Advances in Precipitation Measurement Technology

OTT MESSTECHNIK has developed,what the company believes is the most advanced precipitation measurement technology available. The initial version of the instrument offered users much greater resolution and accuracy across a broader range of weather conditions in comparison with older techniques, and the latest version provides even better performance at a significantly lower cost. This article will illustrate the advantages of the new technology over techniques that have existed for centuries.

History

The first known records of rainfall were kept by the Ancient Greeks about 500 B.C. This was followed 100 years later by people in India using bowls to record the rainfall. The readings from these were correlated against expected growth, and used as a basis for land taxes. Subsequently, graduated cylinders were employed to collect precipitation that could be inspected daily for the manual collation of precipitation records.

Automatic Raingauges

Sir Christopher Wren, the 17th century English designer, astronomer, geometer, and one of the greatest English architects of his time; was best known for the design of 53 London churches, including St Paul's Cathedral. However, one of his lesser known achievements was the creation in 1662, of a rain gauge that did not require daily visits - the world's first tipping bucket raingauge. The real advantage of this technique was that it enabled a clockwork chart to record rainfall so that Sir Christopher did not need to read and record every single day's data.

Astonishingly, the same basic principle survives to this day in raingauges currently operating in many countries world-wide.

The Tipping Bucket Raingauge (TBR)

The TBR consists of a funnel which is mounted in the top of a cylinder set into the ground or standing upon it. The funnel collects precipitation and passes it on to one of two small buckets which are balanced upon a pivot.

After a specific amount of precipitation (typically 0.2 or 0.5 mm) falls, the bucket tips and an electronic signal is sent to a recorder or datalogger. This process tips (almost all of) the water from the bucket so that it is ready to repeat the process.

Anyone that has been responsible for the collection of data from a tipping bucket raingauge (TBR) will be well aware of its shortcomings:

1. The bucket within a TBR will only tip once it has collected the requisite amount of precipitation. This means that a small amount of, say, light rain will not be recorded, but when at a later stage further rain falls, a tip is induced which would show in the record (incorrectly) that the rain fell at that moment.
2. When a bucket tips, not all of the precipitation is removed; some water adheres to the bucket as a result of surface tension which means that less rain is required for a further tip.
3. Particles of dust or dirt collect in the buckets and affect the surface tension of the drips as well as the tipping volume, until the buckets are cleaned.
4. A filter is often placed in the funnel to limit the entry of detritus to the buckets, but these can become blocked and create significant errors in the data.
5. Water will also adhere to the funnel of a TBR and may be lost through evaporation.
6. In periods of intense rain, TBRs tend to under-read because rain is splashed away by the rapid movement of the pivoting bucket. Precipitation may also be lost under such circumstances as the collection moves from one bucket to the other.
7. A further limitation of TBRs is their inability to collect snow or hail accurately, or to function at low temperatures. This can be assisted by the addition of heating, but remote locations may lack the power requirement that this necessitates.

In summary, whilst the TBR was a brilliant invention in 1662, meteorologists have been looking for something more accurate and less labour-intensive for over 300 years!

New Technology

OTT MESSTECHNIK has developed a raingauge ('Pluvio') that addresses the weaknesses of the TBR by collecting precipitation and weighing the collected liquid with a highly accurate load cell.

The Pluvio was first launched in 1994 and there are now more than 5000 units in operation all over the world. However, the first version of the OTT Pluvio was expensive. So the company has developed a successor, 'OTT Pluvio^2', which provides even better precipitation measurement but at significantly lower cost, which makes it accessible to a much larger range of applications.

OTT Pluvio^2

The key advantages of OTT Pluvio^2 are that it can measure precipitation accurately and reliably in all weather conditions. OTT Pluvio^2 is able to record the smallest amount of precipitation at exactly the moment that it takes place.

The instrument's accuracy is not diminished by the intensity of precipitation - the measurement range extends from 0.1 to an impressive 30 mm/min.

This technology is also well suited to freezing conditions. The collection chamber contains antifreeze liquid which prevents the accumulation of hail and snow. As a result, the OTT Pluvio^2 is able to offer an accurate measurement range of minus 40 to +60 °C.

OTT Pluvio^2 is available with a choice of two collection orifices; a 200 cm^2 orifice offers a collection capacity up to 1500 mm of precipitation and a 400 cm^2 orifice offers 750 mm capacity. This is a greater capacity than was offered by the original Pluvio which extends the period of operation even further.

An optional heating ring is available for the smaller of the two orifices to prevent snow capping.

During the summer months, most of the collected water evaporates which extends the measurement period further.

Older technologies such as the TBR occasionally include thermostatically controlled internal heaters to address the problem of snow/ice accumulation, but this can incur a delay in the measurement and may be impractical in remote locations for reasons of power consumption.

In contrast, the OTT Pluvio^2 operates on very low power – typically 12 mA at 12V DC and the power requirement is 9.6 to 28 V DC. A sophisticated software filter eliminates the potential effects of wind and each OTT Pluvio^2 is individually temperature calibrated. In contrast with TBRs, this is a life-time calibration so users can expect long-term accurate data throughout all weather conditions.

The OTT Pluvio^2 weighing measuring principle is based upon an edge compensated and sealed single load cell, overload protection, direct mounting on the weighing platform and highly sophisticated electronics and algorithm features. The individual temperature characteristics of the load cell are memorised in the

electronics and corrected by in-situ temperature compensation. This achieves precise weight measurements with incremental accuracy of 2 grams equal to 0.10 mm and provides an impressive resolution of 0,01 mm of precipitation. The load cell is insensitive to eccentric load that may occur for example, as a result of unsymmetrical distribution of snow in the buckets.

Designed and built by OTT MESSTECHNIK in Germany, the OTT Pluvio² complies with WMO guideline 306 No.8 and is built to high engineering standards to provide a long working life. Cost of ownership is minimised because there are no tipping buckets to clean and no filters to unblock; an annual maintenance check is all that is required. A calibration check can be performed with a calibration weight set according to ISO standards.

OTT Pluvio² has a USB interface that is employed for configuration and monitoring either with a PDA or computer running the Pluvio Operating Program. This also provides convenient service access to the instrument.

The Pluvio design team has also taken into account the possibility of a need to repair the instrument, should damage or a fault occur in the field. The electronics unit can be easily removed and replaced on site and data loss and maintenance costs are reduced to a minimum, because it is not necessary for the whole gauge to be transported to a service laboratory.

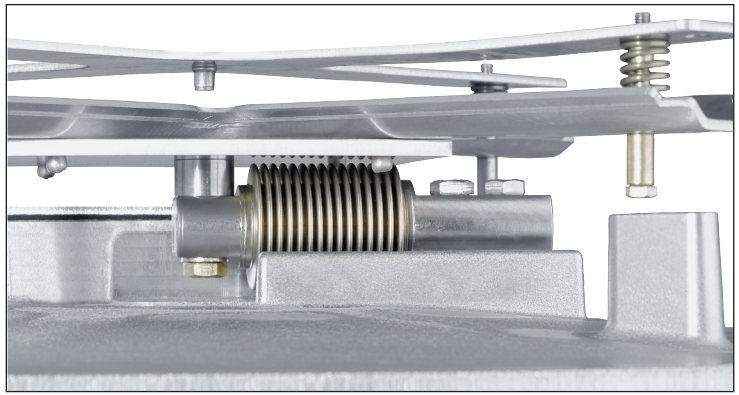
One of the ways in which OTT MESSTECHNIK has been able to reduce the cost of OTT Pluvio² has been to make the internal datalogger optional. Many customers have their own loggers or simply wish to attach the OTT Pluvio² to an existing monitoring station, and for this reason OTT Pluvio² can be supplied with one of the company's own low-power dataloggers or with an impulse, SDI -12, or RS 485 output.

Many OTT customers purchase the OTT Pluvio² as part of an environmental monitoring system which may include other meteorological or hydrological sensors in conjunction with a datalogger, a field power supply and a data communication technology. Such systems can be configured prior to delivery so that monitoring can begin immediately.

As a specialist in environmental monitoring, OTT is able to offer a range of low power data communication technologies from hand held devices to GSM, radio or satellite transmitters.

Applications

The OTT Pluvio² is the preferred instrument in applications for which users require accuracy and reliability in all weather conditions. It is particularly popular in remote locations for which frequent visits would be impractical. These include national monitoring networks for meteorological forecasting and flood alerts, research, agriculture, irrigation, airports and many more.



High precision OTT Pluvio² load cell

The enhanced real-time data collection capabilities of the OTT Pluvio², providing both intensity and precipitation accumulation information, make the instrument an ideal tool in risk management for flood warnings and other weather related emergencies, particularly those involving extreme precipitation events.

Highly accurate precipitation data can be produced for climatological and synoptic purposes to facilitate the exchange of meteorological data with other weather services worldwide.

The Future

The OTT Pluvio² will continue to replace older technologies as the standard instrument for precipitation measurement. In Germany, for example, it is the method by which all others are judged. In the United States the Pluvio outperformed competing products in recent testing by several government agencies; the National Weather Service selected the Pluvio for use in key airport facilities, and the USGS has completed an extensive testing program to assist the National Atmospheric Deposition Program (NADP) in determining the appropriate precipitation gauge for the National Trends Network.

The release of OTT Pluvio² with a lower cost will enable many countries to adopt the new technology, particularly those with extensive networks of TBRs with continuity of comparable data being preserved through the creation of appropriate comparative trials.

In summary, Sir Christopher Wren invented the first TBR because he could see a need for automatic measurements and with the benefit of many decades of instrument design, at OTT we believe that if he was alive today he would heartily approve of the OTT Pluvio²!

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