Corrections of LED instability in IR gas analyzers.

Mid-IR LEDs offer a lot of advantages over incandescent lamps used for many years in optical instruments. However the drawback of the LEDs is their output power and wavelength variation with temperature. This kind of instability directly affects the readings as radiation intensity that enters photodetector is the measure for gas concentration. Very obvious way to overcome this instability is decreasing temperature fluctuation through the use of TEC and temperature control electronics. However TEC device version is expensive and in some cases does not provide desired measurement accuracy. Listed below are approaches utilized so far to overcome this drawback. Some of the approaches are used in commercial products; while other exist in publications only.

1. Single channel analyzers.

The single channel approach is based on an assumption of lack of degradation of LED main characteristics with time. In other words all LED parameters can be predicted through the use of calibration curves recorded in the past the temperature of the LED being known at the time of measurements. This approach has been considered in [1] and recently used in the CO2 monitor utilizing LED42Sr and PD42Sr and produced by TRITON ELECTRONICS without any additional optics [2].

Close to [1] ideas were reproduced in LED based analyzer with calibration curves obtained by a series of pumping currents. It was assumed that using temperature value it was possible to estimate the wavelength and the intensity values in the CO2 analyzer [3].

2. Two channel analyzers.

There are two possible options of this type of the device: two LEDs+1 detector, Two detectors+1 LED. In the second case LED intensity is monitored by one of the detectors whose signal does not depend on gas concentration. The performance was described elsewhere [4] and was used for 1-year period in a production of the hand held CO2 analyzer GIAM-302 (NPO "ANALITPRIBOR", Smolensk, Russia).

3. Four channel analyzers.

This type of analyzer enables compensation of both LED and detector instability and is though to be the best in terms of accuracy. It was suggested in [5] and then reproduced in many instruments (see e.g. Fig.1 taken from [6, 7]). It is believed that some companies are still using construction shown in Fig.1 in their sensor heads.

$$d = \frac{I_{и1}}{I_{o1}} \cdot \frac{I_{o2}}{I_{и2}} \quad (2)$$

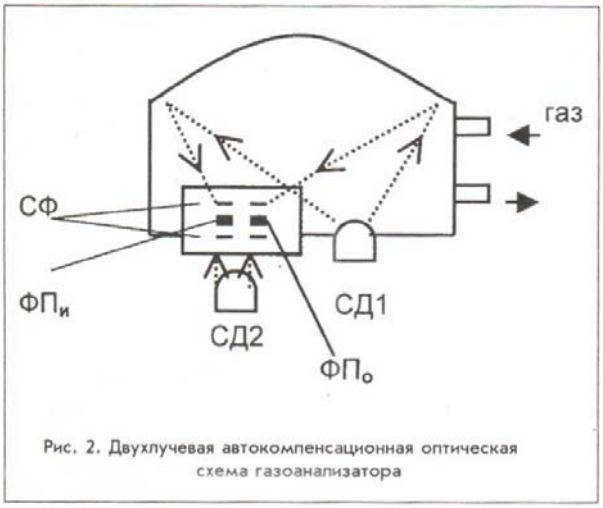

Рис. 2. Двухлучевая автокомпенсационная оптическая схема газоанализатора

Fig. 1 Schematic of the gas cell and compensation formula from [5, 6, 7]. (СД=LED, ФП=PD, СФ=filter).

Of cause, in practice one can hardly find "pure" cases indicated above. Instead temperature stabilization is commonly used in most of the instruments in addition to compensation procedures. For example in [2] the gas cell is heated to a certain temperature in order to get stable signal. In addition to digital corrections made by a microprocessor this resulted in high measurement accuracy and speed.

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