L.7 : Wavelet based Distributed Temperature Sensor with Improved Performance

The optical fibre distributed temperature sensing (OFDTS) technique represents a new physical approach for temperature measurements over long gas pipe lines, high voltage electrical cables, coolant loops of fast breeder test reactors etc. It can also be used for air-conditioning management in server rooms and for fire detection in tunnels, mines and buildings etc. OFDTS permits measurement of spatial temperature distribution over very long distances with a single optical fiber that itself acts as sensing element. If a conventional temperature monitoring system based on point sensors (like thermocouple, RTD etc.) is designed to yield similar performance as that of OFDTS, it would require a large number of sensors, cables and connectors, making it practically complex and difficult to handle. Wavelet transform based signal processing has been used to drastically improve the performance of OFDTS. An OFDTS system has been developed at Fiber Sensors Lab., SSLD for the temperature range of 25-300°C with a temperature resolution of ~ 3°C over a sensing length of 200 m with a spatial resolution of 1 m.

The principle of operation of OFDTS is based on optical time-domain reflectometry (OTDR) involving time of flight measurement in conjunction with Raman scattering wherein sensing fiber is coupled to short interrogating laser pulses and the backscattered optical anti-Stokes (AS) and Stokes (St) components are monitored for signal changes. Ratio of temperature sensitive AS signal and St signal, which is measured simultaneously and synchronously to make temperature measurement independent from fiber geometry and fiber bend losses.

Highlights of the developed system:

- Immune to EMI and safe for use in hazardous environment.
- Temperature range: 25-300°C
- Temperature resolution: ~3°C
- Spatial resolution: 1 μm
- Automatic self calibration. No need to maintain a constant temperature hot bath for calibration zone
- Discrete Wavelet Transform based dynamic compensation of errors caused by difference in anti-Stokes and Stokes wavelengths
- Zone selection and preset zone alarm indication for safety warning
- Fully automatic. No user intervention required. User friendly graphical user interface
- Sensor enclosed in a protective stainless steel tube and can be bonded to pipelines or vessels

Figure L.7.1 shows the photograph of the developed system whereas Fig.L.7.2 depicts the photograph of the calibration unit and sensing fiber.

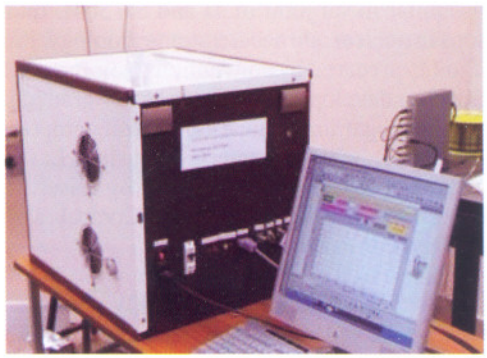

Fig.L.7.1: Photograph of the developed Raman OFDTS

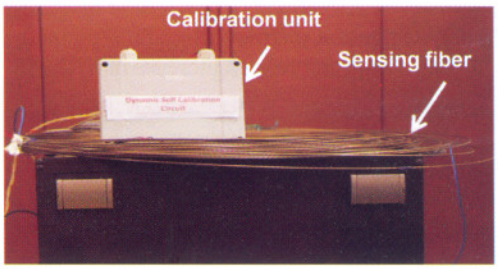

Fig.L.7.2: Photograph of the calibration unit and sensing fiber

The distributed temperature profiles measured for two hot zones, selected in 200 m long fiber are shown in Fig.L.7.3.

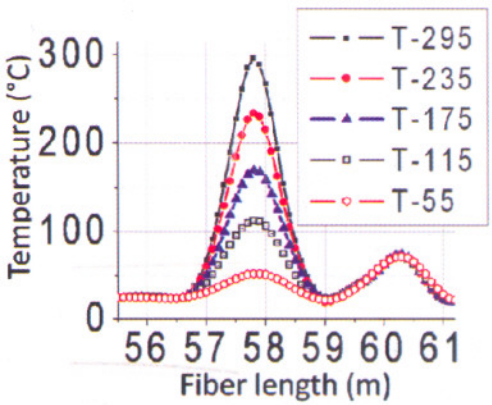

Fig.L.7.3: Zoomed view of distributed temperature profiles at hot zones

[For details please see : M. K. Saxena, S. D. V. S. J. Raju, R. Arya, S. V. G. Ravindranath, S. Kher, S. M. Oak, Measurement, Vol. 47, p 345 (2014)]

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