REMOTE MONITORING

Why, what, how, when?

Always By Your Side.

The technical development of remote monitoring technology has evolved dramatically over the last few years. Whether it's good or bad, you will be overwhelmed by all the offers regarding automatic solutions, with one boasting to be more self-sustaining than the next. But is it cost effective – and will you still get reliable measurements if no one is actually on site to check? The answer isn't entirely clear.

This article addresses the questions to ask prior to choosing a measurement system that delivers readings remotely; these systems are often more expensive than manual or logged solutions. The areas we examine will hopefully in turn help you to make cost-effective choices.

THINK THROUGH YOUR MEASURING SITUATION

There are some key questions you should always ask yourself, before undertaking any measurements:

- *Why do I want to measure?*

Is the answer: quality requirements from the client, control for better productivity, risk management, project knowledge sharing or something else?

- *What needs to be measured?*

It is important to distinguish between what can be measured and what needs to be measured.

- *How and when should the measurement be carried out and reported?*

In order to obtain relevant decision-making evidence, it is important to first consider how carefully and how often data needs to be measured.

Remote readings can replace instantaneous on-site readings or logged measurement data that are read regularly.

There are obvious gains, but there is also a risk that we will lose valuable information. This is expanded upon below.

WHAT MAKES REMOTE MEASUREMENT SYSTEMS EVEN MORE INTERESTING?

The rapid development of technology drives down the cost, whilst a better user-friendly interface makes it easier to use measuring equipment. The development of wireless sensors, which are easy to position, has reduced installation costs so that it has become cost-effective to use the technology even in short-term construction engineering.

A major advantage is that readings don't have to be made at a given time. Data is created and can be processed when required. This ensures more freedom to plan working hours.

Cloud services and central data storage make it easier to compare data from several projects, for example looking at average measurements and trends over time. This provides added value in terms of lessons learned. More closely read data series also make it possible to discover behaviour that may be missed during more sporadic readings.

Another major advantage of cloud services compared to logged data is the possibility to detect deviations, e.g. a broken meter which can be rectified directly. Reading logged data and discovering that the heater has been switched off for a number of days is not ideal. With continuous remote monitoring, it is possible to detect a fault and send a technician to restart the heat source. In addition, there are plenty of examples where logs haven't been started, the battery was empty, or the memory was full – all resulting in major data loss.

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In today's age, more and more measurement systems are becoming integrated with each other. The ability to control them makes work more efficient in other aspects too. Today, for example, there are smart electricity networks for construction sites that, in addition to measuring electricity use, can be used for controlling lighting and heating, for example. They also warn of uneven loads in the system where outlets can be blocked in order to prevent the electricity network from going down. There are also remote shut-down possibilities for incoming construction water, whereby the water can be shut off via text message or even controlled via a schedule.

CHALLENGES

Most remote systems are built around a discipline's specific measurement needs. This means that you rarely manage with just one remote system on the construction site – the number of different systems is a learning problem in itself. In principle, however, it is more about creating a better user interface so that there is no need to learn multiple technical systems.

A measurement system and a measurement technician are not the same thing. A good measurement technician can see other things when reading results on site. However, if a technician is due to visit the site regularly, in order to service machines for example, the benefit of remote reading decreases quickly.

It is easy to create the illusion of very exact measuring when the equipment is always there to read and measure. However there is the possibility that many unchecked measurement errors could happen. It can take a long time to move and process data for decision making, unless measurement intervals are chosen with care, i.e. more data is not always better.

ABOUT LOGGING EQUIPMENT

The very idea of monitoring through measurement is to follow a course, either from a climate perspective or from a construction perspective. In this article we have chosen to include mobile devices that can be temporarily mounted to items to be checked. Technology that can be built into systems and buildings also exist, but they are not accounted for in this text.

In today's market there are several manufacturers offering many equipment models. Which of these you choose depends on your current measurement need, i.e. what data is needed for decisions over the course of the current project.

The most common units measured in construction engineering in order to control drying are:

- *Relative humidity (RH%)*
- *Moisture content in wood (MC%)*
- *Temperature (°C/F)*
- *Water content in air (g/m³ or g/kg)*

There are other measurement units that may be of interest, but they are seldom measured within the moisture area. The reason for this is that more complex sensors and equipment often are required, for instance when measuring electricity, carbon dioxide and pressure.

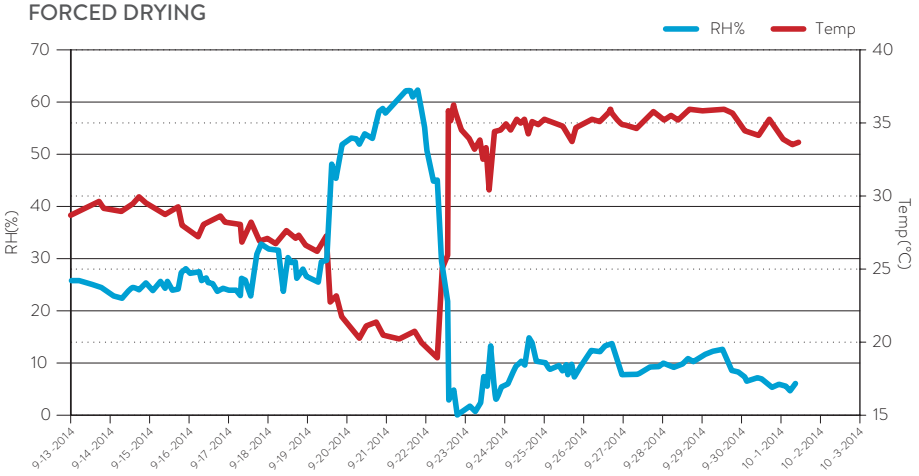
Basically, from a metrological perspective, the same results can be achieved regardless of whether you choose logging equipment or carry out frequent measurements in person. The most significant time saver when using logging equipment is that a technician does not have to be on site carrying out readings all the time. The logging equipment saves data either in a local memory or on some form of digital platform such as the cloud.

on site who monitor the equipment and can continuously read data or save it elsewhere. The sensors are usually built in or are surface-mounted wire sensors connected to the transducer. The limitations of local memory systems are battery capacity and storage capabilities for example, closer logging intervals drains the battery faster.

To this group of sensors, we can also connect the systems with intelligent sensors that provide data to handheld devices and smartphones via Bluetooth. The basic technology is the same as stationary main units. The difference is that you are able to collect data faster when you are on site.

The second group contains systems that are continuously connected. In this group of equipment, work is often carried out via a web portal. The hardware itself only has contact with the cloud service and is controlled via the software from your phone, tablet or computer. The hardware consists of a main unit with wire or wireless sensors that send data to the main unit.

FORCED DRYING



Logging of the drying environment can reveal when machines come to a stop. This graph shows stoppage in a dryer. When the temperature drops, the RH increases. For a period, extra heat is used to compensate for the poor drying environment. Advanced systems also have alarms letting you know instantly when the drying environment goes beyond set limits.

Equipment that saves data to a local memory doesn't have the ability to continuously supply readings to the technician – the information will need to be downloaded to a computer. There are also limitations in memory capacity which in itself may require more work. However, in principle, the equipment that delivers data using GSM, GPRS or radio waves provides the possibility to read gathered data unrestricted at any given moment in real time.

Local logging systems are the simplest and cheapest hardware on the market. It is often used in management and industries where there are personnel

Wireless systems are often a little more expensive than those that are wired between the sensor and the main unit. Wired sensors often provide a more secure data delivery since the wireless versions can have problems connecting between the sensors and the main unit. An advantage of working wirelessly is that it is often possible to connect a number of sensors to the same main unit. It is not uncommon to connect over 200 sensors to the same unit.

CHOICE OF EQUIPMENT

As stated, it is wise to choose equipment depending on what you intend to measure. If, for example, the intention is to measure what happens in a certain amount of air during construction, it may be appropriate to choose equipment that measures RH, T and water content. The equipment required is among the most simple and cheap apparatus on the market and often has the accuracy required. Which one you choose depends more on your preferred website layout.

If instead, you wish to monitor what happens within a material, the requirements are different. Here the governing factor would be how the sensor material behaves in relation to the relevant moisture levels. When measuring in a material, whether this involves following a design or drying process, sensors from well-known manufacturers are often needed. The reason is that the sensors have been tested in the environment you intend to measure in.

The units you normally measure in are the same as before, ideally with additional sensors that can measure moisture ratio. Regardless of which one is used, it is often a safer method to measure material instead of air when measuring over longer periods of time. Of course, you can also measure the air around the material. Then there is often a defined key metric for air to relate to. The limitations are then set by the measurement area in which the measuring will take place (over 95% RF and below 30% RF is often difficult).

EXAMPLE

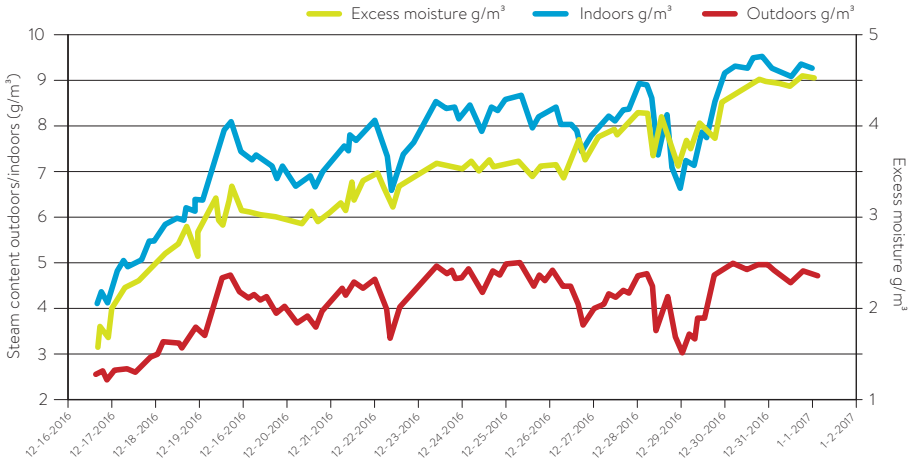
Three common measurement situations are described below. This is where logging is often needed in order to obtain a sufficient decision basis.

Large variations in measurement results

When measuring in an environment, which is not constant either in terms of moisture or temperature, it is necessary to carry out continuous measurements on many different occasions in order to see a connection. In these cases, logging is unbeatable when collecting data for evaluation. When carrying out an evaluation it is often necessary to measure and compare results with something. A common procedure is to use the outdoor climate as a basis to work around. If I want to monitor an indoor climate, I usually use the outdoor air as a comparison.

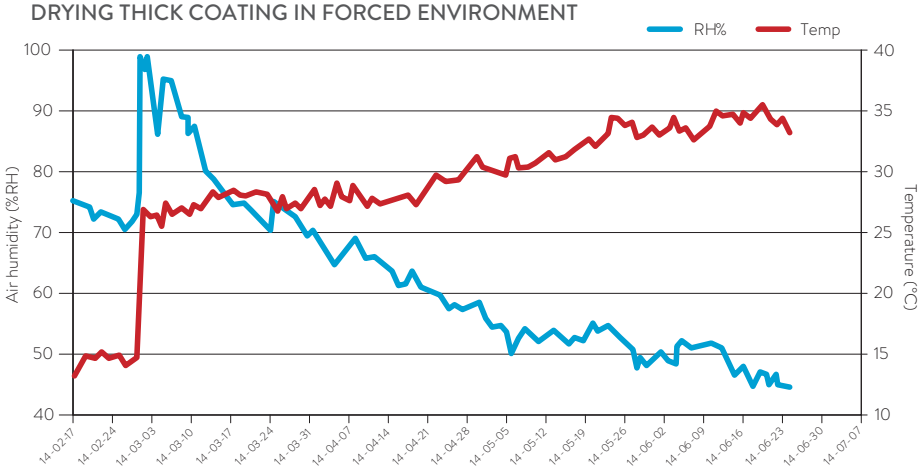
If I want to monitor a crawlspace or attic, I use both indoor and outdoor air as a comparison. In addition to the level of relative humidity, the water content in the various measuring points is of the greatest interest. For these types of issues, wireless sensors are superior as it is often difficult to place a main unit so that wired sensors reach the parts I wish to measure.

DRY ENVIRONMENT/EXCESS MOISTURE



Excess moisture is tracked to see if dehumidification or ventilation is needed. In winter, it is dangerous if air containing a large amount of excess moisture leaks out and condenses against cold structures.

DRYING THICK COATING IN FORCED ENVIRONMENT



Logging of the drying environment is carried out to ensure that the mechanical equipment has the intended effect on the drying environment.

QUESTION CARD

ARE MY NEEDS MET?

1. Do I want to control my construction site or verify results for someone else?
2. Do the measurement results vary widely depending on varying external circumstances?
3. Do I want warnings when it ceases to function?
4. Do I get a good decision basis without multiple readings?
5. Do I need to carry out measurements in the evenings and at weekends?
6. Is there project knowledge-sharing available locally?

IS IT EFFECTIVE?

1. Does the user interface support my decisions?
2. What is the amount of time needed?
3. How far away is the device if it can't be read remotely?
4. What is the start-up cost?
5. What is the rental cost?
6. What about theft and damage?
7. Wired or wireless on the construction site?
8. Is there a need to process data for accounting?

IS IT POSSIBLE TO MEASURE REMOTELY FOR MY PROJECT?

1. Is a fully developed system available in my area for my application?
2. Is it possible to set up networks so that sensors can talk to the internet?
3. Is there sufficient battery life or is there a power supply?

	Celsicom	Mitec Sat 80	Mitec Monitor/Winlog	Testo 174H	Testo 175H1	Testo CA1510	Caption Data RDL1000
							
[1] Local			■	■	■	■	■
[2] Internet	■	■	■				■
Battery	■	■	■	■	■	■	■
Electrical connection	■	■					■
RH	■	■	■	■	■	■	■
T	■	■	■	■	■	■	
MC%	■	■					■
g/m³	■	■	■	■	■	■	■
dp	■	■	■	■	■	■	
Pressure	■						
CO^2	■					■	
kW	■						
[3] Wireless	■						■

[1] Data needs to be read locally or manually transferred to a computer.
[2] Data is being transferred via GSM and GPRS. Can be read via app or software.
[3] The sensors communicate with the main unit – wireless or through an internet portal.

Follow and understand a process

When the intention is to follow wooden material, e.g. a roof panel in an attic or an exterior wall sill, it is wisest to measure the moisture ratio, MC %. The unit is quite good to use as it is possible to follow the moisture even if the material becomes very moist. However, the unit is very slow in the sense that the moisture takes time to migrate from the air on the surface and into the material. It is not uncommon to see a delay of a few days between air and material. The reverse applies when moisture migrates from the material to the air. When measuring relative humidity in materials, most sensors usually work well when temperatures fall between 5-35°C (and humidity is between 30-95% RH). Above or below that temperature, it is common to note deviating measurement results. The same applies if there is condensation on the sensors.

The moisture ratio measurement is ideally supplemented by the previously stated method, mainly because RH and Temp give an idea of the driving forces between structural parts via the water content/vapour content.

Forced drying

When performing active dehumidification of materials and the intention is to measure by logging, the sensors are subjected to an extremely high load. It starts with the temperature of the water-damaged material increasing significantly and due to this, the vapour pressure/ water content in the air increases (in the material). When temperatures above 40-50°C are reached in water-damaged materials, conditions are created which in principle disqualify measurement of relative humidity in materials. The result is that the sensors short circuit. After the moisture drops in the material, the sensors recover so that a drying process can be followed to a satisfactory level following dehumidification.

With conventional dehumidification, temperatures above approximately 35°C are rarely reached in material. For dehumidification with directed energy such as with IR, heating mat or heating rods, it is easy to achieve above 50-60°C. If it is necessary to follow drying over the hygroscopic area, i.e. where the material is water damaged, there may be reason to measure the moisture ratio instead. In lightweight concrete or brick material it is possible to indicate moisture directly in materials (not measuring) with magnetic field indicators. In concrete, it is not possible to do it the same way.

There are several ways to carry out moisture indications with the intention of following the drying process. One of the easiest is to use wood as a sensor in inorganic material that is connected to the logging equipment.

The advantage is that you measure and indicate the progress of a material with a known sorption curve/equilibrium curve. Wooden sensors are mounted in the material and act as indicator material.

It is very important to carry out a verifying moisture measurement using a verified method after the dehumidification is complete.

SUMMARY

In most cases, remote monitoring is not about providing exact measurement results. In most cases the purpose is to verify connection and function in order to be able to make changes if needed.

First ask yourself why you want to measure and what you want to measure. Then the question of how you need to measure, and which system gives you the best value for money, will be easier to answer. Next come the other parameters, e.g. ease of use, price, reliability, service set-up and versatility.

Whatever the purpose of logging, the method of close measurement results is unbeatable when it comes to:

- *See the connection*
- *Forecast drying targets*
- *Verify function*
- *Determine deviations*

OBSERVATION

In the documentation we have selected a few different suppliers and models. There are many more on the market, but they belong to one of the two main groups mentioned in the documentation.

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