Scientific Workshop

« Environmental friendly technologies for reducing and controlling the GHG emission from human activities (EftechGHG). »

(This scientific Workshop is organized under the FICEM Consortium)

March 11th and 12th, 2015

At the "Institut Français Indonesia" French ambassy,Jl. MH Thamrin 20 – JAKARTA 10350

Coordinators:
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Program

Wednesday, March 11, 2015

09 :00 – 09 :30 : Welcome coffee

09:30 – 09:45: Reception

09:45 – 10:00: Opening speech

Speaker: Prof Joel Le Bail, scientific and technologic cooperation fellow at the French Institute of Indonesia (IFI)

10:00 – 12:00: session 1:

Topic: Waste to energy

10:00 – 10:30: **Dr. Joko Prayinto**: Carbon Capture Technology Using Microalgae Photobioreactor and Its Biomass Utilization as Biodiesel. *Environmental Technology Center, Agency for the Assessment and Application of Technology, Indonesia*

10:30 – 11:00: **Dr. Farah Diba**: Portable Applicative Technology in Producing of Biodiesel and Bio Charcoal Briquette from Biomass Rubber Plant Kernel (Hevea brasilliensis), *Forestry Faculty Tanjungpura University, Indonesia*

11:00 – 11:30: **Dr. Sary Awad**: Biodiesel production from waste water sludge lipids, *Mines-Nantes, France*

11:30 – 12:00: **Dr. Sri Wahyono** : Overview of landfill gas management in several Indonesian cities, *Environmental Technology Center, Agency for the Assessment and Application of Technology, Indonesia*

12:00 – 14:00 : lunch break – RdV at 12:00 at Café Kayser, lunch offered by IFI

14:00 – 15:30 : Session 2

Topic: Waste reuse

14: 00 – 14:30: **Ing - Dr. M. Abdul Kholiq**: Development and Application of Anaerobic Processes for Treatment and Utilization of Organic Wastes, *Environmental Technology Center / Agency for the Assessment and Application of Technology, Indonesia*

14:30 – 15:00: **Dr. Cindy Priadi**: Optimal Paper Sludge Sequential Reuse for Biogas and Fertilizer, *Engineering Faculty, Universitas Indonesia*

15:00 – 15:30: **Dr. Yves Andres**: Valorization of sustainable chars/activated carbons and alternative fuels by an environmental friendly production, *Mines-Nantes, France*

Thursday, March 12, 2015

08:30 – 09:00 Coffee break

9:00 – 11:00 Session 3

Topic: **Air control and water sanitation**

09:00 – 09:30**: Mr. Arysca Wisnu Satria,** Design of Submerged Biofilter For Processing Wastewater Nitrification and Denitrification Study, *Gadjah Mada University, Indonesia*

09:30 – 10:00: **Dr. Alleman Laurent**: Formation, origin, fate and health impact of atmospheric pollutants: a few perspectives, *Mines-Douai, France*

10:00 – 10:30: **Dr. Liming LIN:** Wastewater reuse: treatment technologies and risk assessment, *Mines-Alès, France*

10:30 – 11:00: **Dr. Yves Andres**: Treated wastewaters and rain water management in urban areas, *Mines-Nantes, France*

11:00 – 13:00: Round table: “Identification of collaborative main topics”

13:00: Closing session

Speaker: Prof. Joel Le Bail, scientific and technologic cooperation fellow at the French Institute of Indonesia (IFI)

Title	Authors	Affiliations
Topic 1 : Waste to energy		
Biodiesel production from waste water sludge lipids	Sary Awad, Khaled Loubar and Mohand Tazerout	Mines-Nantes, France
Portable Applicative Technology in Producing of Biodiesel and Bio Charcoal Briquette from Biomass Rubber Plant Kernel (Hevea brasilliensis)	Sarma Siahaan[1], Gusti Hardiansyah[1], Lolyta Sisillia[1], Nurhaida[1], Farah Diba[1*], Harlia Djuhardi[2], Ivan Sujana[3]	[1]Forestry Faculty Tanjungpura University, Indonesia [2]Mathematic and Natural Science Faculty Tanjungpura University, Indonesia [3]Engineering Faculty Tanjungpura University, Indonesia
Carbon Capture Technology Using Microalgae Photobioreactor and Its Biomass Utilization as Biodiesel	Joko Prayitno	Environmental Technology Center Agency for the Assessment and Application of Technology, Indonesia
Overview of landfill gas management in several Indonesian cities	Sri Wahyono	Environmental Technology Center Agency for the Assessment and Application of Technology, Indonesia
Topic 2 : Waste reuse		
Valorisation of sustainable chars/activated carbons and alternative fuels by an environmental friendly production	M. Dieme[1], M. Hervy[2], A. Villot[2], Y. Andrès[2], C. Gérente[2*] and L. Le Coq[2]	[1]Laboratoire de Chimie et Physique des Matériaux, Université Assane Seck, Cameroune [2]Mines-Nantes, France
Development and Application of Anaerobic Processes for Treatment and Utilization of Organic Wastes	M. Abdul Kholiq,	Environmental Technology Center Agency for the Assessment and Application of Technology, Indonesia
Optimal Paper Sludge Sequential Reuse for Biogas and Fertilizer	Cindy Priadi*, Iftita Rahmatika, Dwica Wulandari, Chihiya.Fitria Nurhayati, Setyo Sarwanto Moersidik	Engineering Faculty, Universitas Indonesia
Topic 3 : Air control and water sanitation		
Wastewater reuse: treatment technologies and risk assessment	Mingming LI[1]and Liming LIN[2]	[1]Tsinghua University, China [2]Mines-Alès, France
Treated wastewaters and rain water management in urban areas	S. Ladislas[1], PL David[2,] C. Gerente[1], F. Chazarenc[1], K. Borne[1], G. Bulteau[2], P. Humeau[2], Y. Andres[1]	[1]Mines-Nantes, France [2]Centre Scientifique et Technique du Bâtiment (CSTB),
Formation, origin, fate and health impact of atmospheric pollutants: a few perspectives	L. Y. Alleman, P. Coddeville, S. Crunaire, S. Dusanter, N. Locoge, F. Mathé, E. Perdrix, N. Redon, V. Riffault, S. Sauvage, F. Thevenet, A. Tomas, M. Verriele and J.-L. Wojkiewicz	Mines-Douai, France
Design of Submerged Biofilter For Processing Wastewater Nitrification and Denitrification Study	Arysca Wisnu Satria*, Agus Prasetya[**]	Gadjah Mada University, Indonesia

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Carbon Capture Technology Using Microalgae Photobioreactor And Its Biomass Utilization As Biodiesel

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Abstract

The development of renewable energy to solve energy crisis should prioritize the technology with characteristics such as carbon neutral, no potential land use conflict with food production, utilize less water, and has ability to reduce carbon dioxide (CO_2) as a greenhouse gas. Microalgae is a potential candidate for renewable energy source since its capacity to produce biofuel (biodiesel) with those characteristics. This paper presents the results of an integrated pilot scale experiment consisting of culturing microalgae in a photobioreactor, biologically CO2 uptake by microalgae, and conversion of microalgal biomass to biodiesel. Microalgal photobioreactor used was a Multi Tubular Airlift Photobioreactor (MTAP) with a total volume of 300 L, developed by the Center of Environmental Technology, Agency for the Assessment and Application of Technology (PTL-BPPT). Microalgal biomass was converted to biodiesel through a process of extraction and trans-esterification. CO2 absorption capacity of MTAPs were 4,58-5,33 g CO_2/g dry weight, or 1,74-1,60 g CO_2/L/d. Lipid yield from extraction process was 36%, and biodiesel production from trans-esterification of lipid was 59,8%. Although further improvements are required for the integrated processes consisting of CO_2 uptake by microalgae in MTAP, biomass production and the conversion of microalgal biomass to biodiesel, our results indicate that the system has a good prospect to be developed to a larger scale.

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Portable Applicative Technology in Producing of Biodiesel and Bio Charcoal Briquette from Biomass Rubber Plant Kernel (*Hevea brasilliensis)*

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ABSTRACT

Most of daily used energy was came from unrenewable natural resouces and it is cousing the fosil fuel scarcity and significanly increase the price as well. The government was already issued a regulation of PP No. 5 2006 regarding National Energy Policy by used renewable energy as an alternative resources to substitues oil base energy which are cheapest, eco friendly, and abundant. This regulation still hard to implemented on district level due to the lack of socialization as well as applicable technology transfer. Meanwhile, there so many resources of alternative energy that could be transform becoming biofuel, such as rubber plant.

Rubber plantation in West Kalimantan has reached 81,655 hectares. Rubber plant was favorable as it becoming as a livelihood for collected latex from rubber tree. Meanwhile, instead of using as a commodity, rubber plant kernel still consider as unprofitable plant waste. The potency of rubber plant kernel was huge. Each plant can produced 200 – 300 kernel, while the population of rubber plant in 1 hectare is about 400 – 500 trees. Therefore the number of plant rubber kernel in 1 hectare is around 1.5 million kernels. The fruit season of rubber plant is twice a year, so it is meaning the number of rubber plant kernel from 1 hectare plantation is about 3 million kernels/year. This huge potency of rubber plant kernel could be used as an alternative of biodiesel energy and bio charcoal briquette resources to increase people prosperity.

The objectives of the study are to utilize the rubber plant kernel waste as a new renewable energy resources to produce bio diesel and bio charcoal briquette, to create portable equipment to produce eco friendly and profitable of bio diesel and bio charcoal briquette as well, and create the policy that could implementing a reliable and clean energy technology as well as sustainable and affordable. The benefit of empowering community is for sustainable rubber plantation people will be able to protect and conserve their existing rubber plantation and take advantage the rubber plant kernel as a valuable commodity.

The methods used rubber kernel waste with portable applicative technology to produce biodiesel. Design of the machine based on some reference and made for people in village. Rubber kernel then flow to sortation and shell peeling. The shell was continued to burnt and refining for making charcoal briquette. Meanwhile the kernel was crushing and pulp pressing. The crude oil from kernel continued process with Trans-esterification methods for several hours to produce biodiesel for energy. This product was zero waste.

Keywords: rubber kernel waste, biodiesel, charcoal, portable machine, bioenergy

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Dr. Sary Awad Achieved his Ph.D in energy and process engineering in 2011 at Ecole des Mines de Nantes. He was a temporary lecturer and research assistant at Ecole Polytechnique de l'Université de Nantes between 2010 and 2012. Since 2012 he is assistant professor at Ecole des Mines de Nantes and is in charge of alternative fuels adaptation on combustion engines.

He is currently involved in research projects dealing with biofuels production from different types of residues and their adaptation to internal combustion engines. He also develops models of combustion analysis and predictive models correlating fuels characteristics to their behavior while used on engines. He was also involved in studies aiming the industrialization and economic analysis of waste to biofuel processes.

He has published 10 peer reviewed papers and participated to more than 15 national and international conferences, working groups and thematic meetings.

Biodiesel production from waste water sludge lipids

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The modern society is, nowadays, facing two major problems: the energy sources depletion and the degradation of the ecologic system because of wastes rejection. The energetic valorization of wastes contributes on the resolution of both problems. Under this scope, biodiesel production from waste lipids feedstock is an attractive way to produce cheap fuel grade fatty acid methyl esters (FAME). However, the highly degraded feedstock, like fat trap grease (FTG) might result in the presence of hydrocarbon chains that can not be found in non-degraded feedstock which will alter fuel quality and affect engine functioning. Actually, the effects of the use of biodiesel from degraded raw material on combustion in engines are not discussed by researchers.

In this work, the production of biodiesel from waste water sludge lipids (WSL) via acid-catalyzed process was performed. Using a single step process, the treatment of the WSLs with 5.4% (w/w) of 17 M H2SO4 at a methanol/WSL ratio of 13:1 (50% w/w) at 60°C converted more than 95% of the triglycerides into fatty acid methyl esters (FAMEs) with an acid value (AV) of 1.3 $mg_{KOH}/g_{biodiesel}$. Response surface methodology indicated that a lower AV cannot be reached using a single-step acid catalyzed process. Thus the two-step acid catalyzed process was employed using 3.6% catalyst and 30% methanol for 5 h for the first step and 1.8% catalyst and 10% methanol for 1 h in the second step, resulting in a yield higher than 98% and an AV of 0.3 $mg_{KOH}/g_{biodiesel}$.

The product biodiesel was characterized and it was revealed that it is conform with European Norm EN14214 relative to biodiesel. Then engine tests were performed using a single cylinder, air cooled, DI diesel engine at 1500 rpm. Performance and pollutant emissions were measured and the combustion parameters were analyzed. The use of WSL biodiesel (WSLBD) in the engine resulted in similar performance with slight brake thermal efficiency decrease at low loads and a slight increase at high loads. A decrease of 9% of power output at 1500 rpm was also detected. As per pollutant emissions, a drastic reduction of unburned hydrocarbons between 55% and 68% was obtained with WSLBD. Particulate matter emissions were also reduced at low and medium load ranges, but no differences were detected at high loads. Nitric oxides emissions were also measured and slight increase was detected at low loads and a slight reduction was noticed at full engine load.
Then, the estimated value of annual production of WSL on a French city like Nantes was esteemed to be 1000 tons/yr. Thus the study of an installation that is able to transform this amount was conducted. All necessary equipments were sized based on lab scale optimization experiments. Installation energy balance was also realized and it showed that the energy required for the installation functioning does not exceed 3.5% of the heating value of produced biodiesel.

Keywords: biodiesel, waste lipids, engine test

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SUMMARY

A professional, with over 15 years working experience as a Solid Waste Management and Biological Treatment of Organic Waste. Holding doctoral degree in Environmetal Science in University of Indonesia, and master degree of Biotechnology as well as Bachelor Degree in Biology in Bandung Institute of Technology. Working at Agency for the Assessment and Application of Technology Indonesia, working as Division Head of Environmental Management Division. He has developped the expertise to overcome many environmental problems, such as solid waste aerobic composting and anaerobic digestion, landfill gas to energy, and other municipal solid waste treatment technology.

OVERVIEW OF LANDFILL GAS MANAGEMENT

IN SEVERAL INDONESIAN CITIES

Dr. Sri Wahyono, M.Sc

Environmental Technology Center
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Abstract

Landfill gas management had an important role for the operation of landfill. The goals of landfill gas management were to prevent the environmental pollution by greenhouse gasses and to recover the energy from the landfill gasses. Most of Indonesia landfills still used open dumping system. Based on the tropical climate and socio-economy situtions, landfill gas management in Indonesia can technically be classified into two types: first, landfill gas management used a simple technology and second used of an advanced technology. The simple technology usually applied by small and medium cities, while the advanced technologies applied by major and metropolitan cities. Application of simple technology was done by local government, while the advanced technology was done by the private sector with the economic motives. Both of technologies had unique characteristics those can be adapted to the type of cities. These experiences of Indonesia landfill gas management could be a good lesson for improving landfill gas management in the future.

Keywords: landfill, gas, energy,

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Development and Application of Anaerobic Processes for Treatment and Utilization of Organic Wastes and Wastewater

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Anaerobic Processes can be used for treatment and utilization of organic wastes and wastewater through degradation of organic substances into biogas which can be used as an alternative energy source. At the same time, the potential pollution to the environment of the organic substances in wastes or wastewater can be reduced significantly. This paper presents some examples of anaerobic processes which were developed by the Indonesian Agency for the Assessment and Application of Technology together with partners. These include a wastewater treatment plant from a slaughter house in Jakarta, a wastewater treatment plant from a bioethanol production plant in Lampung, a biogas plant for processing cow dung in Serpong, and a pilot plant of so-called anaerobic composting for compost and biogas production from organic wastes. Additionally, some other examples of development and application of anaerobic processes in Indonesia will be also presented.

Key words: Anaerobic Processes, Biogas, Organic Substances, Wastes, Wastewater

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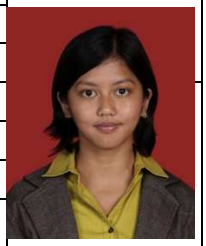
1.	Full Name	Cindy Rianti Priadi	
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2. EDUCATION BACKGROUND

NO.	INSTITUTION	MAJOR	YEAR OF GRADUATION	TEMPAT
1	Institut Teknologi Bandung (Bachelor)	Environmental Engineering	2004	Bandung
2	Universite Paris 7 – Ecole Naional des Ponts et Chaussees (Master of Science)	Environmental Science and Engineering	2007	Paris, France
3	Universite Paris Sud 11 (Doctor)	Water Geochemistry	2010	Orsay, France

3. WORK EXPERIENCES

NO.	COMPANY/ORGANIZATION	POSITION	LOCATION	YEAR
1	Faculty of Engineering, Universitas Indonesia	Lecturer of Civil Engineering	Depok, Indonesia	2011-Now
2	IWRM Citarum	Integrated Water Resource Management Expert	Bandung, Indonesia	2011

4. RESEARCH GRANTS and PROJECTS

Surface Water Quality Assesments

a. The Role of Heavy Metals Mobilization to Water Contamination Level: Lake UI as Potential Source of Raw Water
b. Water quality analysis of Ciliwung and Citarum River
c. Study of Waste Condition on The Saguling Reservoir, Upstream of Citarum River

Wastewater Treatment

a. Building a green Engineering Faculty: Towards Green and Sustainable Society
b. Demonstration Site of Waste Water Phytoremediation on a Pilot Scale for Tourism Area of Cikapundung River, Bandung, West Java.
c. Implementing Sustainable Anaerobic Digestion System in Indonesia

Laboratory Development

a. Infrastructure Development of Environmental and Sanitation Engineering Laboratory: Heavy Metals Analysis in Waste Water.
b. Infrastructure Development of Environmental and Sanitation Engineering Laboratory: Solid sample preparation.

Dr Pryadi has published 7 papers in international and national journals, books and seminars

Optimal Paper Sludge Sequential Reuse for Biogas and Fertilizer

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Introduction

Pulp and paper mills production generate large amounts of waste organic matter that can be treated and converted to renewable energy with anaerobic digestion method [1] .The anaerobic digestion method had been successfully applied worldwide. The previous study showed that the anaerobic process of paper sludge produced the methane of 14.7 ml/g volatile solid (VS). The co-digestion of paper sludge with cow manure yielded higher methane production to 269 ml/g VS until day 28 due to the more optimum initial C/N ratio and volatile solid [2]. Aside from potential energy from the process, the disposal of the residual digestate at the end of the process is also a concern. Digestate is the biologically stable material generated from anaerobic digestion [3]. Digestate has been observed to have very good fertilizing properties because of the high nutrient content (N,P and K), so that it can be a good candidate to replace the synthetic N and P fertilizer [4]. However, the effect of the use of digestate as fertilizer to the plants is rarely examined in previous studies. Although digestate has high nutrient content, their potentially hazardous heavy metals should be a concern especially when the substrate originates from the industrial wastewater treatment process. The aim of this research is to investigate the fertilizing potential and risks of paper sludge from digestate of biogas production.

Material and Method

The paper sludge originated from sludge holding tank in wastewater treatment process of pulp and paper industry in Surabaya, East Java, Indonesia. Two sets of experiments were conducted in two separate
reactors in parallel, labelled R1 and R2. The first set contained only paper sludge without any seeding of cosubstrate.
The second set combined paper sludge with cow manure to adjust C/N ratio to fit the ideal range of 20- 30. [2]. The residual digestate at day 30 for R1 and day 45 for R2 were dried before used as a fertilizer due to the high water content and afterwards mixed with organic material rice hulls to adjust the nutrient requirements of fertilizer and the water content of 50%. The digestate were tested to *Vetiveria zizanioides* (vetiver) to observe the growth and heavy metal (Pb and Zn) accumulation to the root and shoot after 4 weeks. The vetiver plant is chosen because it is reported to have high tolerance of heavy metal(oids) such as As, Cu, Cd, Pb, Hg, Ni, Se and Zn [5]. The vetiver plants were grown in 4 conditions, in soil as a control, in the soil mixed with raw digestate sludge, soil mixed with dried digestate R1, soil mixed with dried digestate R2 and soil with fertilizer (without digestate).To study the effect of digestate on the plants, the digestate were dried in the oven 105oC before subjected to nutrient content and heavy metal measurement. The nutrient content (C, N, P and K) of the digestate after anaerobic process were measured using spectrophotometer DR2000. For heavy metal analysis, approximately 2 mg of dried digestate were extracted and then digested at at 150-300oC with 10 ml HNO3 and 5 HClO4 until the samples were completely clear. The Pb and Zn concentration were determined using AAS GBC ExplorAA. After a growth period of 4 weeks, the shoots were cut at 5 mm above ground. Plant materials were washed with distilled water, oven dried (105oC), milled and then subjected to the heavy metal analysis with the same manner as mentioned.

Results and Discussions

The result in table 1 showed that the total organic carbon of digestate from both R1 and R2 were lost after AD process due to the transformation into biogas. The Total Kjehdal Nitrogen in R2 was also lost because of the migration of gaseous NH3 and N2 with the biogas flux. In AD process, complex organic-N compounds, such as protein, urea,etc, are mineralized to $NH4^{+}$-N that is used by the microorganisms for growth and can be transformed into a gas [6]. The total Phosphorus and Potassium were resulted in losses during the process, probably because of the sorption of the nutrient to the microorganisms. Heavy metal concentration in both reactors met the compost standard SNI 19-7030-2004 and can be used without any specific restriction.

Table 1. Characterization of digestate before and after anaerobic digestion process

	Input		Output	
	R1	R2	R1	R2
Organic carbon (%)	36.15	38.56	22.07	31.95
TKN (%)	0.95	1.19	1.19	1.17
Total Phosphorus (%)	0.013	0.007	0.0021	0.0069
Total Potassium	3.23	4.29	2.56	2.74
Pb (ppm)	1.53	1.26	1.61	0.97
Zn (ppm)	13.1	11.3	5.99	12.51

The potential and risk of paper sludge as digestate is presented in Table 2. The plants grown with soil mixed fertilizer had the highest growth rate. The nutrient content (N, P and K) play the major role of the plant growth on soil. The height of the plants were in the descending D>C>B>E>A. The plants grown in soil mixed with digestate R2 also show the good growth rate, because digestate R2 has the higher nutrient content due to the mixture of cow manure before anaerobic digestion process. The plant grown in the raw sludge showed poor growth performance, because the sludge had not been stabilized by anaerobic digestion before applying to the plants.

Table 2. Growth of *Vetivera zizanioides* grown on digestate under different treatments for a period of 4 weeks

Treatment		Number of experiment	Height (cm)[a]			
			Week 1	Week 2	Week 3	Week 4
Soil mixed with raw sludge	A	N=4	24±2.73	47.4±3.85	61.2±7.93	69.5±14.53
Soil mixed with digestate R1	B	N=4	32.0±5.69	52.8±7.86	66.8±13.82	79.5±17.72
Soil mixed with digestate R2	C	N=3	35.6±9.82	58.9±14.23	73.4±20.42	87.2±28.44
Soil mixed fertilizer	D	N=3	47.2±6.51	71.2±13.79	78.6±12.95	91.1±14.46
Soil (control)	E	N=4	31.7±5.30	52.7±7.82	66.6±12.14	75.4±9.79

The heavy metal measurement indicated that the total amount of heavy metal accumulated in roots is much higher than in shoots with the exception of the the Zn concentration in E. Similar results were also observed in the previous study of growth and heavy metal accumulation in the mine tailing [7]. Since the accumulation of heavy metal to the plants is still in tolerable amount for the plant to grow, the digestate can be used as a good candidate as fertilizer to replace the use of synthetic fertilizer. This shows that the use of anaerobic digestion can tackle the high production of sludge in the paper industry as well as produce a significant amount of clean energy, thus reducing greenhouse gas production (GHG). Moreover, by-product of digestion process can also be beneficial for fertilizing use, thus reducing the need for chemical fertilizer

that also produces GHG in the process. The overall potential of anaerobic digestion to reduce GHG should be estimated to provide valuable information for the paper industry as well as decisionmakers to support the use of AD for paper sludge management.

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Dr. Y. Andrès, holds a PhD from the University of Strasbourg (1994) in Molecular Biology and microbiology: environmental microbiology. He is currently a Professor at the Ecole des Mines de Nantes, France. In addition he is coordinator of the European joint Masters ME3, head of the "Project Management for Environmental and Energy Engineering" (PM3E) Master course and leader of the "Environmental Engineering" team from GEPEA UMR CNRS 6144 laboratory. His work focuses on bioprocess applied to water and air treatment as well as the fate and persistence of microorganisms in these processes.

Valorisation of sustainable chars/activated carbons and alternative fuels by an environmental friendly production

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Different wastes/residues from agriculture, restaurant and industry have been converted into sustainable materials of interest (char or activated carbons) and potential alternative fuels (condensable and gas). Pyrolysis were conducted in a batch quartz rotative furnace at 500°C (or 700 °C) with a temperature ramp of 15°C/min during 30 min under nitrogen flux, with buckwheat husk, wasted wood or mixture of wasted wood, food waste and WWTP sludge. The activated carbons (AC) were produced by a combined pyrolysis and activation (*ie* incomplete gasification) in the same batch quartz rotative furnace with a temperature ramp of 10°C/min under nitrogen flux to reach 850°C during 80 min for activation. Water steam was selected as activating gas and no other chemicals were added. The precursors were mil stalk, cajou shell and rice husk. Both productions have led to solids of interest (chars and AC), and co-products (gas and condensable) which have been characterised in terms of physical, chemical and thermodynamic properties in order to be valorised. The Table 1 presents some results about the AC production. Liquid and gaseous co-products are studied for energy recovery and chars and AC are under investigation in two environmental applications: adsorption of micropollutants from water and syngas purification. This global approach is original and contributes to a recycling of biowastes and to the water-energy nexus.

Table1. Activated carbons production, co-products and properties

AC production	Mil Stack	Cajou shell	Rice husk	Properties
AC	**12**	**15**	**32**	**Mass balances (%)**
	31	**30**	**13**	**Low heating value (MJ.kg^{-1})**
				Chemical properties
	86	**71**	**37**	C (%)
	12	**21**	**3.4**	O (%)
	0.1	**6.5**	**59**	Ash (%)
	8.0	**10.6**	**8.5**	pHpzc
				Porous properties
	1324	**942**	**384**	S_{BET} ($m^2.g^{-1}$)
	0.588	**0.416**	**0.168**	Microporous volume ($cm^3.g^{-1}$)
	0.033	**0.045**	**0.057**	Mesoporoux volume ($cm^3.g^{-1}$)
Gas	**76**	**47**	**47**	**Mass balances (%)**
	8	**8**	**6**	**Low heating value (MJ.kg^{-1})**
Oil	**11**	**40**	**8**	**Mass balances (%)**
	25	**36**	**16**	**Low heating value (MJ.kg^{-1})**

Treated wastewaters and rain water management in urban areas

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The increase in the size of the urban metropolis due to the increase in world population and combined to rainfall uncertainties caused by climate change makes crucial the issue of "water footprint" of urban areas.

In this context, many countries, including France, have in recent years responded by seeking to regulate, to reduce the levy in the water resource. This legislative work including use of rainwater or treated urban wastewater (TUWW) for garden irrigation or watering green and recreational spaces. This use of treated wastewater and rainwater has the advantage of mobilizing the available water resources and reduce water consumption for irrigation of urban green spaces that provide recreational and cultural role. It is in this context that both approaches will be presented:

- ✓ Treatment and reuse of gray water for watering of green and recreational areas. Indeed gray water (from showers, bathtubs, sinks and washing machine) represent between 50 to 80% of domestic waste water produced every day. They seem to be an ideal resource to reduce the consumption of drinking water for outdoor uses. Figure 1 present the experimental set up used for this work including a biological fluidized bed reactor.

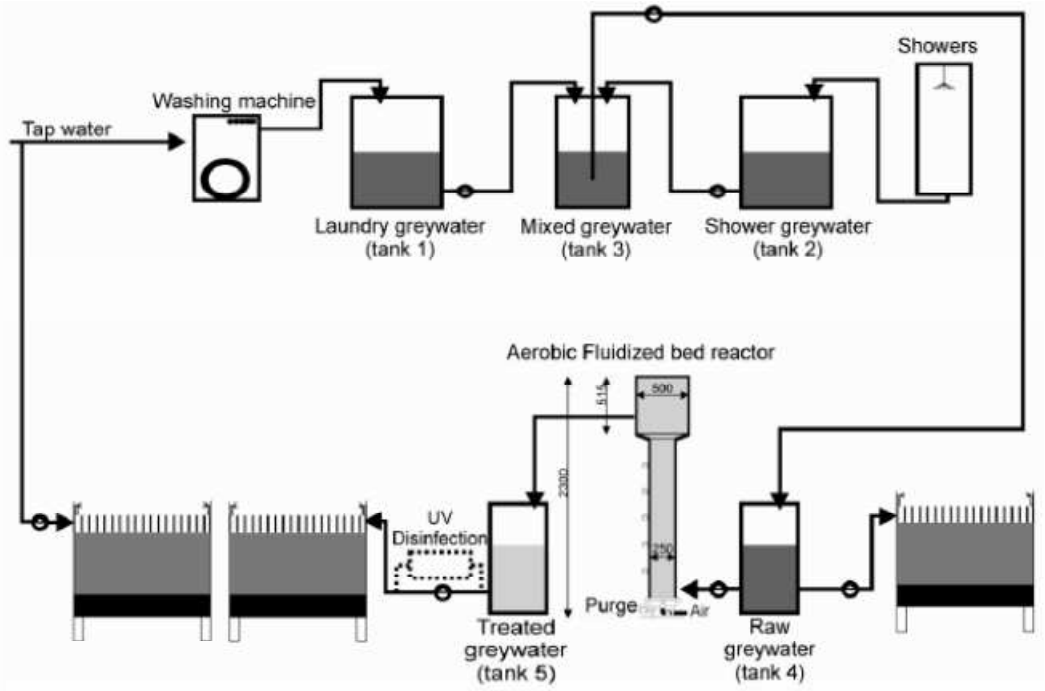

Figure 1: Gray water reuse experimental set up.

- ✓ The development of new remediation techniques called alternative or compensatory for rainwater management. It should be noted that each year the France receives 440,109 m^3 of water on average is 750 mm of rain. 60% evaporated, leaving 180 109 m^3 of rainwater flowing to the land surface. This leads to a real problem of stormwater management quantitatively with the risk of flooding due to important hydraulic flows in rainy weather, but also qualitatively with the pollutant loads carried by runoff and sometimes discharged untreated into receiving waters. The treatment process used is floating wetland. Road/highway stormwater runoff has been considered as a major source of contaminants and one of the most frequent causes of surface water pollution. The heavy traffic flows have provided numerous sources of contaminants, such as motor vehicle emissions, drips of crankcase oil, vehicle tyre wear and asphalt road surfaces, etc. The contaminants are deposited on the road surface, during the rainfall they are carried by the road stormwater stream flowing ultimately to rivers, lakes and oceans. Among these contaminants in highway stormwater, heavy metals and polycyclic aromatic hydrocarbons are two significant pollutants of concerns due to their high toxicity to the ecosystem and their persistence in the environment. Floating marshes can be considered as effective systems for the treatment of the dissolved metal fraction present in the urban runoff but only few studies are interested in full-scale conditions. This work is intended to provide new data to:
  - verify the technical feasibility of an implementation of floating marsh directly to the surface retention basins runoff,
  - assess the accumulation of metals in real conditions by the two plant ie Juncus effusus and Carex riparia,
  - measure microbiological activity and metal accumulation in the root biofilm.

  The studied site is a detention pond located in the northeast of Nantes, in France which received the storm water runoff coming from the highway section (27 000 vehicles/day, basin surface 375 m2). Three floating marshes have been drilled on the detention pond and each raft has a surface area of 1.5 m2 (125 cm x 120 cm) and contains 16 plants. After 4 months plant samples were harvested, mineralized and analyzed by atomic spectrometry absorption to determine cadmium, nickel and zinc concentrations. Concerning the results, the Ni concentration in the leaves is between 23 and 31 µg/g dry matter and between 113 and 131 µg/g in the roots. For Zn, the results show an accumulation of 45 to 80 µg/g in the leaves and 168 to 210 µg/g in the roots. A root/leaves ratio between 2,6 et 5,7 for Ni and Zn is calculated highlighting the important function of roots in heavy metal accumulation. Regarding cadmium, no accumulation has been detected in plants. These metals have also been measured in the biofilm present onto the roots as well as the microbial respiration activity. Moreover, we observe that the roots present a particulates filtration capacity.

  The root biofilms study showed that the microbes of root biofilms can easily degrade one benzene ring aromatic hydrocarbon benzoic acid and toluene (in 5 days, 10.1 mg benzoic acid was degraded 93%; in 15 days, 40 mg benzoic acid, 10mg toluene and 40.4mg toluene was degraded 83%, 84% and 64%, respectively), whereas they cannot degrade two-ring PAH (the derivative of naphthalene tetralin), three-ring PAH (fluoranthene) and four-ring PAH (pyrene) in test experimental conditions. Not appropriate PAHs concentrations used in the BOD tests and the relative short duration conducted might be the main reasons that cause not found of PAHs degradation

  This study shows the feasibility of floating marsh for the metal removal of storm water pond.

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Experiences

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DESIGN OF SUBMERGED BIOFILTER FOR PROCESSING WASTEWATER: NITRIFICATION AND DENITRIFICATION STUDY

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ABSTRACT

Water pollution is a problem that often arises and gives serious impact to the environment. Therefore, it should be reduced by conventional methods or modern methods. Submerged biofilter is a biological waste treatment plant which utilizing microorganisms grown in a packingmedium. The advantages of submerged biofilter as a waste treatment plant are easy use and low energy consumption so the operational cost is cheaper. In this study, bioball is used as packing medium with wastewater containing pollutants, i.e. ammonia and nitrate. This study aimsto determine the operational parameters of submerged biofilter and to develop a model that can be use to estimate the rate of elimination of each pollutants using nitrification reactor for ammonia and denitrification reactor for nitrate.

The experiments were conducted by draining the wastewater in a cylindrical biofilter column. At first, microorganism was grown for two weeks with residence time of one day. Furthermore, the wastewater removals are conducted with HLR variation of 0.44; 0.74; 1.11; 1.66; 2.21 $m^3/m^2/day$. Samplings are performed in various height of column, i.e. 0.15; 0.3; 0.45; and 0.9 m. Then the effluent from each point is analyzed using UV-Vis Spectrophotometer.

The results showed that the optimum ammonia and nitrate removal was obtained in column height of 60 cm. The operational parameters for scale-up application are 0.74 $m^3/m^2/day$ for ammonia removal and 1.11 $m^3/m^2/day$ for nitrate removal. While the removal of ammonia and nitrate percentage from both condition are 99.27% and 84.91% respectively. The changes of HLR will give an effect on substrate reduction rate (SRR), microorganism's growth rate, Monod saturation constant, and the percentage of substrate removal. The model developed based on efficiency factors shows a good agreement with expectation data.

Keywords: *nitrification, denitrification, HLR, submerged biofilter.*

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Dr. Laurent Alleman achieved his PhD in Isotopic Geochemistry in 1997 at the University of Marseille III. He was a Post Doctoral fellow at the College of marine Studies, university of Delaware, USA from 1997 to 2000 and a First Assistant at the Royal Museum for Central Africa (Belgium) from 2001 to 2004.

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He is currently involved in different programs dealing with major and trace elements on atmospheric particles in order to trace pollutant sources indoor and outdoor. He has been developing source-receptor modelling to characterize pollutant sources depending of their particle size distribution (ultrafine to coarse) and bioaccessible extraction techniques to estimate their potential health impact. He is also part of various European and French normalization or technical working groups (EU WG20, AFNOR, LCSQA). He has published 28 peer reviewed articles and participated in more than 80 national and international conferences.

Formation, origin, fate and health impact of atmospheric pollutants: a few perspectives

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Abstract

Atmospheric pollution plays an important role in global climate change as well as environmental and human health issues. Outdoor air pollution in cities and rural areas was estimated to cause 3.7 million premature deaths worldwide per year in 2012 due to exposure to particles of 10 microns or less in aerodynamic diameter (PM_{10}), causing cardiovascular and respiratory disease. In 2013, WHO's International Agency for Research on Cancer (IARC) concluded that outdoor air pollution is carcinogenic to humans, with the particulate matter component of air pollution (PM_{10}), closely associated with increased cancer incidence. Atmospheric pollution can also affect the climate by changing the amount of solar radiation retained in the earth's system, inducing positive (GHG) or negative (aerosols) forcing.

Developed countries are frequently submitted to high-pollution episodes often exceeding existing ambient air quality standards due to both natural (dust, volcanoes, forest fire, sea salt) and anthropogenic (road traffic, industrial activities, household heating, biomass combustion) sources. This is becoming a major concern not only for researchers but also for governments and the general public as it has political, societal and economical consequences.

In this context, the department of Atmospheric Sciences and Environmental Engineering (SAGE) is developing various research programs representing 0.6 M € of funding per year in order to identify the potential sources of gas and particles and their relative contribution to the total content of pollutants present in the atmosphere. Our studies include laboratory and field studies in an attempt to elucidate the first moments of formation/reaction of gas and particles (ultrafine particle, photochemical reactivity, kinetic), their fate in the ambient air (indoor and outdoor) and their potential harmful effect on human health (bioaccessibility of reactive oxygen species, lung cell toxicity).

In the laboratory, VOCs are of particular interest as they may represent a health threat and are largely involved in the troposphere ozone and other pollutant production. Various projects related to photolysis of VOCs (carbonyl species) are performed to estimate radical production or to better understand the formation of secondary organic aerosols during ozonolysis mechanism of biogenic compounds.

A large set of instruments, mostly online monitoring analyzers (ACSM, PTR-MS, MARGA, SMPS, GC on line,…) or air sampling devices are frequently deployed on field to monitor trace compounds and answer specific questions. Various models (Positive Matrix Factorization, Chemical Mass Balance and Concentration Field) are developed and applied to better constrain the physicochemical and meteorological parameters controlling the air quality. This is a prerequisite in order to help regional and national policy-makers to take suitable and efficient measures against pollution considering that climate change will have a significant impact on pollutant emissions sources and atmospheric physicochemical processes in a near future.

As atmospheric pollutants can be transported over long-distances, measured concentrations are due both to local and long-range sources as well as primary or secondary formation processes of organic and inorganic species (SOA, SIA) that may involve homogeneous (gas-gas) or heterogeneous (gas-particle) interactions. To entangle long-range sources, one of our approaches is based on the available PM_{10} concentrations measured by the North of France Regional Network for Air Quality Monitoring (27 stations over 5 years, 2009-2012) and on air mass back-trajectories provided by the British Atmospheric Data Centre. A multi-site concentration field method was applied to daily PM_{10} concentrations at selected and spatially representative stations. This statistical method consists in redistributing the concentrations of PM_{10} to the trajectories in order to identify potential source areas influencing the receptor site. Major potential sources area impacting the northern region were located in central Europe, probably associated to coal combustion emissions mainly observed during the cold season. Additionally, we investigated matches and discrepancies between these resulting potential source areas and the regional 3 km^2 grid-based emission inventory.

The chemical composition of the particles brings much information on their origin, allowing to pin-point emissions sources and to address specific actions to reduce them. As an example, the sources of PM_{10} collected over a one year period at an urban background site in North of France were determined with Positive Matrix Factorization (US EPA PMF v3.0). Components measured and used in the PMF included the conventional species (soluble ionic species, trace elements, levoglucosan, elemental carbon (EC) and organic carbon (OC)) but also a wide range of organic tracers (sugars alcohols, hopanes, alkanes, PAH). The PMF outputs showed that the main emission sources were: secondary inorganic aerosols, biomass burning, aged marine emissions, with probably predominant contribution of shipping activities, mineral dust, fresh sea salts, primary biogenic emissions, traffic emissions, and coal combustion. Significant temporal variations were observed for most of the identified sources. Biomass burning emissions were weak in summer but responsible for a much larger fraction of total OC in wintertime. Conversely, primary biogenic emissions were negligible in winter but represented a large fraction in summer.

Exposure to fine particles ($PM_{2.5}$) and their component (metals, PAHs, PCBs, etc) is of major health concern, especially in urban and industrialized areas. SAGE is performing studies to better characterize the chemical composition (especially metals) of fine and ultrafine particles (UFP) and to determine their lung bioaccessibility, in relation to their health impact. In a recent work, UFP and $PM_{2.5}$ were collected in an urban area influenced by traffic and industrial emissions, at the stacks and in the vicinity of a ferromanganese industrial plant, in Dunkirk (France). Metals pulmonary bioaccessibility was determined using a synthetic lung fluid (Gamble solution), and compared to a 4-step sequential extraction method, in order to infer metal speciation. In the urban area, UFP elemental concentrations were primarily related to local sources (traffic and domestic heating), while larger submicronic particles (100 nm to 1 μm) were mainly affected by metallurgical plants. The bioaccessibility varied according to the particle properties (metals chemical speciation and particle size distribution) linked to their origin and formation processes and was also affected by physicochemical transformations of the particles occurring during atmospheric transport (mixing/agglomeration, aggregation, oxidation or reduction processes). The *in-vitro* bioaccessibility assessment is of interest to better understand the metal bioavailability and thus for a better appreciation of the health impact of toxic metals in terms of risk assessment.

The environmental impact is estimated through long term monitoring networks such as MERA, part of the French European EMEP rural network dealing with long distance atmospheric

pollution. Started in 1978, the program (13 sites in 2015) monitors wet deposition (ions, heavy metals, PAHs), gas (O_3, NO_2, VOCs), particles (heavy metals, PAHs, PM_{10}, $PM_{2,5}$, anions, cations, EC/OC,...) and meteorological parameters. It allows a spatial and temporal monitoring of pollutants over the country and across the borders and to evaluate the long term trends in terms of ecosystem and health impact. In France and Europe, a clear phasing out of $nssSO_4^{2-}$ over the 1995-2007 period was connected to reduction of SO_2 emissions, confirming the positive impact European regulations.

The Department of Atmospheric Sciences and Environmental Engineering (SAGE) led by Prof. Patrice Coddeville is one of five teaching and research units at the Engineering School Mines Douai. It has currently a staff of about 45 people including 14 full-time faculty members.
There research projects are based on fundamental and applied research in Atmospheric Sciences and aim at a better understanding of the physicochemical processes of generation transport and aging/transformation of gaseous and particulate pollutants in outdoor (troposphere) and indoor ambient air.
The primary objectives are to characterize pollutants and identify their sources, to determine their fate in the atmosphere, with a special focus on their health impacts and ecosystems and to develop innovative air treatment processes to improve air quality.
SAGE also develops analytical methods and sensor techniques allowing conducting laboratory and field-based studies. SAGE contributes to the Excellence Laboratory project named CaPPA (Chemical and Physical Properties of the Atmosphere) as part of the Program for Future Investment (PIA) with 6 other laboratories from the University of Lille 1 (LOA, PC2A, PhLAM, LASIR, CGTD/ICARE) and the University of Littoral (LPCA).
SAGE is a member of the National GIS LCSQA (Central Laboratory for Monitoring Air Quality), a structure set up by the Ministry of Ecology and which are entrusted with tasks related to metrology of pollutants in indoor and outdoor ambient air, modeling and identification of sources. It provides technical and scientific coordination of the National Observatory of "Measurement and Evaluation of the long range air pollution (MERA)" over twenty five years, integrated in a European monitoring programme EMEP and a global one (WMO-GAW).

The Department provides internships for undergraduate and graduate students. It also issues double diplomas for graduate and PhD students enrolled in the Doctoral School of Engineering Sciences or the Doctoral School for Science of Matter, Radiation, Environment of the University of Lille 1 or the "Université du Littoral Côte d'Opale" (ULCO).

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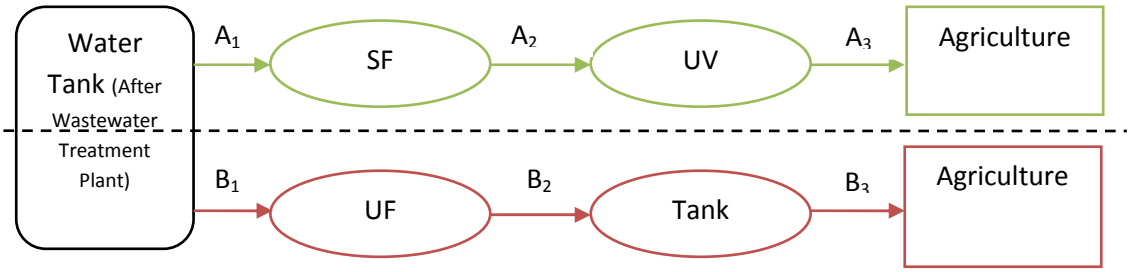
Wastewater reuse: treatment technologies and risk assessment

Mingming LI (Tsinghua University, China) and Liming LIN (Ecole des mines d'Alès, France)

Due to the limited water resources and increasing population, water shortage is major concern in some regions of the world. Global climate change and water pollution issue worse the current situation. Water reuse comes up as an interesting solution, together with water diversion and seawater desalination and especially for mitigating local water scarcity. Water reuse covers typically agriculture, urban, industrial, indirect portable, groundwater recharge and environmental restoration, which contributes definitely to preservation of water resources. However, the critical parameter of water reuse is biological quality of treated water because potential risk for human health exists if the microorganisms in reclaimed water are not removed efficiently. A complementary treatment stage (tertiary treatment) is essential in addition to conventional activated sludge treatment of waste water.

The results showed in this workshop come from a French experience known as NOWMMA project (New process for optimizing wastewater reuse from Mauguio to Mediterranean area in support of the French reuse directive). It is a 3-year pilot study carried out in the WWTP of Mauguio (South of France). The effluent of activated sludge treatment is refined by two processes which consist in either sandfiltration and ultraviolet disinfection or ultrafiltration and storage tank. The objective is to meet the quality criteria for the irrigation purpose. The study focuses on the effective removal of microorganisms on the basis of bacteria indicators like E.coli, coliforms and enterococcus.



The analysis of potential risk and the determination of the acceptable microorganism concentrations are one of the aspects of this study. We used quantitative risk assessment method for estimating the risk levels in the light of reclaimed water standard from USA, European countries, China and WHO. The Monte Carlo approach was adopted to deal with the data from each treatment process.