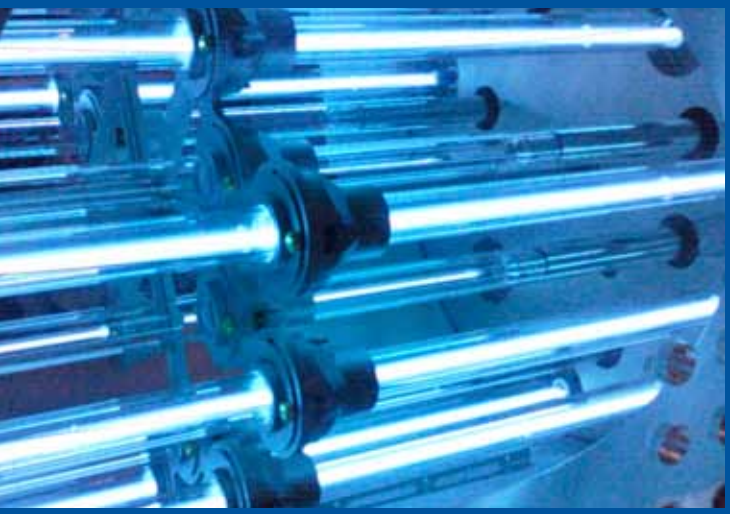
International Specialised Skills Institute

PRATT FOUNDATION

ADVANCED WATER TREATMENT AND RECYCLING PROCESSES



Rick Milnes

The Pratt Foundation/ISS Institute Overseas Fellowship

Fellowship supported by The Pratt Foundation

ISS Institute Inc
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International Specialised Skills Institute

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Executive Summary

This Fellowship enabled Rick Milnes to complete a course of study titled *Advanced Water Treatment Technology* at the UNESCO-IHE Institute for Water Education in Delft, The Netherlands. This is a 'best in class' university level, international academic institute for water education created in 2003 that carries out research, education and capacity building activities in the fields of water and the environment.

The knowledge and skills gained from this course in the areas of water recycling, desalination, advanced disinfection and water filtration are not taught in Australia.

Due to a rapidly rising population, climate change, and an increase in water use in agriculture, industry and private homes, this nation's water supplies are now and, according to all scientific data, will always be tenuous. Drinking water is currently being used in manufacturing, for processes such as cooling machinery, washing bottles and equipment, hosing down polluted workshops and many other wasteful practices.

Drinking water is also being used in agriculture to irrigate pine plantations and other non-food crops, to hose down dairies, to wash machinery and in many other areas that could effectively use recycled water.

Milnes is a qualified TAFE teacher and will write educational resources and teach advanced water treatment technologies to apprentice plumbers, existing plumbers and industry engineers. The resources will be available at TAFE institutions and the Fellow will be talking and making presentations at industry seminars, conferences and stakeholder group meetings.

This report makes a number of recommendations, including:

- Compliance officers, with local, state and federal departments overseeing any compliance issues related to water use in industrial and agricultural building and building processes, to attend appropriate advanced training.
- Industry is to use the training to improve the skills and knowledge of their technicians and maintenance staff.
- Manufacturers are to seek to design and manufacture a state-of-the-art water treatment plant and water treatment equipment in Australia, the driest inhabited country on Earth.
- The finished teaching resources are to be shared among TAFE institutions through groups such as the Plumbing Training and Moderation Group. This would ensure that any training courses developed regarding advanced water treatment techniques will remain current and relevant throughout the state of Victoria and will be accessible to all the stakeholders.
- ISS Institute and ISS Institute Fellows are to maintain the vital role they play in facilitating knowledge sharing partnerships with overseas education and training centres, such as UNESCO, thereby keeping currency with the latest science and technology in the world.

Table of Contents

Abbreviations/Acronyms

NMIT	Northern Melbourne Institute of TAFE
SWRO	Seawater Reverse Osmosis
TAFE	Technical and Further Education
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNESCO-IHE	United Nations Educational, Scientific and Cultural Organisation – International Hydraulic and Environment Engineering
UV	Ultraviolet

Definitions

Break-point chlorination

The process of shocking the water with significant quantities of chlorine to oxidize all contaminants and organic wastes and leave all remaining chlorine as free chlorine.[1]

Coagulation

The clumping together of very fine particles to form larger particles; caused by the use of chemicals (coagulants). The chemicals neutralize the electrical charges of the fine particles and cause destabilization of the particles.[2]

Colloid

A stable system of two phases, one of which is dispersed in the other in the form of very small droplets or particles. An intimate mixture of two substances one of which, called the dispersed phase (or colloid), is uniformly distributed in a finely divided state throughout the second substance.[3]

Design

Design is problem setting and problem solving. Design is a fundamental economic and business tool. It is embedded in every aspect of commerce and industry and adds high value to any service or product—in business, government, education and training, and the community in general.[4]

Flocculation

Flocculation is, in the field of chemistry, a process where colloids come out of suspension in the form of floc or flakes. The action differs from precipitation in that, prior to flocculation, colloids are merely suspended in a liquid and not actually dissolved in a solution.[5]

Ion exchange

Ion (anion or cation) exchange systems soften hard water by removing the minerals (calcium and magnesium) that cause hardness. Ion exchange units also remove iron, manganese and many heavy metals. The hard water is pumped through a tank containing an exchange resin.[6]

Precipitation (sludge blanket) softening

Precipitation softening processes are used to reduce raw water hardness, alkalinity, silica, and other constituents. This helps prepare water for direct use as cooling tower make-up or as a first-stage treatment followed by ion exchange for boiler make-up or process use. The water is treated with lime or a combination of lime and soda ash (carbonate ion). These chemicals react with the hardness and natural alkalinity in the water to form insoluble compounds. The compounds precipitate and are removed from the water by sedimentation and, usually, filtration.[7]

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[1] www.spadepot.com/spacyclopedia/tubterms.htm

[2] www.greenfacts.org/en/water-disinfectants/glossary-water-disinfectants.htm

[3] en.wiktionary.org/wiki/colloid

[4] 'Sustainable Policies for a Dynamic Future', Carolynne Bourne AM, ISS Institute 2007.

[5] en.wikipedia.org/wiki/Flocculation

[6] www.uldrinkwell.com/drinkwell/glossary.html

[7] http://www.gewater.com/handbook/ext_treatment/ch_7_precipitation.jsp

Definitions

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.[8]

Skill deficiency

A skill deficiency is where a demand for labour has not been recognised and training is unavailable in Australian education institutions. This arises where skills are acquired on-the-job, gleaned from published material or from working and/or studying overseas.[9]

There may be individuals or individual firms that have these capabilities. However, individuals in the main do not share their capabilities, but rather keep the intellectual property to themselves. Over time these individuals retire and pass away. Firms likewise come and go.

Sustainability

The ISS Institute follows the United Nations for Non-Governmental Organisations' definition on sustainability: *"Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*.[10]

[8] wordnetweb.princeton.edu/perl/webwn

[9] 'Directory of Opportunities. Specialised Courses with Italy. Part 1: Veneto Region', ISS Institute, 1991.

[10] http://www.unngosustainability.org/CSD_Definitions%20SD.htm

Acknowledgements

Rick Milnes would like to thank the following individuals and organisations who gave generously of their time and their expertise to assist, advise and guide him throughout the Fellowship program.

Awarding Body – International Specialised Skills Institute (ISS Institute)

The International Specialised Skills Institute Inc is an independent, national organisation that for over two decades has worked with Australian governments, industry and education institutions to enable individuals to gain enhanced skills and experience in traditional trades, professions and leading-edge technologies.

At the heart of the ISS Institute are our 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:

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

Over 180 Australians have received Fellowships, across many industry sectors. In addition, recognised experts from overseas conduct training activities and events. To date, 22 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, but also multiple and higher level skills and qualifications. Deepening skills 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 across a range of industries and occupations.[11]

In this context, the ISS Institute works with Fellows, industry and government to identify specific skills 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 practice, 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 www.issinstitute.org.au.

[11] Skills Australia's 'Australian Workforce Futures: A National Workforce Development Strategy 2010', pp. 1-2 http://www.skillsaustralia.gov.au/PDFs_RTFs/WWF_strategy.pdf

Fellowship Supporter

The Pratt Foundation was established in 1978 by Richard and Jeanne Pratt with the shared vision of supporting charitable enterprises and adding value to philanthropy. The Foundation is now one of the largest private sources of philanthropy in Australia. In the words of its mission statement, it aims *"to enrich the lives of our community"* and, in the words of Jeremiah, it works to fulfil this aim in a spirit of *"kindness, justice and equity"*. Milnes would like to thank them for providing funding support for this Fellowship.

Supporters

The following organisations/individuals were involved in and supported the Fellowship submission:

- Gary Bath, Manager – Practitioner Development, Plumbing Industry Commission
- Wayne Morley, Water Industry Advisor, Government Skills Australia, Industry Skills Council
- Ian Roberts, Previously – Associate Director, Northern Melbourne Institute of TAFE.

Employer Support

Milnes wishes to recognise that his employer, Northern Melbourne Institute of TAFE, has allowed the time to prepare the Fellowship submission, attend the course and has supplied any funding shortfall.

Organisations Impacted by the Fellowship

The following organisations and industry groups should benefit from the findings of this report.

Government

- Gary Bath, Practitioner Development Manager, Plumbing Industry Commission
- Tony Burke, The Hon. Minister for Sustainability, Environment, Water, Population and Communities, Australian Federal Government
- Greg Combet, The Hon. Minister for Climate change and Energy Efficiency, Australian Federal Government
- Chris Evans, The Hon. Minister for Tertiary Education, Skills, Jobs and Workplace Relations, Australian Federal Government
- Paul Warmington, Skills Victoria
- Bob Wilson, Examiner, Plumbing Industry Commission

Industry

- Anne Barker, Managing Director, City West Water
- Palenque Blair, Engineer, Water Corporation
- Betsy Cody, Specialist Engineer, Congressional Research Service
- James Chan, Manager, KBR
- Sue Gipson, Sustainable Production Manager, Sustainability Victoria
- Gonzalo Jimenez, Marketing Co-ordinator, Acciona
- Phil Krasnostein, CEO, Nubian Water Systems
- Michael Malouf, Managing Director, Barwon Water
- Tara McCormack, Technical Officer, South East Water
- Brent Papapoulos, CEO, Sustainable Plumbing Solutions
- George Theo, Chief Operating Officer, Unity Water
- Geoff Watson, Engineer, GHD
- John Zupancic, Project Manager, Beneterra International

Professional Associations

- Peter Rorke, Industry Development Officer, Australian Business Council for Sustainable Energy
- Bob Vaughan, Organiser, Plumbing Trades Employees Union
- Ross Young, Executive Director, Water Services Association of Australia

Education and Training

- Fay Byrne, Teacher, ESL
- Geoff Dixon, Manager, NMIT
- David Draper, Manager, NMIT
- Paul Gray, Co-ordinator, NMIT
- Peter Jacobson, Associate Director, NMIT
- Brian McDonald, CEO, NMIT

Community

- Annette Milnes, CEO, Point Lonsdale Probus

Course Leaders and Fellow Participants

Course Leaders and Fellow Participants in the United Nations Educational, Scientific and Cultural Organisation – International Hydraulic and Environment Engineering (UNESCO-IHE) Course Program. The overseas program, titled *Advanced Water Treatment Technology*, has been developed by United Nations Educational, Scientific and Cultural Organisation (UNESCO's) Institute for Water Education. The campus is located in Delft, The Netherlands.

The following individuals were course leaders or fellow participants in the UNESCO-IHE course program that was the major component of Milnes's Fellowship investigation. All contributed to the findings included and the development of this report.

Staff of UNESCO-IHE, Delft, Netherlands, from whom the Fellow acquired considerable new knowledge and information, include:

- JP Buiteman, MSc, Lecturer UNESCO-IHE
- Dr Maria D Kennedy, PhD, Lecturer UNESCO-IHE
- Sergio G Salinas Rodriguez, MSc, Lecturer UNESCO-IHE
- Professor Jan C Schippers, PhD, MSc, Lecturer UNESCO-IHE

Course Participants, whom the Fellow worked with during the course, and will be networking with in the future include:

- Ervin Buspapaj, Engineer, Albania
- Nirajan Dhakal, Engineer, Nepal
- Barun Lal Karna, Engineer, Nepal
- Antony Mwangi Kibe, Engineer, Kenya
- Alex Watharo Kibubi, Engineer, Kenya
- Zlatanovic Ljiljana, Engineer, Serbia
- Stephen K Musimba, Engineer, Kenya
- Juliet Wangari Mwangi, Engineer, Kenya
- Emmanuel Mwkmpashi, Engineer, Tanzania
- James Messo Rande, Engineer, Kenya
- Jane Wangari Wangui, Engineer, Kenya
- Fahimullah Ziaee, Engineer, Afghanistan

About the Fellow

Name: Rick Steven Milnes

Current Employment

- Plumbing Trade Teacher, Northern Melbourne Institute of TAFE (NMIT).

Qualifications

- Diploma of Vocational Education & Training 15560VIC, NMIT, 2007
- Diploma of Vocational Education & Training Practise 21697VIC, NMIT, 2007
- Diploma of Training & Assessment TAA50104, NMIT, 2007
- ICT VBM112 Applications for Teaching, NMIT, 2005
- Certificate 4 Workplace Training and Assessment, NMIT, 2005
- Registration and License in Plumbing & Gasfitting, Box Hill TAFE, 1982
- Leaving certificate, Vermont High School, 1977

Memberships:

- Member of the Plumbing Training Moderation Group of Victoria

Milnes has been aware of climate change (often incorrectly referred to as global warming) and the apparent detrimental effects to rainfall in Southeast Australia since the 1970s. He has always incorporated appropriate sustainable practices and techniques in all the companies he has worked for or owned.

From 1993 to 1996 Milnes was an International Sales Engineer for Atlas Air (a General Electric company) working in China and Southeast Asia with various governments and industries.

In 1996 Milnes was in Southeast Asia developing his aerated bio-sewage treatment plant. After meeting with government and private industry his system was accepted as an accredited sustainable treatment plant. In 2000 he was awarded the tender to supply and install the sewage treatment plant for the Australian mission in Dili, East Timor. This plant uses only bacteria and has solar power backup when necessary to treat the sewage of 45 houses, plus administration buildings.

Milnes is currently a Plumbing Trade Teacher at NMIT and is overseeing the sustainable plumbing development in the Institute.

Milnes's vision is to educate society to save as much of our potable water as possible through rainwater collection, stormwater collection and recycling.

Aims of the Fellowship Program

In the future the area of study that this Fellowship focussed on, water recycling processes and in particular the process of membrane filtration, will be recognised as a new and important stream of the general plumbing industry. One of the roles of the plumbing industry is to ensure the ongoing protection of the health of the community by ensuring the continuity of supply of clean drinking water.

The overseas study program will assist in addressing the identified skills deficiencies by bringing back to Australia the skills, knowledge and the most advanced technologies. The Fellowship enabled the Fellow to:

- Understand the basic principles of membrane filtration processes in industry, agriculture and domestic systems.
- Comprehend the basic principles of coagulation, flocculation and disinfection processes.
- Select an appropriate membrane process for specific applications.
- Determine effective management of sustainable water supplies and the underpinning technologies and processes related to specific industry sectors.

The Australian Context

General Outline

The membrane filtration industry involves removing man-made and naturally occurring pollutants from water to restore it to a level of purity for reuse. The most common membrane processes used for water filtration are reverse osmosis, ultra filtration and nanofiltration.

These processes have traditionally been used for producing water for industrial and pharmaceutical use but are now being applied to the treatment of drinking water.

The most widespread reverse osmosis applications are being used for seawater desalination. Over 12,500 desalination plants are in use worldwide. The largest is the Ashkelon Seawater Reverse Osmosis (SWRO) Plant in Israel with a capacity of 330,000 cubic meters per day.

The agricultural industry treats bore water with reverse osmosis membranes for use in irrigation and drinking water. The filtered water is then used in the dairy industry, viticulture, horticulture and aquaculture.

In secondary industries it is used in food production, pharmaceutical manufacture, plastic extrusion, bottle and can manufacturing and any manufacturing process requiring water to cool machinery.

In the general community the process is used to purify brackish drinking water and in the treatment of industrial and municipal wastewater.

Membrane filtration will remove organic and inorganic pollutants from the water, sized from visible to the naked eye to minute radius pollutants.

Current Water Treatment Processes in Australia

Reverse Osmosis

- Is used in food production industries such as dairy to remove all harmful microorganisms, colloids, metals and pollutants.
- Is used in agriculture to desalinate bore water.
- Is used by bottled water producers.
- Is used by homeowners to remove fluoride, colour and chlorine.
- Is used in cities and towns to remove salt from drinking water.

Granular and Powdered Activated Carbon

- Is used as a pre-treatment in all drinking water treatment plants in Australia.
- Is used by many provincial towns to treat brackish water for colour, odour and taste.

Ultraviolet Disinfection

- This process is used in many houses in rural areas that are dependent on rainwater collection.
- Is used in large-scale water treatment plants for both pre- and post-process disinfection.

[12] www.water-technology.net/projects/israel/

SWOT Analysis

Water Recycling Using Membrane Filtration Processes

Strengths

- Very efficient
- Cost effective
- Very specific
- Small equipment footprint
- Global recognition of the technology
- Community need has never been greater
- Proven water saving technology
- An exact and robust plant room presence, easy installation and maintenance
- Cleans every level of waste water.

Weaknesses

- Lack of research and development by private companies.
- Lack of government incentive and support.
- Urgency and timeliness not recognised and addressed by government or private enterprise.
- No accredited training courses available in Australia.
- Lack of community education in understanding technology as a water-saving measure.
- Negative community feeling for desalination plants.

Opportunities

- Members of the community are creating pressure on Government to legislate to make manufacturers use this technology.
- Will generate new high skilled jobs and up-skilling opportunities for existing workers in the manufacturing, installation and maintenance of equipment.
- Will potentially put up to 24% of the drinking water used in industry back into the drinking water storage.

Threats

- Water recycling using membrane filtration processes is a small part of the solution to combat severe water shortage, so could be given low priority.
- The global financial crisis has depleted government funds and private investment funds available for alternative water supply solutions.
- Government and community apathy to the water crisis.
- Community reluctance to use recycled water.

Identifying the Skills Deficiencies

1. **Understand the principles and application of coagulation, flocculation and disinfection processes.**

- Identify and determine the nature of impurities polluting the water, such as organic pollutants from run-off, or industrial, domestic and commercial waste.
- Select the appropriate processes required to produce the class of recycled water needed, e.g. to enable the polluted water to be treated so that it is useable condition, such as taking grey water to a potable standard.
- Analyse the technologies and methodologies required to ensure the appropriate level of water purity after treatment.

  Action: To gain knowledge and information regarding the principles, technologies and methodologies of coagulation, flocculation and disinfection in the water recycling process.

  Action: To write resources and develop and implement training programs on the principles of coagulation, flocculation and disinfection in the water recycling process.

2. **Comprehend the basic principles of membrane filtration processes in industry, agriculture and domestic systems.**

- Identify and differentiate the skills, knowledge and understandings of using membrane filtration in particular water recycling processes.
- Identify, analyse, and understand the constraints of using membrane filtration in various water recycling processes
- Develop a practical knowledge on the design and operation of these processes.

  Action: To gain the knowledge to develop and write resources, and to develop, implement, communicate, and teach training programs in the principles of membrane technology.

3. **Select an appropriate membrane process for specific applications.**

- Understand the filtration spectrum and be able to select the membrane required for various applications.
- Differentiate between the various target range of the pollutants such as macro particle, micro particle, macro molecular, molecular and ionic in order to select the appropriate membrane for various applications.

  Action: To develop the skills and knowledge necessary to be able to Identify and differentiate the appropriate filtration process required, such as particle filtration, microfiltration, ultrafiltration, nanofiltration or reverse osmosis.

4. **Determine effective management of sustainable water supplies and the underpinning technologies and processes related to specific industry sectors.**

- Analyse the factors related to effective water management in specific industry sectors:
  - Agriculture, including rivers and lakes.
  - Aquaculture, salinity. Understand the filtration spectrum to select the membrane required for various applications.
  - Domestic, such as low volume cisterns and reduced flow outlets.
  - Industrial, such as heavy water usage in commercial applications.
- Investigate the ‘third pipe system’: the technology, processes and maintenance.

Identifying the Skills Deficiencies

- Identify and match the methods and types of technologies to the various applications.
- Determine monitoring, evaluation and reviewing processes as part of quality assurance, including maintenance strategies.

  Action: To be able to identify appropriate pre-treatment and post-treatment schemes and cleaning protocols for these processes.

  Action: To gain the skills and knowledge to enable the Fellow to write resources and develop and teach training programs in the selection of an appropriate membrane process for particular applications.

The International Experience

This Pratt Foundation/ISS Institute Overseas Fellowship enabled the Fellow to travel to Delft near Amsterdam, and to attend a high-level course offered by UNESCO on water treatment. This is normally only accessible to qualified engineers as part of their postgraduate study. The level of instruction, the course materials, and the quality of the lecturing staff was extremely high, enabling the Fellow to expand his knowledge in a very short period of time.

Destinations

1. **UNESCO-IHE Institute for Water Education, Delft, Netherlands**

   Course Title: Advanced Water Treatment

2. **Evides Industriewater Water Treatment Plant, Rotterdam, Netherlands**

- Field trip to observe working plant
- Field trip to ultrafiltration plant supplying pure water to industry in Rotterdam

UNESCO-IHE Objective

Objective: To attend the UNESCO-IHE course.

The objective at UNESCO-IHE was to study the current, mainstream techniques and science behind the treatment of polluted, brackish and salt water to produce drinking water quality. The course is an elective module of a Master of Science Degree, but also admits fee-paying course participants from around the world.

These additional students have the option of sitting for a final examination paper at the conclusion of their course.

UNESCO-IHE Institute for Water Education building, Delft, The Netherlands

Canal in Delft

The subjects covered included:

- Water quality aspects of lakes, canals & rivers.
- Theory of coagulation and flocculation processes, coagulation kinetics, effects of coagulation.
- Break-point chlorination, advanced disinfection processes (ozone/ultraviolet [UV]).
- Laboratory course on water treatment techniques and analysis of common water quality parameters.

- Principles of microfiltration, ultrafiltration and reverse osmosis; specific membrane problems such as fouling, scaling and cleaning, and pre-treatment options; commercial membrane elements and systems, computer-aided design of brackish/seawater reverse osmosis plants.
- Ion exchange resins (selectivity, column operation, regeneration of resins and applications).
- Principles of chemical softening and sludge blanket softening; design and operation of pellet softening and membrane softening plants.
- Process schemes of water treatment plants.

Laboratory experiment to purify canal water (Milnes centre) using activated carbon

Lecture hall UNESCO-IHE with Maria Kennedy, Phd

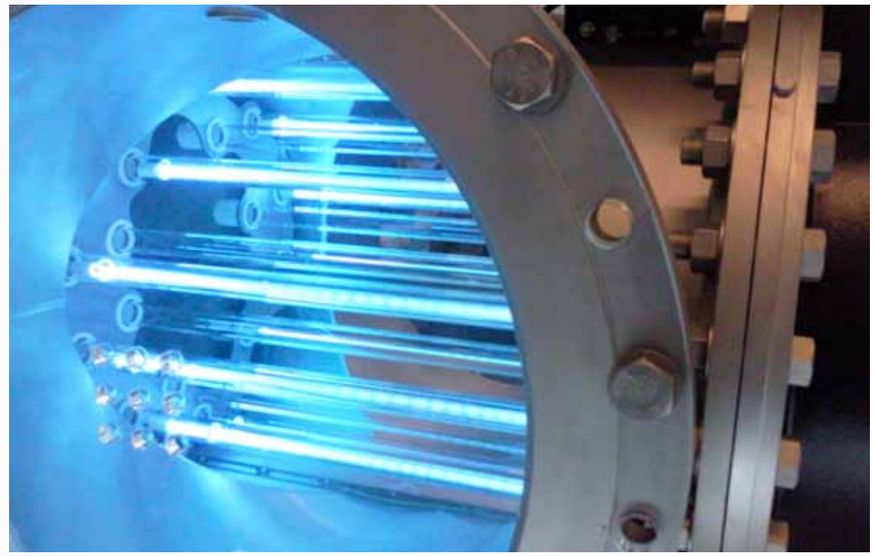
Evides Industriewater Objective

Objective: Attending the field trip to Evides Industriewater water treatment plant, Rotterdam.

The objective of the visit to the Evides Industriewater plant was to observe and analyse the processes learnt at UNESCO-IHE and that are put into practice at such a large-scale water treatment plant.

Coagulation beds 1, Evides

This is the largest brackish water treatment plant in Holland and had recently undergone an extensive renovation; the technology being used is the most modern in Europe. It is also unusual as it is a large plant (18,000 litres per hour), but due to the relatively clean source water, membrane filtration is not used. The technology used is a mixture of eight treatments including microfiltration straining, coagulation, activated carbon, chemical dosing, and UV disinfection.



Self-cleaning ultraviolet chamber, Evides

At the conclusion of the visit the processes used and the massive scale of urban water treatment plants had become evident. Without doubt, this confirmed and enhanced and the knowledge of the technology covered during the course.

Ultraviolet room, Elvides Industriewater

Outcomes

The identified skills deficiencies as outlined in the 'Identifying the Skills Deficiencies' section of this report were addressed by attending the UNESCO-IHE course and then the field trip to Evides Industriewater to see the theories put into practice.

Milnes at Ultrafiltration plant, Rotterdam

The presentation of the course was very professional at all times, and the resources provided were excellent.

The subjects were detailed and directly focussed as would be expected from a course aimed at engineers who will be designing and operating water treatment plants at the conclusion of their studies.

The subjects taught and the knowledge gained was at the peak of the technologies and techniques available anywhere in the world.

The Fellow has returned to Australia with a good working knowledge of the processes involved in treating water and sufficient hard copy and electronic information to write educational resources and teach these technologies and techniques.

The overall aims and objectives of the overseas component of the Fellowship were met.

The photograph on the left shows the breakdown of an Ultrafiltration cartridge, Rotterdam Plant

Knowledge Transfer: Applying the Outcomes

With the active cooperation of Northern Melbourne Institute of TAFE (NMIT) the Fellow will be writing a selection of teaching resources to be delivered in a purpose-built green skills training facility at the NMIT Epping campus and to be introduced into current Certificate III Plumbing resources. NMIT have agreed to purchase the necessary equipment to enable both theoretical and practical, hands-on courses to be developed and delivered.

The Subjects to be Developed and Made Available

- Introduction to membrane technology:
  – the hydrological cycle
  – global water availability, water consumption, water stress
  – desalination techniques
  – reverse osmosis technical description.
- Basic principles of microfiltration and ultrafiltration:
  – micro- and ultrafiltration processes
  – micro- and ultrafiltration membrane technical description.
- Microfiltration and ultrafiltration modules, elements and systems:
  – applications
  – types of membranes
  – methods of filtration through membranes
  – fouling characteristics
  – backwashing and chemical cleaning.
- Granular and powdered activated carbon filtration:
  – applications
  – materials
  – methods of activated carbon filtration.
- Basic principles of reverse osmosis systems.
- Advanced disinfection methods including ultraviolet radiation systems.

The aim of these courses is to offer training in the latest technologies and techniques available in water treatment. Studies indicate that up to 24% of Melbourne's drinking water is used and discarded in the agriculture and manufacturing industries. Governments are under increasing pressure to encourage the private and public sectors to install water treatment systems within their processing plants. The courses will be designed for plumbers, plant engineers, plant maintenance technicians and other related professionals to have the basic knowledge and skills to work with this technology.

In addition to the formal courses to be developed and delivered, the Fellow will offer a number of industry seminars and sessions for practising plumbers, to enable the knowledge to be shared as widely as possible. These will be offered in conjunction with the ISS Institute and the relevant plumbing industry bodies.

Recommendations

Following the Fellow's findings, the recommendations outlined below were suggested.

Government

- The compliance officers working for the various government bodies that oversee the installation and compliance issues relating to clean drinking water to attend the NMIT training.
- As a partner in the Wonthaggi Desalination Plant, the Victorian Government is to make the plant available to the students studying this field of water treatment.

Industry

- Industry is to use the training to improve the skills and knowledge of their technicians in a rapidly growing sector.
- High tech. Manufacturers are to look at designing and manufacturing systems and/or components in Australia.

Education and Training

- Resources are to be shared among Technical and Further Education (TAFE) colleges through groups such as the Plumbing Training and Moderation Group. This would enable any training courses that are developed and delivered to be relevant and current throughout the state of Victoria.

ISS Institute

- Skill and knowledge deficiencies will always be an issue in Australia due to delayed government action. Australian private enterprise companies have a traditional lack of investment in research and development, and also our geographical position away from those countries that traditionally lead the way in research and development may result in Australian industry not keeping up to date with the rest of the world.

  ISS Institute and ISS Institute Fellows have a vital role to play in facilitating knowledge sharing partnerships with overseas learning centres, such as UNESCO-IHE, and therefore keeping currency with the rest of the world in this area of science and technology.

Further Skills Deficiencies

Australia is large country with very isolated communities lacking in basic clean water and safe sanitation. There are no common guidelines in Australia for our citizens residing in these locations to have access to clean water and safe waste treatment.

There related further skills deficiencies are as follows:

- Creating a common set of guidelines to give the development of training a focus on addressing the deficiencies.
- Understanding the different technologies and management issues of remote areas, low cost water treatment, water abstraction and waste treatment.
- Understanding the different techniques and management issues of safe nutrient reuse in agriculture in remote communities.
- Acquiring the skills and knowledge to prepare a basic concept design, including the planning, financing, implementation, operation and maintenance, of remote area water supply and sanitation infrastructures based on intra-level government participation and local community management.

References

The following websites were accessed to generate definitions and explanations of the many processes and activities relating to water filtration:

- www.spadepot.com/spacyclopedia/tubterms.htm
- www.greenfacts.org/en/water-disinfectants/glossary-water-disinfectants.htm
- en.wiktionary.org/wiki/colloid
- en.wikipedia.org/wiki/Flocculation
- interpretivegroundwaterglossary.com/interpretivegrow.html
- www.uldrinkwell.com/drinkwell/glossary.html
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- wordnetweb.princeton.edu/perl/webwn
- http://www.unngosustainability.org/CSD_Definitions%20SD.htm
- www.water-technology.net/projects/israel/

Attachments

Attachment 1: Low Pressure Membrane Technology, Maria D. Kennedy, PhD

http://www.issinstitute.org.au/pdfs/milnes/Attachment_1.pdf

- Introduction or desalination and membrane technologies
- Basic Principles of Ultrafiltration and Microfiltration
- Ultrafiltration and Microfiltration elements, modules, systems
- Membrane fouling of Ultrafiltration and Microfiltration
- Membrane cleaning of Ultrafiltration and Microfiltration.

Attachment 2: Advanced Oxidation Processes, Professor Jan Schippers, PhD, MSc

http://www.issinstitute.org.au/pdfs/milnes/Attachment_2.pdf

- What are Advanced Oxidation Technologies
- Radicals, Electrons and Shells
- Carbon Sharing
- Application

Attachment 3: Desalination Processes, Sergio G. Salinas Rodríguez, MSc

http://www.issinstitute.org.au/pdfs/milnes/Attachment_3.pdf

- Reverse osmosis technology
- Particulate fouling
- Organic fouling
- Scaling
- Process design of spiral wound systems
- Process design calculations.

Attachment 4: Advanced Water Treatment

http://www.issinstitute.org.au/pdfs/milnes/Attachment_4.pdf

- Disinfection By-products, Professor Jan Schippers, PhD, MSc
- Advanced Disinfection Methods, Dr. Joop Kruithof, Dr. Bram Martijn, (PWN Water Supply Company, Holland)
- Oxidation & Advanced Oxidation Processes, Professor Jan Schippers, PhD, MSc
- Bank Filtration & Biofiltration, Saroj Sharma, PhD, MSc
- Softening & Ion Exchange Technology, J.P. Buiteman, MSc
- Microfiltration & Ultrafiltration, Professor Schippers, PhD, MSc, M.D Kennedy, PhD
- Desalination & Desalination Design Exercise, Maria Kennedy, PhD
- Laboratory Exercises (Ion Exchange Filtration, Granular Activated Carbon, Ultrafiltration, Microfiltration)
- Field Trip to Evides Industriewater (Dordrecht/Rotterdam), Maria Kennedy, PhD.

Detailed lecture notes and information available on each of these topics. Please contact Rick Milnes through the ISS Institute office for further detailed information.