

Optimized Sampling to Detection: Simultaneous Analysis of Siloxanes and Sulfur in Biogas

Ayush Agarwal^{1,2}, Laura Torrent^{1,3}, Julian Indlekofer¹, Sylvain Bouchet⁴, Lucy P. Culleton⁵, Serge M.A. Biollaz¹, Christian Ludwig^{1,2}

¹Paul Scherrer Institute, PSI Center for Energy and Environmental Sciences, 5232 Villigen PSI, Switzerland.

²École Polytechnique Fédérale de Lausanne (EPFL), School of Architecture, Civil and Environmental Engineering (ENAC IIE GR-LUD), 1015 Lausanne, Switzerland.

³University of Girona (UdG), Department of Chemistry, Faculty of Sciences, 17003 Girona, Spain.

⁴Federal Institute of Metrology, METAS, Lindenweg 50, CH-3003 Bern-Wabern, Switzerland.

⁵National Physical Laboratory (NPL), Hampton Road, Teddington, Middlesex, UK, TW11 0LW

ayush.agarwal@epfl.ch

Sulfur and volatile organosilicon compounds are some of the common contaminants in waste-to-energy systems, where they contribute to catalyst poisoning, corrosion, and mechanical wear, even at trace levels. Such detrimental effects make precise monitoring crucial for maintaining energy production efficiency. To address this challenge, we developed an analytical approach capable of simultaneously quantifying siloxanes and sulfur compounds in biogas. This method integrates a liquid quench (LQ) sampling system with gas chromatography-inductively coupled plasma mass spectrometry (GC-ICP-MS), providing a robust and efficient means of detection.

A key advantage of this method is its ability to employ liquid calibration standards in place of gaseous standards, ensuring both accuracy and reproducibility. Participation in a round robin test further validated its reliability. Additionally, this approach minimizes the limitations of traditional gas-phase sampling, offering improved precision and reducing potential sources of error. Samples can be stored for at least four weeks without significant analyte loss, making the method well-suited for small and medium scale biogas plants. Results from sampling and measurement campaigns conducted at multiple biogas plants across Switzerland further demonstrate its practical applicability.

