International Specialised Skills Institute

CELEBRATING 25 YEARS

PASSIONATE PEOPLE. GREAT IDEAS.
A BETTER SKILLED AUSTRALIA.

Italian Services Institute

Technical wastewater treatment plants - Energy efficient technologies

Michael Capuzza

2014 Italian Services Institute Overseas Fellowship Report

An ISS Institute Fellowship sponsored by

Sponsored by the Italian Services Institute of Australia

ISS Institute Inc
SEPTEMBER 2015 ©

International
Specialised
Skills
Institute

ISS Institute
Level 1
189 Faraday Street
Carlton Vic
AUSTRALIA 3053

T 03 9347 4583
E info@issinstitute.org.au
W www.issinstitute.org.au

Published by International Specialised Skills Institute, Melbourne

Extract published on www.issinstitute.org.au

i. EXECUTIVE SUMMARY

This Fellowship allowed Michael Capuzza to attend ecoSTP2014, The International Water Association (IWA) conference on 'EcoTechnologies for Wastewater Treatment, Technical Environmental and Economic Challenges 2014'. This Conference was held at Polo Zanotto University of Verona, Italy.

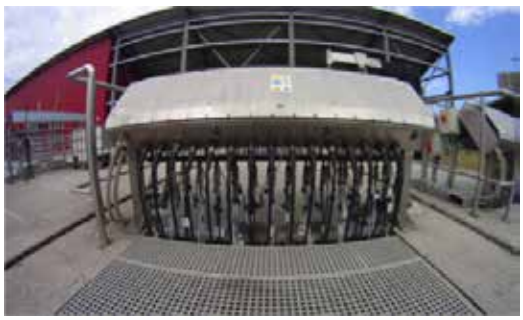
The information obtained relating to aeration technologies is still very new to Australia. Due to climate change and the continual increase in global population, an increase in both water and energy use, and energy and resource optimisation is crucial for our generation and generations to come.

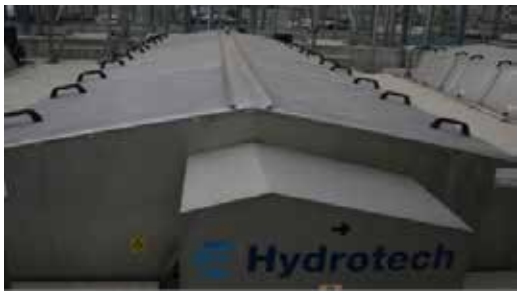
The focus of the conference was on technical wastewater treatment plants and covered a range of topics, including new technologies implemented overseas, videos and photos of technical treatment plants, eco technologies for wastewater treatment to mitigate the environmental impacts, odour abatement techniques, the concept and understanding of wastewater treatment plants used overseas and information on sustainable wastewater treatment plants.

During the site visit to the newly constructed Venice Fusina waste water treatment plant the Fellow was treated to viewing a series of seven Hydrotech Disc filters in action. This filtration system was extremely efficient, could handle large volumes of effluent to be treated, The system had an extremely small footprint that minimise construction works and also had a patented back wash system which increased the filtration media's life time up to 20%.

The system also incorporated a highly impressive ultraviolet disinfection treatment system situated below out feet, which them fellow did not realise was there until specifically told.

Ultra violet Disinfection system





Hydro tech disc filter

Seven hydro disc filters in operation

The conference and two site visits enabled the Fellow to obtain information on low operational cost wastewater treatment plants and will therefore enable the Australian Plumbing Industry to gain technical information from the research findings, pictures and presentations.

i. EXECUTIVE SUMMARY

This new enhanced knowledge gained will be shared via presentations to the moderator plumbing groups within the TAFE plumbing specialisation, and within Melbourne Polytechnic (formerly NMIT). The information gained has already been shared throughout the Victorian plumbing training moderators group via Dropbox, amongst all TAFE colleges in Victoria.

TABLE OF CONTENTS

ii. ABBREVIATIONS/ACRONYMS

Biotechnology	Living organisms are used to make useful chemicals and products or to perform an industrial task
EcoSTP2014	Eco Technologies for Wastewater Treatment 2014 Conference
EPA	Environmental Protection Association Authority
EPDM	Ethylene Propylene Diene Monomer rubber
IWA	International Water Association
MBR	Membrane Bio Reactor
MLSS	Mixed Liquor Suspended Solids
MP	Melbourne Polytechnic (formerly NMIT, see next line)
NMIT	Northern Melbourne Institute of TAFE
OTE	Oxygen Transfer Efficiency
PVC	Poly Vinyl Chloride
TAFE	Technical and Further Education
UV	Ultraviolet
WWTP	Wastewater Treatment Plant

iii. DEFINITIONS

Acidogenic

Producing acid as bacteria or causing acidity

Aeration (also called aerification)

The process by which air is circulated through, mixed with or dissolved in a liquid or substance

Anaerobic treatment

Treatment in the absence of air or free oxygen

Air diffuser (or membrane diffuser)

An aeration device typically in the shape of a disc, tube or plate, used to transfer air and oxygen into sewage or industrial wastewater

Biodegradable

Capable of decaying through the action of living organisms

Clarifier

Used in applications to settle solids from the water phase in wastewater treatment

Climate change

A long term change in the distribution of weather patterns.

Dropbox

A free cloud storage service for sharing and storing files including Photos, documents and videos

Energy Optimisation

The process in wastewater treatment energy optimisation where Wastewater treatment plants are running extremely efficiently with the latest technologies and processes this ensuring minimum use of energy to treat wastewater

Fellowship

An association of persons having similar tastes, interests, etc

FLOC

A loosely clumped mass of fine particles

HIOX

A brand of Aeration Panels

Holistic sustainability

A holistic approach that uses four pillars of sustainability; being Social, cultural, environmental and economic

iii. DEFINITIONS

Horsepower

Horsepower is defined as the power that a horse gives when pulling, and it is used informally to mean power, or is the power needed to raise 550 pounds a distance of one foot in one second, or the power needed to move 33,000 pounds a distance of one foot in one minute

Lagoon of Venice

The Venetian lagoon is the enclosed bay of the Adriatic in which the city of Venice is located

MAR GH ERA

The harbour area of Marghera, a borough of Venice (Marghera in Venitian language means 'there was the sea')

Membrane diffuser

An aeration device typically in the shape of a disc, tube or plate, used to transfer air and with that oxygen into sewerage or industrial wastewater

Methanogen

An anaerobic microorganism that lives on carbon dioxide and hydrogen and gives off methane, found in swamp sediment, cows' stomachs, etc.

Membrane Bio Reactor

The combination of a membrane process like microfiltration or ultrafiltration with a suspended growth bioreactor, and is now widely used for municipal and industrial wastewater treatment with plant sizes up to 80,000 population equivalent (i.e. 48 million liters per day)

Microfiltration

A type of physical filtration where a contaminated fluid is passed through a special pore size membrane to separate microorganisms and suspended particles from P-process liquids (see next definition)

P-process liquids

Flammable liquids with a flashpoint below 100 °F (37.8 °C) that can contaminate an otherwise potable water supply

Microorganisms

An organism too small to be viewed by the naked eye

Odour abatement

Refers to the process of odour becoming less than it was at a prior time

Plumbing practitioner

A person who carries out plumbing work. The practitioner is either Licensed or registered

Reverse osmosis

A method of producing pure water, a solvent passes through a semipermeable membrane in a direction opposite to that for natural osmosis when it is subjected to a hydrostatic pressure greater than the osmotic pressure

Sparger

A perforated pipe, device or distributor which allows air or gas to sprinkle or emit in the form of bubbles. This can be used to remove dissolved gases (e.g. oxygen) from the liquid.

Ultraviolet filtration

Ultraviolet (UV) filtration penetrates harmful pathogens in water and destroys illness-causing microorganisms by attacking their genetic core (DNA). It is not enough to purify water down to drinking water purposes. This is because the UV radiation is only effective for treating bacteria and viruses. UV light does not work to eliminate contaminants such as chlorine, heavy metals and VOC's (Volatile Organic Compounds). UV systems are often paired with Reverse Osmosis Systems to provide a complete purification process for the safest drinking water.

Utility company

An organisation that generates, transmits and/or distributes electricity, water and/or gas from facilities that it owns and/or operates.

1. ACKNOWLEDGEMENTS

Michael Capuzza thanks the following individuals and organisations that have generously given of their time and their expertise to assist, advise and guide him through this Fellowship program.

Awarding Body – International Specialised Skills Institute (ISS Institute)

The International Specialised Skills Institute (ISS Institute) is an independent, national organisation. In 2015 it is celebrating twenty-five (25) years working with Australian governments, industry education institutions and individuals to enable them to gain enhanced skills, knowledge and experience in traditional trades, professions and leading edge technologies.

At the heart of the ISS Institute are our individual Fellows. Under the Overseas Applied Research Fellowship Program the Fellows travel overseas. Upon their return, they are required to pass on what they have learnt by:

- Preparing a detailed report for distribution to government departments, industry and educational institutions
- Recommending improvements to accredited educational courses
- Delivering training activities including workshops, conferences and forums.

Over 300 Australians have received Fellowships, across many industry sectors. In addition, recognised experts from overseas conduct training activities and events. To date, 25 leaders in their field have shared their expertise in Australia.

According to Skills Australia's 'Australian Workforce Futures: A National Workforce Development Strategy 2010'.

> *Australia requires a highly skilled population to maintain and improve our economic position in the face of increasing global competition, and to have the skills to adapt to the introduction of new technology and rapid change. International and Australian research indicates we need a deeper level of skills than currently exists in the Australian labour market to lift productivity. We need a workforce in which more people have skills and knowledge, but also multiple and higher level skills and qualifications. Deepening skills and knowledge across all occupations is crucial to achieving long-term productivity growth. It also reflects the recent trend for jobs to become more complex and the consequent increased demand for higher-level skills. This trend is projected to continue regardless of whether we experience strong or weak economic growth in the future. Future environmental challenges will also create demand for more sustainability related skills and knowledge across a range of industries and occupations.*

In this context, the ISS Institute works with our Fellows, industry and government to identify specific skills and knowledge in Australia that require enhancing, where accredited courses are not available through Australian higher education institutions or other Registered Training Organisations. The Fellows' overseas experience sees them broadening and deepening their own professional knowledge, which they then share with their peers, industry and government upon their return. This is the focus of the ISS Institute's work.

For further information on our Fellows and our work see http://www.issinstitute.org.au.

Michael Capuzza also thanks the CEO (Bella Irlicht AO) and staff (Ken Greenhill and Paul Sumner) of ISS Institute for their assistance in planning and development of the Fellowship and completion of this report.

Governance and Management:

1. ACKNOWLEDGEMENTS

Fellowship Sponsor

The Sponsor, Italian Services institute, Inc. was set up, inter alia, to advance the education of Australian residents who are of Italian descent and who need the support of a Fellowship to enable them to advance or enhance their skills.

The Italian Services Institute and ISS Institute will work with the successful recipients upon their return to share and publicise the learnings and recommendations from their Fellowship investigation.

The International Specialised Skills Institute (ISS Institute) and the Italian Services Institute of Australia (ISIA) together with the people at Melbourne Library Services, Melbourne Immigration Museum, the Federazione Lucania Club, the Italian Cultural Institute (Melbourne), Penguin Books Australia, Museo Italiano Melbourne, SBS Radio Melbourne, Victorian School of Languages and Swinburne Education were all invaluable in defining and developing the scope of this Fellowship.

Fellowship Supporters

- Gary Bath, Practitioner, Development Manager, Victorian Building Authority
- Doug Rennie, Gas investigations officer. Energy Safe Victoria
- Paul Gray, Victorian Building Authority Examiner

Industry

- The Master Plumbers Association
- Sustainable Plumbing Solutions
- Universita degli studi Verona

Professional Associations

- The International Water Association
- Plumbing trades employees union.

Education and Training

- Certificate II, Plumbing Moderation Validation Group, Victoria
- Melbourne Polytechnic (formerly Northern Melbourne Institute TAFE)

2. ABOUT THE FELLOW

Name:

Michael Capuzza

Position:

Certificate II, Plumbing Group Coordinator NMIT

Qualifications and Licences:

- Green Plumbers Environmental Solutions – 22079VIC
- Certificate IV in Training & Assessment – TAE40110, NMIT, 2012
- Licence to Perform High Risk Work – Scaffolding Basic, NMIT, 2011
- Diploma of Vocational Education and Training, NMIT, 2010.
- Registered and licenced plumber, 1989

Brief Biography:

Capuzza completed his four-year apprenticeship in 1989 and worked in the plumbing industry until 2010 as a plumbing practitioner, employee, self-employed and excavator operator. He commenced his teaching career in 2010. He took on the challenging role of Certificate II group coordinator at Northern Melbourne Institute of TAFE, Heidelberg campus. His experience with representation on a range of industry network groups has been important to Capuzza's growth in the training sector and has assisted his work in developing ongoing placements for students in relevant industry sectors, and ongoing industry placements in relevant industry sectors.

Capuzza has played a major role in integrating the Certificate II plumbing program at the new green skills centre at the Epping campus. He is passionate about portraying new and old skills for new young plumbers in the heavily challenging plumbing industry. His range of plumbing knowledge is broad and he has a passion for understanding the mechanics of plumbing engineering systems.

3. AIMS OF THE FELLOWSHIP PROGRAM

The aims of this Fellowship program were multiple:

- To obtain the most up to date processes with technical wastewater treatment plants.
- To obtain data on the latest state of the art treatment plants.
- To collect photographic and conference information of Technical Wastewater Treatment Plants abroad.
- To return to Australia with technical information and share this information with students in Australia.
- To utilise the required resources in the green skills centre at Melbourne Polytechnic.
- To make resources available to all TAFE colleges via moderator group meetings.
- To make the skills and data available in Dropbox for all colleges to use throughout Victoria.

4. THE AUSTRALIAN CONTEXT

Australia's plumbing industry has an important role to play in safe guarding the health of the general public and maintaining high sanitation and water qualities.

The industry has a high level of expertise and a comprehensive training regime across all plumbing streams.

To enable a comprehensive and detailed control of the industry and its training, the plumbing industry is currently categorised into eight streams:

- Water supply
- Sanitary
- Roofing
- Irrigation
- Mechanical services
- Gas fitting
- Fire protection
- Drainage.

In addition there are fifteen separate restricted classes:

- Hydrants and hose reels
- Commercial and industrial fire sprinklers
- Residential and domestic fire sprinklers
- Fire system pump sets
- Gas disconnect and reconnect
- Gas restricted to type A Appliances
- Gas mobile homes
- Solid fuel heaters
- Duct fixing
- Single head split systems
- Class 10 a roofing
- Domestic hot water services
- Refrigeration air conditioning basic
- Refrigeration air conditioning intermediate
- Refrigeration air conditioning split systems.

There are also five specialised classes:

- Gas servicing Type A appliances
- Gas conversion Type A appliances
- Type B gas fitting advanced
- Refrigeration air conditioning
- Backflow prevention.

An article from The Age newspaper in May 2007 further alerted the Fellow to water consumption statistics in Australia:

Most people view personal water consumption in terms of running taps or toilet flushing. But these are trifling compared to the surface, ground, soil water and rainfall it takes to produce everything we consume. The following examples further re-inforce this statement:

- It takes an estimated 8,000 litres of water to produce a single pair of leather shoes [1]
- Consumption of a kilogram of steak is responsible for using up to 16,000 litres of water [2]
- Production of a bag of potato chips requires 185 litres of water, and

1 Mekonnen, M.M. and Hoekstra, A.Y. (2012) A global assessment of the water footprint of farm animal products

2 Mekonnen, M.M. and Hoekstra, A.Y. (2010) The green, blue and grey water footprint of farm animals and animal products, Value of Water Research Report Series No.48, UNESCO-IHE.

4. THE AUSTRALIAN CONTEXT

- Every apple consumed requires at least 70 litres of water.[3]

  A global study of the "water footprints of nations", by international water experts Arjen Hoekstra and A. K. Chapagain, found that Australian households held the world's worst record for water consumption, despite our industry and farmers being relatively efficient.[4]

  Published in January in the journal Water Resources Management, the study found that Australian households had a "water footprint" equivalent to 341,000 litres per person per year.[5]

  Out of 21 countries, only Canada came close to Australia, with the average person there consuming the equivalent of 279,000 litres per year. The global average was found to be 57,000 litres per year.[6]

  Add water used for farm and industrial production, and Australia's annual water footprint the water used domestically and internationally to produce everything we consume balloons to about 1.4 million litres per person, the 14th worst out of 21 nations.

  This study confirmed that a nation's water footprint depends on how much and what is consumed, weather conditions and farm practices.

  Rich countries such as Australia the USA and Canada tend to have big footprints because of the large amount of meat and industrial goods consumed, while countries like China are relatively efficient.

  The study also highlighted that it took an average of three years before a cow is slaughtered to produce about 200 kilograms of boneless beef. In that time, the cow consumes roughly 1,300 kilograms of grains, 7,200 kilograms of roughage (pasture and hay), 24,000 litres of water for drinking and 7,000 litres for servicing.

  All up, it takes almost 16,000 litres of water to produce a single kilogram of beef. [7]

  The web site - www.waterfootprint.org - has some useful information on water usage.

Approximately 14 years ago, Australia was in the grip of a major drought and this had a dramatic effect on the population. There was major concern that Melbourne was running out of a Potable water supply and this led to a major transformation of water re-usage, including wastewater reuse, grey water reuse, and water tank installations.

Despite the above water usage statistics, and the data presented at the conference (and confirmed by the fellow's own research), in Australia we are already on the right track, incorporating 5 star ratings in our properties, but more must be done. This fellowship was undertaken to investigate the best approaches used in other part of the world.

Energy saving techniques in plumbing, and specialised wastewater treatment plants became a high priority, not only in Australia but worldwide particularly in Western/Industrialised countries, as explained above.

The Australian plumbing apprentices of today and tomorrow must be educated in the new techniques in wastewater treatment and future plumbing practices in order to ensure sustainable plumbing practices.

3 Mekonnen, M.M. and Hoekstra, A.Y. (2010) The green, blue and grey water footprint of farm animals and animal products, Value of Water Research Report Series No.48, UNESCO-IHE.

4 Mekonnen, M.M. and Hoekstra, A.Y. (2011) National water footprint accounts: the green, blue and grey water footprint of production and consumption, Value of Water Research Report Series No.50, UNESCO-IHE

5 A. Y. Hoekstra · A. K. Chapagain Water Resource Manage (2006)

6 A. Y. Hoekstra · A. K. Chapagain Water Resource Manage (2006)

7 http://www.waterfootprint.org/Reports/Hoekstra_and_Chapagain_2006.pdf

SWOT Analysis

The SWOT analysis focuses on the following areas: technical wastewater treatment plants, energy efficient technologies, aeration and energy optimisation.

Strengths

- Highly efficient.
- Cost effective.
- Global recognition of the technology.
- Allows existing air pump equipment to be used rather than upgrade of pumps.

Weaknesses

- Requires a continuous maintenance program schedule.
- Lack of understanding of the technologies by utility companies.
- The public's lack of knowledge of efficient technologies in treatment plant systems.
- System downtime whilst new technologies are being installed in treatment plants.

Opportunities

- As energy becomes more expensive, efficient technologies are required to lead us into the future.
- This technology will create higher skilled jobs and reskilling opportunities for existing workers in the manufacturing, maintenance and installation of wastewater equipment.
- Will potentially save energy and water consumption.

Threats

- Aeration is a small part of the solution. Treatment plants as a whole require upgrading to efficient technologies to minimise energy usage.
- Community reluctance to understand wastewater treatment and why they pay the utility fees for disposal of wastewater.
- Government and consumer apathy to the energy and water crisis.

5. IDENTIFYING THE SKILLS AND KNOWLEDGE ENHANCEMENTS REQUIRED

There are examples of areas in Australian industries where there are weaknesses in innovation, skills, knowledge, experience, policies and/ or formal organisational structures to support the ongoing successful development and recognition of individuals and the particular sector.

The focus of all ISS Institute Fellowships is on applied research and investigation overseas by Australians. The main objective is to enable enhancement and improvement in skills, knowledge and practice not currently available or implemented in Australia and the subsequent dissemination and sharing of those skills and recommendations throughout the relevant Australian industry, education, government bodies and the community

The Fellowship provided the Fellow, Michael Capuzza, with an opportunity to examine the ways in which the industry is addressing these necessary enhancement areas. Specifically, it allowed him to:

5.1. Understand the principles and application of Energy Optimisation for wastewater treatment.

- Identify currently used air blower systems in wastewater treatment systems.
- Determine if current blower systems can be utilised with new technologies.

Current blower pumps can be incorporated into new diffuser systems.

5.2 Understand the past, present and future fine pore diffuser technologies.

- Identify previous aeration techniques using air spargers.
- Identify, analyse and understand the future technologies with using fine pore diffusers.
- Identify and analyse the constraints of using fine pore diffuser technologies.
- To consult with world-wide experts in wastewater treatment facilities.

The existing sparger systems were viewed during presentations at the conference and during a site visit.

5.3 Select appropriate fine pore diffuser systems for specific wastewater treatment installations.

- Compare the different fine pore diffuser systems available.
- Develop a practical knowledge of the systems available.

Systems were compared and a realisation that some systems were suited to specific installations.

5.4 Determine effective technologies and processes related to specific industry sectors.

- Determine monitoring and evaluation of the new aeration systems installed.
- Match fine pore aeration systems to existing treatment plants.
- Ensure programmed maintenance of new systems to ensure the highest efficiency possible.

The fine pore systems are highly efficient but require a continually monitored maintenance programme.

6. THE INTERNATIONAL EXPERIENCE

Destination: ecoSTP2014 - The Second IWA specialised International Conference, Verona Italy

"Eco technologies for wastewater treatment -Technical, Environmental & Economic Challenges", Department of Bio-technology, University of Verona, Italy

Conference Location:

Palazzo Della Gran Guardia, Verona, Italy

Young water professional's ice-breaker workshop

The conference planners organised an ice-breaker workshop where like-minded industry presenters, teachers and students had the opportunity to introduce themselves and to deliver a five minute presentation prior to the conference commencement. This allowed participants to understand their focus, research and presentation topics and help everyone to feel comfortable with the large conference about to take place.

Polo Zanotto University of Verona

Biotechnology department pre confence workshop

ECOstp2014 Registration session:

The Registration session was held at the Palazzo Della Gran Guardia, Verona, Italy. The registration session allowed all applicants to obtain the important Conference schedule, the vital book of abstracts, the five-day scheduled program, the pass to all Conference sessions, and allowed the media to commence integration with stakeholders, presenters and conference attendees.

Palazzo Della Gran Guardia

Conference vital resources

6. THE INTERNATIONAL EXPERIENCE

Welcome session:

"Water science meets water policy and water practice".

The water-themed opening was presented by the Chair of Water 2020 - Juan Lema, Spain, and representatives from local authorities and stakeholders.

The discussions at this session, chaired by Francesco Fatone (University of Verona), Italy and Roberto Canziano (Politecnico Milano), focused on:

- Francesco Fatone - Holistic sustainability and life cycle assessment
- Glen Diagger, former IWA president - made it clear there is a high necessity for researchers in this area, and that they must push the boundaries of wastewater treatment technologies for the future
- Franco Cecchi, University of Verona - concentrated on co-digestives process control (to do the best for the environment). The view presented identified that major companies were centred on economic structure instead of the environment
  - » All three speakers agreed that Italy is a much diversified complicated land with many high peaks, volcanic areas, problems with potable water supply. The environment and economy are currently in a bad situation
- Jun M Lema's, University of Santiago de Compostela, Spain - focused on ideas concerning water treatment. He wants to see sewage treatment plants changed from treatment plants to energy producing plants, utilng wastewater nutrients and bio-plastics produced from wastewater, as this could save up to five per cent of current energy costs

Plenary session: Water energy, carbon nexus in water reclamation, reuse, and wastewater treatment:

Daniel Nolasco (Argentina), IWA Water Energy Climate leader, and Diego Rosso (USA), Civil and Environmental Engineer, Urban Water, Research Centre, Director, University of California, Irvine.

Discussions were focused on challenges in water, energy, climate, change in mental models, technologies - future and current, and conclusions.

The presentation concentrated on the global water crisis caused by population, living standards, climate change, and urbanisation. The speaker highlighted that by the year 2025, half of the human population will experience water stress. New technologies, approaches, mind set and realisation will be required to return to sustainability.

Global water and sanitation are our biggest challenges:

- 3 billion people without water at home or in the vicinity
- 4 billion people without continuous access to water
- 4.5 billion people with no sewerage
- 5.5 billion people with no treatment.

The following commentary was then made regarding the undeniable nexus between water and energy.

Water is energy! Water passes through a spinning turbine, creating energy. This is one reason why humans build huge dams. Energy is then required to treat non-potable water, and then water is required to replace the energy used. In the USA Thermoelectric-power withdrawals accounted for 49 percent of total water use, 41 percent of total freshwater withdrawals for all categories, and 53 percent of fresh

surface-water withdrawals.[1] So the power created already has a tight link to water usage (e.g. One Kilowatt hour of coal power equals one 40 watt light bulb for one day, and requires 100 litres of water. If we then use that Kilowatt hour for water pumping or treatment, the link is complete.

An example is the water flow down a river. It gets used to spin a turbine generating electricity, then a partial amount of electricity can be used to re pump the water back up stream and be reused in the turbine creating a further percentage of electricity and enabling reuse of the water.

Another example as is already in place in the Venice Fusina waste water treatment plant. Once the water is treated prior to release into the waterways it passes through an Electricity generation plant used in the cooling towers, then retreated and sent back into the water ways.

Source: http://www.epa.gov/watersense/water_efficiency/how_we_use_water.html

The problems faced by humanity are population growth, consumption, urbanisation and climate change. There must be a shift in the way natural resources are used for a sustainable future. Resource management must be incorporated into our homes with improved attitudes to:

- Water conservation
- Storm water management
- Low impact development
- Rain water harvesting
- Distributed water treatment
- Water reclamation and recycling
- Heat recovery
- Carbon management for energy production
- Nutrient recovery
- Source separation.

A graph was then presented on a large screen showing water consumption of many different countries. The amount of water Australians actually use is astounding. The data highlighted that Australians are one of the highest users of water in the world. The Fellow was not convinced so upon his return to Australia he undertook his own research and unfortunately confirmed that Australia is one of the highest water users in the world. [2]

1 Estimated Use of Water in the United States in 2005 (Modified January 2013), Joan Kenny et al, US Geological Survey

2 Source Vertical Research Partners, Global Water Intelligence, OECD Global Water Tariff Survey 2010

6. THE INTERNATIONAL EXPERIENCE

This plenary session of the conference explored examples of integrated systems such as rainwater harvesting, wastewater reclamation and in-building recycling. Such systems aim to achieve lower net extraction from the environment, significantly reduce environmental discharge of stormwater and wastewater and enhance the urban environment and green infrastructure. Such natural systems are key technologies for a sustainable future.

There is a need to shift the way rainwater is distributed from properties (such as households). The rainwater from all properties must be collected and once the rainwater tanks reach capacity, the overflow water should be distributed into garden beds, specially made driveways or paths soaking the overflow water into the land surrounding properties. Incorporating green infrastructure and natural systems is important, even critical for success with this approach.

Use of technology to reclaim water was also discussed, concentrating on high quality water filtration being achievable with the three technologies of microfiltration, reverse osmosis, and/or ultraviolet filtration.

The Water Environment Authority [3] believes that wastewater treatment plants are not waste disposal facilities but rather water resource recovery facilities that produce clean water, recover nutrients (such as Phosphorus and Nitrogen) and have the potential to reduce the nation's dependence upon fossil fuel through the production and use of renewable energy.

The vision of what is needed in the future to achieve systems of sustainability while minimising energy, water and carbon footprints involves new technologies, and new ways of thinking, but must not ignore simple down-to-earth technologies and sensible practices.

An aerial view of the industrial and domestic treatment plants on the fringe of the Venetian lagoon

3 Water Environment Authority Federation, October 14, 2011

Conference site visits:

The conference program schedule included two field trips to wastewater treatment plants in the Venetian lagoon.

The first trip was to the industrial zone of Venice and the Porto Marghera treatment plant. This is a petro chemical treatment plant and its major objective is to remove micro pollutants up to a very strict standard for discharge into the lagoon.

(Note: The name “Marghera”, comes from the fact that the area where the present city was built, was once a marine swamp. In the Venetian dialect, “Mar gh’era” means “There was the sea”).

A Biological aeration tank

The second field trip was to the the VENICE-FUSINA Waste Water Treatment plant. This WWTP is located at the border of the Lagoon of Venice and is integrated with the previously described Porto Marghera MBR (Membrane Bio Reactor). This treatment plant includes a conventional WWTP and the tertiary large constructed wetland. Both field trips were very constructive in obtaining information and understanding the importance of wastewater treatment, especially with discharge into the Venetian lagoon.

6. THE INTERNATIONAL EXPERIENCE

Aerial view of both plants and how they are linked with the overhead bridge.

The link between the two plants

Technology Sessions:

Simple technologies within our reach are:

- Anaerobic treatment of raw sewage.
- Anaerobic treatment of raw sewage converts carbon into biogas while producing acceptable effluent.

Anaerobic digestion is a collection of processes by which microorganisms break down biodegradable material in the absence of oxygen.[4] The process is used for industrial or domestic purposes to manage waste and/or to produce fuels. Much of the fermentation used industrially to produce food and drink products, as well as home fermentation, uses anaerobic digestion.

The digestion process begins with bacterial hydrolysis of the input materials. Insoluble organic polymers, such as carbohydrates, are broken down to soluble derivatives that become available for other bacteria. Acidogenic bacteria then convert the sugars and amino acids into carbon dioxide, hydrogen, ammonia, and organic acids. These bacteria convert these resulting organic acids into acetic acid, along with additional ammonia, hydrogen, and carbon dioxide. Finally, methanogens convert these products to methane and carbon dioxide. The methanogenic archaea populations play an indispensable role in anaerobic wastewater treatments.

With the re-use of waste as a resource and new technological approaches that have lowered capital costs, anaerobic digestion has in recent years received increased attention among governments in a number of countries, among these the United Kingdom, Germany and Denmark in 2011.[5]

4 http://en.wikipedia.org/wiki/Anaerobic_digestion#cite_note-nnfcc-1

5 Source Wikipedia, March 2015

Technologies - future and current for sewage treatment facilities

Technologies for current systems is in the below air sparger picture which is a fairly primitive but effective way of creating large air bubbles in sewerage treatment plants systems. Technologies for future systems is instead of air spargers the move is towards fine pore diffusers which blow smaller bubbles with more surface are for bacteria to attach to.

Do we evaluate our sewage treatment systems before expanding them ?

A sewerage treatment plant requires continual and correct maintenance. If the system is not maintained and cleaned it will not run at its optimal capacity. A simple example can be used to demonstrate the importance of timely maintenance. If a dish washing machine is not running properly you would first maintain it by cleaning the filters, and then if necessary call a technician to service the dishwasher, thus ensuring it continued to work at its optimum capacity. It is highly unlikelythat you would purchase another dishwasher and run the two alongside each other, one at less than optimum capacity and the other half full of dishes.

The water industry operates sophisticated and costly water, wastewater networks and sewage treatment plants. As a result it is usually run as a public service by a public utility which is owned by local or national government. In some countries, notably France, the UK and the Czechoslavakian Republic, the water industry is regulated but services are largely operated by private companies with exclusive rights for a limited period and a well-defined geographical space.

Smart utilities use process audit technologies and mathematical modelling for design purposes.

Digesters

A digester is a huge vessel (tank) where chemical or biological reactions are carried out. These are widely used in different types of process industries.

The importance of keeping digester tanks clean cannot be understated ! Sometimes this may be overlooked, but it must be recognized that there can be up to a third of the tank capacity being unusable and only two thirds available for active volume.

If the digesters were continually and correctly maintained the systems would run more efficiently and existing digesters would not have to be upgraded.

Aeration systems

Sewage aeration is necessary to provide oxygen to the effluent to be treated. After leaving the primary clarifiers, the sewage goes to aeration tanks. These tanks enable the biological treatment of the wastewater, where microorganisms and wastewater in various stages of decomposition are mixed, aerated, and maintained in suspension.

The contents of the aeration tanks, which require a delicate balance of nutrients and oxygen, are commonly referred to as the mixed liquor suspended solids (MLSS) or activated sludge. The activated sludge converts organic substances into oxide products and floc, which is settled out in the secondary clarifiers. The aeration tanks have a great deal of flexibility built into them. Raw sewage can be introduced in various locations and be aerated and mixed for varying lengths of time and intensity

Diffusers

An air diffuser or membrane diffuser is an aeration device typically in the shape of a disc, tube or plate, which is used to transfer air and with that oxygen into sewerage or industrial wastewater. Oxygen is

required by microorganisms/bacteria residents in the water to break down the pollutants. Diffusers typically use either rubber membranes or ceramic elements and produce either fine or coarse bubbles.

There are various diffuser varieties, among them being Parkson Hiox panels, Aero strips and Air Spargers

The leading manufacturers of the diffusers are Sanitaire, Envirex, Ott, Edi, Parkson, Messner, Aerostrip and Ovivo.

Aeration Bubbles

Older styles of aeration systems used air spargers as pictured left, some newer systems now use aeration panels or aero strips:

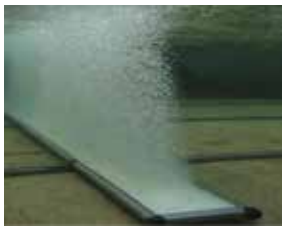
Air sparger

Aeration panels

Aeration strips

Aeration bubbles in older style systems create coarse bubbles as below, while Newer style systems use fine bubbles as in fine pore diffuser picture.

Coarse bubble diffuser



A fine pore diffuser

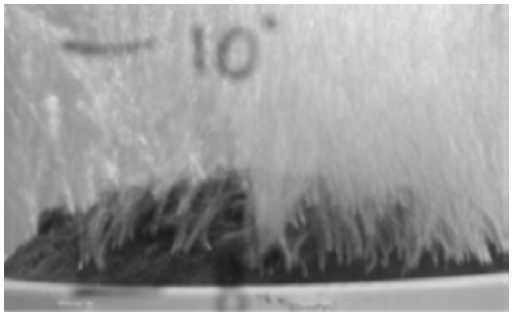
The newer style aeration system of Fine pore diffuser is energy efficient.

Fine pore diffusion is a subsurface form of aeration in which air is introduced in the form of very small bubbles. There has been increased interest in Fine pore diffusion of air as a competitive system due to its high oxygen transfer efficiency (OTE). Smaller bubbles result in more bubble surface area per unit volume and greater OTE.

Diffuser fouling

Commonly known as plugging diffuser orifices, bio film coating, scaling precipitation of inorganic salts. Fine pour diffusers become clogged and foul.

When the diffusers fouls efficiency of the system decreases, as efficiency decreases biological treatment of the wastewater takes longer this causes more energy usage to biologically treat the wastewater.



The diffuser picture illustrates a half fouled diffuser and a half clean diffuser

Fine pore diffuser maintenance

Diffusers require air to operate, The air is provided by large blower pumps. The pump in the picture below is rated at 4000 horsepower.

A 4000 horsepower blower pump

Large blower pumps consume large amounts of electricity if the pores on the diffusers are fouled then the treatment process takes longer causing more energy usage.

The fine pore diffusers require a programmed maintenance cleaning schedule to operate efficiently. In turn this will reduce energy consumption. An example of energy saving, operational costs and treatment of more amounts of effluent is to change from Air spargers to Fine pore diffusers. The fine pore diffusers will provide smaller more regular bubbles with more surface area compared to the air spargers with large air bubbles. In effect the change from Spargers to fine pore diffusers has caused the air blower to not work as hard this means the system can be expanded upon using the existing air blower pumps. The concluding summary on Aeration is monitoring of Aeration efficiency provides the quantitative tools for energy conservation and cost reduction.

New technologies emerging

One of the emerging technologies for energy optimisation and aeration is Ethylene Propylene Diene Monomer rubber (EPDM rubber), a type of synthetic rubber that is an elastomer. Diffuser Tubes or Sleeves are commonly used for aeration in wastewater treatment facilities and other applications. Diffusers are rubber tubes with thousands of very small, almost invisible perforations. When installed over PVC pipes on an air delivery system, they diffuse millions of tiny bubbles into the medium, which in turn promotes the treatment. The method of installation is a sleeve over the pipe clamped on both ends. The EPDM sleeve has hundreds of tiny perforations sequenced along its lengths. These perforations are flat bladed and horizontally placed along the lengths of sleeving, causing the air bubbles to emerge from the tube as flat oval shaped bubbles.

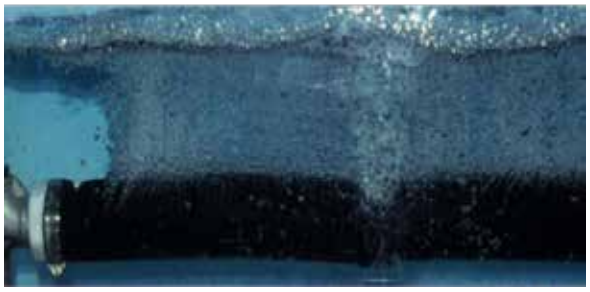
6. THE INTERNATIONAL EXPERIENCE

However, various water authorities tried this method and had issues with the pipe, which was underneath the sleeve.

At the connection point to the tee the piping was either snapping, or at best was under stress. Further investigation revealed that the pipe when submerged under fluid and full of air was being forced to float out of the tanks. This was further compounded by the fact that air rushing through the perforations was causing vibrations along the pipes length.

A trial was therefore put in place, to have the pipes with open ends so the fluids could fill the pipe branches. This eliminated the pipe trying to float and the vibration of the tee branches becoming stressed or snapping. Effectively the air was between the pipe and the sheath not inside the pipe with a connection point at the commencement of the pipe.

EPDM rubber diffuser tubes and sleeves.



Correct emitting bubbles

The over-stressing or snapping issue occurring on the connecting tubing can be resolved by not using a fixed tee to connect to the main line in the conventional fashion. Instead, a flexible style connector from the main pipe can be run to the branch with an internal plug that is glued or plastic welded approximately 150 mm into the branch. This will cause the internal tube to be empty except for the 150 mm of pipe. An end cap can then be glued over this 150mm end. The flexible connector can then be connected to the tubing between the cap and 150mm plug, and holes drilled in the 150mm section to allow air to enter the rubber sheathing. Hose clamps placed over each end of the sheathing securing it to the tube will allow air to run along the outside of the tube rather than the inside.

7. KNOWLEDGE TRANSFER: APPLYING THE OUTCOMES

With the active cooperation of Melbourne Polytechnic (formerly NMIT), the fellow will write a selection of teaching resources to be delivered in a purpose built green skills training facility and at the Heidelberg Campus of Melbourne Polytechnic.

The aeration technology sleeving special internal plugging, piping issues and new technologies which are linked with the units CPCPDR2002A Install domestic Treatment plants,CPCPDR2003A Maintain Effluent Disinfection Systems & CPCPDR3003A Onsite Disposal Systems have already been implemented with students in the Certificate III program. knowledge presentations and images will be implemented, moderated in the future with all plumbing staff.

The pictorial and written resources will be used with Certificate II and III students to ensure they understand the importance of wastewater treatment. The resources will also be shared with and disseminated at the Certificate II Plumbing Training moderators group of Victoria and will be available on Dropbox for the invited moderator's group members to use with all plumbing students.

Capuzza is also available to work with or present to other VET institutions involved in plumbing education to develop and implement these new techniques into curriculum and teaching resource materials.

The Fellow will liaise with relevant Industry Skills Councils to advise on development standards for nationally accredited courses.

The Energy Optimization Technologies EPDM rubber and method of piping connections has already been implemented with students and teachers in the TAFE sector. The resource will be discussed with the Certificate 2 moderators group at our next meeting. The resource will also be place in the CERT 2 PTMG Dropbox for teachers to share with their collegues and students.

8. RECOMMENDATIONS

Government – Federal, State, Local

- To minimise energy consumption, adopt fine pore diffuser technology into future built treatment plants.
- Provide grants and retro fit into existing treatment plants.
- Audit treatment plant operators to ensure a vigorous maintenance schedule is in place.

Industry

Through the Victorian Building Authority examiners discuss and recommend standards relating to energy optimisation and fine pore diffuser technologies.

Education

The product manufacturers should discuss with educators the importance of EPDM technologies. The Educators moderate the products suitability. The products can then be implemented into the module numbers.

- DR2022A Install domestic treatment plants
- DR2023A Maintain effluent Disinfection systems.
- DR3023A Install On site Disposal systems

Community

To ensure minimising of wastewater disposal by using grey water in domestic gardens through installing water saving tap ware and toilet suites.

A system of Educating plumbing students in our TAFE sector which will be spread amongst their future clients (The Community)

International Specialised Skills Institute

Skill and knowledge enhancements are required throughout the Australian Plumbing Industry regarding different certification systems operating in international markets. These skill and knowledge enhancements should be addressed by ISS Institute through the provision of further Fellowship opportunities in partnership with Australian Plumbing Industry associations.

Further skills enhancement

Australians use large volumes of water creating large volumes of wastewater. Implementing fine pore diffusers, energy optimisation technologies and other new approaches is critical to ensuring a sustainable future for generations to come and this will minimize treatment plant size, area of land used, quality of treated water discharged into our surrounding oceans or water ways.

9. REFERENCES

1. www.waterfootprint.org/Reports/Hoekstra_and_Chapagain_2006.pdf
2. http://en.wikipedia.org/wiki/EPDM_rubber
3. www.waterfootprint.org
4. http://www.icra.cat/files/noticia/Program%20ecoSTP2014.pdf
5. http://www.xylemwatersolutions.com/scs/italy/it-it/news-and-events/Agenda-Convegni-e-Corsi-formazione/Agenda%20convegni/Documents/IWA%20ecoSTP2014.pdf
6. http://www.epa.gov/watersense/water_efficiency/how_we_use_water.html
7. http://en.wikipedia.org/wiki/Sewage_sludge_treatment
8. http://en.wikipedia.org/wiki/Air_sparging
9. http://www.parkson.com/products/hiox/ultrafine-bubble-aeration-system
10. http://www.hydrofluxhuber.com.au/aerostrip-fine-bubble-diffusers/
11. http://en.wikipedia.org/wiki/Public_utility