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Edited by: Konstantina Roxani Chatzipanagiotou

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Introduction

Every two years, at Wageningen University and Research Centre (Wageningen UR or WUR), PhD students organize an academic study trip outside the Netherlands, to get a broader view of their field of activity (i.e. biobased chemistry and technology). In the spring of 2015, we decided to visit China. Our two-week trip included various visits to universities, institutes and companies, with the aim to exchange knowledge and enable strategic cooperation. Since the focus within the BCT group ranges in scale (from molecules to systems) and research approach (from chemistry to modelling), institutions specializing in different areas and activities were included in our planning. A summary of the contents and outcomes of these meetings is presented below.

China is a rapidly developing economy and contains a vast amount of natural resources. It is therefore expected that China is a key player in determining the future of our planet and the transition towards a biobased economy. The research field of our group (BCT) and university (WUR) matches perfectly with the future challenge of securing reliable food resources for the increasing population, while minimizing the environmental impact of our practices. Several aims were set prior to this trip, regarding networking, building and reinforcing connections, and exchange of knowledge on innovative research and successfully implemented technologies. Looking back, we achieved these goals, having identified opportunities for cooperation, and having gained valuable insight into our own fields, but also in areas such as technology commercialization, research and innovation in industry.

Last but not least, an important aim was teambuilding within our own group, which was also successfully achieved. During our two week journey from Beijing to Shanghai, we had the chance to visit significant landmarks, such as the Great Wall, Summer Palace and Yu Garden, enjoy the nightlife of Beijing and *sing our hearts out* at karaoke, *shop until we drop* at the local markets, and, for those brave enough, experience the local delicacies at the insect market. We got to know a different culture, and by the end we were richer for the experience.

Organising Committee

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Advisor of the PhD study trip:

Prof. Dr. Harry Bitter (harry.bitter@wur.nl) – BCT chair holder

PHD trip program

PhD trip Program					
Week	2015	Day	Location	Morning activity (9:00-12:00)	Afternoon activity (14:00-17:00)
	24.04	Fr	NL→ Beijing	Work WUR	Travel
	25.04	Sa	Beijing	Arrival	Weekend
	26.04	Su	Beijing	Weekend	China Agricultural University, College of Information and Electrical Engineering
1	27.04	Mo	Beijing	China Academy of Sciences, Institute of Process Engineering	
	28.04	Tu	Beijing	Mini-symposium in Tsinghua University, Department of Chemical Engineering	
	29.04	We	Beijing		
	30.04	Th	Beijing	Beijing University of Agriculture, Urban and Rural Development College & Food science and Engineering College	Yanjing beer factory
	1.05	Fr	Beijing → Weifang	Official free day	Travel
	2.05	Sa	Weifang (Shouguang)	INAPRO Aquaponic park	Weekend
	3.05	Su	Weifang → Suzhou	Weekend (Agri-tech fair)	Travel
2	4.05	Mo	Suzhou → Shanghai	Soochow University, Chemical Engineering and Materials Science	Senhui Microsphere Technology
	5.05	Tu	Shanghai	Mini-Symposium at East China Normal University, The Global Institute for Urban and Regional Sustainability	
	6.05	We	Shanghai	Shanghai Jiao Tong University, School of Agriculture and Biology	Minhang waste water treatment plant
	7.05	Th	Shanghai	BASF	
	8.05	Fr	Shanghai	Dupont	Unilever
	9.05	Sa	Shanghai → NL	Weekend	Weekend
	10.05	Su	NL	Arrive in the Netherlands	Netherlands
grey=visit, green=cultural activity/weekend, orange=travel					

China Agricultural University, College of Information and Electrical Engineering

Date of the visit: 26/04/2015

Location: 17 Tsinghua East Road, Beijing, 100083, China

Responsible for visit: Chen Zhang

Report by: Chen Zhang, Daniel Reyes Lastiri

Our trip started with a visit to the Great Wall, followed by a dinner meeting with Professor Daoliang Li from the College of Information and Electrical Engineering at CAU.



Every year, Wageningen University receives about 25 students from CAU to do their master or PhD studies. Research collaboration between both universities has increased in recent years. Prof. Li is director of Beijing Engineering Research Center for Advanced Sensor Technologies at CAU. On March 2015, Prof. Li visited our group to discuss possibilities for cooperation, and we decided to visit him in China. We really appreciated that Prof. Li took the time to invite us for dinner just before his departure to Belgium later that evening.

During the dinner, we discussed recent topics on research, education, and possible cooperation in the modelling field. We want to extend our special thanks to the students Hassan and Huihui, who introduced us to their study life in CAU and Beijing, giving us a nice first impression of the city.



China Academy of Sciences, Institute of Process Engineering

Date of the visit: 27/04/2015

Location: Beijing, BeiErTiao 1, Zhongguancun Haidian District

Responsible for visit: Rachel van Ooteghem

Report by: Konstantina Roxani Chatzipanagiotou



The visit to the Institute of Process Engineering, Chinese Academy of Sciences (IPE-CAS) included a presentation session, and was concluded by a visit to the two National Key Laboratories of Multiphase Complex Systems and of Bio-chemical Engineering (NKLBE).

The presentation session was initiated by a short introduction of the participating faculty and students of the host and visiting institute. A brief introduction on the research areas and scopes was provided through videos about IPE-CAS. Prof. dr. Harry Bitter presented the mission of WUR and our group, followed by a more extensive presentation of the research fields within the two National Key Laboratories. The session was followed by two presentations from WUR, in the fields of technology (waste-water treatment, by Rungnapha Khiewwijit) and conversion (amino acids to nitriles, by Andrada But).



Prof. Wei Ge, the director of the National Key Laboratories of Multiphase Complex Systems, presented the work of the Laboratory and the EMMS group in the field of energy and materials. Multi-scale structure is important for the study of such complex systems. The group aims to develop multi-scale models for real-time simulation, ranging from the molecular to the reactor level. Multiple scales, such as the material, reactor, and system scale, need to be taken into account, but the interface, or boundary scales between these steps, can be a problem in simulating. The

EMMS model has been successfully developed and applied to explore the meso-scale phenomena. During the visit of the Laboratory we saw the impressive supercomputer (Parallel Computation System for Multi-scale Discrete Simulation), currently used to investigate various research areas, as introduced by prof. Wei Ge. Examples of research within the group include the atomic simulation of dynamic structures of flu virions in aqueous solution, real-time simulation of granular and fluidized bed reactors, continuous simulation of individual particle and between-particle liquid movement, simulation of liquid movement through porous materials.



Prof. Guanghui Ma, the director of NKLBE, followed with a presentation of the history and research of the Laboratory in the field of Bio-chemical Engineering. The group focuses on the physical, chemical and biological conversion of raw materials to products, within the broader research areas of bio-petrochemical, bio-metallurgical, bio-pharmaceutical and biomass engineering, and aims to create new process designs,



technologies, equipments and products. Some of the highlights of their progress were presented in the field of biorefinery of corn straw, bioseparation (chromatography and membrane technology), and vaccine formulation engineering. The group has extensive experience in applying material technology to promote bioprocess engineering development, with impressive examples of particle design and development for different applications. In the area of uniform particle development, prof. Guanghui Ma highlighted the advantages of the Membrane Emulsification Technique, which has already been commercialised and applied in the large scale. Especially





in medicine, controlling the particle size is detrimental for the effectiveness of the medicine and targeting specific vessels and organs. They research particles for storing and slowly releasing medicine into the organism, with the aim to optimize delivery and minimize negative environmental impact. Gigaporous particles are also investigated, and hold interest in the fields of large molecule separation and vaccine development, with already successful applications on the large scale.



Mini-symposium in Tsinghua University

Date of the visit: 28/04/2015

Location: 30 Shuang Qing Lu, Haidian, Beijing, China

Responsible for visit: Chen Zhang

Report by: Neus Blanch, Jurjen Spekreijse

The 28th of April we organized a mini symposium together with the Department of Chemical Engineering at Tsinghua University.

Tsinghua University was established in 1911 and is one of China's most renowned universities. The Department of Chemical Engineering was founded in 1946. The main research areas are Chemical Engineering, Process System Engineering, Biochemical Engineering, Applied Chemistry and Polymer Science and Engineering. One of the main goals/objectives of this department is to put equal emphasis on theoretical research and practical applications.



The mini symposium was divided into three sessions: (Bio)Chemical conversion, Biorefinery technology, and System modelling. Aiming for a sustainable future, all lectures were given by representatives of Beijing University, Wageningen University and Tsinghua University, on different areas **within the theme "how to utilize bio-feedstocks in an efficient and sustainable way"**.

The symposium started with a session on the (bio)chemical conversion of biobased feedstocks. Harry Bitter opened the session with a presentation on deoxygenation using non-noble catalysts. Wang Bin from the

national R&D center for biorefining showed us how to produce acrylic acid from white rice bran **via** lactic acid, to prevent the poisonous effect of acrylic acid. Jurjen Spekreijse from WUR presented the conversion of PHB and Qiang Tang from Tsinghua described the conversion of fatty acids with lipases.

In the second session, the technological challenges of a biobased economy were discussed, where Xuebing Zhao reminded us of the importance of the most abundant organic material, lignocellulose, and how to process it. Nathan Bowden discussed the crystallisation of amino acids and Du Wei presented the conversion of glycerol to 1,2-propanediol.

After lunch, the third session continued on the topic of (bio)chemical conversion, where Haichao Liu presented the use of glycerol as an alternative source of acrolein, which can be further converted to acrylic acid. Dr. Tany from Tsinghua university discussed the challenges of pyrolysis oil, and Neus Blanch and Frits van der Klis from Wageningen discussed the aqueous phase reforming and selective catalytic transformation of carbohydrates.



After these presentations a poster session was held, where PhD students from Wageningen university and Tsinghua University could share the progress of their work, and find overlap on their thesis subjects.



Beijing University of Agriculture (北京农学院)

Urban and Rural Development College

Food science and Engineering College

Date of the visit: 30/04/2015

Location: Beinong Road 7, Huilongguan, Changping District, Beijing, 102206 China

Responsible for visit: Chen Zhang, Sanne Moejes

Report by: Sanne Moejes, Neus Blanch

The 30th of April we visited the Urban and Rural Development College of Beijing University of Agriculture.



Arriving at the Beijing University of Agriculture (BUA) at the other side of Beijing gave us a more rural first impression. In size it is slightly smaller compared to Wageningen UR, having 8000 students subdivided over the departments of Biotechnology, Plant Science & Technology, Animal Science & Technology, Economics & Trade, Landscape Design & Forestry, Food Science, Computer Science & Engineering, Humanities & Social Sciences, Basic Courses, Foreign Languages, and the three secondary Colleges (College of Higher Vocational Education, College of Continual Education, College of International Education).



Professor Liu Kefeng introduced the group by a short presentation, mentioning that BUA is the only agricultural university that belongs to Beijing. The group focuses on waste water treatment, turning it into fertiliser. Nowadays they also develop their own equipment, which used to be imported, but can now be adjusted to the local farmers' needs. After this introduction, Harry Bitter took over to introduce our group.

Thanks to Yu and Chen (WUR), as well as the members from BUA, that

made the translation during the visit the communication went alright. Wang Shunli gave a presentation about the university in general, and more in depth information on the waste conversion to fertilisers. The university focuses on undergraduate (BSc) programs, and about 10-30% of the students continue with



an MSc program, either there or at other universities. Farming in China is mostly local and different from Europe, and small farms are scattered over a large area. This requires to take a different approach to waste conversion, in which the group specialised themselves.

As Elvira and Chen Zhang both work on waste streams and recycling, they introduced their topics. During the discussions the audience seemed especially interested in the idea of small scale biorefineries.



Although they only focus on the production of fertilisers at present, they were also interested in the production of other high value products like chemicals and proteins.



Beijing Yanjing Brewery Co., Ltd.

Date of the visit: 30/04/2015

Location: Shunyi District, River Road on the 9th double zip code 101300, Beijing

Responsible for visit: Chen Zhang; Neus Blanch Raga

Report by: Neus Blanch Raga

The 30th of April, after lunch, we visited Beijing Yanjing Brewery Co., Ltd, a brewing company founded in 1980 in Beijing, China. It ranks first in total output and profit in China's beer industry. The company produced 57.1 million hectoliters of beer in 2013, making it the 8th biggest brewery in the world, and the 3rd biggest in China.

When we stepped out of the mini bus, the first thing that we thought was: "wow". The main building of the company was impressive: the luxurious entrance, the big fountain in the hall, huge ceramic vases, four elevators, seven wall clocks indicating the time at different countries, a red carpet in each elevator indicating the day of the week, everything built in marble...



We met several board members of the company and they gave a presentation of the company itself, talking about the history, the ranking position of their beer in the Chinese market, the high profits of the company, but also about the whole production process, providing us with some insights on their waste water treatment plant. After that, we had a short discussion, and Harry Bitter (our group leader) had the chance to introduce our group and our PhD study trip.



The presentations were held in Chinese, which was a challenge we had to overcome for the exchange of knowledge. Nevertheless, our PhD candidate Chen came through, and did a great job translating all the talks and slides to English.



Right after this part, we went to a factory tour to see some of the facilities of the company. The first thing we saw was a huge plastic scaled down model of the factory. That was really nice, with all the lights and lots of details... so we could see all the different parts and figure out how big the company actually is!

Then we visited the Product Dispatching Command Centre, from where they can control each of the processes with online video cameras installed around the buildings. We also saw the Brewhouse, where malt is changed into wort by many procedures, such as milling, gelatinization, mashing, filtration, boiling, clarification and cooling.



The Fermentation house was visited, where according to a set of techniques, the wort is fermented and filtrated under the auto-control of computers, after being conveyed into the fermenter (they have 80 different fermenters to be able to carry out all their production).

The last part of the factory that we visited was the bottling and packaging facilities. There we could see their high economic investment in the automated production line.

Finally, we went to Yanjing bar, to take a rest and sample the draft beer. Yanjing beer is naturally brewed with mineral water, hops, rice and barley malt, resulting in a distinctly clear taste. It has a floral scent and dry, crisp malty smoothness, which provides a refreshing finish with an undertone of hops. It is considered a clean, smooth and refreshing wheat-free beer, brewed with natural mineral water that comes from the beautiful clean Beijing YanShan Mountain. After our free tasting, we could not agree more!



Nowadays, Yanjing beer has the nickname "the real taste of China", because locals really enjoy this quality beer. Yanjing beer is also the State beer of China, and one of the official beer sponsors of 2008 Beijing Summer Olympics, an honour fit only for top beers.

China Shouguang Vegetable (CSV)

Date of the visit: 02/05/2015

Location: Shouguang City, Shandong Province. Shu Cai Building 9, Hao Yuan Road.

Responsible for visit: Daniel Reyes Lastiri, Yu Jiang

Report by: Daniel Reyes Lastiri, Andrada But, Rungnapha Khiewwijit

Shouguang Vegetable Industry Holding Group (CSV) was established in 1998 in Shouguang City, Shandong Province, in the eastern part of China. CSV conducts business all over China and commands a production chain inside the vegetable industry. CSV produces fresh vegetables but also freeze dried vegetable chips.

BCT group visited the West demo site of CSV, where 23 greenhouses produce mainly zucchini, sweet pepper, eggplant, tomato and cucumber, which are supplied with warm water from district heating produced from coal. The Dutch experimental tomato greenhouse was visited as well, where CSV has to



improve and adapt the system to the local conditions. We were impressed by the creative mushroom production room, which was combined with a greenhouse for growing vegetables, and in this way the CO₂ produced by the mushrooms is supplied to the greenhouse for more intense vegetable growth. The East demo site was also visited, where a solar greenhouse operates. At the same location, the construction of the demo aquaponic system for the EU project INAPRO is almost completed.



The workshop with CSV was hosted by Li Lixin, director of the science and technology department of CSV. A previous collaboration between CSV and the Netherlands came to a stop due to objectives not being met for project proposal application, but CSV has high interest in having new collaboration with the Dutch agriculture sector and Universities.

The aim of the workshop was to find collaboration opportunities, starting from possible solutions for the use of agricultural waste. The initial interest of CSV was the production of biogas, but they are open to implement alternative but mature technologies.



Soochow University, Chemical Engineering and Materials Science

Date of the visit: 04/05/2015

Location: Suzhou, Road 199, Suzhou Industrial Park, Jiangsu Province

Responsible for visit: Rachel van Ooteghem

Report by: Sanne Moejes



When we arrived in Suzhou we immediately saw and felt why this city is famous for its parks. The School of Chemical and Environmental Engineering (SCEE) of Soochow University was recently founded in April 2013, and to get an impression of their facilities, we were shown around by former Wageningen UR PhD student, and now associate professor here, Xin Yin. We could have a look at the NMR location, pilot plant facility, and the offices and laboratory spaces. The interior is very nice, the roof terrace with a view of the surroundings is impressive.



Having an idea of what topics people within SCEE are working on, we started the presentation session. The school of Chemical and Environmental Engineering was introduced by the head of SCEE, Professor Xiao Dong Chen, who explained the symbol of the school and how it relates to the old Chinese character for the city Suzhou, with thy symbols for fish and rice growing together. He showed his vision of biology inspired chemical engineering and topics related to drying (especially spray drying), new coatings to

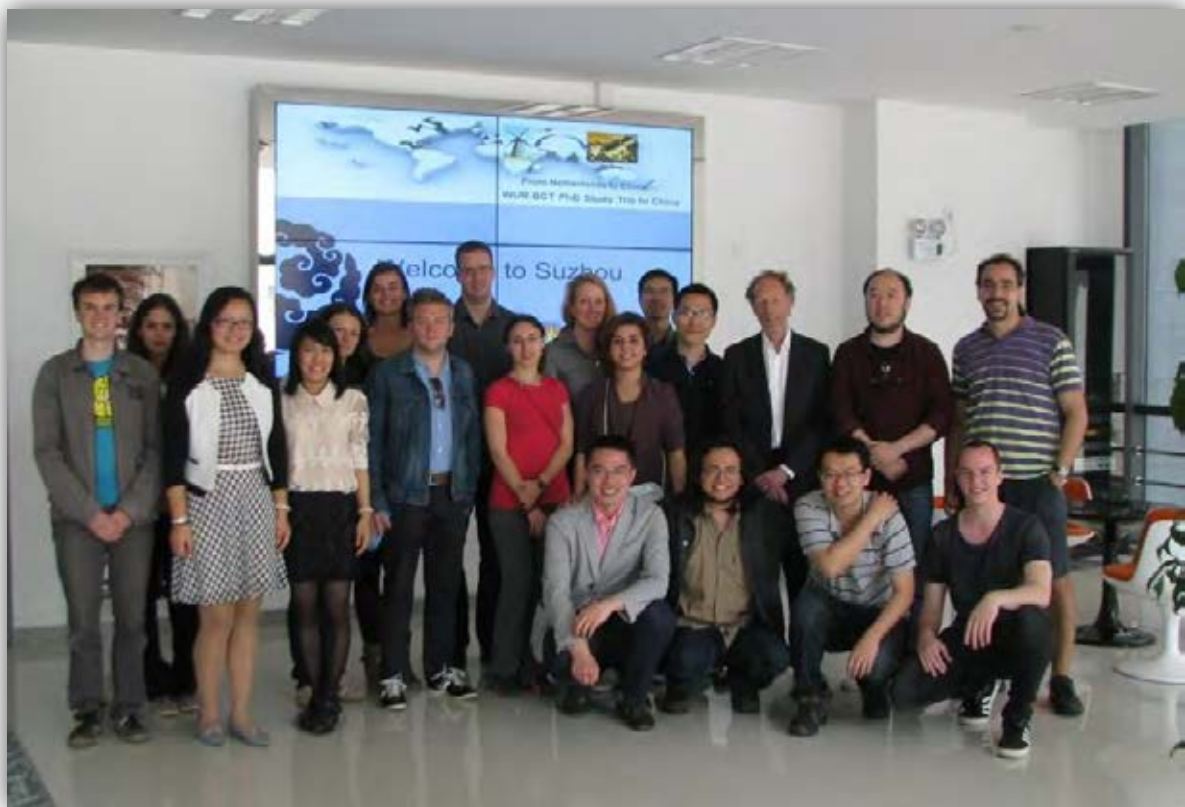
prevent fouling, cleaning, soft reactors (like the stomach), membrane operations, system modelling, etc. Subsequently Karel Keesman introduced Wageningen UR and our group.

Next two presentations were given by our PhD students and two researchers from China side. The first presentation was given by Zhang Xiong Wu on functional porous materials, focusing on amorphous carbon materials. These ordered mesoporous carbon structures can be used for example for adsorption and separation, conversion, and supported catalysis in the carbon pores.

Farnoosh Fasaei presented her work on system analysis of algae biorefinery. The focus of SCEE is not on algae, but similar optimization methods as the ones presented can also be applied on other systems, making the approach useful for the biorefinery concept in a broader sense.

Up next was the presentation of MSc Qian Gao. She presented her thesis work on the numerical modelling of root hydrotropism from a chemical engineering perspective. ComSol is used to simulate the effect of the place of a water and nutrient source on root growth, where water is the dominant factor. Experimental work supported the simulation findings.

The last presentation was given by Sanne Moejes, introducing her topic on the redesign and optimization of the milk powder production chain. By introducing new technologies, energy and water can be saved. One of these technologies is mono dispersed droplet drying. Besides TNO in the Netherlands working on this topic, they are also working on it in Suzhou.



Senhui Microsphere Technology (Suzhou) Co., LTD - 中科森辉微球技术有限公司

Date of the visit: 04/05/2015

Location: #713, Building NW-02, No.99 Jinji Lake Avenue, Nanopolis, Suzhou Industrial Park, JiangSu Province

Responsible for visit: Rachel van Ooteghem, Sanne Moejes

Report by: Sanne Moejes

Outside of the university campus zone, Suzhou also has a rapidly growing nanotechnology and biotechnology industry, hosting not only large enterprises, but also many start-ups. The visit to the start-up company Senhui Microsphere Technology (Suzhou) Co., Ltd was a follow up to the visit to the group of Professor Guanghui Ma (director of NKLBE) at the Chinese Academy of Sciences. It is an innovative high-tech enterprise which endeavours to provide leading-edge proprietary products and integrated solutions to clients of life science and biotechnology. Located at the Nanopolis of Suzhou Industrial Park. R&D, the manufacturing and sales services are all here. The R&D team is led by Professor Guanghui Ma and Professor Zhiguo Su, both renowned experts in the field of biomaterials and bioseparation.

The three core technologies of Senhui Microsphere Technology are: 1) membrane emulsifier, to prepare micro emulsions, microspheres and microcapsules of uniform and controllable droplet size; 2) chromatographic media and the gigaporous microspheres that are used for the purification of proteins, antibodies, vaccines, enzymes etc; and 3) a Protein purification system.

After the introduction to the company, we went on a lab tour and demonstration of the membrane emulsifier, making a simple water in oil emulsion. Using a digital microscope, the created emulsion with the narrow size distribution was shown.



Mini-Symposium at East China Normal University, The Global Institute for Urban and Regional Sustainability

Date of the visit: 05/05/2015

Location: No.500 Dongchuan Rd, Shanghai

Responsible for visit: Yu Jiang

Report by: Konstantina Roxani Chatzipanagiotou



The BCT group visited East China Normal University (ECNU) to attend a mini-symposium with presentations and posters, hosted by ECNU and the Global Institute for Urban and Regional Sustainability (GIURS). GIURS is dedicated to interdisciplinary research and application in urban ecology and sustainability, as became clear through the variety of topics presented.

The opening session was on urban ecology, including bioenergy policies for sustainable cities in the future (Yu Jiang, WUR), wetland phytoremediation (dr. Hong Deng, ECNU), the effects of urbanization on the distribution patterns of weeds (Yichong Cui, ECNU), and biomimicry for sustainable bio-cement production (dr. Achal Varennyam, ECNU), a concept that perfectly reflects the mission of WUR: "to explore the potential of nature to improve the quality of life".



The affinity of research fields was also apparent by the discussions following each presentation. For example, matters that were highlighted are the societal and scientific significance of understanding the effect of human population growth on plant species distribution in relation to climate change, and using that knowledge in adaptation strategies to climate change; the feasibility of bio-cement production and application at specific conditions (e.g. high pH) in terms of commercialization; and the possible added value of the process of wetland phytoremediation, if coupled with phytomining or renewable energy production.



The second session was on the subject of (bio)chemical conversion of waste products, aiming either at waste treatment, for example N₂O emission control coupled with nitrogen removal (Dong Wu, ECNU) and elimination of pharmaceuticals from waste (dr. Yaping Zhao, ECNU), or at waste utilization and recovery, specifically the bio-production of nitriles from biomass (Andrada But, WUR). Adding value to the processes presented was a major part of the discussion following this session, and, although the coupling of N₂O emission control with nitrogen removal for landfill



leachate recirculation is still in an early stage of development to already consider the recovery of materials as an extra step, the recovery of nitrogen was discussed as a promising but challenging option for valorization of waste. Finally, the development and tailoring of a novel catalyst for improved efficiency of pharmaceutical waste treatment was of particular interest for the representatives of WUR working on heterogeneous catalysis.



The third session focused on biorefinery technology, which can be approached either via simulation and modelling, as in the case of Farnoosh Fasaei (WUR), who presented her work on system analysis of algae biorefinery, or with a more technological approach, as for example in the work presented by Yu Wang (SJTU), who focuses on the bio-production of C3 platform chemicals from CO₂, and the presentation of Xishu Xiang (ECNU), on the subject of synthesis of zinc nanoparticles from spent batteries. The commercial feasibility of algae biorefinery was discussed, and it was concluded that it can be improved by maximizing the product spectrum of the process. Aiming at glycerol production out of CO₂ was hotly debated during the discussion session, considering that it is also the

by-product of other processes, and therefore the value may not be as high as it would be for other C3 products. A further conversion step shows potential to add more value to the process. Finally, the physical method selected for recycling spent batteries was extensively discussed, especially in terms of energy consumption for treatment at high temperatures and pressures, instead of a possible alternative chemical or biological process. On the other hand, the possibility of using this method to directly produce supported zinc nanoparticles downstream was also discussed with enthusiasm from both sides. It was concluded that both the sustainability of the process, as well as the possible application in nanoparticle preparation, should be further investigated. A systematic approach at the interface of modelling and technology could help shed some light on these aspects.

The fourth and final presentation session was in the field of system modelling, which can be applied to design and optimize a bio-production system, as explained by Daniel Reyes Lastiri (WUR), who focuses on aquaponics, or to aid decision making and management, as presented by XiaoDan Niu (ECNU), who works with the theory of reasoned action in the context of public participating environmental protection. The final



presentation set the ground for an interesting discussion on the subject of environmental policy and management in China. The topic caught our attention, and highlighted the shared themes of the two institutes, especially with the group of Environmental Policy (ENP) in WUR.



Shanghai Jiao Tong University (SJTU), School of Agriculture and Biology

Date of the visit: 06/05/2015

Location: Academic Hall, Agricultural Building, 601 Jianchuan Road, Minhang District

Responsible for visit: Andrada But

Report by: Rungnapha Khiewwijit



Shanghai Jiao Tong University (SJTU) was established in 1896. At present, SJTU has 44020 students and 2851 teachers. The School of Agriculture and Biology, Shanghai Jiao Tong University, is originally grown out of the Shanghai Agriculture that was later renamed as the School of Agriculture and Biology in 2002. The school currently has 29 full professors and 49 associate professors, including 71 Master student supervisors and 24 PhD student supervisors. The School Consists of five departments, three major research centers, the college of Continuing Education, and the Shanghai Municipal Key Laboratory for Veterinary Biotechnology.





The School of Agriculture and Biology inspires and promotes multidisciplinary research activities through a highly research-oriented atmosphere; faculty members have generated more than 14 million RMB research funds in 2004. The school focuses on several topics, such as biomass, biomass pyrolysis, biochar, gasification, bioethanol, and biogas.

Our visit was part of the "Food security and Eco-environment PhD Forum" activities for the celebration of the 56th anniversary of Shanghai Jiao Tong University, School of Agriculture and Biology.



At SJTU we met the groups of Prof. Dayun Zhao and of Prof. Ronghou Liu. The first lecture was given by Prof. Ronghou Liu, who introduced the research of the Biomass Energy Engineering Research Centre. As a example, he presented a project regarding the development of equipment for biomass fast pyrolysis for bio-oil production demonstration in the thousand tons scale in China. Following the first lecture, assoc. Prof. Karol Keesman presented Wageningen University and BCT group. Four lectures followed, two from each university, given

by PhD students presenting their work. After the presentations we visited the lab facilities of our hosts, and then the discussions about science but also regarding further collaboration were continued during the lunch that was offered by Prof. Ronghou Liu.



Shanghai Minhang Wastewater Treatment Plant

Date of the visit: 06/05/2015

Location: No. 757 Jiangchuan E Rd, Minhang, Shanghai

Responsible for visit: Yu Jiang

Report by: Elvira Bozileva

Minhang Wastewater Treatment Plant (MWWTP) was established in 1960 as a small-scale wastewater treatment plant. The plant's current capacity is 50.000 m³ of wastewater per day. Wastewater that is treated at MWWTP comprises both domestic (about 70%) and industrial (about 30%) streams. MWWTP uses AAO (Anaerobic – Anoxic – Oxidic) technology, and produces effluent that satisfies the requirements of class 1 of China Integrated Wastewater Discharge Standard (<50 g(COD)/L, <20 g(BOD)/L).



Treatment processes used at MWWTP include rough pre-treatment (screening), chemical phosphorus removal, conventional activated sludge process with alternating oxygen supply for carbon and nitrogen removal (nitrogen is removed during the anoxic phase via denitrification process), and post-treatment steps. Post-treatment includes disinfection with chlorination and UV treatment, as well as odour removal through the use of biological membranes.



Quality of the effluent produced at MWWTP is monitored with samples being taken every two hours. Treated effluent is discharged to the river. Secondary sludge produced at MWWTP is chemically dried and landfilled.



BASF

Date of the visit: 07/05/2015

Location: R&D-Building 1, 1/F, Meeting room "Leather & Textile", No 300, Jiangxinsha Road, Pudong, Shanghai 200137, P.R. China.

Responsible for visit: Frits van der Klis

Report by: Rungnapha Khiewwijit, Frits van der Klis

BASF is one of the world's largest chemical companies, employing around 104,000 people worldwide with an annual turnover of more than US\$31 billion. BASF Innovation Campus Asia Pacific (Shanghai) is **BASF's largest research site in Asia Pacific, and an important component of BASF's global research and development (R&D) network.** Spanning 35,000 square meters, the Innovation Campus Asia Pacific is located at Pudong Shanghai, adjacent to the new BASF Greater China headquarters. Since its inauguration in November 2012, it has formed a strong R&D network with various BASF sites and universities in Greater China, Japan, South Korea, and other countries in Asia. The R&D activities are supported by a strong analytics and material physics team, a formulation research platform, and process & chemical engineering departments.



At the site, scientists from over six different countries and with strong international experience focus on advanced materials and sustainable solutions. BASF Innovation Campus Asia Pacific has currently 15 research topics in various research fields. Examples of the research include 1) novel breathable coatings, 2) life prediction of wind turbine blades composites, 3) bio-based polymers for home and personal care applications, 4) advanced polyurethane formulations for foot-wear components, and 5) thermally conductive plastics for energy-efficient lighting.



150 years

 **BASF**
We create chemistry

During our visit, we attended informative presentations about the history of the company and the facilities that we visited, the products, as well as the process of product development, R&D and commercialization. From our side, assist. prof. Rachel van Ooteghem gave an introduction on our group and university. Frits van der Klis followed with an interactive presentation, during which he explained the three main areas of research that BCT specialises in, giving the opportunity to all PhD participants to introduce their research and show where their topic stands within the matrix of Conversion, Technology and Modelling. The field of interest of BASF is more closely related to the research conducted on conversion within BCT, and therefore two representatives were selected from that sub-group to present their research. Piet van der Zaal discussed the conversion of starch to novel polysaccharides, and Jurjen Spekrijse presented his progress on the subject of synthesis of bulk chemicals from pollutants in waste water.



DuPont China Research & Development Center

Date of the visit: 08/05/2015

Location: 600 Cailun Road, Zhangjiang Hi-Tech Park, Shanghai, China

Responsible for visit: Piet van der Zaal

Report by: Piet van der Zaal

Shanghai, China is the home to the DuPont China Research & Development Center (CTC). This site is the main center for research, product development, customer support, and material testing in China.

With a wide span of expertise of the scientists and engineers, the center provides an enhanced platform to enable technological exchange and research collaborations among local customers and their overseas partners, delivering innovative solutions to the Chinese market and around the globe. Scientists and engineers at the CTC are involved in materials research for photovoltaic, automotive, computer, communications, consumer electronics, bio-based applications, packaging, chemical, and safety and protection markets.

CTC scientists and engineers also provide process capability for polymer blending, part fabrication, and advanced manufacturing as well as analytical capability for materials characterization, failure analysis, and performance properties.



The department we visited specializes in enzyme engineering. The research in this lab ranges from enzyme discovery in nature to improvement and implementation. When an enzyme with interesting functionality is discovered, research is done on how to optimize the enzyme itself and on how to efficiently produce the new enzyme. Enzyme production can **also be done in a different 'host' organism, such as a yeast or fungi**, to increase efficiency. Since enzyme functionalities vary wildly, **Dupont's enzyme research** varies from enzymes for low temperature laundry to enzymes for bio-ethanol 2.0 production. When an enzyme is ready for large scale production, it can be produced on several locations around the world, depending on the host microorganism.



Unilever Research and Development centre, Shanghai

Date of the visit: 08/05/2015

Location: 66 Linxin Road, Linkong Economic Development Zone, Changning District, Shanghai

Responsible for visit: Sanne Moejes

Report by: Piet van der Zaal

The last visit of our trip was to Unilever's Research and Development centre, and it included a presentation session and a tour of the laboratories.

Ben Wang gave the opening presentation about the company and the new facilities, from corporate structure to fun teambuilding activities that employees at Unilever's R&D centre participate in. The center is one to the six main research hubs of Unilever. Equipment used here is equal to equipment at other Unilever facilities, so experiments can be reproduced quickly in other research sites around the world. Following his presentation, we had the chance to briefly introduce ourselves and our research, and get some insight on innovation, R&D and intellectual property from a corporate perspective by Ben Wang, a specialist in the subject. Assist. prof. Rachel van Ooteghem closed the session with a short presentation about our university and department.

After the introduction, we continued with a tour of the facilities, and we were shown some application labs, ranging from lab to pilot scale. Most of the research we observed was on application testing and product quality. Ranging from tea, soups and powder foods, house cleaning and personal care, to a device that tests the effectiveness of hair products by simulating brushing on actual hair. The tour was concluded with a visit to the pilot plants for food and ice-cream.



Biobased Chemistry and Technology Group (BCT)

BCT group is leading research in **Biorefinery & Biobased Economy**. Biorefinery value chains combine biomass cultivation with different biomass processing steps; such as storage, pre-treatment, disruption of biomass, extraction, separation of biomass components, and finally conversion of intermediates into a spectrum of marketable biobased products, for food, feed, chemicals, materials and bioenergy. We also analyse and design sustainable processes with a reduced footprint and closed cycles for components. The Biobased Chemistry and Technology group conducts research focused on:

- **Conversion:** production of biobased chemicals by conversion of biomass (homogenous, heterogeneous and enzymatic catalysis)
- **Process Technology:** biorefinery technology, to separate biomass components in order to enable their use at the best economic and social value
- **Modelling:** modelling, control & design of processes related to biorefinery, food and water, including logistic and upstream issues

The slogan of the group is "*TIPTOP Chemistry and Technology*". TIPTOP is the acronym for Turning variable InPut into Tailored OutPut, which relates to one of the grand challenges in biomass conversion: converting a feedstock that is variable, into products that are still the same. This requires an integrated approach on different length scales to make it successful.

Participants & Research topics

Below is the list of the participants of the PhD trip, together with the title of their research topics.

Conversion

1. Jurjen Spekrijse – Utilization of PHA from Waste Water for Synthesis of Bulk Chemicals
2. Andrada But – Biocatalytic formation of industrial nitriles from biomass
3. Frits van der Klis - Selective catalytic transformations of non-edible carbohydrates
4. Piet van der Zaal – Novel polysaccharides from starch with mixed alpha-1,4 & alpha-1,6 backbones
5. Neus Blanch Raga – Aqueous phase reforming of bio-feedstocks
6. Konstantina Roxani Chatzipanagiotou - Combining **Chemo**- and **Bio**-Electro-Catalytic Synthesis of Chemicals

Technology

7. Nathan Bowden – Crystallization of Single Amino Acids From Industrial Waste
8. Chen Zhang – Increasing the utilization of low value leaves by use of new protein extraction methods
9. Rungnapha Khiewwijit – Computer-aided design and monitoring of water waste treatment plants towards energy and nutrient recovery

Modelling

10. Farnoosh Fasaei – System analysis of algae biorefinery
11. Elvira Bozileva – Simulation of urban resource cycles: towards sustainable cities of the future
12. Sanne Moejes – Redesign and optimization of the milk powder production chain
13. Daniel Reyes Lastiri - Modelling aquaculture-horticulture systems
14. Yu Jiang - Bio-energy policies for achieving liveable and sustainable cities of the future: an integrated game-model-data approach (E-game)

Staff members

15. Assist. prof. Rachel van Ooteghem – Bioparks, Physics, Modelling and Control
16. Assoc. prof. Karel Keesman – Mathematics, computers and simulation in bio-based and environmental sciences
17. Prof. Harry Bitter (BCT chair holder) – Heterogeneous catalysis

Sponsors

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