Hydranautics HYDRAcap® Testing at the Alameda County Water Authority

Introduction

Montgomery Watson invited Hydranautics to pilot test its HYDRAcap® Capillary Ultrafiltration Membrane for a 10MGD surface water treatment plant upgrade for the Mission San Jose Water Treatment Plant. The source water was South Bay Aqueduct Water. The pilot test was quite extensive, lasting six months and consisting of numerous pretreatment options. Figure 1 provides a process flow guideline.

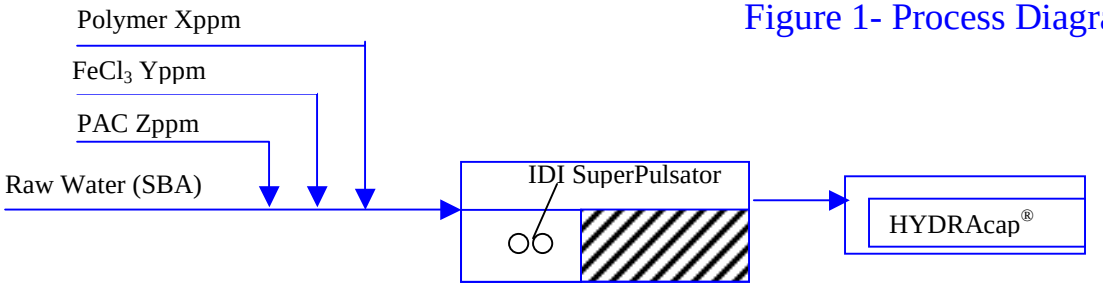

Figure 1- Process Diagram

Table 1- Water Quality

Constituent	Unit	Raw Water	Post Clarified Water	Uf Filtrate	UF BW Effluent
TSS	mg/L	8	4	0	48
Turbidity	NTU	~20	~3		
TOC	mg/L	3.1	2		
UV254	cm-1	0.102	0.094		
Alkalinity	mg/L	64.0	60		
pH		8.2	7.2		
Hardness	mg/L	86.0			
Color	cu	25.0	15		
Iron	ug/L	758	1070	80	~6300

Performance

Summary

The HYDRAcap module ran for over 3000 hours during this pilot study. The study can be divided into eight distinct runs with five different pretreatment options. Two of the five pretreatment options were repeated to reflect different water conditions. This can be summarized by the examination of table 2 below.

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Table 2-Condensed Pilot Summary

Run	Description	Date	Run Hours	Ave Feed NTU	Filtrate GFD	Recirc GPM	BW v, min	Rcvry	Chemical in BW
1	Clarified Water	3/9/99-3/31	5200-5656	3	43	Usually 0	30	85%	5ppm Cl2 every BW
	15ppm FeCl3-SP-UF								
2	Raw Water	4/1 - 6/3	5656-6600	19	43	8	20	80%	5ppm Cl2 every BW
									Ph2 HCl every 3BW
3	PAC	6/3 - 7/5	6600-7260	25-30	43	16	20	80%	15ppm cl2 every BW
	10/20ppm PAC-SP-UF								
4	Clarified Water II	7/5 - 7/22	7260-7640	2	64	0	30	90%	15ppm cl2 every BW
	15ppm FeCl3-SP-UF								
5	PAC/Clarified	7/22 - 8/13	7640-8088	4	64	0	30	90%	15ppm cl2 every BW
	20ppm PAC-15ppm FeCl3-SP-UF								
6	Raw Water II	8/13-8/24	8088-8300	12	43	10	30	85%	15ppm cl2 every BW
7	PAC Taste and Odor Spike	8/25 - 8/27	8300-8350						
8	Clarified w/ Polymer	8/30 to 9/15	8350-8680		43	0	20	80%	15ppm cl2 every BW
	5-15ppm FeCl3-Polymer-SP-UF		(different						
	Either 1-3ppm Calgon Cat-Floc TL		module)						
	or 0.3 to 1ppm Betz 1115LP								

In summary, per Montgomery Watson[1], the HYDRAcap® membrane demonstrated the following parameters during the Pilot Study:

Table 3 HYDRAcap Qualifications

Feedwater Conditions	Nominal Flux@20C	Crossflow Rate	Backwash Interval	Recovery
Raw Water (<10NTU)	40GFD	0 to 7 gpm	30 min	85%
Raw Water (>10NTU)	40GFD	7 to 16 gpm	20 min	75%
Clarified Water	60GFD	0	30 min	90%

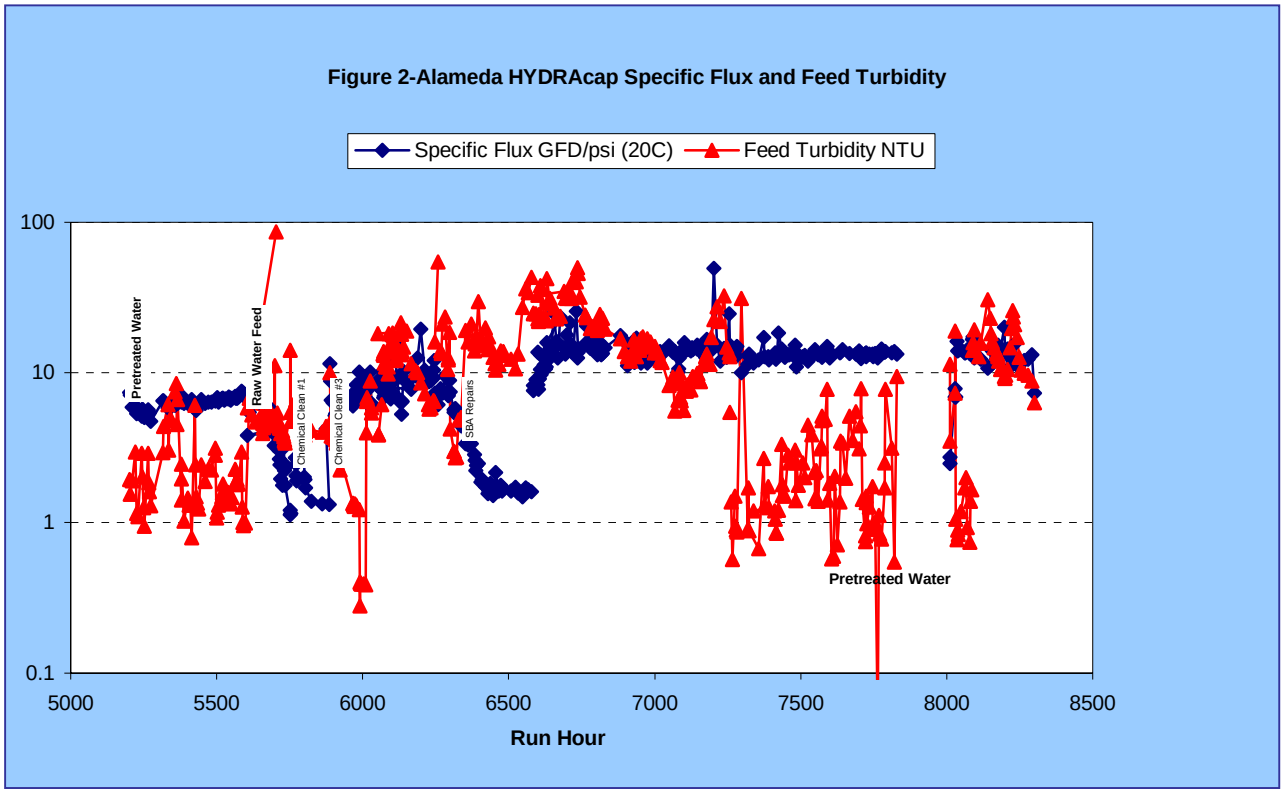
Furthermore, HYDRAcap® has demonstrated the following operational attributes:

1. Reducing the turbidity level from a raw water of 2 to 60 to less than 0.06NTU
2. Reducing the Total Suspended Solids to below the limit of detection
3. Reducing iron at >90%
4. Reducing MS2 Phage >4log (virus seeding)
5. Taste and Odor Compounds:
6. Reducing methyl-iso-borneol (MIB) >90% in conjunction w/ 30ppm PAC and clarification
7. Reducing Geosmin >90% in conjunction with 30ppm PAC and clarification Polymers
8. Operating for 5 days with up to 1.0ppm of Anionic Polymer (Betz Dearborne 1115LP) in conjunction w/ $FeCl_3$ without any specific flux decline
9. Operating for 9 days with up to 3ppm of Cationic Polymer (Calgon Cat-Floc TL) without any specific flux decline

In addition, HYDRAcap® ran for over 3000 hours without breaking a single fiber.

[1] Taken from the ACWD-Zone Z UF Pilot Study Report by Montgomery Watson, October 1999.

Membrane Performance Analysis



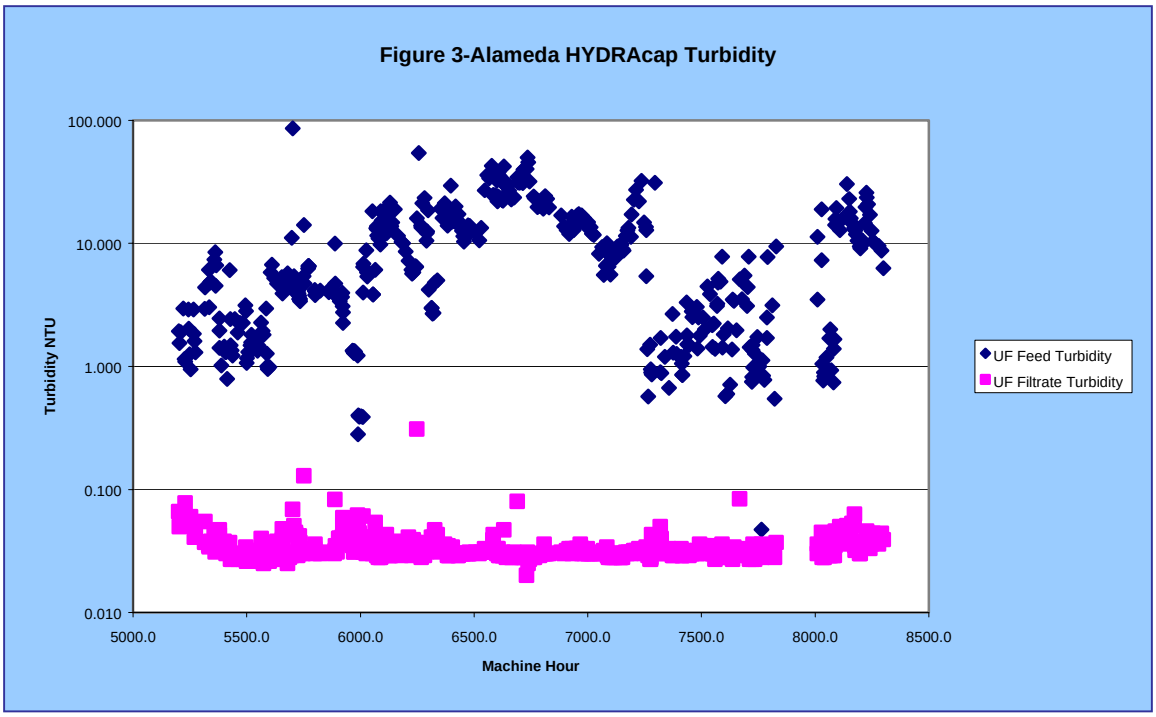
Fouling/Membrane Stability-

Figure 2 above demonstrates the specific flux and HYDRAcap® feed turbidity for the entire study. The following are points of interest:

1. Only two fouling episodes are observed (specific flux declines). Each of these occurred during the first raw water study. The second raw water study was without a fouling episode.
2. The specific flux is very stable for most of the pilot study. No specific flux decline is observed for the pretreated runs. Apparently, HYDRAcap® could have been pushed to a higher flux under pretreated water conditions
3. Montgomery Watson ran a virus seeding study at the end of the pilot study and the results are the HYDRAcap® provided an average of >5log virus reduction, certifying the integrity of the membrane.

Turbidities-

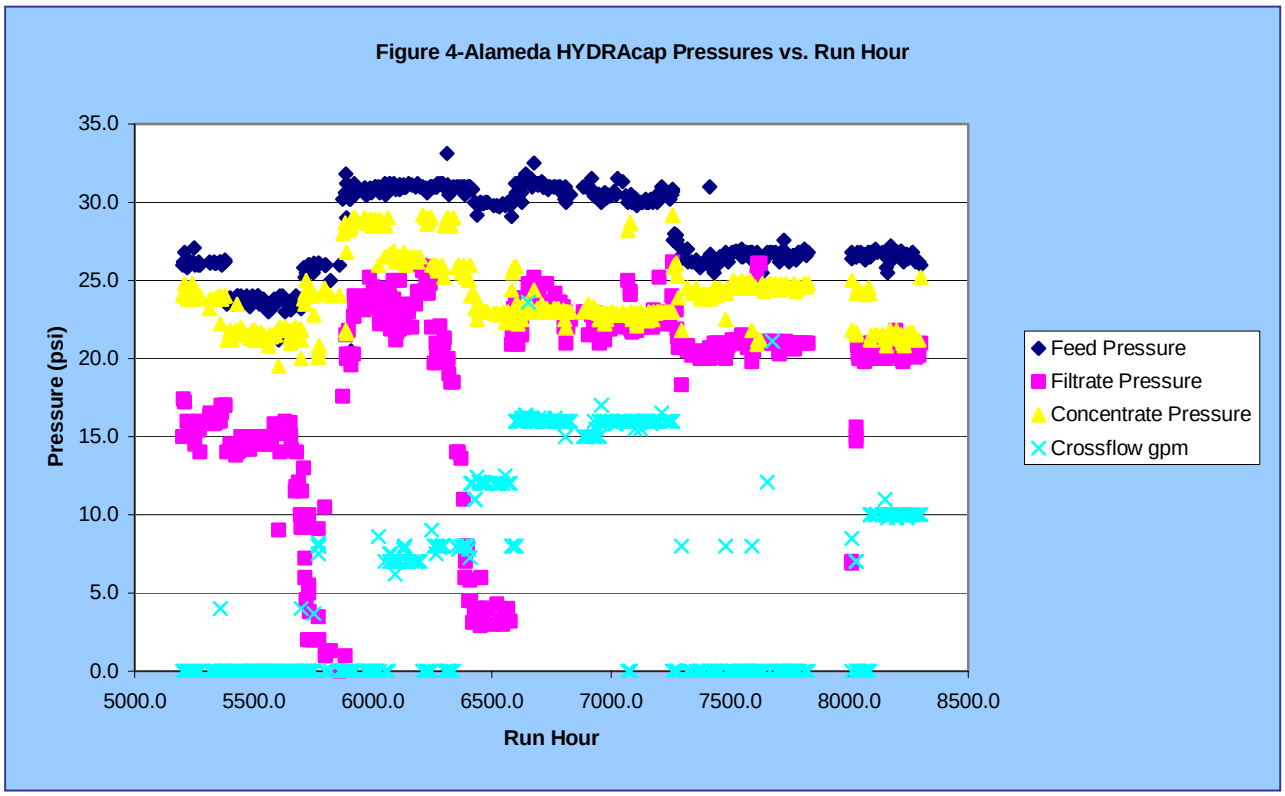
Figure 3 demonstrates that although the feed turbidity to the HYDRAcap® UF system was often as high as 60NTU, HYDRAcap® consistently demonstrated a filtrate turbidity of <0.1NTU (typically <0.06NTU)



Pressures-

Figure 4 shows the pressures and the crossflow rates for the entire pilot study. The following are points of interest:

1. The feed pressure varied between 25 and 30psig. The transmembrane pressure was typically between 5 and 10 psi. During the two fouling episodes, the TMP ran as high as 25psi.
2. During the 16gpm crossflow run with PAC, the Feed to Concentrate (bottom-to-top) pressure loss was ~8psi, resulting in a very low net driving pressure at the top end of the module.



Taste and Odor Removal Study-

Table 4 below provides the results of the Geosmin and MIB spiking analysis:

Table 4-MIB and Geosmin Spiking Study results			
		MIB mg/L	
PAC Dose, mg/L	**Spiked Raw H20**	**Post Superpulsator**	**HYDRAcap Filtrate**
10	77	24	23
20	94	25	6.4
		Geosmin mg/L	
PAC Dose, mg/L	**Spiked Raw H20**	**Post Superpulsator**	**HYDRAcap Filtrate**
10	26	3.8	<3
20	31	7.5	<3

MS2 Virus Challenge Results-

Table 5 demonstrates that the average MS2 phage removal was 5.0log. As expected, the removal rate increases over the course of a single procession cycle (increasing time after backwash).

Table 5-MS2 Phage Removal

		Mode		
Time	**Directflow1**	**Cross flow**	**PAC Addition**	**Directflow 2**
Right after Backwash	4.8	3.3	4.2	5.5
Mid Cycle	5.8	4.7	5.2	5.9
Before Backwash	4.6	5.2	5.3	5.9

HYDRAcap® Integrity-

Although the data is not presented here, HYDRAcap® successfully passed 10 visual bubble tests, and did not break a single fiber in the entire study.