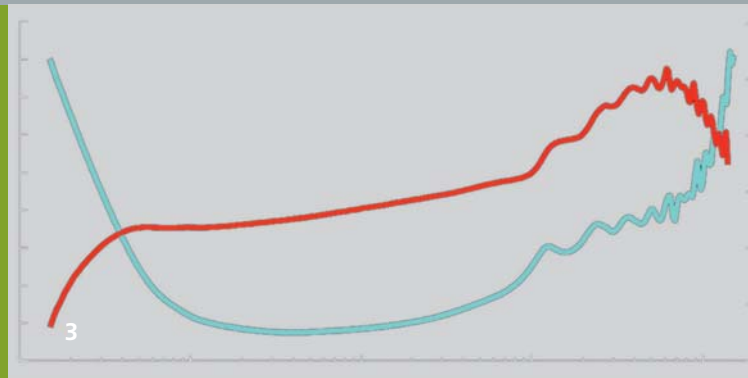




1



2



3

1 *Algae, various genotypes*
 2 *Sensor taking measurements in liquid*
 3 *Complex valued impedance spectrum,*
 Photos: Udo Seiffert

QUALITY ASSURANCE OF LIQUIDS BY MEANS OF RADIO SPECTROSCOPY

Fraunhofer Institute for Factory Operation and Automation IFF

Prof. Michael Schenk

Sandtorstrasse 22
 39106 Magdeburg
 Germany

Contact
 Biosystems Engineering

Prof. Udo Seiffert
 Phone +49 391 4090-107
 udo.seiffert@iff.fraunhofer.de

Dr. Andreas Herzog
 Phone +49 391 4090-767
 andreas.herzog@iff.fraunhofer.de

www.iff.fraunhofer.de

A Novel Sensor

A measurement system based on the principle of radio spectroscopy, a subfield of dielectric spectroscopy in the VHF radio frequency range, consists of compact sensing electronics and a remote forked sensor module. Made of a highly chemically resistant, biocompatible ceramic material, it contains the capacitive sensor elements and the active signal converter.

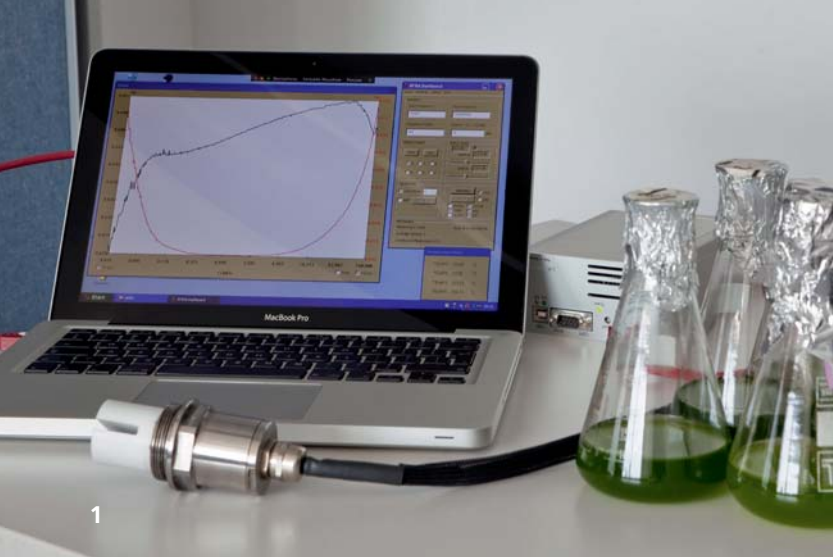
When measurements are taken, the sensor head is immersed in the medium being analyzed. Thus, the sensor element and medium form a capacitor. Variable frequency alternating current generated by the sensing electronics is applied to build up an alternating field. Complex dielectric mechanisms cause the medium to react by characteristically changing its electrical properties as a function of frequency. It can be specified fully by employing the complex

valued relative permittivity and the electric conductivity. These quantities are determined by measuring the pattern of sensor impedance as a function of the frequency range. The pattern contains information on the analyzed medium's biochemical composition.

Intelligent Data Evaluation

The challenge is to interpret the complex, high-dimensional signal patterns generated when measurements are taken. Creating models that use a reference database for quantification and evaluation is time consuming and not very reliable.

The Biosystems Engineering unit relies on another more efficient approach. We take advantage of the potentials of self-learning systems to model the correlation between spectral signatures and dependent



variables, whether this is liquid identity or chemical composition. We implement intelligent data processing by means of machine learning as a key component. Based on systematically acquired reference data, mathematical models are generated, which make it possible to process spectral data in a production process in real time.

Applications

- Identification of a crude liquid's quality parameters
- Online monitoring of liquid products in the production process
- Quality assurance of finished products

Our Services

The Fraunhofer IFF Magdeburg's Biosystems Engineering unit is your partner for the development and implementation of quality control systems customized to your needs. Our development may entail the following stages:

Systematic Data Acquisition

First, we use the sensor to systematically acquire dielectric spectral data at your facilities or in our spectral laboratory. If necessary, supporting dependent variables can be acquired by a contracted food chemistry laboratory. The data acquired will cover your specified needs.

Measurement Model Development

Based on the data acquired, a measurement model is created, which calculates the non-trivial correlation between the spectrum and dependent variables, e.g. the liquid's classification or chemical properties. A range of methods of machine learning is resorted to and the best model is selected for or adapted to your needs.

Model Validation

We validate the measurement model's performance extensively so that we are able to provide information on the expected measuring accuracies, processing times and necessary spectra. This validation is the foundation for the subsequent development of the system.

Systems Development and Integration

Based on the findings from the model's validation, we create a quality control system customized for you, which is based on spectral data and optimized data evaluation. This system can be integrated in your existing production systems.

Value Added for You

- **Automated:**
Analysis is performed during running operations without any manual procedures.
- **Online:**
Data is evaluated in the production cycle and can be used to intervene in the production process.
- **Integration:**
The system uses compact and rugged sensors, which can be integrated in the production process. Results of data evaluation can be integrated in existing data acquisition and control systems.
- **Noninvasive:**
This method of measurement does not damage your product.
- **Optimized:**
You receive a control system with hardware and software customized to your needs.

1 Laptop to activate and display measurements; control electronics completely integrated in the embedded PC and sensor head.

Photo: Udo Seiffert

2 Probe with embedded PC. Photo: TEPROSA

In collaboration with:

TEPROSA
Miniaturized Analytical Systems