, and large commercial buildings. The amount of SF_6 in service in gas-insulated distribution equipment is relatively small compared to the SF_6 in service in transmission applications.

C.2 – Transformer Nitrogen Blanket

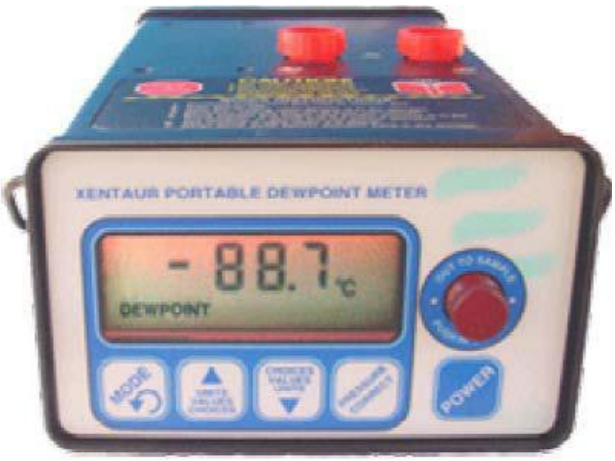
The oil used as insulation in power transformers is adversely affected by moisture. In order to cushion the effects of the oil's expansion and contraction with temperature, a nitrogen blanket covers the oil. If moisture from the environment or from the oil itself enters the blanket, it can oxidize the switches and reduce efficiency. Maintenance personnel routinely check the moisture content of the N_2 blanketing the oil in transformers. The equipment that comprises a substation, including circuit breakers and transformers, is expensive, and is the cause of power interruptions. Because of the cost of scheduled and unscheduled maintenance, especially at remote sites, the utility industry is investing in instrumentation and monitoring equipment for substations. One of the major costs of providing electrical energy is the maintenance of substation equipment. The transformer is one of the key components to any substation. There are currently transformers that handle one thousand megavolt-amperes (MVA). The savings that would accrue from the prevention of failures in these large transformers are in the millions of dollars.

Currently, maintenance done on most transformers is based on a pre-determined schedule. Depending on the health and age of a transformer, the transformer may be tested from several times a year to only one time a year. During the testing, a crew takes the transformer

off-line and does invasive tests on the oil and maybe the insulation. The goal with predictive maintenance is to constantly monitor a piece of substation equipment (i.e. transformers and circuit breakers) with non-invasive monitors that will provide information that can be used to predict when a failure is about to occur. In this way, maintenance can be done when a warning is sent by the diagnostic system that there is a problem. Money is saved because catastrophic failures and unneeded maintenance can be avoided.

Substation equipment has highly non-linear behavior and therefore the predictive maintenance system must identify this behavior and serve as an observer that can notify when a failure mode is imminent.

Nitrogen moisture content measurements in transformers are normally all accomplished with use of a portable dew point meter. The Xentaur model XPDM (shown on the right) is the instrument of choice among power utilities for these measurements due to its ease of use, compact size, accuracy and most importantly, its speed of response. Operators connect the transformer to the XPDM usually with stainless steel or Teflon tubing. The proper fittings for these connections are included with the meter. Operators purge a small sample of nitrogen through the instrument wait a minute or two for a stable reading and their test is done.



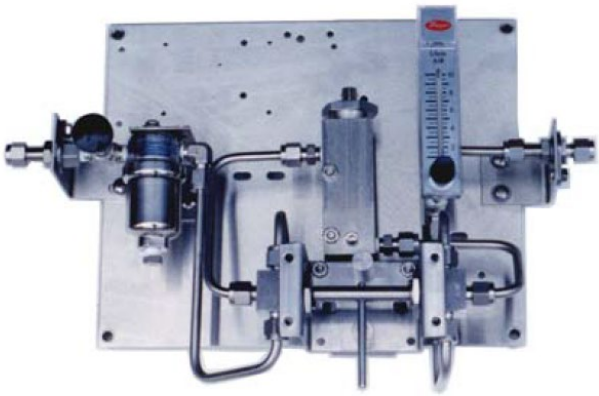
We've discussed above how critical and expensive predictive maintenance is on substation equipment. Utilities don't have the luxury of waiting around to get results on these tests. Other portable dewpoint meters have 3 to 10 times or more, longer response times costing utilities substantial time and money.

Large Transformer

C.3 – Transformer Commissioning or Re-commissioning

When a new or rebuilt transformer is prepared to be put into service it must first have the winding section of the transformer purged, initially using Air and then Nitrogen. Typically a vacuum is pulled on the transformer for up to 24 hours.

a. Some utilities measure the moisture in this vacuum stream to determine pump down times, although most evacuate the transformer for a predetermined time and don't bother to measure the moisture at this point. There is a lot of interior surface area, windings insulation etc. that has to be dried out. This is an intermittent application, however because the measurement is for a prolonged time the use of portable instruments such as the XPDM is not practical. Xentaur has had great success using a specifically designed on-line sample system (Self Drying ESS shown below) ideally suited for this application. The sensor is kept dry in between measurements so the response times are fast.



b. In between the transformer windings there is approximately 1000 pounds of paper that contains high levels of ambient moisture. During the dry-down & evacuation of the ambient air with Nitrogen, up to 30 gallons of water is extracted from the transformer. It takes approximately 24 hours to dry the system down and then another 12 hours to stabilize the system. The transformer is then back filled with nitrogen and allowed to stabilize. Just about all utilities perform a spot-check (using portable instruments such as the Xentaur XPDM which is ideally suited for measurement) at this point to be sure the transformer is sufficiently dried.

c. Once the system has been evacuated and the dewpoint verified and stabilized to approximately -40°C, the system is ready for oil filling. The transformer is then filled with new or reconditioned oil. Many utilities carry out this re-commissioning procedure in the field, using tractor trailer rigs containing pumps, filtration, heaters and test equipment. Be sure to inquire if your utility uses this type of equipment because there will be need for dewpoint measurement equipment in there or potential replacement on-line hygrometer and HDT liquid sensor business to be had.

C.4 – Transformer Oil

As discussed in the previous application, to fill or refill a transformer with Insulating Oil, it must be dried by purging it with dry Air and Nitrogen. When the purging is completed, the transformer is under high vacuum, and can be filled with Oil. The new or regenerated Oil is put into the transformer at approximately 20 gpm, it is heated as high as 90°C in order to drive off gases and moisture.

Portable HiVac Dryer and oil cleanup (regenerating) system

Utilities regularly sample the oil and send it back to corporate or third party labs for Karl Fischer (KF) analysis, remember that COSA also provides KF analyzers. We have been told by many utilities that it is extremely difficult to get an uncontaminated representative sample back to a lab. Therefore, it is preferable to perform the moisture measurement in the field on-line. For this purpose, liquid probes are used to measure moisture in the transformer oil. This is a great Xentaur HDT application where maintenance personnel can do the measurement on site.

Insulating oil is also utilized in tap changers which are attached to transformers. The taps adjust to insure the correct voltage comes from the transformer. They require constant maintenance because they are vented to atmosphere. The tap changer oil is routinely processed to remove moisture. It is done in the field by a filter cart as depicted below. By measuring moisture with a transmitter calibrated to report Karl Fischer moisture grab samples and trips to the lab are eliminated.

Transformer with Tap Changer

Filter Cart

Xentaur HDT on Filter Cart

D. COSA/Xentaur Hygrometers as relating to Gas Applications

D.1 – XPDM

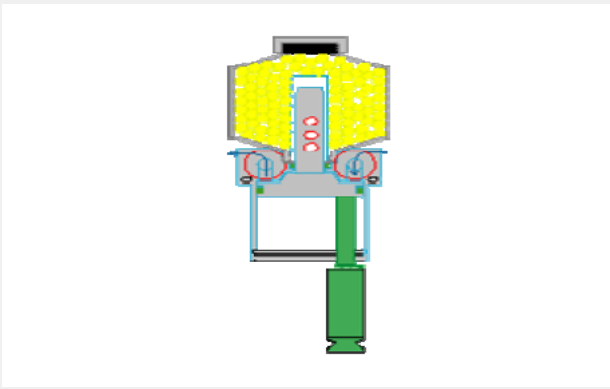
The model XPDM Xentaur portable dew point analyzer is the industry standard for all of these substation gas applications. It is the most suited for insulating gas measurements because of its size, speed of response, rugged construction and insensitivity to gas contaminants.

Size: These measurements are taken in the field. A lot of test equipment has to be brought on site. The XPDM is the smallest and lightest instrument on the market. The less weight and instruments maintenance personnel have to lug around the better. Also much of this equipment is huge and field technicians have to climb ladders and get into tight spaces, the XPDM's size makes it very attractive to technicians.

Speed of Response: SF_6 is an extremely expensive gas. Gas consumption is of critical concern to substation people. Because of the internal dry down chamber (shown below) the XPDM gives users the fastest results of any instrument on the market. Also time is money and people don't want to be standing around for hours waiting for their meters to dry out. Another important advantage of fast measurement is because, SF_6 is considered a greenhouse gas, the less gas that is released to the environment, the better. In Europe, SF_6 gas samples are saved into special catch bags and discarded properly or recycled. Typical field measurements for go/no-go at approximately 10ppmV (-60degCdp) are performed under one minute.

Rugged Construction: Because these are field measurements for the most part, this equipment gets beat up pretty badly. Substation personnel are overloaded with work therefore they need something they can quickly throw into the back of pick-up trucks and not worry about getting it damaged. Simple operation is something they have to have.

Contamination Resistance: SF_6 gas can break down over time with extensive arcing and form corrosive and aggressive by-products such as hydrogen fluoride (HF), or free fluoride F_2. Model XPDM is more resistant to the contaminants than any other meter due to the internal desiccant chamber. The desiccant absorbs impurities from the sensor and keeps the sensor dry in between measurements so that no acid formation can occur, degrading performance and shortening sensor life. Because the XPDM response speed is so fast, exposure time is minimized so that the sensor performs well for years. Some manufacturers, in an attempt to improve response time, heat their sensor (e.g. MCM Stephens Analytical) to dry it out, but heating speeds up chemical reactions and thus causes premature failures.potential replacement on-line hygrometer and HDT liquid sensor business to be had.



D.1a – Accessory guidelines for substation applications

In general optional accessories should be recommended only if they are required as the more components you have upstream of the sensor the more surface area has to be dried out and the longer the response time will be.

Carry Case: Most of the measurements discussed in this document (up to 95% with the exception of some transformer re-commissioning which is done at the substation maintenance facility) are performed in the field. Therefore, a carrying case is always recommended for these and just about all other portable measurement applications.

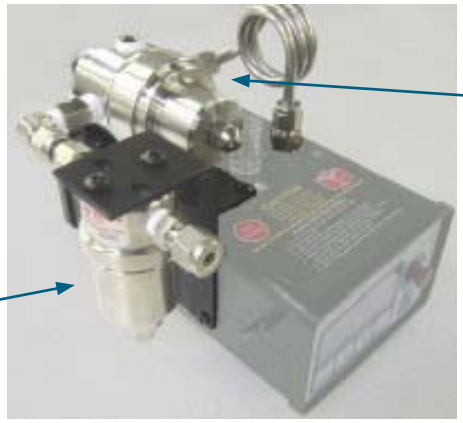
Tubing: Always recommend the Teflon or stainless braided Teflon tubing regardless of the application. One common problem we see is the end-users do not utilize suitable components for moisture measurement (tubing, valves, regulators, flow meters, leak tight fittings, connections, etc.). This leads to leaks, erroneous readings and longer response times. It is surprising at how many instruments we get back for recalibrations that have rubber or Tygon tubing attached to them; they might as well not perform the measurement.

If the XPDM is used only for SF_6 circuit breakers, then no accessories other than a case and tubing should be recommended.

Regulator: Most SF_6 breakers are under 80 PSIG of pressure so a regulator isn't necessary and SF_6 is a fairly pure gas so a filter isn't necessary, but if the end user wants to check the moisture in high pressure SF_6 cylinders and doesn't have a suitable pressure regulator (i.e. stainless steel with a Teflon diaphragm) then recommend our regulator option.

Filter: If the end user is going to use the XPDM for transformer measurements and is concerned that there is a possibility of transformer oil carry over, then recommend the filter option.

If the end user is going to use the XPDM for all of the above uses then recommend the regulator and filter option.



XPDM with regulator and filter option

D.2 – Self-drying sample system for transformer recommissioning applications

COSA/Xentaur model ESS-SD is an extractive self drying sample system that can store the sensor in dry storage during idle times. Easily field replaceable long life desiccant cartridge is utilized to remove unwanted contaminants and moisture for years of maintenance free operation.

This is well suited for intermittent use for either onsite or mobile applications. This system will provide meaningful measurements without extended recovery time. Transformer operators can significantly reduce evacuation times, saving energy and resources.

This sampling technique is unique and virtually free of competition. Multiple sales opportunities exist, as many utilities have multiple mobile or onsite recommissioning operations. Replacement opportunities exists, because if the customer currently has a competitor's equipment in recommissioning applications, they are certainly experiencing extended recovery times, drift and premature sensor failure; and as a result less timely and meaningful measurements.

E. COSA/Xentaur Hygrometers as relating to Oil Applications

The Xentaur Hybrid Dew point Transmitter - model HDT, is a loop powered HART enabled transmitter which can be applied to all transformer oil applications using a newly developed in-liquid measuring sensor.

Recently Xentaur has developed a sensor capable of measuring water vapor content in liquids. A liquid standards laboratory has been built at our facility, and for the last few years we have produced a variety of studies relating to measurement of water vapor in liquids, written white papers, and presented at industry trade shows.

Just as a chilled mirror is the principle primary standard for measuring water vapor content in gases, so is Karl Fisher (KF) Titration the principle primary standard for measuring water vapor content in liquids. Our liquids laboratory utilizes several KF titrators to establish a traceable standard.

In the current marketplace there are two secondary measuring technologies applied to moisture measurement in transformer oil. The first technology is Al_2O_3. This type of sensor is supplied by Panametrics (the market leader) and Xentaur (a new entry). The second technology is polymer sensors, which are supplied by Vaisala and on an OEM basis by Doble Engineering.

Al_2O_3: sensors measure changes in partial water vapor pressure. Partial water vapor pressure is correlated to moisture concentration in parts per million by weight (ppmW) via a dimensionless proportionality constant named after its discoverer Henry. In transformer oil, Henry's constant is essentially independent of temperature.

"As the temperature rises, the oil's ability to hold dissolved water rises; while its moisture concentration remains the same"

Polymer: sensors measure relative humidity (RH) and temperature. They calculate partial water vapor pressure from the RH measurement and saturation water vapor pressure from the temperature measurement. The ratio is reported as water activity (0.0-1.0). This ends up being essentially a temperature measurement, telling little about the absolute moisture concentration in the oil.

Although both Xentaur and Panametrics utilize Al_2O_3 technology to measure partial water vapor pressure, the approach to reporting the measurement is very different. Panametrics ignores the sensor temperature coefficient, a well know issue with Al_2O_3 sensors. In addition, when using a Panametrics analyzer, one must rely on an in depth knowledge of temperature saturation curves in order to obtain results expressed in ppmW. Xentaur eliminates sensor temperature coefficient and complicated mathematical calculations by building a data array containing sensor response, temperature and moisture concentration (ppmW). We calibrate our oil sensors in oil using a KF standard. The HDT simply monitors water vapor pressure response & temperature, and reports moisture concentration in ppmW.

During the summer of 2003 an HDT was delivered to Xcel Energy, of Denver, CO. The unit was fitted to one of their tap changer filter carts. The results of the trial were favorable. The HDT tracked the oil drying cycle at 5 independent sub stations. The customer also validated the HDT measurements with “grab samples”. The correlation between the HDT readings and the lab results were deemed acceptable. The raw data from this trial is available upon request.

Recent Power Transmission and Distribution Customers

Abb Power T&D Co, Inc	Maine Energy Recovery
Ameren Ue	Metropolitan Utilities
American Electric Power	Mid American Energy Co.
Aep/Central Power Light	Mitsubishi Electric Power Prod
Alabama Power	National Utilities
Allegheny Power	Northeast Utilities
Arizona Public Service	Nstar (Boston Edison) Electric & Gas Corp.
Arizona Elec & Pwr	Nyseg
Aubrey Silvey	Ohio Power Company
Baltimore Gas & Electric	Oklahoma Gas & Electric
Basin Electric	Omaha Public Power District
Bonneville Power Admin.	Orange & Rockland Util.
Carolina Power & Light	Oregon Electric Inc.
Central Illinois Light Co.	Otter Tail Power Co.
Central Maine Power Co.	Pacific Gas & Elec.
Central Power & Light	Pacificorp
Chelan County Pud	Penelec
Cincinnati Gas & Electric	Pennsylvania Pwr & Light
City Of Garland	Peoples Energy
City Of Redding	Potomac Electric Power Co
City Of Spokane	Potomac River Generating Sta.
City Water Light & Power Il	Ppl Services
Con Edison	Pse&G
Connective Power	Public Service Co.of Col.
Consumers Energy Co. Mi	Public Svc Of Col. Denver
Cutler-Hammer	Puget Sound Energy
Dashiell Corp	Reliant Energy
Detroit Edison	Roberts Transformers
Dominion Virginia Power	Salt River Project
Duke Energy Corp.	San Diego Gas & Electric
Duke Power	Seminole Electric Coop
Duquesne Light Co.	Siemens Westinghouse
Dynegy Power Corp.	South Carolina Electric & Gas
El Paso Electric Company	Southern Cal Edison
Entergy	Southern Nuclear Co.
Eugene Water & Electric Board	Southwestern Power Administration
Exelon Energy Co.	Southwestern Public Serv.
First Energy Oh	St. Joseph Light & Power
Florida P&L St.petersburg	Summit Electric
Florida Power Corp.	Tampa Electric
Ge Hitachi High Voltage	Tennessee Valley
Georgia Power Company	Transformer Testing & Repairs
Gulf Power	Trigen-Syracuse Engery Corp
Hawaiian Electric Company, Inc.	Tucson Electric Power Co.
Hydro-One	Virginia Power
Illinois Power	Waukesha Electric Systems
Kansas City Power & Light Co.	Wisconsin Public Service
Keyspan Corporate Srvcs.	Xcel Energy

G. Single Sheet Summary – Utility Power Transmission & Distribution

Background: All electrical handling equipment is filled with some sort of insulating medium: Air, SF_6, N_2 or Oil. Insulators have to be bone-dry. Maintenance crews routinely visit substations to test the electrical equipment (transformers & breakers), as well as the bottled sources of dry gases.

Reason for Customer to measure: Moisture in electrical handling equipment can cause failures, outages, explosions and very expensive maintenance procedures.

Recommended Instrument: Xentaur Portable Dewpoint Meter model XPDM is the industry standard for all of these substation gas applications. It is the most suited for insulating gas measurements because of its size, speed of response, rugged construction and insensitivity to gas contaminants.

Size: The XPDM is the smallest and lightest instrument on the market. Much of the equipment being serviced is huge and field technicians have to climb ladders and get into tight spaces, the XPDM's size makes it very attractive to technicians.

Speed of Response: Because of the internal dry-down chamber the XPDM gives users the fastest results of any instrument on the market. Typical field measurements for go/no-go at approximately 10ppmV (-60degCdp) are performed under one minute, thus minimizing gas consumption, which is of critical concern to substation people because: 1) SF_6 is an extremely expensive gas. 2) SF_6 is considered a greenhouse gas, the less gas that is released to the environment the better. In Europe, SF_6 gas samples are saved into special catch bags and discarded properly or recycled. 3) Time is money and people don't want to be standing around for hours waiting for their meters to dry out.

Rugged Construction: Substation personnel are overloaded with work, they need something they can quickly throw into the back of a pick-up truck and not worry about getting it damaged. Simple operation is a must.

Contamination Resistance: With extensive arcing, SF_6 gas can break down over time; and form corrosive and aggressive by-products such as hydrogen fluoride (HF), or free fluoride F_2. Model XPDM is more resistant to the contaminants than any other meter due to its internal desiccant chamber. The desiccant absorbs impurities from the sensor and keeps the sensor dry in between measurements so that acid formation can not occur, thus avoiding degrading performance and shortening sensor life. The XPDM's fast speed of response minimizes exposure time and thus prolongs performance. Some manufacturers, in an attempt to improve response time, heat their sensor (e.g. MCM Stephens Analytical) to dry it out, but heating speeds up chemical reactions and thus causes premature failures.

Sensor Range: XTR-100 sensor -149°F to +68°F dewpoint; most measurements will be at approximately -75°F

Recommended accessories: • Carry Case, • Teflon or stainless tubing, • Filter - if using on oil filled transformers and can have oil carryover, • Pressure Regulator - if testing high pressure bottles w/ direct hookup.

Who to Contact:

1. Visit http://www.utilityconnection.com/page2b.asp and identify local utility.
2. Go to their website and get main phone number.
3. Ask receptionist for Substation Maintenance Supervisor or Substation Maintenance Manager in the Transmission and Distribution group.
4. If receptionist can't help, ask for someone in the Transmission & Distribution Engineering department, then try to locate the Maintenance Manager or Supervisor.

We dominate the market place, and are indisputably the best product for this application.

H. Comparison of various vendor's portable hygrometers

Manufacturer	Cosa/ Xentaur	General Electric			Meeco
		Panametrics		General Eastern	
Private labeling	Teledyne				
Picture and web link					
Model	COSA: XPDM Teledyne: 8800P	MMS 35	PM880	Dewpro MMY245	Waterboy 2
Accuracy	high	medium	medium	low	medium
Speed of response	fast	slow	slow	medium	slow
Weight	4 lbs	15 lbs	6.5 lbs	7 lbs	17 lbs
Size	2.5" x 4.2" x 7.5"	11"x11"x6"	9.4"x5.5"x1.5"	11"x7"x7.1"	Briefcase size
Principle	HTF™Al2O3	Al2O3	Al2O3	Al2O3	P2O5
Representatives	www.cosaic.com	www.gepower.com/businesses/ge_panametrics/en/contact/pci_usa.htm		www.geind.com/html/Locations4.htm	www.meeco.com/pages/reps.htm
Price	$4,350.00	$4,555.00	$5,325.00	$3,295.00	
Cost of NIST	$475.00			$199	

H. Comparison of various vendor's portable hygrometers

Manufacturer	Shaw		Michell Kahn	Ametek
	Shaw	Alpha Moisture		
Private labeling		Dilo		
Picture and web link				
Model	SADP	Alpha DSP-Ex Dilo 3-031-R002	Cermax	303B
Accuracy	low	medium	low	medium
Speed of response	medium	medium	slow	slow
Weight	13.2 lbs	α =12.8 lbs Dilo=25 lbs	8.8 lbs	14 lbs
Size	8"x11"x9"	14.6"x12.4"x6.2"	9.8"x11.8"x5.9"	13.5"x9.3"x5"
Principle	Al2O3	Al2O3	Al2O3 claims to be Ceramic but all Al2O3 sensors are ceramic	P2O5
Representatives	www.jlcusa.com/ dewpoint_meters_1.htm	www.deltainstrument.com www.amsystems.co.uk	www.michell.co.uk www.kahn.com	www.ametekpi.com/ about/locations.cfm
Price				
Cost of NIST				

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