REUSE AND RECONFIGURATION OF "END-OF LIFE" UF MEMBRANES FOR LOW COST POTABLE WATER APPLICATIONS IN DEVELOPING COUNTRIES

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Summary

There exists a global opportunity for the "rework" and regeneration of commercial ultrafiltration membranes that have reached "end-of-life" status. There are potential applications to harness second-hand membrane stock from existing installations throughout Australia.

Initial R &D is already being undertaken as a project funded by the NCEDA that includes RO and UF membranes. The sources for harvesting commercial membranes include potable water installations, pre-treatment filtration in desalination plants or within advanced treatment of wastewater installations

When put in the context of the developing world, a physical "disinfection" process such as UF/MF when combined with optional chlorination (to ensure viruses are killed) produces "safe" drinking water from the majority of non-saline surface and ground waters. The question is how we can effectively source a reliable low cost UF/MF module for these conditions that can be operated in a sustainable manner. There is an increasing use of UF membranes being applied to low cost potable water and emergency water systems.

A cheap and reliable source of UF membranes can be utilised by existing systems, such as SkyBox™ and Skyhydrant™ systems. These units would become more affordable and accessible if the "real" cost of membranes were reduced or gifted at "end-of-life" to be "reconfigured". Low cost potable water systems and other derivatives operate under as little as one metre gravity head. They can potentially use a variety of commercial available asymmetric UF membrane media

There is an increasing move by development agencies to use UF in these low cost potable water applications. The possibility of avoiding pre-treatment, power or chemicals to produce a "safe" potable water alternative is compelling. This means that operation and cleaning are simple and manual. The flexible design allows it to be operated in a range reworked UF media configurations should be possible.

For example, it can be configured to operate in a pressure or suction mode. It is economical; compact, easy to transport and quick to deploy in the field. The filtration membrane is robust, cleanable and long lasting. The system offers a truly sustainable alternative for "safe" drinking water in these poorer and needy communities

It will be important to validate the integrity and long-term performance of these second hand "reconfigured" modules. It is hoped a steady supply of reworked UF media "offerings' can be supplied to WATSAN NGO's and humanitarian agencies to fulfill the need for safe affordable potable water.

There are many possible options to address the wider global issue. However, a cost effective and robust validation protocol is essential to ensure confidence in the media offered and

protect public health. More work needs to be undertaken and greater water industry corporate social responsibility (CSR) involvement is imperative.

The opportunity for ultrafiltration in the context of developing countries

Low cost UF technology has recently been applied for disaster relief and low cost community potable water systems. International WATSAN agencies have trialled several UF alternatives. Feedwater conditions can be challenging and difficult. Membrane technology has traditionally been viewed as "inappropriate" and relatively costly.

It has not been considered a viable option for low cost sustainable potable water supplies. Recent advancements in low-pressure ultrafiltration membranes have seen extensive deployment of systems in the developing world for emergency water and medium term potable water installations.

Cost implications are promising, especially if the UF membrane media can be supplied at a nominal cost below normal commercial value (end-of-life) . We are evidencing in Africa that safe affordable potable water systems that incorporate UF are now feasible under these difficult conditions via Safe Water Kiosks (SWK's) and Small Water Enterprises (SWE's). These novel "decentralised' solutions are challenging our established views of how to solve the global MDG potable water issue.

Sourcing suitable ultrafiltration membrane media

On the opposite scale of UF membrane applications, we are witnessing a significant move to UF as the preferred pre-treatment for large-scale seawater desalination. There will soon be a huge inventory of "used" or discarded UF membranes in the next 3-5 years.

Australia has its fair share of desalination plants with UF pre-treatment. The global installations are steadily increasing. The number will be large and they will escalate. This paper suggests that there is common ground to perhaps mutually address the problem.

The recycle of UF membranes should be critically examined. The growth in seawater UF-RO installations is the "opportunity" to perhaps recycle used UF membranes discarded from SW desalination projects. Could "end-of-life" UF modules be sustainable recycled ? The output and energy performance of UF membranes is not as critical for low cost community projects, as say as large desalination pre-treatment applications.

High quality "safe" potable water at relatively low cost is a new paradigm for distributed and decentralised water supply. It is time to critically examine if a sustainable new paradigm based on technology developments, micro entrepreneurs and novel financing mechanisms can seriously address the entrenched issue of global affordable water supply.

The immediate need of developing countries is "safe" water verses WHO compliant water

We also need to critically assess the context of "safe" water that does no tangible harm, as being an achievable outcome verses a fully compliant WHO standard that is not easily obtainable. An interesting aspect is how the international desalination industry might participate in these projects.

Technical issues do not appear as the main impediment to developing mutually beneficial potential projects. A one-stop UF process certainly will not produce WHO compliant potable water, but in many cases it is a "no harm" solution and a substantial improvement to existing water supply alternatives.

The proposition is that high quality, affordable decentralised water solutions that utilise new technologies, such as UF membrane technology should be seriously considered by major health and humanitarian agencies.

There is no magic bullet to meet the MDG's. WHO, indications are that there will be a significant shortfall in the MDG potable water target numbers of at least 210 million people. Perhaps the desalination industry could be a catalyst moving forward.

Opportunities to re-use asymmetric hollow fibre ultrafiltration membranes

If membrane integrity can be validated at end of life, then "reworking " should be feasible for these "second-hand" membranes. They should be suitable for lower duty applications, such as gravity fed MDG potable water systems. Another interesting application is rainwater harvesting systems and "low" duty industrial projects.

The UF modules of most interest are typically current "potable" systems or installations (ie, not water reclamation). They will still require validation and be expected to efficiently remove all suspended solids, large organics species, and pathogens from feed streams.

Reconfiguration of modules to develop a "chop and pot" harvesting technique

These second-hand UF membranes are also being "reconfigured" by harvesting the hollow fibers using a novel "chop and pot" (CAP) concept for a unique low cost water disinfection system for rural communities and in developing countries. This is just one example of an application that is currently being trialed with these discarded (and therefore relatively expensive) membranes. At this stage, no attempt has been made to use flat sheet UF membranes, but this is not entirely excluded form further possible research work.

The concept of using membranes in a pressure or gravity driven configuration has been thoroughly investigated in literature and a number of products are currently available based on this concept. Membrane systems that are currently under test and the previous work conducted on decentralized operations, particularly low cost gravity driven systems conform that they could be used in developing countries and remote water applications. Initial investigative work has been undertaken by LeClech at UNSW Australia as well as Grey at Victoria University, in Australia using RO membrane media.

Recently, several proponents have developed novel low cost UF systems. As outlined, the possibilities are promising if "reworked " or "reconfigured " modules can be sourced form end-of-life installations.

This initial thinking is mainly municipal drinking water and seawater desalination plants. The SkyJuice Foundation has a MemRegen project that has developed prototype designs utilizing reworked UF membranes and reconfigured UF media. It has been targeted three primary user groups. These are;

a) Families of up to 6-8 persons (SkyCandle: 2-3 L/hr capacity)

b) Small communities clusters up to 50 people (SkyBox 20 L/hr capacity)

c) Communities of 500-1000 people (SkyHydrant 500 L/hr capacity)

The harvesting and reconfiguration work has been undertaken with the co-operation of Memcor. The primary source of UF modules has been either "end of life" or factory rejected polymeric hollow fibre ultrafiltration modules (UF 0.04 micron PvdF or 0.2 micron Polypropylene modules).

The CNP process is subject to IP protection, but can include the cutting and/or physical sealing of membranes fibers, either as an integral module or as a partial module. The reclaimed UF element can potentially be reworked into any number of configurations, depending surface area requirements and physical parameters of an end user agency.

For example, the SkyCandle element (shown in figure 3 below) is specifically designed to be inserted into 10 litre and 20 litre water containers commonly used in Africa.

It is envisaged that UF media (mainly PvdF at this stage) from any number of suppliers can be used as the source media and develop tailored “mini modules” (see Figure 1). It would be preferable to obtain an interagency agreement amongst WATERSAN agencies as the preferred configuration. This would facilitate a more effective harvesting, deployment and participation in CSR programs by industry players

Scaling up, MemRegen applied to low cost potable water applications

Already pilot "MemRegen" systems are offering a sustainable alternative for drinking water in poor communities. They are now being deployed in fixed and mobile installations throughout the developing world, and particularly in Asian and African countries.

Particular emphasis should be given as to how we can effectively implement a sustainable "membrane exchange bank" solutions that deliver meaningful long-term outcomes. An important component in any project is managing expectations and the sensible balance between technical protocols and social related interfaces within these communities.

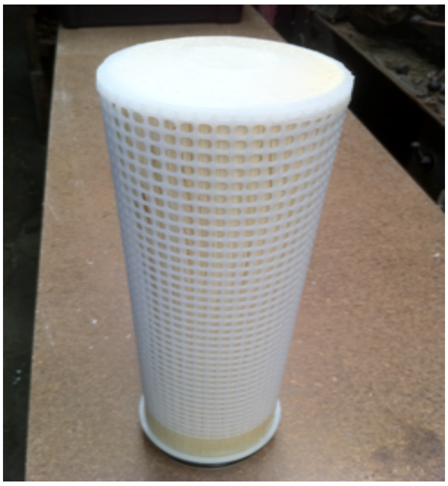

FIGURE 1

FIGURE 3

FIGURE 2

FIGURE 4

FIGURE 5

1 - A "chop and pot" UF mini module developed from a used UF Module - used in SkyBox design
2 - Harvested UF media partially deconstructed that is reconfigured into candle UF modules (SkyCandle)
3 – SkyCandle units with screw in connection and valve ready for use with 20 litre containers
4 - SkyBox unit, using recycled UF mini module for decentralised and emergency potable water (20 L/hr)
5 - SkyHydrant units, shown here, can utilise existing commercial reworked UF modules

Real opportunities for collective action and greater CSR involvement

Over 1500 SkyHydrant ™ units are now deployed in 55 countries over 5 continents. All major NGO's and authorities have had an opportunity to use and assess the systems. SkyHydrant ™ units. The next logical step is to look at cost minimisation of the UF membrane supply and alternative mini module designs that will meet the immediate need of international agencies.

The unit cost is approximately $3000. Based on 20 litres per person per day output, the unit has an installed cost of less than $0.50 per person, per annum. (This can be extended to US $1.00 per person per annum with ancillary tanks and equipment and the minimum guarantee of manufacturer membrane life of 5 years, is used) Since "direct" operating costs are basically zero, the application of robust membrane technology could change the way we approach the issue of affordable potable water. If recycled or "end-of life" UF modules can be integrated into these programmes (as a CSR initiative), then enormous leverage can be tangibly applied.

Base of the pyramid consumers for water, energy and mobility will require cost effective and robust solutions. Those customers exist. A global ethical initiative to service our fellow citizens and provide them with basic dignity must surely rate as and immediate and overdue obligation. Now is the time to act. Technology is only part of the answer. Are we willing to act???

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