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**Abstract:** To develop an online probe that is not only sufficiently robust, but also able to measure crucial process variables in biogas plants is a tough challenge. Therefore, a mid-infrared (MIR) spectroscopic attenuated total reflection (ATR) probe and robust probe fitting were established. A fully automated probe control, calibration after probe cleaning, and analysis of the absorption spectra using machine learning were implemented in order to reduce maintenance of the probe to a minimum. The relevant wavelengths in the MIR spectrum for organic acids, total alkalinity, and ammonium nitrogen concentration were identified. Finally, intensive lab testing was carried out, followed by operation of the complete online measurement system at an industrial biogas plant. In order to improve signal strength and sensitivity, microelectronic mechanical system (MEMS)-based Fabry-Pérot interferometers were also investigated.

**Keywords:** Anaerobic digestion, Biogas, Machine learning, Microelectronic mechanical system interferometer, Mid-infrared