



AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

SUCCESS STORIES

PLANT NAME AND LOCATION

BUTLER WATER TREATMENT PLANT – BUTLER, MO

DESIGN DAILY FLOW

2.0 MGD (7570.8 M³/DAY)

AQUA-AEROBIC SOLUTION

84 Aqua MultiBore® MEMBRANE MODULES (21 MODULES IN EACH OF 4 TRAINS)

BUTLER WTP SOLVES MEMBRANE INTEGRITY ISSUES AND MEETS EPA LT2 RULE WITH Aqua MultiBore® MEMBRANES

Butler Water Treatment Plant (WTP), located in Missouri, receives its influent from a surface water impoundment fed from Butler Lake, Maris de Cygenes River, and Miami Creek. Following treatment, it provides potable water to over 300 businesses, (4) schools, 4100 residents and (4) other Public Water Supply districts.

Butler WTP was originally constructed in 1967 with a 1 MGD capacity and utilized upflow clarifiers, dual-media filters, and a disinfection tank. The plant operated successfully with this flow scheme until 2002 when its dual-media filters were in desperate need of replacement in order to meet state effluent permit requirements.

The city decided to replace the dual-media filters with low pressure, hollow-fiber ultrafiltration (UF) membranes to resolve the issue. The system had a 2 MGD capacity and consisted of (4) disk-type 100-micron strainers, (4) membrane trains - each with (27) modules, (2) backwash pumps and (1) clean-in-place (CIP) chemical cleaning system. Not long after startup, the membranes failed periodic air integrity tests (AIT)s given to detect fiber breaks or other integrity failures. Eventually, none of the (4) UF trains could pass an AIT without multiple fiber repairs. This was costly and the plant was struggling once again to meet its water demands in 2012.

To combat the integrity failures quickly, the city decided to replace membrane modules in 3 of the 4 trains with membranes from the same manufacturer. The supplier's newer, more-robust membranes would not retrofit easily

into the existing module racks, requiring costly skid modifications, so they decided to stay with the original model. These membranes, like the ones before them, began to fail the AITs shortly after startup. At the same time, the plant was informed that the Long Term 2 (LT2) Enhanced Surface Water Treatment Rule would go into effect in October 2014. This rule would demand automatic, daily AITs. Knowing that the existing membranes would not meet the new stringent requirements or pass daily testing, a different alternative needed to be explored.

In April 2014, Butler decided to conduct a 9-month pilot study with (21) Aqua MultiBore® membrane modules retrofitted into Train 2. Train 2 was tested alongside the other (3) UF trains and proved the superior performance

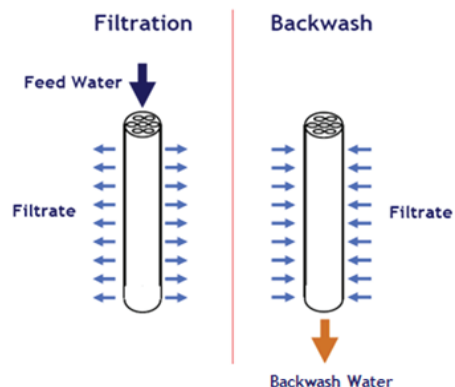
of the multibore membranes. The city finally found a solution and would retrofit the other trains in 2014 and 2015.



(1) Aqua MultiBore® Membranes module in Train 2.

Aqua MultiBore® MEMBRANES PROCESS

The membrane system alternates between top and bottom **filtration modes** to evenly distribute impurities along the entire length of the fiber. The 0.02μ pores allow water to pass through to the outside of the fiber while suspended solids, bacteria, cysts, and viruses are retained. Filtered water flows through the filtrate port on the side of the module.



The system also alternates between top and bottom **backwash modes** so impurities can be efficiently flushed out. Filtered water enters the filtrate port, flows into each fiber, then exits out to the drain. Backwash occurs every 20-80 minutes, depending on influent quality.

A **Clean-in-Place (CIP) mode** is performed periodically to dissolve any remaining impurities not removed during backwash modes. Small amounts of chlorine (for organic matter) and citric acid (for inorganic matter) are used. The membranes are soaked before being flushed out. CIP is executed every 2-6 weeks, depending on influent quality.

DESIGN CHARACTERISTICS

Butler's existing (4) train system was retrofitted with (84) multibore membrane modules (replacing 108 old modules) with a design capacity of 2 MGD. Effluent values would meet the EPA LT2 rule of $\geq 99.99\%$ (4-log) cryptosporidium removal and ≤ 0.1 turbidity in order to discharge potable water.

The Aqua MultiBore membranes have outperformed the existing membranes by removing 13 - 36% more turbidity at a 24 - 33% higher permeability (specific flux). In addition, the membranes pass continuous indirect and daily direct air integrity testing to consistently meet the stringent permit requirements.

The ability to retrofit into the old membrane module racks reduced the plant's upgrade cost and minimized system modifications.

AVERAGE OPERATING DATA (April 2014 - February 2015) Pilot Study

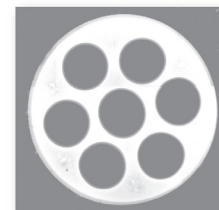
LOADING	UF TRAIN 1	UF TRAIN 2 (Aqua)	UF TRAIN 3	UF TRAIN 4
Net Product Flow (GPM)	253	277	249	244
Trans-Membrane Pressure, TMP (psi)*	1.8	1.6	1.7	1.8
Specific Flux (GFD/psi)*	16.2	20.4	16.5	15.3
Product Turbidity NTU	0.038	0.028	0.044	0.032

*TMP and Specific Flux have been corrected for temperature.

Train 2, utilizing (21) Aqua MultiBore membrane modules for the 9-month pilot study, was tested side-by-side with the other (3) UF trains. As shown in the table above, Train 2 outperformed the Trains 1, 3 and 4.

Aqua MultiBore® MEMBRANES ADVANTAGES

- No-break membranes
- Inside-out flow path requires no air scouring
- Less fouling tendency
- Less chemical usage
- High water recovery rate
- Less trans-membrane pressure
- Low energy consumption
- High permeability
- No basins or lifting equipment needed
- Can be cleaned with caustic
- Compact and expandable
- Simple operation and low maintenance
- Available in polymeric and ceramic options
- Low cost of ownership



Each membrane fiber has 7 bores.



Aqua MultiBore® membrane fibers.