analytikjena

RTM – Remote Temperature Monitoring

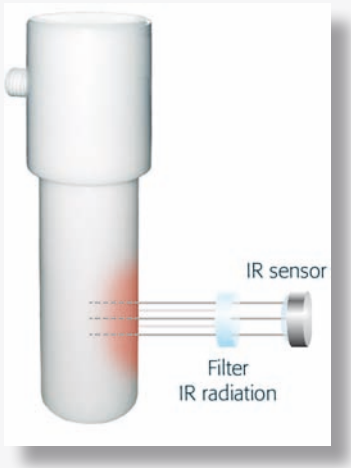
Basic requirements

The fast heating of digestion reagents and samples by microwave radiation requires careful monitoring of the temperature inside the digestion vessel.
Temperature based power adaptation allows to maintain permanent control of any reaction. Spontaneous exothermic reactions that may occur during decompositions of reactive samples must be recognized by the temperature sensor to guarantee maximum operational safety even in such cases.
The measurement technology must be resistant to the reagents used, usually mineral acids. Additionally, handling of the vessels should not become complicated by the sensor assembly to prevent leakage or damage by handling errors and to avoid the resulting safety risks and costs.
Immersion probes frequently used to measure the temperature in a reference vessel do not fulfil these requirements.
That kind of sensors must pass through the vessel lid into the sample. Not only does this increase the risk of leakage, it is also a frequent source of contamination and makes handling more difficult because the sensor has to be cleaned, installed, connected, and replaced regularly.
The sensor element must be protected from the corrosive reagents by a special coating. The poor thermal conductivity of such coatings leads to a delay in the temperature reading, thus recognizing fast exothermic reactions too late.
Most of these sensors use cable connections to transmit the data to the instrument. These cables and connectors are subject to corrosion because they are located in the oven interior where acid fumes at increased temperatures may be present. They can also get entangled in the rotating turntable and be damaged.

Broadband - IR sensors are commonly used alternatively to measure the sample temperature. The infrared radiation generated by the heated sample is mostly absorbed by the vessel material. The broadband - IR sensor then measures the surface temperature of the decomposition vessel to deduce the internal temperature.
A significant delay is inherent to that technology. Deducing the internal temperature from the surface radiation is error-prone, the error depends on the vessel material.
To compensate for this, most suppliers combine an internal sensor in one reference vessel with infrared-measurement of all vessels and correlate the two readings. This procedure assumes that all samples behave in a similar way which often is not the case. The better way would be to measure the real sample temperature in all vessels individually.

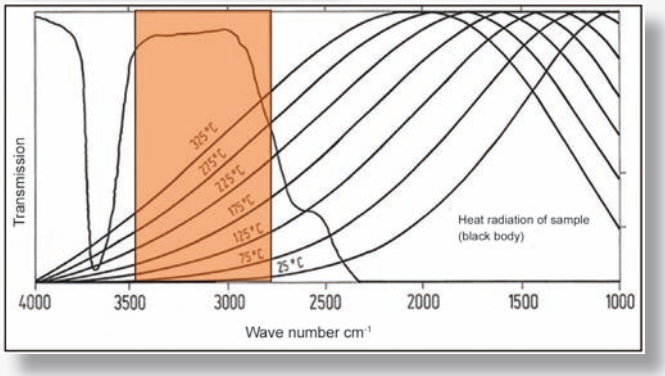
Advantages

- Direct measurement of all sample temperatures in real time per rotation (ca. 10 sec interval). For method development a single vessel can be positioned in front of the Sensor (interval < 1 sec.)
- No sensor inside vessels, no difficult assembly
- Absolute chemical resistance
- No damage by frequent connection/ disconnection of sensors
- No contamination by immersed probe
- No connectors for sensors, no dead-volumes
- No cables inside oven
- Sensor is located outside microwave field



◀ Measurement principle of RTM

▼ IR-spectrum of TFM



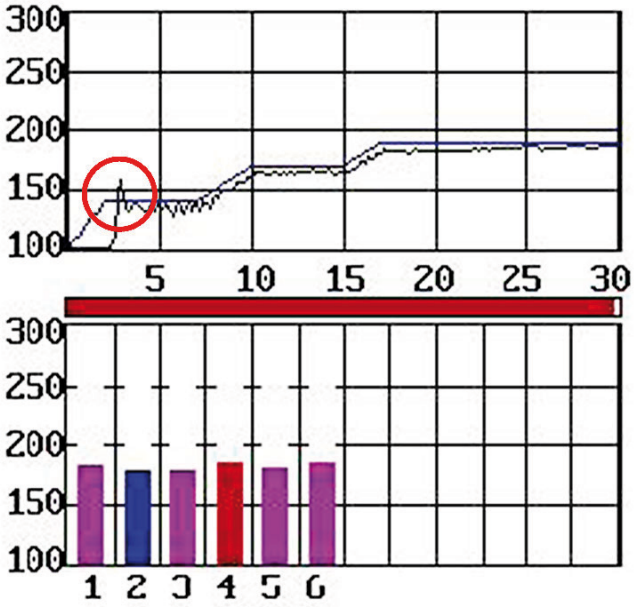
Analytik Jena Remote Temperature Monitoring (RTM)

Analytik Jena makes use of the patented mid-IR technology. This technology can measure the real sample temperature remotely by an IR sensor.

It uses a special wavelength range of the infrared spectrum in which the vessel materials are transparent. This way the heat radiation from the sample can be measured directly, without being adulterated by the vessel material. Measurement accuracy is additionally improved by filtering out the heat radiation from the vessel surface. The internal temperature of each digestion vessel can be measured very precisely and without any delay by this detection technology.

The fast response of the temperature measurement is beneficial for reaction control. Spontaneous exothermic reactions generate heat and pressure very fast and should be detected as accurately as possible to maintain control of the reaction and consequently protect the equipment and personnel.

▼ Recognition of spontaneous exothermic reactions
Digestion of 6 plant samples with 5 mL HNO_3 / 2 mL H_2O_2



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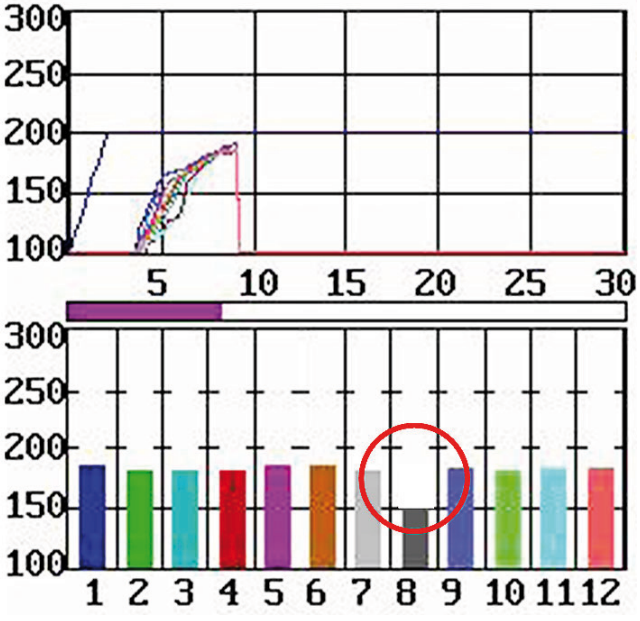

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