Environmental Biotechnologist wins Lee Kuan Yew Water Prize 2012

In successfully marrying nature and engineering, environmental biotechnologist Prof Mark van Loosdrecht, is recognised for introducing a paradigm shift in the understanding of the used water treatment process and for his significant contributions in creating sustainable solutions in the field of used water treatment.

Singapore, 8 March 2012 – Singapore International Water Week today announced that Prof Mark van Loosdrecht has been awarded the Lee Kuan Yew Water Prize 2012 for his breakthrough contributions in creating sustainable solutions in the field of wastewater treatment. The highlight of the Singapore International Water Week, the Lee Kuan Yew Water Prize is an international water award that recognises outstanding contributions towards solving global water problems by either applying technologies or implementing policies and programmes, which benefit humanity.

As the fifth recipient of the Lee Kuan Yew Water Prize chosen from over 61 illustrious nominations received from across 25 countries, Prof van Loosdrecht is recognised for pioneering an innovative biological process that provides a cost-effective, robust and sustainable way to remove unwanted pollutants from used water. This was made possible by the discovery of a unique group of bacteria which removes pollutants in used water using less oxygen and no added organic carbon compared to conventional processes. His process named Anammox can greatly reduce the overall energy consumption, chemical usage and carbon emissions of conventional used water treatment plant.

The use of Anammox shortens the conventional used water treatment process, where the pollutant ammonia in used water is converted to harmless nitrogen gas, bypassing an intermediate nitrate form which occurs in the conventional used water treatment process. At the heart of the Anammox process is a unique group of bacteria that possesses a unique set of enzymes which enables them to convert ammonia to harmless nitrogen gas. The end result is a significant reduction in the energy consumption in used water treatment.

Currently, the traditional used water treatment is an energy-intensive process. It is estimated that in most industrialised countries, the energy used in the water cycle takes up about 1% to 3% of a country's total energy budget. A part of this energy may be considered wasted as the end product of used water treatment is discarded back into the environment. However, with the application of Prof van Loosdrecht's Anammox technology to used water treatment, biological nitrogen removal systems worldwide will see substantial energy savings.

Commenting on Prof van Loosdrecht's achievement, Mr Tan Gee Paw, Chairman of the Lee Kuan Yew Water Prize Nominating Committee said, "Prof van Loosdrecht's technology is set to create a paradigm shift in the used water treatment industry. The adoption of such energy-saving technology is essential for used water treatment plants seeking complete energy self-sufficiency and will be the future for the used water treatment industry. For that, the Lee Kuan Yew Water Prize celebrates Prof van Loosdrecht's outstanding achievement in the development of Anammox and honours his relentless pursuit for highly sustainable technologies that are critical for the future sustainability of urbanised cities."

The road to the development of Anammox process was not an easy one. Although the theoretical possibility of such a process was theorised as early as the 1970s, it was only until the 1990s that researchers at the Delft University of Technology discovered the group of bacteria responsible for this phenomenon. Prof van Loosdrecht then devised the engineering tools and systems to deliberately harness the natural properties of these bacteria. His ground-breaking work in marrying nature and engineering has formed the basis for many variants in use today and this technology is seeing increasing adoption worldwide.

"I am truly humbled to receive one of the most prestigious awards recognised in the water industry and among our profession. With this award, I am further encouraged to ensure that my technologies and research will continue to help create more sustainable solutions that are applicable to our modern world while protecting the quality of precious water," said Prof van Loosdrecht.

Prof van Loosdrecht was instrumental in building the world's first demonstration plant using the Anammox process in Rotterdam. As of January 2012, there are 16 referenced full-scale Anammox plants implemented by Paques (licensee of Prof van Loosdrecht's technology) and more than 30 full-scale variant plants in Netherlands, Austria, China, Japan and USA in

operation around the world. Singapore is currently conducting a pilot trial of the anaerobic ammonia oxidation process at its water reclamation plant and this has shown positive results. National water agency PUB is looking into the adoption of this technology to improve energy efficiency.

“Mark van Loosdrecht’s career is an outstanding example of academic achievements translated into innovation as a result from interdisciplinary research. His research will undoubtedly lead to further innovation, which makes him an excellent role model for young scientists and engineers studying at the Delft University of Technology as well as those that he touches through his international activities.” said Dr James L. Barnard, winner of last year’s award and Global Practice & Technology Leader in Black & Veatch, USA.

Prof van Loosdrecht has dedicated his career to pushing the boundaries and challenging the paradigms in used water treatment. Aside from Anammox, Prof van Loosdrecht is also credited with the development of Sharon®, Nereda®, CANON® and BABE®.

Prof van Loosdrecht is currently a full professor and the Group Leader of Environment Technology at Delft University of Technology. He did his Masters of Science in Environmental Engineering at Wageningen University and obtained his PhD in Microbiology and Colloidchemistry at the same university in 1988. He has been lecturing at Delft University of Technology since 1988.

The Lee Kuan Yew Prize award ceremony and banquet will be held at the Marina Bay Sands, on 2 July 2012 during the Singapore International Water Week 2012, the global platform for water solutions. As the winner of the Lee Kuan Yew Water Prize 2012, Prof van Loosdrecht will deliver the 5th Singapore Water Lecture prior to the award ceremony, where both the Water Prize and the World Cities Prize will be presented to the respective laureates.

For more information on the past winners and the nominations for this year please refer to the press release on the nominations received for the Lee Kuan Yew Water Prize 2012.

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About the Lee Kuan Yew Water Prize

Launched in 2008 to honour outstanding contributions by individuals or organisations towards solving the world's water problems by applying innovative technologies or implementing policies and programmes which benefit humanity, the Lee Kuan Yew Water Prize is the highlight of the Singapore International Week. Named after Singapore's first Prime Minister Lee Kuan Yew, the Lee Kuan Yew Water Prize comes with a cash prize of SGD300,000, an award certificate and a gold medallion. The award is solely sponsored by the Singapore Millennium Foundation, a philanthropic body supported by Temasek Holdings. The Lee Kuan Yew Water Prize 2012, together with the Lee Kuan Yew World City Prize 2012, will be presented at the Lee Kuan Yew award ceremony and banquet on 2 July to honour the laureates' outstanding contributions towards liveable and sustainable urban development solutions.

About Singapore International Water Week

The Singapore International Water Week is the global platform for water solutions. It brings policymakers, industry leaders, experts and practitioners together to address challenges, showcase technologies, discover opportunities and celebrate achievements in the water world. Comprising the Water Leaders Summit, Water Convention, Water Expo and Business Forums, it culminates in the presentation of the Lee Kuan Yew Water Prize, a prestigious international award to recognise outstanding contributions in solving global water issues.

The 5th Singapore International Water Week, themed "Water Solutions for Liveable and Sustainable Cities", will be held from 1 to 5 July 2012, in conjunction with the 3rd World Cities Summit and the inaugural CleanEnviro Summit Singapore.

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FACT SHEET
Prof M.C.M (Mark) van Loosdrecht and Annamox technology

Prof M.C.M (Mark) van Loosdrecht
Prof Mark van Loosdrecht is a world renowned, award winning scientist and engineer from the Delft University of Technology (TU Delft). Prof Mark van Loosdrecht's work is focused on the interface between microbiology and biotechnology, specifically pertaining to wastewater treatment. His research focus can be categorised into three broad areas: biological nutrient removal; biofilms and granulation; and lastly modelling of processes. Realizing that research discoveries take a very long time to reach the market, Prof van Loosdrecht works actively with the wastewater industry to develop working solutions of his research findings. As a result of his direct involvement, many breakthroughs in wastewater treatment have been successfully commercialized in a relatively short time.

Conventional wastewater treatment for nitrogen removal requires a lot of energy to maintain aerobic conditions for nitrification to take place. Fifty percent of the energy that is currently consumed in wastewater treatment is used for aerobic processes, followed by sludge treatment and the use of pumps which consume 30% and 15% respectively. With such high energy requirement, there is a pressing need to look into alternative technologies to reduce energy consumption, which was precisely what Prof van Loosdrecht has done.

In the 1980s and 1990s, researchers discovered that there could be other biological processes other than nitrification/denitrification that are able to remove nitrogen from wastewater. The phenomenon of anaerobic ammonia oxidation was observed and the scientists at TU Delft identified the organisms responsible for the process to be from the Planctomycetes family. With this information, Prof van Loosdrecht, together with his team, designed an innovative process – Anammox (ANaerobic AMMonium OXidation) process which converts ammonium to harmless nitrogen gas using significantly less aeration and no organic carbon compounds. Conventional nitrogen removal processes involve nitrification/denitrification, which involves the conversion (through aeration) of ammonium to nitrite and to nitrate followed by denitrification of nitrate to nitrite and finally to nitrogen gas with the use of organic carbon compounds as an energy source. This innovative process only requires the conversion of half of the ammonium to nitrite resulting in the reduced need for aeration, thus saving energy. The bacteria involved in the Anammox process will then convert ammonium and nitrite together into nitrogen gas without the need for any additional organic carbon compounds. Anammox is able to reduce carbon dioxide emissions by up to 90% compared to conventional nitrification / denitrification processes. It occupies up to 50% less space and reduces aeration energy by up to 60%.

Prof van Loosdrecht was instrumental in building the world's first Anammox® demonstration plant with a volume of 80m^3 in Rotterdam, The Netherlands, in 2002 to treat high-ammonium sludge water from Dokhaven-Sluisjesdijk wastewater treatment plant. This reactor was scaled-up directly from laboratory scale to full-scale without building a pilot plant. By third quarter 2006, this reactor was in full operation and was converting 8-10kg of nitrogen per m^3 every day, twice its design capacity.

Advantages of Anammox over conventional nitrification/denitrification

- Energy used to introduce oxygen can be reduced by up to 60%
- The annamox process do not require organic carbon while nitrification/denitrification requires organic carbon such as methanol. In turn this also reduces carbon dioxide emissions by up to 90%
- Anammox bacteria produce biomass very slowly, which reduces the amount of sludge to be disposed of

The Anammox® process was initially implemented only in wastewater treatment plants in the Netherlands, but has quickly been adopted globally, as it can be applied to any stream with high concentrations of ammonia or organic nitrogen, such as wastewaters from chemical industries, food industries, power plants and those from animal waste. As of January 2012, there are 16 referenced full-scale Anammox plants implemented by Paques (licensee of Prof van Loosdrecht's technology) and more than 30 full-scale variant plants in Netherlands, Austria, China, Japan and USA in operation around the world.

Anammox reference sites implemented by Paques:

Company	Country	Wastewater from:	ANAMMOX® reactor vol	Ammonia load kg/day	Year
Kuaijishan Shaoxing Winery	China	Distillery	560	900	2011
Confidential client	The Netherlands	-	-	-	2011
Severn Trent	United Kingdom	Reject water sludge treatment	1760	4000	2011
Xinjiang Meihua Amino Acid	China	Monosodium glutamate	5400	10710	2011
Jiangsu Hangguang Bio-engineering	China	Sweetener	1600	2180	2011
Confidential client	Poland	Distillery (Wheat stillage)	900	1460	2011
Shandong Xiangrui	China	Corn starch and MSG	4300	6090	2011
Waterschap Groot Salland*	The Netherlands	Reject water sludge treatment	425	600	2010
Meihua II	China	Monosodium glutamate	4100	9000	2010
Meihua I	China	Monosodium glutamate	6600	11000	2009
Angel Yeast	China	Yeast	500	1000	2009
ARA Niederglatt	Switzerland	Reject water sludge treatment	180	60	2008
Semiconductor plant	Japan	Semiconductor	50	220	2006
Waterstromen Steenderen	The Netherlands	Potato	600	1200	2006
Industry Water Lichtenvoorde	The Netherlands	Tannery	100	325	2004
WSHD	The Netherlands	Reject water sludge	72	500	2002

Future Directions

The full potential of the Anammox technology will be realized when it can be applied to mainstream used water treatment. This will mean an aeration energy savings of up to 60% for the whole plant nitrogen removal and most of the organic carbon content of the influent can be used to generate methane gas for energy recovery. The current challenges are the stability of the operations and maintaining good effluent quality. There are many laboratory and pilot testing of mainstream Anammox underway and Prof van Loosdrecht expects that in 2-4 years time the first full scale mainstream Anammox reactor will be constructed.

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