WASTEWATER RE-USE AND DESALINATION. A SUMMARY OF THE DRIVERS FOR, AND TECHNOLOGY EVOLUTION TO SATISFY THE GLOBAL PUSH FOR SUSTAINABLE WATER USE.

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ABSTRACT

While population growth and industrialisation of the third world continue to boom, our most precious resource is under threat. Already limited to a meagre 0.007% of the total water on earth for human use, contamination of many fresh water supplies is further reducing the net available water for safe human consumption. Uneven distribution of this fresh water across the globe subjects many countries, including Australia to a point of near constant water shortage. To ensure supply meets growing demand, many technologies have been developed to treat saline water and wastewater of industrial and municipal origin to a potable quality. Intensification of traditional biological wastewater treatment systems with Membrane Bioreactor (MBR) processes with (or without) RO final treatment is increasing capacity and greatly improving discharge quality for industrial and domestic re-use, while desalination technologies such as Multistage Flash (MSF), Multiple Effect (MED), Vapour Compression (VC) and Reverse Osmosis (RO) have evolved to provide more economically viable treatment methods for sea water.

1.0 INTRODUCTION

In modern times, population growth, industrialization and pollution is leading to shortage of potable water in many areas of the world, while some areas have simply always been lacking water. Pollution and contamination of natural waterways has already led to the development of several treatment technologies for potable water production from existing and accessible fresh water supplies that would otherwise be considered unsafe for consumption. In addition to treatment, storage of water has enabled communities and cities to expand, safe in the knowledge that construction of dams, and access to ground waters would suffice to store water during periods of low demand and provide for all our fresh water needs. Unfortunately though, in recent times, water use and widespread drought has exceeded the storage capacity of many countries and has triggered restrictions on water use and the development of new technologies to maximise the efficiency of water use and minimise waste.

The importance of water as the essential element in sustaining life has long been known, however the true value of the resource is still yet to be appropriately realised. Water supply has been a contributor towards war where nations sharing a single supply (such as the river Nile) have come to blows over intentions to dam rivers and restrict supply to users downstream, yet despite all this water still sells as one of the cheapest resources known to man ($1-3/ton), despite the relatively high costs of storing, treating and transporting water for consumption.

There is ample water available, and there should never be shortage given the technologies we have available, but it is the economics of the situation which has led to the current shortage. We can de-salinate sea water and tap into the other 99.993% of the global water supply, but the cost of such treatment far exceeds the current market value for the product.

Or, we could pipe water for remote areas with high annual rainfall such as Australia's tropical north; however again, capital cost far outweighs the potential returns on investment. The push to re-use as much water as possible is now a key component of sustainable development and managing and securing supply for the future.

The following paper will briefly discuss the global water supply situation and the subsequent evolution of treatment technologies which may in the future assist in drought proofing many of the worlds driest countries, Australia included.

2.0 WATER SUPPLY

If all the water on earth could be put into a 1-gallon jug, then the available water resources would be hardly more than one quarter of a table spoon! 97.5% of water on earth is saline (seawater), 2% of water available is locked up in glaciers and polar caps. Most of the remainder is present as soil moisture or lies in deep underground aquifers, not accessible for human use. Water is not a renewable resource. Accessible freshwater for human use is thus less than 1% of the available freshwater, or 0.007% of the total water on the planet and this fraction is very unevenly distributed around the world.

The limited, but easily accessible freshwater resources in rivers, lakes and shallow ground water aquifers are rapidly shrinking due to:

- Over-exploitation and consequent water quality degradation
- Increasing population and standards of living
- Increasing industrial activities …

Already lack of safe drinking water has led to:

- billion cases of illness
- 2 million deaths per year

With the world population at around 6 billion people and normal population growth of approximately 80 million per year, world water use is somehow increasing at twice the rate of world population growth. Industrialization and a modern lifestyle where complex treatment systems and distribution networks are utilized to make access to high quality water easier; improving public health, increasing standards of living, increasing industrialization.

Current water supplies are shrinking and the quality degrading in many places where over 50% of the world's major rivers are dry or heavily polluted and a large proportion of dams and reservoirs holding less than 30% capacity. Twenty two countries are totally dependent on water from other nations, thus there is potential for conflicts such as that between Egypt, Ethiopia and Sudan with respect to the Aswan Dam, which fed the river Nile on which Egypt survived.

In 1990, poor water supply and sanitation was the 2nd leading cause of death and disability worldwide, the UN estimate 9,500 children die each day from lack of water or water-related diseases worldwide. By 2020, 20% more fresh water will be needed for irrigation and 40% more for cities to maintain current per capita water consumption levels.

All this suggests that non-traditional water resources will be needed to address these worldwide water shortage issues. Figure 2.1 shows the progression of water shortage

around the globe since 1950, and prediction of supply shortage issues into the future.
***"Water promises to be to the 21st century what oil was to the 20th century: the precious commodity that determines the wealth of nations."* -** *Fortune Magazine, May 15, 2000*

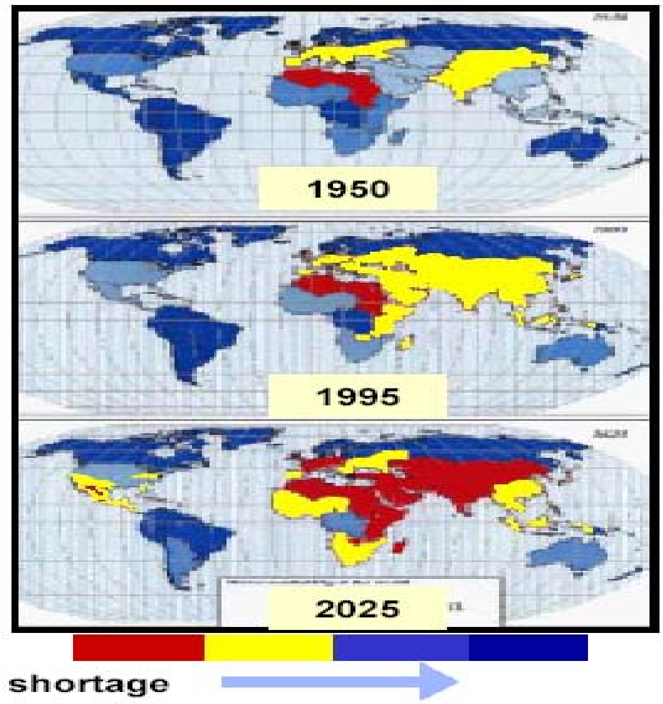

__Figure 2.1:__ ***Global water supply shortage past present and future.***

3.0 DESALINATION AND WATER RECLAMATION TECHNOLOGIES

3.1 Desalination - Why

Desalination of seawater has several advantages over investment in other options such as construction of more dams because;

- Seawater is the most abundant source on earth and unlike dams, will always be available, and not subject to receiving rainfall in river catchments feeding dams and reservoirs.
- Desalination, once an expensive process, is now becoming an economically viable technology due to considerable R&D progresses made during the past 10 to 20 years.
- Desalination is a multi-purpose solution, addressing the domestic, industrial and agricultural issues. It is going to be the cornerstone of many drought-proof water strategies.
- Global desalination market is expected to double to more than US$ 70 billion in the next 20 years.

3.2 Desalination processes

Several technologies for desalination of seawater have been developed over time and can be classified as either Distillation or membrane processes as shown in Figure 3.1. These technologies include Multistage Flash (MSF), Multiple Effect (MED), Vapour Compression (VC), Reverse Osmosis (RO), Hybrid System (MSF/MED + RO).

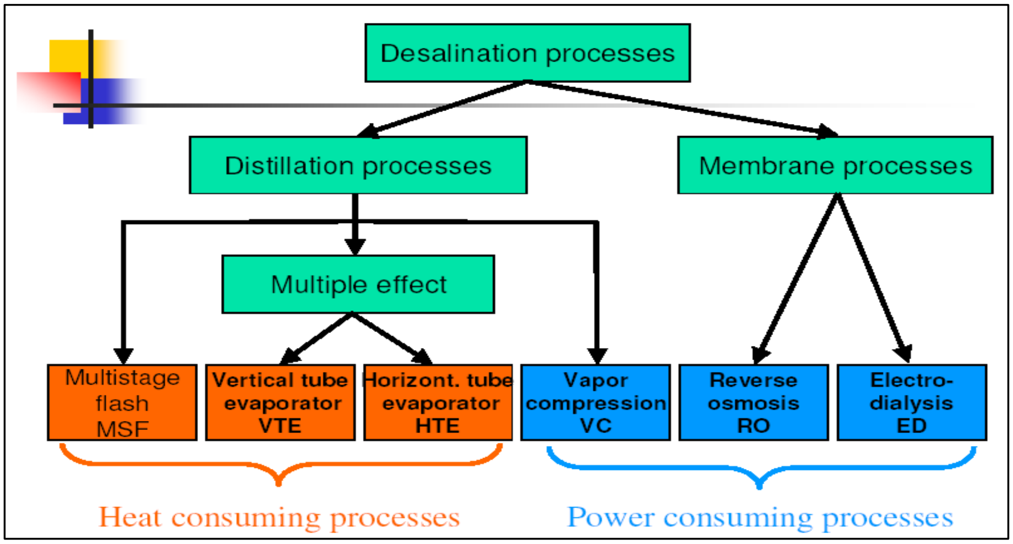

Figure 3.1: ***Desalination processes***.

Distillation is the oldest of the technologies, where by heat is supplied in order to force water vapour from the saline solution which is subsequently condensed as near pure water leaving behind dissolved salts in a brine solution.

MSF is perhaps the most established distillation process, and combines the benefit of utilizing the heat and steam generated by the process to produce electricity. MSF is an established process which needs a large footprint but has reliable operation, long plant life, and high flow capacity and can produce a high purity product from highly saline waters.

MED (Multiple Effect Distillation) is limited to smaller installations however technology advances are seeing it become more feasible for larger flow rates. There are many different types, with horizontal falling film configurations becoming the most common; it also delivers a high purity product from highly saline waters.

Seawater Reverse Osmosis is by far becoming the most common desalination technology utilized in small to mid sized installations where improvements in energy consumption and membrane integrity are now making it a more viable option for very large flows. It is limited by feed water quality where process efficiency is reduced in highly saline waters. Improvements in membrane quality and pre-treatment methods over the past ten to twenty years is further improving the viability of this technology, as well as energy recovery systems which can now retrieve up to 60% of the energy required to drive the system via driving turbines with the high pressure waste stream (60-70 bar). Further to this, membrane production improvements have dropped almost 90% in capital cost of membranes over the past 30 years.

3.3 Water Re-use and Wastewater Treatment Technologies.

The need to minimize our impact on the environment that supports us has been present for many years, however the value of water as an economic commodity and the cost associated with treating wastewater to a standard that is either safe for re-use and human contact, or safe for discharge back to the environment without negative impact, has until now seen wastewater treatment and recovery vastly rejected as an area of priority for

investment.
Several technologies have evolved to improve the quality of effluents for discharge to the environment and now, pressure on existing water resources has resulted in these more intensive processes being implemented to improve operability and control of wastewater treatment systems, and create high quality waters for reuse in industrial, agricultural and domestic applications.

Early treatment processes utilized lagoons to facilitate some degree of solids removal and nutrient reduction via, facultative lagoon processes. Evolution then saw the development of the trickling filter as a means of solids reduction with some improvement in nutrient removal also achieved. Impact of nutrients on natural environments was seen in the increased frequency of algae blooms, in particular blooms of the ‘blue-green’ variety which carried with them toxic consequences for livestock, native fauna and humans alike which has contributed to ever tightening discharge license requirements for nutrient concentrations of Nitrogen and Phosphorus, demanding more intensive treatment. Hence, the Biological Nutrient Removal process (BNR) became utilised more often.

BNR process now exist in many configurations and are capable of reducing nutrient levels to near undetectable when operated under optimum conditions. Oxidation Ditches, Sequencing Batch Reactors, Intermittently Decanted Aerated lagoons are just a few examples of BNR processes which culture bacteria communities known as Activated Sludge to essentially, eat nutrients (predominantly Nitrogen) converting them to gasses released to the atmosphere. Limited success has been achieved in biological removal of Phosphorus where chemical precipitation has become the more common method of removal. Basic process flow for the BNR can be seen in Figure 3.2.

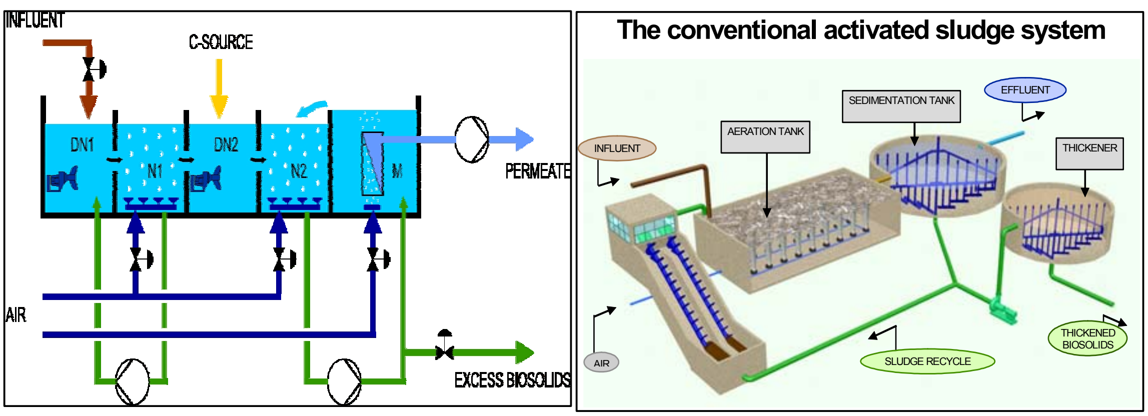

Figure 3.2: ***MBR and Conventional Activated Sludge processes.***

A need to minimise footprint of BNR processes in many built up areas has now seen the development of the Membrane Bioreactor (MBR) process, where an equivalent flow rate can be treated within a footprint up to five times less than that of a conventional BNR process as seen in Figure 3.3.

Figure 3.3: ***Footprint comparison between MBR and Conventional BNR, Activated Sludge process.***

In addition to largely reduced footprint the MBR process also offers the following advantages such as reduced capital cost for civil works, improved effluent quality and consistency (Class A), more durable process, more user friendly as you do not need a settle-able sludge, operate at higher MLSS achieving better BOD removal and reduced sludge production, and the process is more readily automated resulting in reduced labor cost.

Beyond the MBR process, NEWater is a descriptive term gathering momentum for the product produced via the process of treating wastewater to potable standard. The Singapore experience suggests that NEWater will soon be an acceptable source of potable water for many communities. The process utilizes Micro filtration (Included in the MBR process) and Reverse Osmosis to further purify wastewater by removing excess salts, bacteria, viruses and other potential toxins from the liquid waste stream rendering the water perfectly safe for human consumption. Given that indirect potable re-use has been taking place for many years this process will serve to secure public confidence and improve the perception of NEWater as a resource for domestic use.

4.0 CONCLUSION

The worlds water and wastewater industry are developing at great speed, where the value of the resource has made for one of the toughest markets for product and technology development. Technology and process advances need to be more cost effective to be implemented in bulk water production than for any other resource based industry. With current environmental degradation rates water technology is progressing and the future looks like an interesting place, for anyone involved in the industry.

5.0 ACKNOWLEDGEMENTS

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