SKYJUICE TECHNOLOGY IMPACT ON THE U.N. MDG OUTCOMES FOR SAFE AFFORDABLE POTABLE WATER

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Abstract: Low cost UF technology has recently been applied for disaster relief and low cost community potable water systems. Conventional membrane technology has been viewed as "inappropriate" and relatively costly. It has not been viewed as a viable option for low cost sustainable potable water supplies. Recent advancements in "very" low pressure ultrafiltration membranes have seen extensive deployment of systems in the developing world. Cost implications are promising. Safe affordable potable water at realistic volumes is now feasible.

Operating cost, reliability and long term performance are critical issues addressed in this paper. Compact, reliable and sustainable designs are now being deployed. Systems are being critically evaluated by NGO's and humanitarian agencies. Output and performance is documented and further discussed. High quality potable water at relatively low is a new "paradigm". These concepts and solutions are discussed in detail

Keywords : Ultrafiltration (UF), microfiltration (MF), SkyHydrant ™, SkyStation™, sustainable, affordable, membrane.

Introduction

This paper documents and overviews the viability of low cost membrane technology as a viable solution for community based potable water solutions. A new paradigm will be required to achieve the Millennium Development Goals and provide safe affordable water to 1.1 billion people by 2015 (1). The outcome of the Asian tsunami response during early 2005 resulted in new solutions being tested and evaluated. The Skyjuice Foundation provided over 200 low cost potable water systems to that crisis response. This has resulted in a unique solution to low cost community water. Membrane systems have traditionally not been considered affordable or sustainable for emerging communities. With recent United Nations initiatives in place to accelerate access to pure affordable water (2), the results of Skyhydrant installations have challenged conventional cost and delivery assumptions.

The proposition is that high quality affordable water which utilises membrane technology solutions should be seriously considered by major health and humanitarian agencies. There is no magic bullet to meet the MDG's. Indications are that there will be a significant shortfall in the MDG target numbers of at least 210 million people (3) .Concurrently; we also need to address the 4000 preventable deaths every day (4). A critical assessment of the UNDP "benchmark sustainability criteria" coupled with real costs of less than 50 cents per person per annum warrant further independent evaluation of the technology.

Background and overview

Skyhydrant™ is compact high volume membrane water filtration system designed for developing nations (specifically the Millennium Development Goals target No.7 outcomes) and disaster relief applications. The filtration barrier is a micro porous low pressure membrane that removes suspended solids, bacteria, helminths (minute worms), protozoa such as Cryptosporidium, Giardia and some viruses. This "disinfection" process when combined with chlorination (to ensure viruses are killed) produces safe drinking water from the majority of non-saline surface and ground waters.

Skyhydrant™ operates under as little as one metre gravity head and without the need for electric power. There is no pre-treatment, power or chemicals used in the treatment process. Operation and cleaning are simple and manual. The flexible design allows it to be operated in a range of configurations. 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 drinking water in poor communities.

Skyhydrant™ evolved from efforts of the Skyjuice™ Foundation, to develop and deploy a simple membrane drinking water filter for disaster relief situations. The early Skyjuice™ units worked well. They are small and lightweight weighing approximately 25 Kgs. The units were designed for single unit families. It became evident that a larger capacity unit was required for major relief work. Rhett Butler, the founder of Skyjuice™ Foundation, had worked in the membrane industry in Australia for 17 years and looked at using Memcor's proven commercial membrane modules for a scaled up version. Preliminary experimentation began in mid 2004 to develop a simple manual design.

Figure 1 :Installations undertaken in Sri Lanka : Left OXFAM IDP camp installation at Batticola (100,000 L/d capacity) and a Crown Projects Skystation solar site in Seenigama (20,000 L/d capacity)

Low pressure microfiltration (MF) membranes were first applied for municipal drinking water treatment in the 1990's. The Skyjuice Foundation has applied the use of low pressure ultrafiltration (UF) membranes using low cost production and manual operation since 1997. The tsunami of 26 December 2004 was the catalyst to fast track a larger design of existing smaller capacity units used for small communities of less than 50 people. The intention was to deploy simple filters in poor communities and developing countries where power is not available and water scarce. The units are not designed for salt rejection or to operate on brackish water supplies.

The concept was to configure the filter module mounted in an open tube with the clean water siphoned from the top of the module – extremely simple yet effective in areas which relied on community well distribution and collection of potable water. Skyjuice technology relies on agitation to "backflush" ie, draindown the module. Manual rotation around the vertical axis of the membrane element is undertaken to dislodge contaminants. There is no "reverse flow" backwash either using liquid or gas flows. Although the core of the design is a proven and validated commercial municipal low pressure membrane. The housing and associated fittings are made from readily available "off the shelf" plumbing components.

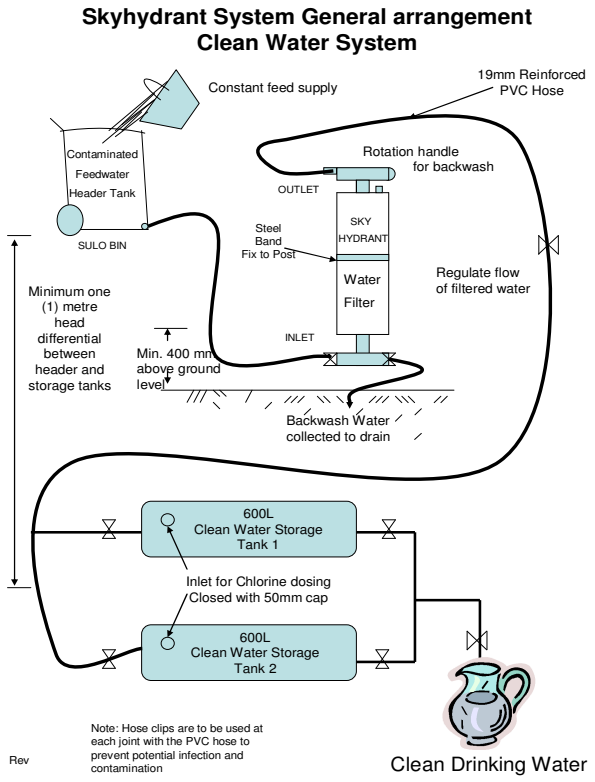

Figure 2 : A typical disaster relief configuration.

Figure 3: A Skyhydrant ™ – 20,000 L/day max capacity.

Operating Description

The Skyhydrant ™ Unit utilises a single MEMCOR® membrane sub-module within a low pressure housing. The unit is suitable for operation under low positive or negative head pressure. Raw water flows along the length of the hollow fibres before being forced through the walls of the fibre to produce a filtrate virtually free of suspended solids. The Skyhydrant™ system removes virtually all solids and bacteria and significantly reduces virus levels (LRV4 accreditation) .

The normal configuration is for the units to operate as single installations. Many units commissioned in disaster relief situations are multiple unit systems arranged in parallel and run under constant head pressure. It is normal for capacity output to designed for 100,000 to 200,000 L/day output.

Figure 4: Kenya Safe Water Kiosk Obambo-Kadenge Village installation which includes wind power and three units.

Filtrate flowrate is controlled manually. Chlorine addition can occurs manually, usually downstream and generally in a batch operating sequence depending on site constraints. The effectiveness of the system design is the manual agitation cleaning process. As described, earlier, this is a manual rotation of the membrane element in situ, followed by a gravity drain down of the filter housing. A quick and simple membrane wash sequence is carried out manually by the operator. The "agitation cycle" duration is approximately 90 seconds and generally occurs every 4 hours. It can be extended to once every 24 hours depending on raw water turbidity and flowrate.

The "drain down" water from the manual agitation cycle can be disposed of by land soakage or return downstream to the source water. Again it is re-iterated that despite very high turbidity feed water (>300 NTU) the "drain down" water is non toxic. There are no chemicals, flocculants or polymers used in the process even with very poor feed water quality. A simple membrane chemical cleaning sequence (CIP - Clean in Place) is periodically required to remove residual fouling that is not removed by the wash sequence and to limit bio-growth. Frequency of cleaning is application specific but is generally weekly.

Often it is asked "what do we do if the "drain down is toxic or contains arsenic"? It is prudent to undertake a thorough site and need evaluation and any potential source. This technology only concentrates feed water. It does not add, precipitate and coagulate feed water. It this is envisaged by using pH correction or oxidation, then normal disposal options should be evaluated, as per any treatment technology option.

Table 1: Skyhydrant ™ unit performance specifications

Number of sub-modules		1
Membrane Material		PvdF (Polyvinyldiflouride), Teflon
Membrane Pore Size (micron)		0.1
Maximum Recommended Feed Particle size (micron)[1]		500
Maximum Recommended Feed Turbidity (NTU)[2]		500
Filtered Water Turbidity (NTU)		<0.1
Log Reduction Value for Particles 2-5 µm (LRV)		>4
Filtration Operating Mode		Pressure and/or Suction
Minimum Recommended Differential Pressure (metres)		0.5
Maximum Recommended Differential Pressure (metres)		4.0
Nominal capacity (litres per hour)		400min (Max 1000)
Cleaning chemical per CIP	10% Hypochlorite (ml)	40
	Citric Acid Powder (g)	300
Approx Weight (kg)	Dry	20
	Operating	25
	Crated (Transport)	30
Overall Dimensions (mm)	Height	1,700
	Width	300
	Length	300
Recommended Opearting Clearance (mm)	Front	1,000
	Back	1,000
	LHS, RHS	1,000
Crate Dimensions for Transport (mm)	Height	1,800
	Width	400
	Length	400
Recommended location		Protection from direct sunlight & rain

Current Deployments and Installations

Over 350 Skyhydrant ™ units are now deployed in 16 countries over 5 continents. All major NGO's and authorities have had an opportunity to use and assess the systems. Additional units are also deployed in many regions of Indonesia including Bandeh Aceh, Yogojarta. Also units have been used in East Timor, Pakistan, Peru, Bangladesh, Mexico, Kenya, Philippines, Fiji and India. They are used in displaced persons camps, hospitals, schools, clinics and villages. As the Sri Lanka moves to a post tsunami transition phase many humanitarian agencies are assessing this technology as viable option to significantly address the goals of providing safe drinking water for other nations with emergency needs or ongoing development requirements.

The experience of the last three years has resulted in a membrane based filtration unit that produce potable water to "U.S. Enhanced Surface Water Treatment Regulations" (ESWTR) standards. It is locally assembled, and distributed. Based on 20 litres per person per day output , the unit has an installed cost of less than US $0.50 per person, per annum. Coupled with the compelling fact that operating costs, including membrane replacement, are basically zero, then the application of robust membrane technology could change the way we have approached the issue of affordable potable water.

The initial Skyhyrdrant™ design has now been extended and improved to include totally autonomous units which require no power as well as solar powered designs to supply entire communities. The AquaBoy™ & SkyStation™ models are now being thoroughly evaluated by all major NGO's as solutions for high quality low cost drinking water.

Figure 5: A typical integrated SkyStation ™ installation that includes a full tank stand and PV array for "waterlift".

Independent Validation to meet the U.N. M.D.G. Guidelines

The Murdoch University School of Environmental Science undertook an independent three way evaluation of the technology in 2004. The objective of the assessment by Wendy Green [(5)] was to verify the Skyjuice technology performance and also determine if it was a suitable environmentally sound technology in comparison to alternative methods. (Laboartory tests over 2 months)

For verification of the Skyjuice technology, laboratory examination of clay and algae turbidity removal by three Sky Juice units as well as bacterial removal by another three Skyjuice units were conducted. Control and membrane fault tests were also performed using deionised water and the bubble point test. The Environmentally Sound Technology – Performance Assessment (EST-PA) was used to assess the Skyjuice, chlorine disinfection (by Calcium Hypochlorite) and SODIS technologies in detail. The EST-PA was still under development by the United Nations Environment Program. EST-PA proposed criteria and indicators were used with some suggested changes to analyse the technologies.

Murdoch University verified that the Skyjuice performance met manufacturer's claims and World Health Organisation guidelines always after five minutes of use since cleaning the membrane. The Skyjuice was found to be the most environmentally sound technology and suitable for low virus risk areas, whilst chlorine disinfection could be suitable but had higher environmental impacts.

Conclusions, Costs and the Future

The Skyjuice™ Foundation continues with long term development programmes. Unit has been developed for immediate disaster deployment as well as medium term requirements. These units are offered to humanitarian agencies on a cost subsidised basis. The standard Skyhydrant™ is available through the Skyjuice™ Foundation for US$3500. In real terms based on the nominal media life of ten years, this represents a cost of approximately US$0.35-0.50 per person per annum. The membrane warranty life is minimum of 5 years and commercial operating plants exceed 8 years

Since there are no tangible operating costs, its makes for a compelling economic supposition. That assertion is that the millennium development goals should be affordable. Skyjuice technology a not a magic bullet and certainly where a communal supply based of poor quality water can suffice then an immediate evaluation is warranted. With the generous support of Crown International Projects the Skyjuice™ Foundation and has most recently commissioned a completely sustainable plant using solar photo voltaic panels, tracker and a solar windmill. It has a long service life. Operating cost is essentially zero.

An installed and commissioned plant for 3000-5000 people is now reality for less than US$1.00 per person per annum. The SKYstation™ essentially means we have no reason to ignore the affordability of pure safe, sustainable water for all citizens of the world. The Skyhydrant™ may just be the critical affordable technology to assist NGO's and aid organizations to meet the multi facet objective of providing safe pure drinking water in a realistic and pragmatic manner.

Note: The Skjuice Foundation is a registered non-profit incorporated charity based in Australia.

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