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Accurate Single-Ended Distributed Temperature Sensing

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Abstract

Distributed temperature sensing (DTS) is a technique to obtain real-time temperature well logs which are used for several applications such as production allocation, heavy oil thermal recovery (e.g., steam-assisted gravity drainage, SAGD) steam-well management, and well-integrity monitoring. This system is based on measuring scattered light at more than one wavelength from an optical fiber placed along the well.

An issue arises when the attenuation of the optical fiber changes with time by different amounts at the different wavelengths used causing degradation in accuracy of the measurement. This differential loss can be compensated for by connecting both ends of the optical fiber to the DTS instrument in a double-ended (DE) configuration. However, it is not always possible to operate in DE configuration because of other constrains in the design such as lack of space or restricted number of penetrations in completion equipment. Single-ended (SE) operation configuration has been used in these cases, exposing the monitoring system to potential loss of accuracy.

An accurate single-ended (ASE) DTS system which provides differential loss measurement and compensation to single-ended installations is described. The instrument uses more than one light source to compensate for the optical-fiber differential losses at the relevant wavelengths. This compensation is applied continuously without the need of external recalibration. A system operating on this principle has been used for some time on single-mode fibers, and recent technical advances have enabled its application to multimode fibers.

Laboratory-test and field-test results are presented showing a dramatic improvement in accuracy in cases where differential losses have developed. Comparative data using DE, SE, and ASE DTS systems are presented showing cases in which optical fibers were subjected to extreme environments where the effect of differential loss is accentuated. Examples are shown in which errors of up to 100°C caused by differential loss were automatically corrected in real time by the ASE DTS instrument.