12 billion Dollars Spent Annually on Throw away filters- There is a better technology

David E. G. Bromley M.Eng, P.E.,

Clow Water Treatment Inc.
4465 Limaburg Rd.
Hebron KY, 41048

1.0 INTRODUCTION

In a world that is focussed at finding methods to use less energy or alternatives to existing energy driven products, one obvious change that is essential is the reduced use of disposable products. Specifically this paper will be addressing the reduced use of disposable filtration cartridges used in the water treatment industry…. ***A 12 plus billion dollar annual world market.*** "Throw away cartridges" is one of the major business units for the largest corporations in the water filtration market place. Reducing reliance on disposable filtration cartridges will have a significant economic impact on companies such as GE Water, Siemens, Pall Corporation and 3 M. This paper addresses the development of an alternative technology that allows filtration media to be reused over and over and as a result disposable filters are not required. It would be presumptuous to suggest that all disposable cartridge filters can be eliminated. For example in locations where there is no method to handle the cleaning waters used to restore the media (commonly referred as backwash water), disposable cartridge filters have an excellent application. Also for applications of low flow or sporadic flow requiring coarse filtration, the disposable cartridge filter serves a purpose in this market.

2.0 THE WATER FILTRATION DISPOSABLE CARTRIDGE MARKET

McIlvaine undertook a study of the cartridge market and reported that the world market size for disposable cartridges (not including the home residential market) was approximately 12 billion dollars by 2010.

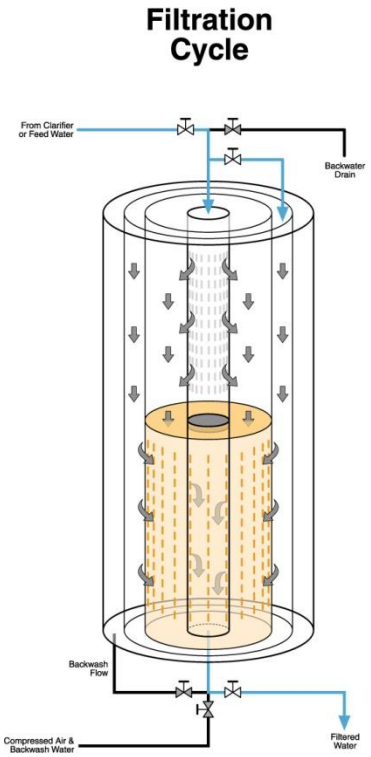
The dollar amounts provided in the McIlvaine study were based on manufacturer's revenue. There are, however, other market revenue components that need to be considered when looking at the complete market. For example each one of the cartridges is sold to the end user at a sale price which includes margins, commission, transportation, warehousing and over head. In addition each cartridge has to be disposed of and as a result there is a labor component to change and replace each cartridge as well as a transportation, storage and disposal fee. Labor alone is a significant cost in the use of disposable cartridges. The industry estimates that it takes about 2 minutes to change a standard 3.75 inch (9cm) diameter and 9.75 inch (25 cm) long disposable cartridge. In the US, the disposable cartridge market represents 28% of the world market or in other words approximately 3

billion dollars based on manufacturer's revenue. A standard cartridge has a value of $15.00. This would correlate to approximately 200 million standard cartridges disposed of each year in the US representing approximately 40,000 tonnes of plastic and almost 7,000,000 hours of labor. If disposal costs are in the range of $100 per tonne for the storage, transportation and tipping fee the disposal cost represents 4 million dollars per year. Since most of these cartridges are in pressure vessels, labor hourly rates are typically high because qualified personnel are required to maintain pressure vessels and replace the disposable cartridges. A typical labor rate of $80/hour would be the cost for this type of personnel. As a result, labor expenditures in the US for the changing of these cartridges would be in the order of $500 million per year. In addition, with other costs such as margins and over head of approximately 50% the estimated cost to the end user of such a product is 18 billion per year world wide or 5 billion in the US alone.

3.0 THE ALTERNATIVE – THE R3f BACKWASHABLE CARTRIDGE SYSTEM

The patented R3f system is comprised of two litres of non bonded media (33 micron size) for depth filtration. A typical R3f Tube is 150 mm (6 inches) in diameter and 1.8 m (6 feet) high as shown in Figure 1. The media can be fluidized and backwashed very quickly resulting in backwash volumes significantly lower than other technologies.

Figure 1 shows the basic elements of the R3f filtration system. The operating concept of the technology can be viewed on the web site www.water-simplypure.com.



The R3f technology is now being used at a number of locations where it is replacing disposable cartridge systems. Some examples are as follows

1. Toyota Manufacturing for cooling water filtration
2. A hospital as a treatment of potable water to reduce cartridge disposal on diagnostic equipment
3. Prefiltration for Reverse osmosis systems instead of using 5 micron and 1 micron or UF prefiltration systems
4. Mine tailings water
5. Ground water remediation
6. Small community water treatment systems.

With regards to the latter application, the US EPA has being testing the R3f technology at their Small Community Drinking Water Test and Evaluation Facility in Cincinnati, Ohio for over 14 months. The EPA have found the results very positive and they have written two technical journal and conference papers (ASCE and AWWA) with a third paper now in the preparation stage.

4.0 THE ECONOMICSAND SELLING OF THE R3f TECHNOLOGY

Based on the writer's experience, the capital cost per gallon per day (gpd) for a cartridge system is $0.05/gpd. However this assessment of costs varies significantly from a 2001 study by the Pennsylvania Department of Environmental Protection where the capital costs for a bag and cartridge filtration system were estimated to range between $0.30/gpd to $0.80/gpd. The operating costs however in the Pennsylvania study were between $0.72 to $2.28 (2007$) per 1000 gallons. A separate study undertaken by the US EPA at there Small Community Drinking Water Test and Evaluation facility estimated the operating costs to be in the order of $0.85 (2007$) per 1000 gallons.

These estimates and operating requirements were used to compare actual installations of the R3f backwashable (non disposable) filtration technology with three alternative technologies (disposable cartridges, multimedia filters and ultrafiltration membranes). Part of this evaluation was undertaken by the US EPA at its Small Community Drinking Water Test and Evaluation facility.

Key observations from the evaluation are as follows

1. The R3f technology allows for the use of fine non-bonded and backwashable media for use in microfiltration markets.
2. The R3f offers lower capital costs than existing microfiltration/ultrafiltration technology and similar costs to multimedia filters (Note: multimedia filters, although considered as a competing technology with the R3f, is actually a macro-filtration technology that is very dependent on the use of chemistry to provide a microfiltration capability).
3. Operator skill requirements are low for R3f filter systems. (i.e. the R3f filtration system can be operated by anyone….it is simple. There is no need to use chemistry for cleaning of membranes and there is no need to continuously change out and dispose of spent cartridge filters)
4. Waste volumes for R3f are lower than any other technology. Disposable cartridges do not require backwash water but waste volumes are very high.
5. The R3f footprint is small.

The R3f was then cost evaluated in two scenarios where the R3f technology is provided to a customer base on a design build own and operate basis. In other words **under these scenarios there would be no capital outlay**. The full treatment system is rented on a monthly or annual basis. The scenarios are described as follows.

Scenario 1 – Customer operates an existing cartridge system for a fine 1 micron prescreen filter (removal of 99.9 % of 1 micron particles- absolute 1 micron filtration).

There are a number of cartridge applications that provide a pre screening of membrane systems or for that matter use a cartridge system to remove colloidal particles. This application is important in any industry needing pure water, such as the beverage industry, pharmaceutical, computer chip or the power/energy industry. In addition such other applications as the use of activated carbon or UV systems now require colloidal particle removal. In this example the cost differential was assessed with the use of a 5 micron nominal cartridge filter followed by a 1 micron absolute cartridge filter.

Scenario 2 – Customer desires a new microfiltration system (99.9% removal of 0.05 micron particles)

There are a number of microfiltration and ultrafiltration systems that are now being considered by a variety of municipal and industrial end users. Much of this market has focused on the use of membranes but certainly for the small flows (25 gpm to 100 gpm) the disposable cartridge system is a good competitor to the high capital cost of membranes. The R3f technology is now a third and obvious option. In evaluating the costs for these filtration systems the information from the studies noted above plus actual quoted costs from one of the membrane manufacturers were used to prepare the cost comparison.

The key observations from this assessment are as follows

1. In the flow range of 25 gpm (6 m^3) to 400 gpm (96 m^3) , the R3f technology priced out at a lower annual cost than options using cartridges or microfiltration/ ultrafiltration membranes .

2. Even with discounts of 10% to 20% to the alternative technologies, the R3f technology filtration platform could satisfy its minimum sale pricing margin of 40% and in most cases was above 50% margin.
3. Typical costs for the R3f Technology filtration system were $0.61 to $0.65/1000 gallons for a system to remove 1 micron particles (Scenario 1) versus a cartridge system which would cost $0.77 to $0.97 per 1000 gallons. The cartridge system costs did not include the cost of labor to change the cartridges nor the disposal costs. It is interesting to note that the sales margin would exceed 60% in most applications if the R3f technology was sold to the customer at the same annual cost structure as cartridge filtration platforms.
4. Typical costs for the R3f Technology filtration system to remove 0.01 micron particles (Scenario 2) ranged between $0.72 to $1.28 per 1000 gallons compared to typical membrane ultrafiltration technology which ranged from $ 0.90 to $1.60 for the same flow rates. The major difference in costing between these two filtration concepts is the high operating cost for typical membrane technology. Again if the R3f filtration platform was charged at the same annual rates as membrane technology the sales margin would exceed 60% in all cases.

5.0 CONCLUSION

Finally a backwashable microfiltration cartridge is available to allow the user of microfiltration applications an alternative to disposable cartridges. In addition , the patented R3f technology also provides an excellent alternative to micro and ultra filtration membrane technologies.

The R3f technology provides this new capability with out the need to use chemistry as a pre-treatment requirement like multimedia filters, or as a requirement to clean the media like membrane technology. The R3f technology is both a lower cost and a simpler to operate technology than the competitive alternatives.

This is an example of the type of change which benefits both the user of microfiltration technology and the world we live within. It is also an excellent example of the need for change and in this case the need for major water technology providers to change…… a change that will be difficult and in the end may slow the acceptance of the R3f technology.

References

Bromley, D.E.G**;** Craig Patterson, P.E.[1], Roy Haught[1], Rajib Sinha, P.E.[2], Nur Muhammad, Ph.D., P.E.[2], Radha Krishnan, P.E.[2] Comparison of Garnet Bead Media Filtration and Multimedia Filtration for Turbidity and Microbial Pathogen Removal, presented at AWWAWQTC in Cincinnati November 2008

Bromley David, P.E., Enprotec-Clow Water Treatment, Inc., Hebron, KY, dbromley@water-simplypure.com; Craig Patterson, P.E., U.S. EPA, Cincinnati, OH, patterson.craig@epa.gov,Radial Flow Fluidized Filter Finds Niche as a Pretreatment System for Surface Water in Small Communities , published in EWRI Currents Emerging Technology News, December 2008

Results of Bag and Cartridge Filtration Studies Conducted at the US EPA Test & Evaluation Facility and at Field Locations in Minnesota and Washington" May 2005

Cartridge Filters –World Market, McIlvaine Company updated annually

Bag and Cartridge Filtration Study, Pennsylvania Department of Environmental Protection, 2001

Comparative Evaluation of R3f Garnet Bead Filtration and Multimedia Filtration systems, US Environmental Protection Agency, National Risk Management Research Laboratory, prepared by Shaw Environmental Inc, April 2008