New

Biosirus

Opto-Sensor

Application Notes – Data Centers, Dist. Cooling, Building

(For details refer to the Opto-Sensor Temp & Strain Mapping System Brochure)

The performance of cooling applications (Data Centers, District Cooling and Building HVAC) is gaining importance due to higher ambient temperatures, higher electrical power consumption, rising power tariffs, and life style choices. In fact, cooling applications in commercial, industrial and residential sectors is a high growth area. Digitalization, connectivity and higher bandwidth is leading to a huge growth in hyperscale data centers globally. These centers have huge cooling requirements and even a small improvement in cooling performance is big savings to the operator. In hot climates, district cooling applications are emerging for urban building clusters with cooling loops and a district chiller plant rather than each building having its own chiller system. *In all these cases, temperatures are measured only at a few input-output points in the cooling system due to the intrusive nature and high costs of such sensors. The new Opto-Sensor changes all that with fibers that can be looped 20 km long and temperature readings obtained periodically every meter on the fiber.*

General Overview:
Opto-Sensor is a two-part system consisting of (a) 19-inch rack mount unit and (b) optical fiber loops. Each unit can have up to 4 channels of dedicated fiber-loops where a single laser switches between each channel. A fiber loop can be dedicated to a test configuration, while other fiber-loops can be placed in-situ into the infrastructure permanently. Hence, a single Opto-Sensor unit can be used across multiple (concurrent) measurements. The choice of the single-strand fiber and its jacketing (PVC, metal, etc.) is based on the application/mechanical requirement. The simplest fiber type is only hair-width. Also, a single channel fiber can be spliced into "zones" and terminated as a contiguous fiber-loop. In multi-channel applications where the sampling rate is high (max 2 samples/minute) and the fiber length is very long (in kms), then a software adjustment is made to time-synchronize the various channel data-sets. Both temperature and strain measurements can be done on the same fiber.

Creating a Cooling Temperature Profile for Optimum Performance:
In all the above cooling applications (whether testing, real-time monitoring and/or digital twinning), the fiber needs to be "affixed" in very close proximity to the object whose temperature is being measured. In simple applications, it could be a single fiber-loop running the entire loop length for all temperature measurements (ambient temp, HVAC input-output temperatures, pipe-loop temperatures, heat-load point temperatures, etc.). For complex systems a multi-channel system is best, where channel-1 is for the fixed plant (ambient, HVAC input-output and exhaust temperatures) and other channel fibers are for the cooling loop lengths and pipe systems.

Data Centers: The fiber will need to be looped not only along the HVAC supply and return plenum but also inside each hyperscale cabinet (along its vertical height) to capture the temperature gradient inside. This will allow for better management of individual cabinet heat-load. Another area is the temperature measurement across cabinet rows including individual floor registers to ensure all are working properly as designed.

District Cooling: The fiber needs to be looped not only inside the district cooling plant (ambient temperature, input-output process temperatures and auxiliaries as required), but also along underground cooling pipe loops that feed the various buildings. Depending on the pipe-loop lengths (and its sub-branches), all such measurements can be done on a single fiber or measured independently using multiple fibers or a combination of both. The fiber needs to be attached to the cooling pipes or in very close proximity.

Buildings: In building HVAC applications the fiber needs to be run along the duct work, supply registers and return-air vents to measure temperature imbalance (and hence heat load) on individual floors and also comparison between floors. Often such imbalance is due to poor approximation, defective controls and/or change in usage over time. Losses in the ductwork/raceways can be detected as well. In colder climates the fiber will serve both the cooling and heating seasons.

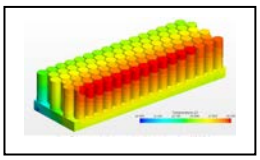
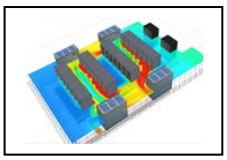
Temperature Measurement:
The fiber is typically run in a contiguous pathway along ducts, cabinets, supply/returns, registers and vents. The fiber bend radius depends on the fiber selected and can be as small as few cm. The fibers can be placed close to each other and there is no risk of any "coupling effect" or electrical interference.

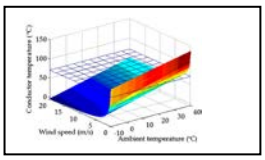
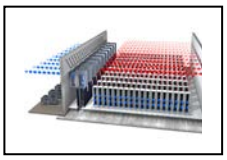
Strain/Flex Measurements:
While both the temperature and strain measurements can be done together in the same fiber, in some cases the fiber orientation for strain measurement may force using its own dedicated fiber (separate from the temperature fiber). It is best to epoxy the strain fiber along its entire length for accurate measurement. It can detect elongation/sags and flexes due to impacts and pin-point such location.

Other Notes:
The 19-in rack unit is independent of the applications. It is a moveable asset to be used across multiple systems if needed. *It is however recommended that large establishments have their own racks to be able to monitor year-round changes in ambient conditions and changing load patterns. They could also be used real-time in a BIMs environment.* The fiber can be procured locally and is the only consumable. Its selection (jacket type) for low temperatures can be inexpensive. The copious data at a sampling rate of every 1-15 minutes, at every 1 meter along the fiber, can be stored in the unit or transmitted to a cloud or other SCADA/HMI systems. The max fiber loop length is 20 km. Pre-engineering services to obtain optimum fiber layout and positioning for a given project is available. *The best part is that only a few fiber connections are needed even for the most complex measurement. It easily substitutes hundreds (if not thousands) of thermocouples.*

A. OEM/Laboratory Applications:
Such tests include measuring temperature profiles on ducts/loops for various operating conditions by varying ambient temperature and load requirements. Often these tests are conducted indoors and the environment could be (a) **Adiabatic** (insulated enclosure with no heat dissipation) and (2) **Isothermal** where cooling and heat transfer is enabled. Adiabatic tests provide critical heat build up while isothermal tests provide heat extraction/flow parameters.

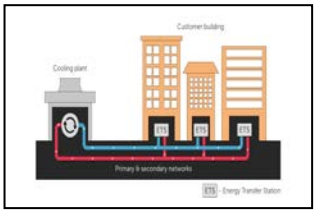
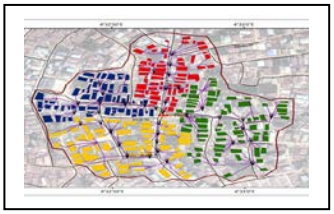
B. Calibration Setup and Periodic Verification across Sites:
Once the fiber is laid as required, the 19-rack can be brought to the site to calibrate and/or periodically verify the temperature profiles against a standard profile developed for the site.

C. Digital Twinning Applications:
In digital twinning applications the entire system is profiled through various combinations of load and temperature manoeuvres, as in real operating conditions. Such measurements include the entire thermal profile, varying ambient temperatures, locational hot-spots, cooling medium temperatures, and other auxiliary systems. This digital profile is then either used stand-alone for simulation and training to understand operating limits and/or is stored on-board NMS, ADMS, SCADA systems to help predict and manage real-time operating situations.

D. Real-time Monitoring & Performance Applications:
It is recommended that high value applications with heavy electrical loads, varying ambient temperatures and critical temperature management, be deployed with a real-time system. This would include both internal or external cooling delivery systems. In such a system a single fiber could be laid the entire route to capture thousands of data points. Output relay contacts can enable alarms and corrective actions. Principally, the performance optimization would include (a) current and immediate forecasted ambient temperatures; (b) estimated short-term load time-series; (c) duct/loop temperatures; (d) hot spots; and (e) HVAC input-output temperatures parameters.

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