

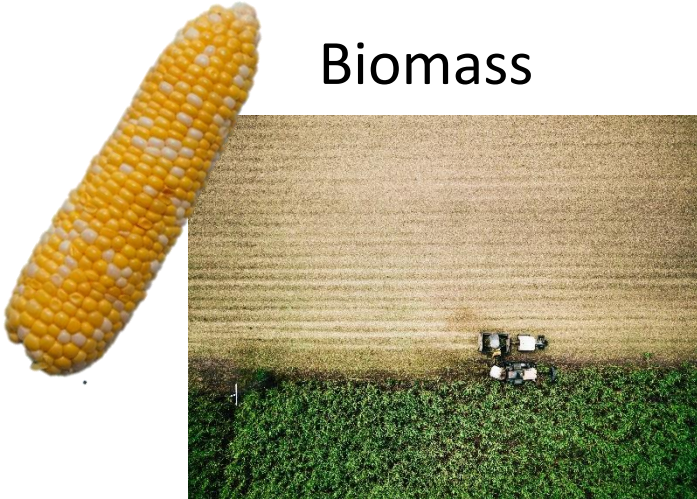


BIOETHANOL PRODUCTION

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Bioethanol production for QA/QC

Biomass



Fermentation



Distillation

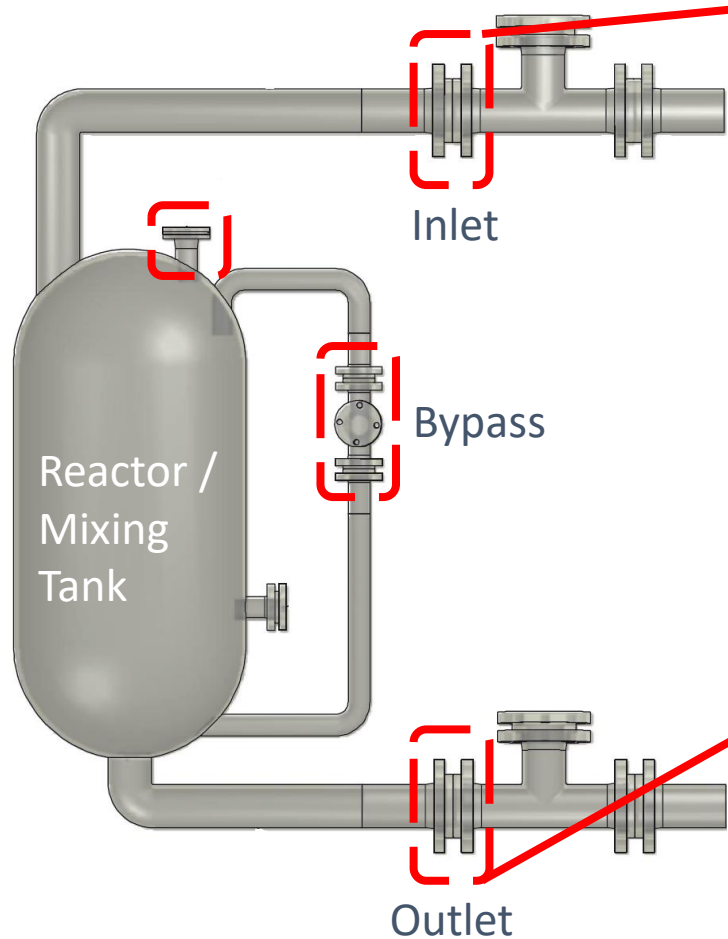


Ethanol



Ethanol production

Advantages of Spectroscopy



- Non – destructive
- Real - time monitoring
- High Sensitivity
- Rapid data acquisition
- Multi – constituent
- True batch representation

Ethanol production

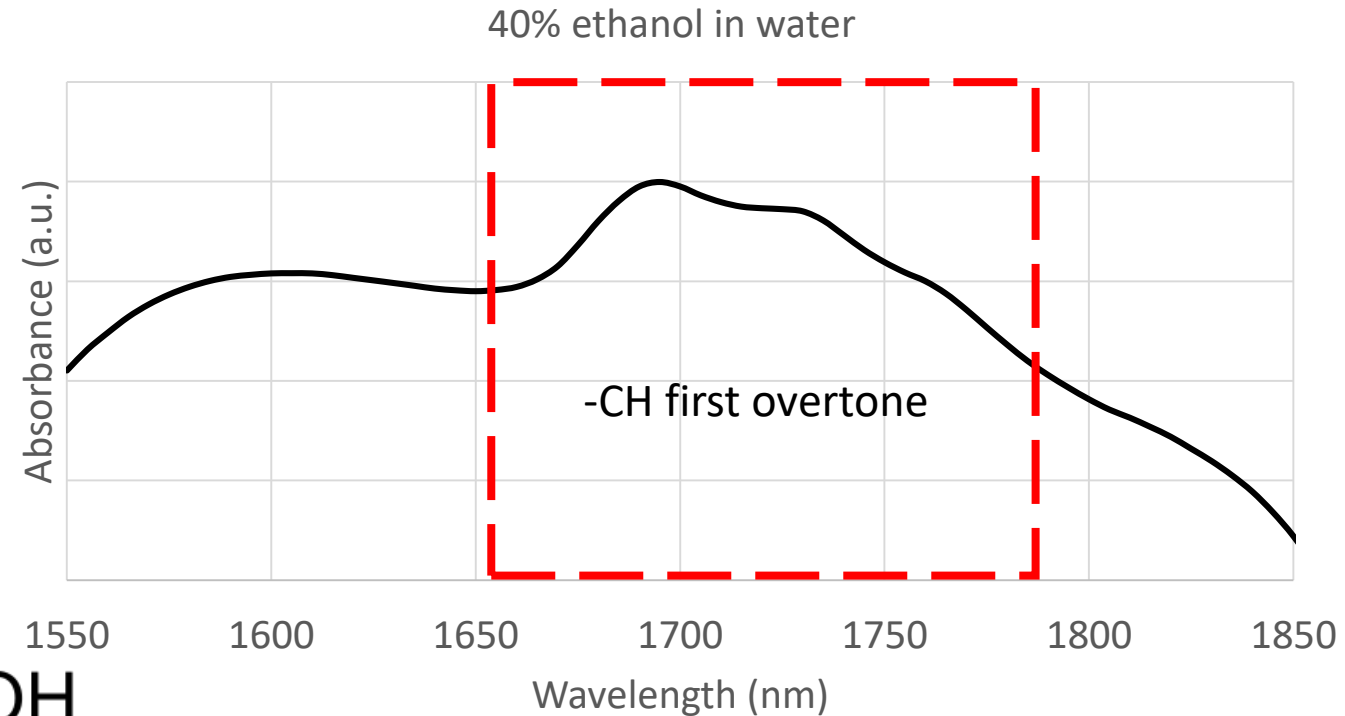
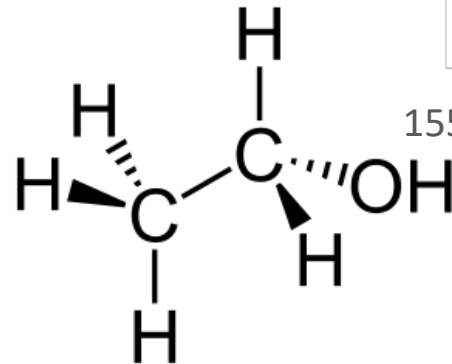
What is being measured?

- Feedstock material

- Moisture
- Protein
- Starch

- Processed broths

- Glucose
- Ethanol

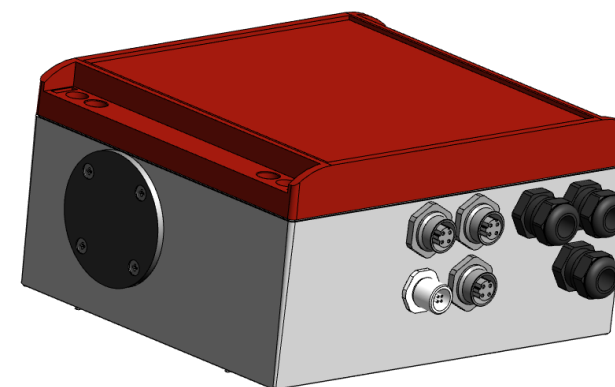


Ethanol production

Compact NIR spectrometer

- Micro Electro Mechanical System (MEMS) Fabry-Perot spectral Sensors
- Wavelength ranges
 - 1.35 – 1.65 μm
 - 1.55 – 1.95 μm
 - 1.75 – 2.15 μm
- Signal-to-noise: >10,000
- Wavelength accuracy: 0.3 nm
- High integration level
- Efficient, Compact & Low Cost
- Robust

tec5USA integrated System

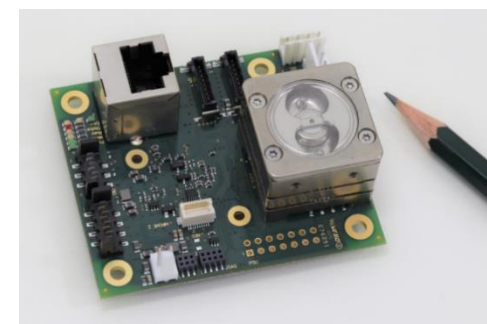


Miniature Halogen lamps

NIRONE Spectral Sensors



tecSaaS embedded technology



Ethanol fermentation

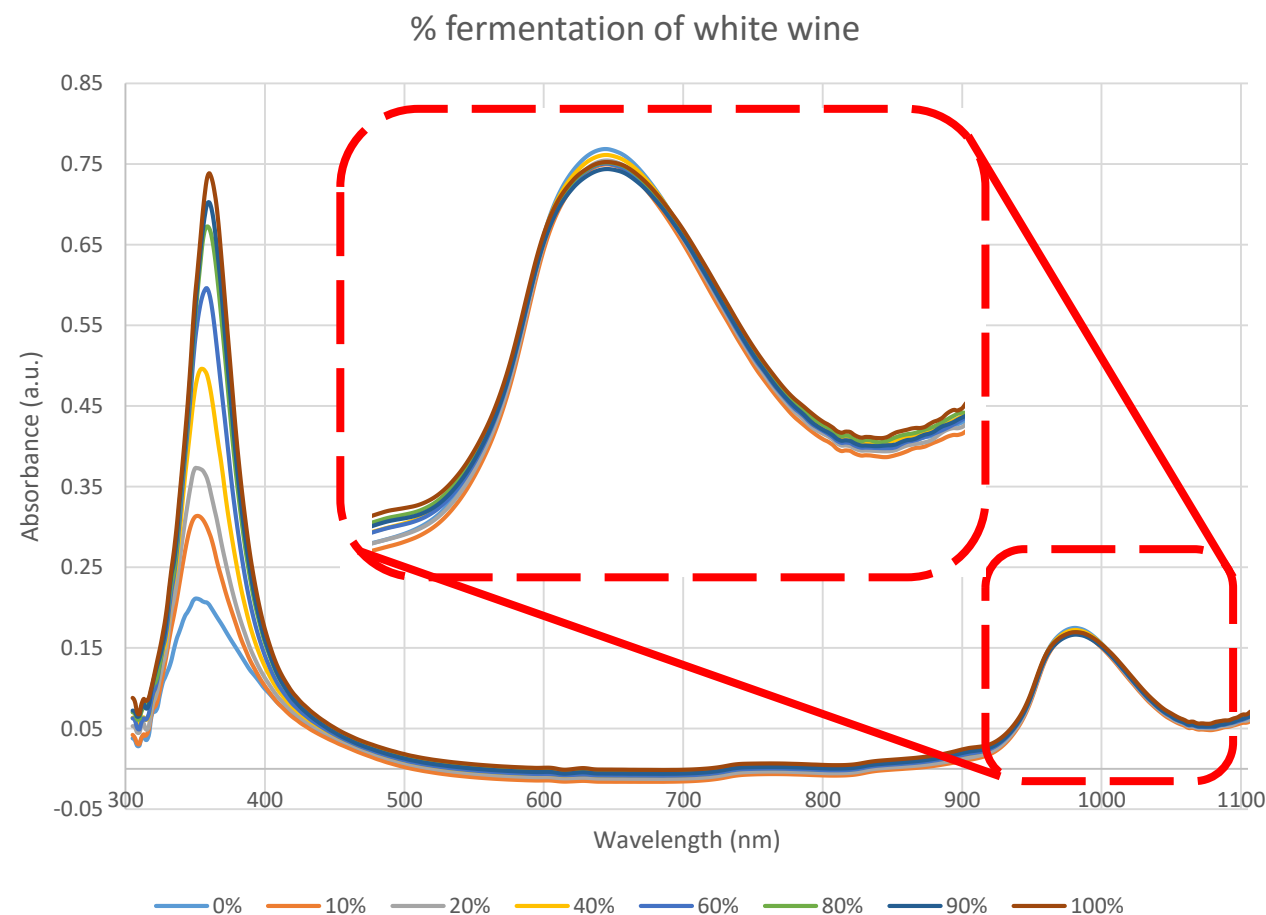
White wine analysis

■ UV range

- Broad absorption band maximum between 350 – 360 nm
- Increase in absorbance with increasing % fermentation
- Likely contributions due to flavanol content

■ NIR range

- Broad absorption band between 900 – 1050 nm
- Expected range for 2nd/3rd overtones
 - Contributions from ethanol and sugar



Ethanol fermentation

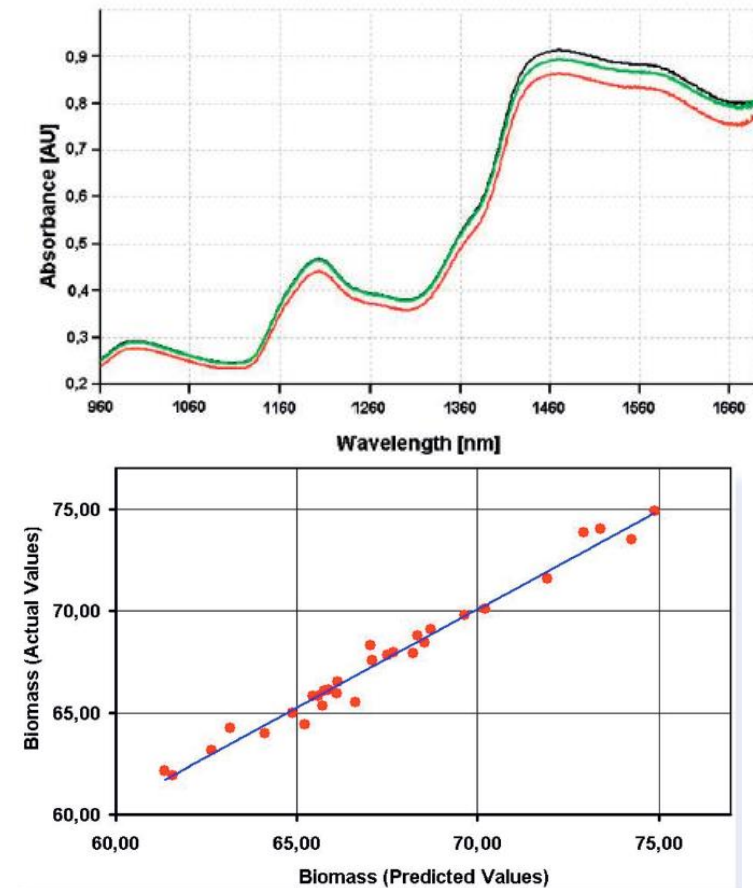
UV VIS NIR spectrometer

- Extended range UV-VIS-NIR spectrometer
- Wavelength range: 300 – 1100 nm
- Resolution: 10 nm
- Wavelength accuracy: <0.3 nm
- Permanently wavelength calibrated
- Halogen light source
- NIR fiber optics



Biomass chemometric modeling

- Determination of biomass by NIR spectroscopy
- Software Interfacing with chemometric software (e.g. SensoLogic, GRAMS, Unscrambler etc.) develops calibration model for process control
- Biomass sampling generated PLS correlation of 0.96
 - Predicted with standard deviation of approx. $\pm 1\%$



Sample spectra with PLS modeling