Environmental Technology

Newsletter | Fall 2016

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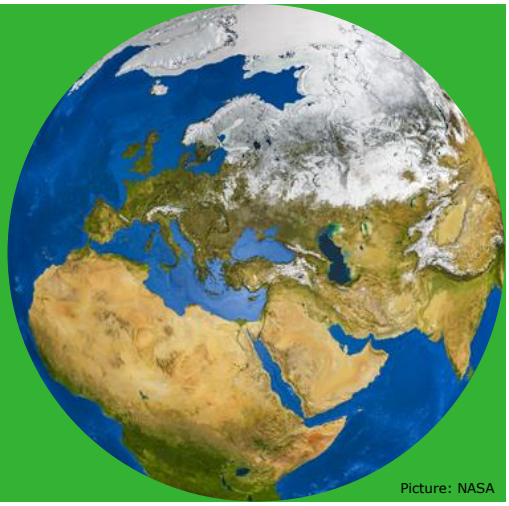


Picture: NASA

News

Good bye to Professor Grietje Zeeman

On October 7th 2016 Professor Grietje Zeeman retired after 36 years of research at ETE. Her scientific field mainly focused on anaerobic treatment and the development and implementation of novel sanitation technologies to efficiently recover resources from wastewater from households.

Anaerobic waste water treatment

The first ten years of her career, Professor Zeeman worked on the anaerobic digestion of animal manure to produce biogas. She subsequently moved into the area of anaerobic low temperature domestic waste water treatment using the Upflow Anaerobic Sludge Bed (UASB) reactor, an invention of Emeritus Professor Gatze Lettinga. She became convinced that the best long-term solution for recovering resources is treatment of source separated domestic wastewater streams.

Successful pilot project

Based on her scientific expertise, Zeeman strongly argued to phase-out the current central sewage systems. These should be replaced by a decentralized sanitation system, where undiluted waste was separated at the source and subsequently processed at the same location with the UASB reactor as the core technology. To maximize efficiency of this method, undiluted waste streams were separated into so called 'grey water' from shower and kitchen, and 'black water' from the toilet. Her strong belief in this 'source-separate, decentralized sanitation' combined with a lot of passion and hard work resulted in 2006 in a successful pilot project in the city of Sneek with 32 households, and later the successful implementation of this principle at a new location in Sneek of 250 households. In addition, her system was implemented in

Column ***Cees Buisman***

For the upcoming Dutch parliament elections pensions and health insurance are dominant political issues. Also economic growth is a topic, since a faster growing economy results in more money to pay for increasing health care and pension costs.

On the other hand there are limits to economic growth due to environmental issues. For example, at this moment the dairy sector is in crisis because farmers exceed phosphate release limits. The sector even has to shrink due to environmental regulations. These limits are very important, because phosphate may wash out to surface waters, polluting lakes and coastal seas. At the same time, phosphate is an essential nutrient for plant, animal and human life. But reserves are limited, requiring efficient use. A more phosphate-efficient dairy system could therefore be very good for our economy as well as a more sustainable future.

The driving force behind nutrient recovery research at Environmental Technology was emeritus Professor Grietje Zeeman, for whom we held a farewell symposium last October. But despite her retirement our department will continue to work on further developing our phosphate recovery technologies.

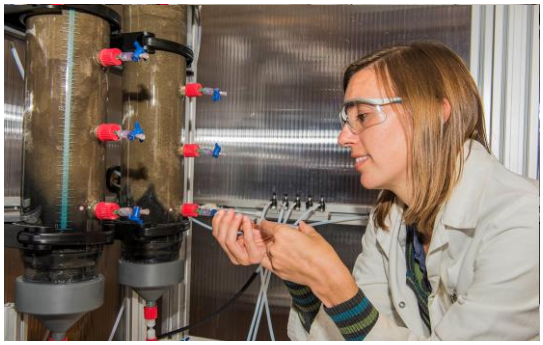
three office buildings: Villa Flora in Venlo, the NIOO building in Wageningen and the office building of the Ministry of Infrastructure and Environment in The Hague. A new location of ca. 450 houses in Amsterdam is in preparation.

Prof. Zeeman together with, Prof. Huub Rijnaarts(left), Prof. Cees Buisman, and Emeritus Prof. Gatze Lettinga

Passion and solid arguments

ETE Professor Cees Buisman knows Grietje Zeeman for many years; they both worked on their Ph.D's in the late 1980'ies. Later, they joint forces in guiding new Ph.D. students together. According to Buisman she is very pleasant person with a typical Dutch directness. Buisman appreciates her vision about new sanitation systems. 'At first, I really didn't see that Zeeman's source-separate sanitation would lead to an improved sanitation system', Buisman admits. 'But she convinced me with her passion and solid arguments. Now I am a big fan of source separation!' Zeeman not only developed the technology, but also succeeded to implement her vision and know how in the 'real world' with several successful projects.

VENI grant for post doc Nora Sutton

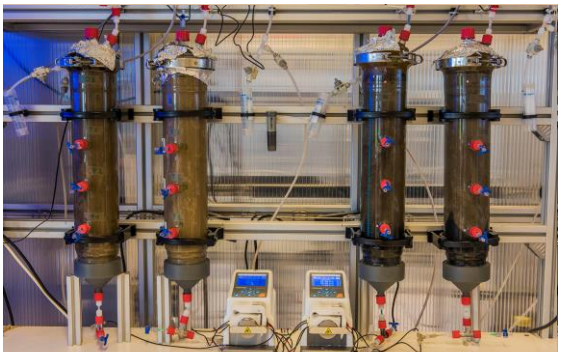


Sutton performing a lab experiment at ETE

This year, again an ETE researcher won the NWO VENI grant of 250.000 euro. Two years after Annemiek ter Heijne's successful application, Nora Sutton was awarded this prestigious grant for her project '*Cleaning groundwater of organic micro-pollutants. Fundamental understanding of biodegradation*.' The grant offers a personal research budget for young researchers during a three-year period. This year, only fifteen percent of the applicants were successful. The jury classified Sutton as 'an outstanding talent for academic research' and her proposal as 'adequate, effective and well thought through, with a high probability to achieve its goals.'

Traces of pesticides

Sutton designed her awarded studies as follow-up on her post-doc research at ETE. Her planned research involves the use of microorganisms to remove micro-pollutants, such as pesticides, from groundwater. In the Netherlands, a lot of these underground water bodies are used for drinking water production. 'Due to infiltration of surface water, very low concentrations of different pesticides and their degradation products may enter groundwater', Sutton explains. 'As a result, more than a quarter of all groundwater reservoirs used for drinking water production contain traces of these pesticides.' Thus, there is a need to remove these compounds to ensure sufficient quality of groundwater reservoirs. However, due to low pesticide concentrations, it is technically challenging to purify this water. Sutton's idea is to use microorganisms to degrade these contaminants in the groundwater before they reach the consumer.



Experimental set-up

Microorganisms

During her experiments, the scientist will focus on developing the groundwater system into a bioreactor able to degrade micro-pollutants. She will identify microorganisms that are involved in pesticide breakdown. In the field, contaminant presence and breakdown will be measured in contaminated groundwater. In laboratory experiments environmental conditions, such as dissolved organic carbon (DOC), will be manipulated to identify possible improvements of contaminant breakdown. 'Our main aim is to increase our understanding of pesticide breakdown under natural conditions', Sutton says. 'We intend to apply our lab results in the field to improve contaminant breakdown at locations where this appears insufficient, for example by adding organic carbon or by adding microorganisms to the soil.'

Award for best poster presentation for Ph.D. student Sam Molenaar

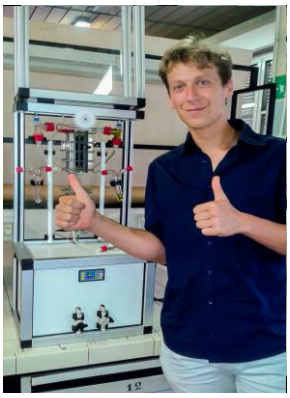


Photo: Sam Molenaar

During the yearly congress of the International Society for Electrochemical Technologies (ISMET), held in Rome last September, Ph.D. student Sam Molenaar won a prize for his 'poster' presentation. Molenaar's research resulted in the design of a completely new rechargeable battery by combining two existing technologies: The Microbial fuel cell and microbial electrosynthesis.

In both technologies, microorganisms play a key role. At the bio-cathode bacteria use electricity and CO_2 to produce acetate, while at the bio-anode different microbiota use acetate to produce electricity. . His finding, the Microbial Rechargeable Battery (RMB) may form a stable, environmental friendly and inexpensive alternative to store energy.
Molenaar's 'poster' was original, to say the least. Instead of an ordinary paper poster, he chose to present his research with a working experimental set-up, where a small propeller was driven by his RMB. 'This way, I could clearly show the proof of principle of my finding', Molenaar explains. The jury specifically valued that the technology was not just stuck in a theoretical stage, but was clearly proven to work: the theory behind the RMB was demonstrated in a visible and working system. Molenaar: 'With my presentation I clearly gave the proof of the concept, and that was highly appreciated.'

Award for best Wetsus Ph.D. student Jan Willem van Egmond

During the Wetsus Congress of last October Ph.D. researcher Jan Willem van Egmond received the Marcel Mulder Award 2016. This annual prize of € 5000,00 is awarded to the 'best Wetsus scientist' of that year. Van Egmond is part of the Wetsus Blue Energy team. Blue energy research focuses on generating energy by mixing fresh and salt water. Van Egmond applies this principle in his studies to design a water battery, where energy is stored in salt water. This resulted in two patents and several scientific papers. According to the jury Van Egmond serves as a role model due to his dedication and innovative approach. In addition, van Egmond is affiliated to the company AquaBattery. This company won a prize as well: the Herman Wijffels innovation award 2016.

Science: Equipment update for ETE's analytical laboratory

In 2016 ETE invested in new laboratory equipment to replace ageing machines. It resulted in a spectacular increase in their analytical strength. Analyses are now substantially faster and more efficient, while maintenance is reduced. Also, the new state of the art machines occupy less bench space.

Hans Beijleveld checking the new GC

'This is one of our newest hypermodern gas chromatograph or GC', says Hans Beijleveld, Laboratory Coordinator at ETE, while he points to an impressive looking piece of machinery. 'This single instrument replaces two older machines that were mainly used to analyze volatile fatty acids and short-chained alcohols.' Volatile fatty acids, briefly VFA's, are formed by bacteria during anaerobic breakdown processes.
The VFA composition gives important information about the presence of different bacteria species as well as the rate and routes of the metabolic conversions.

Outdated system

The analytical procedure to analyze VFA's using the older GC was robust but kind of inefficient; separation was achieved by a so-called *packed column*. This outdated system often required two distinct runs to achieve good separation and quantification of the VFA's and alcohols present. In the new GC, a *capillary*

column takes care of separation, resulting in way more efficient analyses: excellent separation can now be achieved in just one system and one single run.

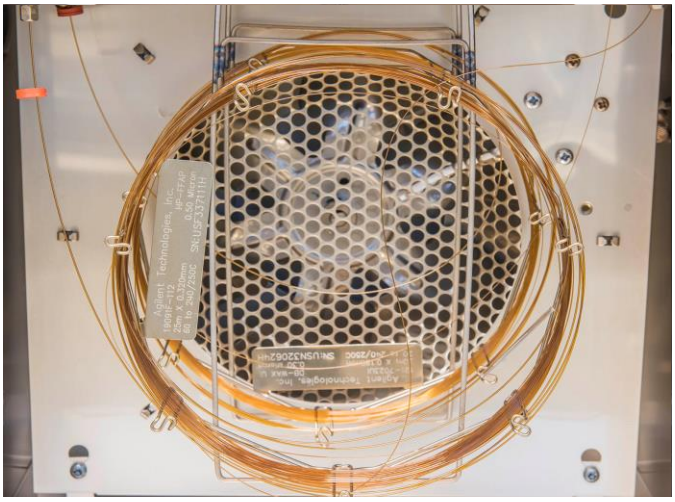
But the new machine is also needed because more substances are relevant in today's environmental research. Beijleveld: 'With our new system we are able to separate many more different VFA's and other components than previously.' And there is another important reason for the GC update. The old system was over 25 years old. Spare parts were increasingly difficult to get, while repair time became a real issue.

Flexible GC

GC auto sampler

Analytical flexibility

A second new GC was purchased aiming at increased analytical flexibility in just one system. 'We are running many types of analyses during a year', Beijleveld explains. 'This machine can run a range of different analyses and replaces four older GC's!'

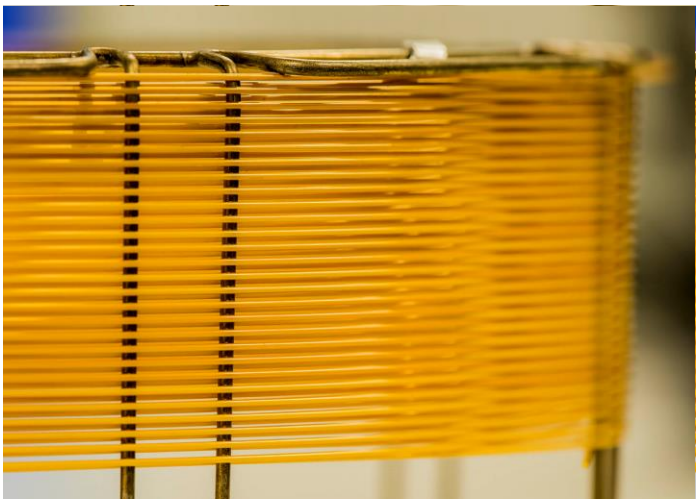


Capillary column in the new GC

At the same time, analyses time is diminished; run time may be reduced by more than 50%. The new multi-purpose machine will be used by many different researchers in the near future.

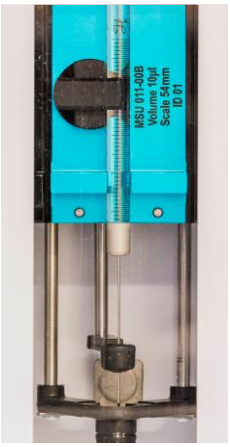
State of the art ETE lab

For example, methane (CH_4), an important component formed during anaerobic conversions, can be analyzed with high sensitivity.But also different toxic solvents can be analyzed, including benzene, toluene, ethylbenzene and different xylenes. These so called BTEX analyses are indispensable in soil surveys. Another group of compounds that can be measured are the mineral oils, important for oil spill research. The versatility of the system is among others due to the presence of two different injection positions. Each position leads to a different detector with specific analytical qualities. The first one is the electron capture detector, ECD. This detector is very sensitive to halogenated compounds, for example some groups of pesticides.



Detail of a capillary column

The second detector, the flame ionization detector, or FID, measures organic compounds without halogens, for example oil components. 'All in all this GC is extremely flexible and will be used in many different projects', Beijleveld says.



GC sample injector

Two different injection positions

Samples waiting to be analyzed

Basic analyses

The third new machine doesn't replace older systems, but adds to the analytical capacity of ETE's laboratory. This so called TOC analyzer is still being installed, but it will be up and running very soon. The TOC analyser is an advanced instrument using infrared light for detection of next to Total Organic Carbon (TOC). It is also able to measure Total Inorganic Carbon (TIC), like dissolved carbon dioxide and total nitrogen (TN). In the recent past, ETE used to outsource these analyses, but now they can be carried out in house. The TOC-related analyses are considered basic in the environmental sciences, resulting in extensive use by many projects. An important project where the TICTOC will play an important role is Water Nexus. This project is aimed at the use of salt water wherever possible, to limit the use of precious and scarce fresh water.

For example, salt water may be used as cooling water in different industrial processes instead of fresh water. To prevent algae growth, a biocide is often added. This results in a new type of waste water: salt water with a biocide. 'To find out if anaerobic cleaning using microorganisms is possible, we need to measure Chemical Oxygen Demand, briefly COD, an indication of total oxidizable organic contaminants present', Beijleveld explains. 'Unfortunately, salt influences the traditional COD analyses.' The new TICTOC can analyze organic compounds, like the biocide, also in salt water without any interference with the final outcome. 'These three new machines have dramatically increased our analytical capacity', Beijleveld says. 'The laboratory team has done a great job in making these new systems up and running in so little time in addition to their regular daily lab support!'

Agenda

PhD defences (Aula, Wageningen):

Nov 21 2016, 13:30: Marieke Zeinstra. ´Oil slick fate in 3D´

Nov 23, 2016, 13:30: Lei Zhang. ´ Anaerobic treatment of municipal wastewater in a UASB-Digester System´

Dec 14, 2016, 13:30: Samet Azman.´Anaerobic digestion of cellulose and hemicellulose in the presence of humic acids´

Apr 21, 2017 (Leeuwarden): Pau Rodenas. ´ Bioelectrochemical metal recovery with Microbial Fuel Cells´

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