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FOUR MEDIA FILTRATION IN SINGLE VESSEL

High Performance Multimedia Filtration

FILTER CLEAR VESSEL—FCV

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120 MLD PRE-TREATMENT FOR SWRO @ KAUST -KING ABDULLA UNIVERSITY, SAUDI ARABIA

FORBES PRO
WATER PROJECTS

What is Filter Clear Vessel– FCV ?

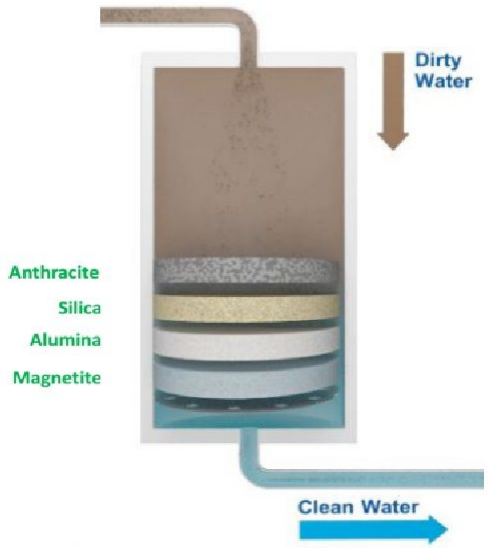
FCV is granular filtration process with a wide range of applications, from sea water and brackish water pre-treatment in membrane RO system to tertiary treatment of secondary effluents.

FCV is a pressured multimedia filter technology capable of separating suspended solids from a wide range of waters with a comparatively high performance, even at high loading velocities. Filter Clear plants are currently treating waters such as secondary effluent at wastewater treatment plants, cooling waters at industrial sites and seawater at desalination plants. Throughput ranges from 5 m3/hr up to 5000 m3/hr.

The FCV is an improved system and process for the elimination of suspended solids from water and wastewater on a commercially viable scale. Taking deep-bed filtration to levels previously not thought possible in terms of both speed and filtrate quality.

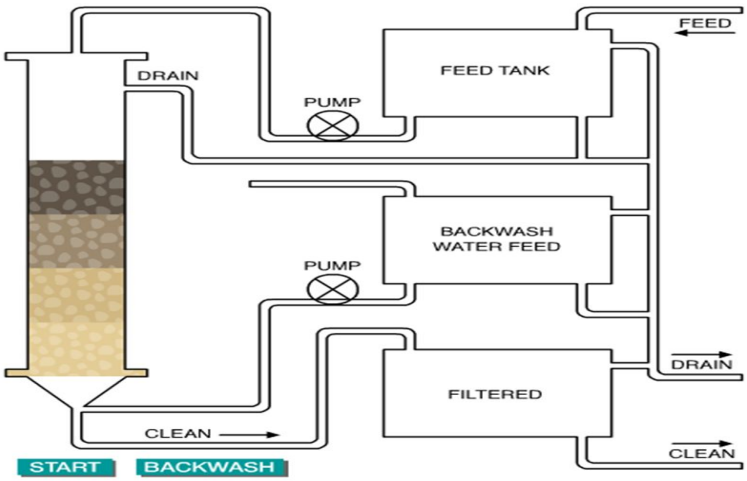
Attributes of FCV– Filter Clear Vessel ?

⇒ Very Cost effective as compare to other multimedia filter.
⇒ High loading rate (25-50 $m^3/m^2/hr$) which is 2-5 times competing technology.
⇒ High solid retention low pressure drop and long backwash interval.
⇒ High qualities filtrate in single stage.
⇒ Low pressure drop and long backwash interval
⇒ Low capital cost.
⇒ Low operating cost, no chemical consumption, low electricity cost.
⇒ Low backwash volume about 6 % of filtrate.
⇒ Low operation and maintenance cost, simple reliable and easy to maintain.



Benefits of Filter Clear Vessel

* Flow rates at least 5x faster
* Remove 15x more suspended solids than rapid sand filter
* Lower backwash consumption
* Lower running costs
* Longer media life
* Chemical free
* Smaller footprint

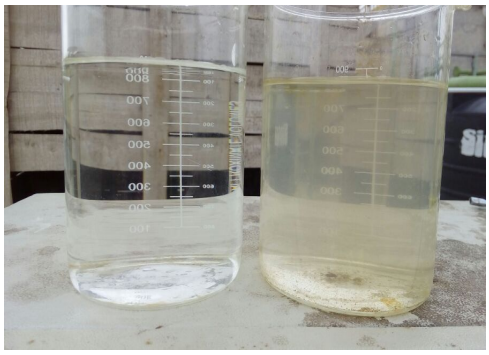


FORBES PRO WATER PROJECTS

PILOT STUDY—Balkrishna Tyres Ltd, Bhuj

The FCV technology is made available to us from Blue Water Bio of UK. This technology uses 4 different media for filtration and offers very good filtrate quality in terms of BOD, COD, SDI, TSS & Turbidity. Reduction in SDI value is a very good advantageous feature of this system. Due to the SDI reduction feature, this technology can be very well used as an alternative to Ultra-Filtration systems.

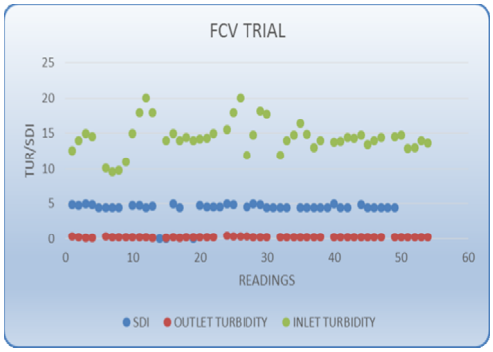
Before offering this product to clients and provide commitment on the FCV performance, we have conducted the trials for 3 m3/hr system at Balkrishna Tyres Ltd, Bhuj. The trials were taken on the effluent water as feed to FCV.



As the existing clarifier was not working properly, we have dosed chemicals in the FCV feed. But in most of the cases where clarifier is working well no chemicals will be required to be dosed in the FCV feed. The SDI value at FCV outlet is consistently monitored as less than 5 and most of the analysis readings show the SDI value of @ 4 to 4.5 max.

RESULT :

The outlet of FCV with the SDI value of less than 5 is acceptable for feed to RO membranes and we have also obtained the confirmations from the leading membrane manufacturers like **DOW** and **TORAY**.



The pilot plant study results produced above were shared with the leading industry consultants like Tata Consulting Engineers, Mumbai and the end user M/s. Balkrishna Industries Ltd.

The Client have accepted the use of this technology in place of Ultra-Filtration system for the waste water RO Pre-Treatment application. They have also changed the original tender specifications by removing Ultra-Filtration System and suggested the use of Filter Clear Vessel (FCV) for the ZLD project and is mandatory for all the bidders to use the proposed technology.

LAB REPORT —Balkrishna Tyres Ltd, Bhuj

Date – 7/7/2016

Time	Turbidity NTU		Pressure Difference Kg/Cm2	SDI of Outlet Water	Flow M³/Hr
	INLET	OUTLET			
11:00 AM	10.1	0.33	0.3	4.9	3.02
12:00 PM	9.6	0.22	0.3	4.8	3.01
1:00 PM	9.8	0.29	0.4	5	2.49
2:00 PM	11	0.28	0.4	4.9	2.5
3:00 PM	15	0.24	0.4	4.5	2.5
4:00 PM	18	0.24	0.5	4.5	3.01
5:00 PM	20	0.21	0.5	4.5	2.6
6:00 PM	18	0.17	0.5	4.5	2.61

Date – 8/7/2016

Time	Turbidity NTU		Pressure Difference Kg/Cm2	SDI of Outlet Water	Flow M³/Hr
	INLET	OUTLET			
10:30 AM	14	0.2	0.6	4.8	2.5
11:30 AM	15	0.22	0.7	4.8	2.5
12:30 PM	14	0.17	0.7	4.5	2.61
1:30 PM	14.4	0.28	0.7	4.7	2.49
2:30 PM	14	0.27	0.8	4..6	2.48
3:30 PM	14.2	0.29	0.9	4..9	2.48
4:30 PM	14.3	0.3	1	5	2.49
5:30 PM	15	0.26	1	4.5	2.47

COMPARISON—FILTER CLEAR VESSEL & ULTRA FILTRATION

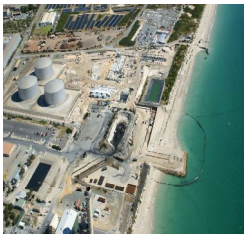
PARAMETERS	FILTER CLEAR VESSEL	ULTRA-FILTRATION
Flow of Plant	63 m3/hr	63 m3/hr
Foot print -space required	7 m2	55 m2
Energy consumption	0.17 KW/M3	0.22 KW/M3
Wastage of water	5.8 M3 /DAY	150 m3/day
Chemical required	NO CHEMICAL	HCl/ NaOH/ NaOCl
Operating cost typical	Rs. 0.86 / m3	Rs. 2.5 /m3
Pre-treatment requirement	Clarified water	Filtered water
Operational requirements	Can operate W/o PLC	PLC is must
Handling of chemical waste	No Chemicals	Problem in Disposing

APPLICATIONS OF FCV TECHNOLOGY

- Municipal / Township level drinking water treatment
- Sewage water recycle & reuse
- Industrial Waste water recycle & reuse
- Cooling water side stream filtration



- Desalination projects Pre-treatment
- Algae water filtration
- Fly ash pond water filtration



- Replacement of slow sand filters
- Industrial Side Stream Filtration.
- Iron, Boron, phosphorous & bacterial removal



FILTER CLEAR VESSEL KEY ADVANTAGES

Compared to:

- Continuous backwash filters
- Deep bed filters
- Other multimedia filters

Key advantages of FCV are:

- Up to four media of differing particle size & density
- Reduces blinding of upper layers
- Two fine 'surfaces' giving improved filtration
- One +ve charged surface adsorbs organics
- Naturally occurring materials (think Volvic) …

Engineered for:

- Greater void age
- Increased holding capacity
- Higher loading rates
- Better filtration performance

FILTER CLEAR VESSEL vs COMPETITION

Feature	Filter Clear Vessel	Rapid Gravity Sand Filter	Continuous Backwash Sand Filter	Disk Filter	Micro filter
Removes >75% of suspended solids	✓	X	X	X	✓
Compact footprint	✓	X	X	✓	✓
Low energy consumption	✓	✓	X	✓	X
Low capital cost	✓	✓	✓	✓	X
Low backwash volume	✓	X	X	X	X
No chemicals required	✓	✓	✓	✓	X

FEED LIMITING PARAMETERS - FILTER CLEAR VESSEL

Parameter	Unit	Value
Oil & Grease	mg/l	< 5
TSS (typical)	mg/l	< 100
Temperature	oC	< 60
pH (typical)	-	2 to 10
Turbidity	NTU	< 50
COD,BOD	mg/l	N/A
TDS	mg/l	N/A

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CASE STUDY

FilterClear™

Wastewater Reuse: Nirlon Commercial Park

Background

Nirlon is a commercial park of offices in Mumbai, India, which uses 800 m³/day of water. The commercial park has its own wastewater treatment plant comprising an aerated balance tank, a moving bed bioreactor (MBBR) followed by a dissolved air flotation (DAF) plant. Mounting pressures on water efficiency, together with the opportunity to reduce the costs of water supply and wastewater disposal, led Nirlon to install a water recycling system.

Solution

A FilterClear™ filter was installed at Nirlon in 2013 to remove residual solids from the treated wastewater, following the DAF plant. Up to 600 m³ per day of filtered water is chlorinated and recycled for toilet flushing, reducing the costs for water supply and disposal by approximately 75%.

The FilterClear™ plant comprises a single filter containing four layers of media, namely anthracite, silica, alumina and magnetite. To maintain permeability, the filter is automatically cleaned by periodically air scouring and backwashing with product water. During these backwashes, which last for up to 15 minutes, the filter feed is stopped and wastewater accumulates in the balance tank. Using the existing flow balancing capacity has avoided the need for a standby filter to treat flows during backwashing.

Figure 1. FilterClear™ Filter Containing Four Layers of Media

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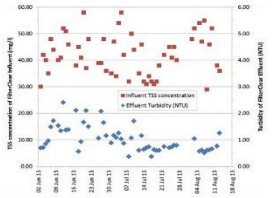
Figure 1 Performance of FilterClear Since Commissioning



The total suspended solids (TSS) concentration of the influent (DAF effluent) has varied from 30 mg/l to 60 mg/l. The TSS concentration of the filtered water is too low for practical measurement so turbidity is automatically measured instead. The data demonstrate that filtration performance improved following commissioning, with turbidity averaging only 0.70 NTU over the last month of the monitoring period.

The filter automatically backwashes when the inlet pressure reaches 1.4 bar; following backwashing, the inlet pressure drops to 0.3 bar. The average filtration pressure is approximately 0.7 bar.

Despite the comparatively high solids loading on the FilterClear™ plant, the average run time between backwashes during the monitoring period was between 8 and 16 hours. Given the comparatively high concentration of the filter influent, such runtimes represent excellent performance.

The biological treatment plant was commissioned at the beginning of May 2013 and the FilterClear™ plant was commissioned at the beginning of June, operating at a loading velocity of 24 m/h. Figure 1 shows the daily performance of the FilterClear plant since commissioning.

Conclusion

FilterClear™ has exceeded the client's performance requirements by a substantial margin and has been chosen for the treatment plant to serve Phase 2 of the commercial development.

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CASE STUDY

FilterClear™

Desalination: KAUST, Saudi Arabia

Background

The King Abdullah University of Science and Technology (KAUST), is located at Thuwal, north of Jeddah in Saudi Arabia. The university is an international, graduate level research institution, dedicated to inspiring a new age in scientific achievement in the Kingdom and around the world.

One of the major research centres will focus on sea water desalination and sewage water treatment, both of which are of vital importance in a region where water scarcity is a perennial challenge.

To meet the demand for fresh water a new Sea Water Reverse Osmosis (SWRO) plant was designed to satisfy requirements of the University and surrounding area. Due to the sensitive nature and location of the seawater supply lagoon, the pre-treatment part of the SWRO plant had to function without use of chemicals.

Solution

FilterClear™ along with its partners, carried out trials of its patented pre-treatment filtration process at sites north and south of Jeddah in July 2007.

These compared the performance of FilterClear™ against other filtration technologies without the normal addition of Ferric Chloride or any other coagulant.

On the basis of the trial results, FilterClear™ was approved by Saudi Aramco for the application.

The FilterClear™ pre-treatment plant installed at the SWRO plant consists of four (10m x 4m) horizontal filters each with a maximum flow of 1200m³/ hour, giving total output of 4800m³/ hour.

The high loading rate achieved by FilterClear™, compared with other media, meant that the number of vessels needed to generate the required water dropped from 16 to 4.

The SWRO plant was commissioned in March 2009 and has been producing water since April 2009

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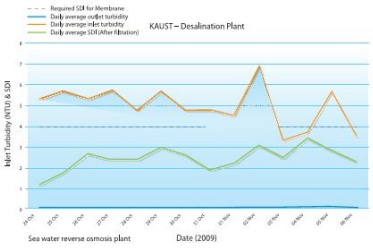
Performance

The filters are currently being run at a loading rate of approximately 30m³/ m²/ hr and have successfully been tested at 40m³/ m²/ hr when extra capacity has been required. Typically, dual media systems are run at 10m³/ m²/ hr.

The filters are backwashed approximately every 10 days for 15 minutes and the water used is sent direct to the intake lagoon, with no polluting chemicals being discharged.

The design specification was to obtain a Silt Density Index (SDI) level <4, upstream of the SWRO plant which contains Toray membrane modules. The SWRO plant runs routinely for 12 months without the need for a chemical clean. This is excellent performance and a strong testament to the performance of FilterClear™.

As shown in the following chart, even when the inlet turbidity hit extreme levels of 10 NTU, the filter easily handled the spikes to deliver consistent results.



Conclusion

FilterClear™ met all required targets from the outset, without the use of chemicals and achieving SDI levels well within the required standards for the SWRO membrane.

Significant capital cost savings were achieved by using FilterClear™ instead of other media filters. Shrinking the footprint of the pre-treatment plant provided enormous civil engineering and plant cost savings.

In addition, operating cost savings from a reduction in power consumption, chemicals (both purchase and disposal) and reducing the frequency of the membrane clean have made the project a huge success for everyone involved. In addition, it should be noted that FilterClear™ guarantees its media for 15 years.

FilterClear™ is a high performance, environmentally friendly, low CAPEX and OPEX alternative to traditional technologies for SWRO pre-treatment.

Project developers, Saudi Aramco, commented:

"FilterClear™ is a breakthrough technology in a very conservative market place. It is important for KAUST to embrace innovation and be aligned to winning technologies; we are pleased to be part of this breakthrough."

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CASE STUDY

FilterClear™

Industrial Water: Brookside Metals

Background

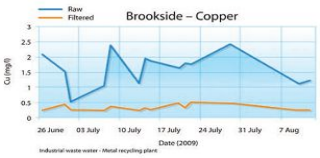
Brookside Metals is a Wolverhampton based manufacturer of bronze castings and has had environmental issues with copper and zinc discharge consents from their surface water collection lagoon. The lagoon is designed to overflow and discharge into a storm water sewer and then into a local river.

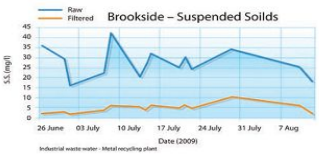
Samples of the discharge water were taken from site and tested in the FilterClear™ laboratory. The processed water was then sent away for independent testing and analysis.

Solution

The results show a dramatic reduction in copper and zinc providing water quality well below the EA discharge consent. This led to a containerised pilot plant being installed at site by FilterClear™ which was operated for two months.

Results demonstrate a consistency of performance that has brought the discharge water within consent. Once Brookside saw the results they took the decision to purchase a fully automated containerised FilterClear™ system.





Performance

Colloidal and particulate capture reducing all problem metals to within their EA standard.

The site now has the option of using lagoon water for cooling bronze castings, which will dramatically reduce the site water bills and carbon footprint.

Brookside can now operate without the risk of heavy fines by the EA and has the added benefit of vastly reducing the environmental impact of their process.

"A scientific solution to a very commercial problem; we were impressed with FilterClear's technical know-how and their practical approach to problem solving. FilterClear™ has given us a complete process"
Brookside Metals Spokesperson

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CASE STUDY

FilterClear™

Case Study: Tertiary Solids & BOD Removal: Bugbrooke WRC, Anglian Water

Background

Bugbrooke Water Recycling Centre (WRC) is a municipal sewage treatment works in Northamptonshire. It serves a population equivalent (PE) of over 7,000, with a flow to full treatment (FFT) of 52 L/s. The original treatment plant consisted of inlet works, primary settlement tanks, trickling filters and humus tanks. In AMP5, the Environment Agency issued a more stringent BOD consent (see table below).

	TSS (mg/L)	BOD (mg/L)	Amm-N (mg/L)
Previous Consent	35	23	-
Current Consent	35	14	20

Having evaluated several options, Anglian Water and @one Alliance decided that the most cost-effective and robust way to meet the new BOD consent is to remove particulate BOD by tertiary filtration.

FilterClear™, one of Anglian Water's framework technologies, was selected as the preferred solution, based on its low whole life cost (WLC), ease of installation and low carbon footprint. The good operability and reliability of FilterClear™ have also been demonstrated by an earlier pilot plant at Cambridge Water Recycling Centre (WRC).

Solution

The FilterClear™ plant at Bugbrooke WRC comprises three filters, sized to treat the full 52 L/s through two filters when one is backwashing. Variable speed submersible feed pumps have been installed downstream of the existing humus tanks, and filtered water passes through a clean backwash tank to the original final effluent sampling chamber.

The FilterClear™ plant was manufactured offsite and delivered to the site as a package comprising three filters, associated pipework and control valves, two backwash pumps, one air scour blower and a control panel, all mounted on a single skid. The skid was assembled and tested offsite, reducing the duration and complexity of the site work, and the H&S risks. A kiosk was built around the FilterClear™ plant, providing security and weather protection; this option would not have been available with some of the alternative filtration technologies considered.

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