Energy Metering of Raw Biogas

Stefan Heinsch, Stefan M. Sarge

Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38116 Braunschweig, Germany

Biogas is regarded as one possible renewable energy carrier for solar energy. It is produced from organic waste, manure or energy crops. The resulting biogas is used either on-side to produce electricity and heat or upgraded and fed into the natural gas grid. Although the efficiency of the conversion of solar radiation into organic material by plants is rather low (0.5 % … 2 %) and the conversion into biogas (mostly methane, carbon dioxide and water vapour) costs another 50 % in efficiency, the big advantage compared to most other so-called renewable energies is its possibility for disconnecting production from use by storage of the gas either in dedicated biogas storage facilities or – after upgrading to pipeline quality – in natural gas storage facilities.

Biogas production offers a number of advantages which makes it promotion attractive:

- reduction of the use of fossil fuels
- reduction of greenhouse gas emissions (CO_2, CH_4, N_2O)
- closing the nutrient cycle (digestate as bio-fertiliser)
- reduction of nitrification of soil and water
- reduction of health risks connected to inhalating high amounts of ammonia
- avoidance of unpleasant odour
- creation of added value in rural areas
- offering farmers new income opportunities

Traditionally, the energy content of natural gas is determined by measuring the volume flow of the gas under metering conditions, converting this volume to standard conditions, subtracting the amount of water and multiplying the result with the superior calorific value of the gas. However, our current research in energy metering aims at qualifying an instrument for reliable, cost-effective, robust and accurate measurement of the energy content of raw biogas.

The biggest challenge here is the water content of the raw biogas (up to 100 % relative humidity at 40 °C, about 6 % absolute humidity) which makes traditional measurement techniques for calorific value like gas chromatography or infrared spectroscopy unreliable. Calorimetry, on the other hand, is in principle not influenced by any component of the biogas as long as it is in the gaseous phase, therefore, this technique is employed here. Many modern calorimeter on the market employ instead of an open flame with differential temperature measurement a catalytic combustion chamber with determination of the residual oxygen concentration in combination with metering of the fuel gas by pressure controlled nozzles. Both technologies add additional complexity to the calorimeter, because now an assumption is made about the stochiometry of the combustion process and the metered volume depends on the density of the fuel gas.

In our research it is shown that with the calorimeter employed here, the stochiometry of the combustion can be taken into

account by computation and the metering issue by using adequate calibration gases. This results in an instrument for the determination of the energy content of raw biogas fulfilling the requirements of legal metrology worldwide as laid down in OIML Recommendation R140 “Measuring Systems for Gaseous Fuels”.