PROCESSING OF SIGNALS FROM A CORRELATION GAS ANALYZER

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We present here an improved electronic block diagram for processing optical signals in correlation gas analyzers that allows essential simplification of the arrangement of the optical section, synchronization system, data processing procedure, and also the enhancement of sensitivity and noise immunity of the system.

In spite of a wide variety of absorption methods and equipment for monitoring of gaseous substances the general level of gas analysis does not meet the requirements of state–of–the–art technology and science. It necessitates searching for new analytical methods and developing gas analyzers that would be simple and reliable, have high sensitivity and selectivity, and also high precision and speed.

Progress in developing modern analytical methods is held back by shortage of researches aimed at improving circuitry of optical–mechanical and electronic system of analyzers.

The majority of existing gas analyzers with gas correlation filters uses a single receiver and the time separation of signals from the reference and measuring channels. The modulation of radiation flux in a gas analyzer is effected by the mechanical choppers in the form of rotatable discs with slits or in the form of vibrating plates. The greatest error in measurements at the frequencies of the mechanical modulation is produced by the thermal noise arising from the thermal motion of electrons in the input electric circuit of a receiver and from the so–called $1/f$ (or excess) noise conditioned by the surface and contact phenomena in the material of the receiver.

To exclude the effect of this noise, the modulation frequency should exceed 350 Hz. In this case, the modulation of signal by rectangular pulses with equal duration of the signal and intervals is the most profitable from an energy standpoint.[1] Performance of such a modulation by mechanical means meets with certain difficulties in a modulator design and signal processing, which, in its turn, calls for rigorous synchronization and cutting out of a part of signals from the overlapped channel.

Electronic units of optical signal processing usually contain the ac amplifiers, the synchronous detectors with low frequency filters in the output and an input narrow–band filter, tuned at the modulation frequency, or the synchronous filter. The temperature stability of performance characteristics of gas analyzers is attained owing to application of a ratio meter.[2]

We have developed a gas analyzer that uses the advantages of the meter of ratio of signals from two–channel optical section but using modulation of an electric signal rather than an optical one, which simplifies the optical section and processing system considerably.

The functional diagram of a gas analyzer is presented in Fig. 1. A radiation flux transmitted through the gas analyzed enters a lens with a narrow–band filter. A beam splitter decreases the light polarization effect on the reflection coefficient at large angles of incidence of a light beam. The gas correlation filter is a cell with the gas to be analyzed whose optical density is much greater than the one under measurement. The signals from the photodetectors *3* and *6* comes to the electronic modulators where they are converted to meanders shifted by a half period relative to each other. In the presence of gas to be analyzed in the space under study, the summed signal is also a meander. The signal processing is done by use of a synchronous detection and a ratio meter.[3,4]

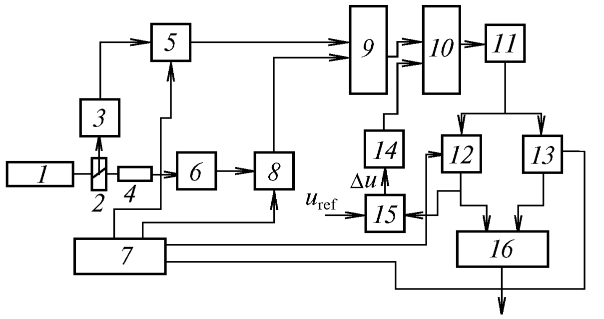

FIG. 1. The single–beam two–channel gas analyzer with a gas filter: 1 – lens with a filter; 2 – beam splitter; 3 – photodetector of measuring channel; 4 – gas correlation filter; 5 – modulator of measuring channel; 6 – photodetector of reference channel; 7 – generator of synchronous pulses; 8 – modulator of reference channel; 9 – summator; 10 – variable–gain amplifier; 11 – clamp; 12 – synchronous detector of measuring channel; 13 – synchronous detector of reference channel; 14 – feedback signal amplifier; 15 – comparator; 16 – subtractor.

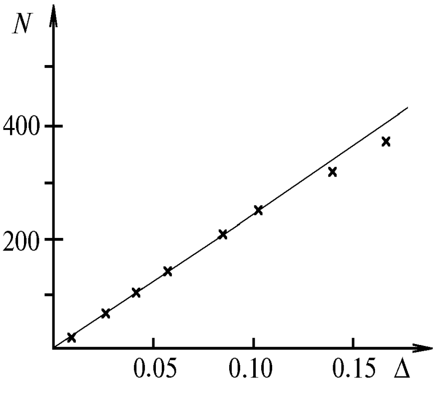

Fig. 2. Relationship between the transfer function N of the electronic unit and the disbalance signal Δ.

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Figure 2 shows the experimentally obtained relationship between the transfer function N of the electronic unit and the signal of disbalance $\Delta = (U_0 - U_1)/(U_0 + U_1)$ brought on by the presence of a analyzed gas on the path at different levels of the signal in the reference channel; U_0 and U_1 are the output voltages of the photodetectors of the reference and the measuring channels.

As shown in this figure the transfer function error is within the limits of 3% up to the disbalance level of 0.12, which corresponds to the range of the disbalance of the correlation gas analyzers.

In such a way the transfer of modulation of the signal from the optical section to the electric one allows the simplification of the optical section design, signal synchronization and processing system and the provision of the rectangular shape of the modulated signal of required frequency.

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