Thermometry in a sealed discharge cell with noble gas

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Noble gas radiation is useful for calibration of optical spectral instruments, since it consists of a set of intensive well-resolved spectral lines. Sealed low-pressure cells with a suitable noble gas are usually used as sources of calibration light radiation. At the same time, the simplest low-power RF generators are used to excite gas, which are manufactured directly in the laboratory. With the operation of such devices, variations in the RF power supplied to the excitation electrodes are observed, which is accompanied by changes in the temperature and pressure of the gas in the cell. In turn, changes in the gas state parameters cause shifts and broadening of the reference spectral lines, which leads to errors in the calibration of optical wavelengths. To estimate the possible errors, it is necessary to determine the changes in the temperature and pressure of the noble gas in the sealed discharge cell when the power of the exciting RF generator is varied.

The gas temperature and pressure can be determined from the spectral line profile. In general, the line has a Voigt profile, which is a convolution of the Doppler and Lorentz contours. The temperature of the gas under investigation can be determined from the Doppler broadening and the gas pressure can be determined from the amount of the Lorentz broadening. In [1] the technique of "reference" points is presented, which makes it possible to separate the Doppler and Lorentz components of the Voigt profile broadening of a single spectral line. However, the results of the verification of the calculated procedure given in [1] do not look quite complete, since experimental data were used from the literature sources and only for the temperature.

In this paper, we compare the calculated data obtained by the "reference" points method from the absorption line profile with the results of direct measurements performed by the pressure sensor. The diode laser spectroscopy and a discharge cell with an established gas flow were used for these measurements. The discharge cell with the gas flow allowed us to change the pressure inside it in a controlled way. Then, the tested technique of "reference" points was applied to the evaluation of variations in temperature and pressure in the sealed argon cell of a optical wavelength calibrator [2].

[1] Naumova N. N., Khokhlov V. N. // Journal of Optical Technology, 73(8), 512-514 (2006).
[2] Chernyshov A. K. // Instruments and Experimental Techniques, 61(1), 153-156 (2018).