Course: **"Environmental thermodynamics"**
Professor: **Dr. Robbert Kleerebezem, Dep. Biotechnology, Delft University of Technology, The Netherlands**
Daily program: **2 hrs theory, and 2 hrs computer practice**

PROGRAMME:

Monday: Stoichiometry of Oxidation-Reduction Reactions

The concept of degree of reduction,
Redox reactions
Stoichiometry of electron donor and acceptor reactions
Stoichiometry of catabolism, anabolism, and metabolism
The COD-concept
A generalized method for waste characterization

Tuesday: Basic thermodynamics

Free energy, enthalpy, and entropy of chemical reactions
Equilibrium and non-equilibrium thermodynamics (Redox potential)
Influence of ionic strength, temperature,
Heat production and heat capacity
Driving forces versus rates

Wednesday: Non-equilibrium thermodynamics

Thermodynamic description of microbial growth;
Black, grey and white box approach

Thursday: Kinetics

Description of substrate uptake and product formation using biomass specific rates
The maintenance and decay concepts
Some words on mass transfer
Implementation of stoichiometry and kinetics in bioreactor models

Friday: An example and general discussion

Acidophilic ferrous iron oxidation by *Leptospirillum ferrooxidans*
Presentation of the results obtained by the students

General

The subjects will be accompanied by numerous examples elaborated in MS-Excel. Students will work on a case study based on their own research that uses the tools presented to conduct a stoichiometric and thermodynamic state analysis. The reaction stoichiometry will be combined with generalized kinetics to establish a mathematical process model. On the last day of the course students are requested to present their results to the other students in the course. Lectures will be given in Spanish, but documentation will be provided in English.