ITT

Water & Wastewater

Treatment – Clarification

Case Story

Comparing Conventional Settling Basin Clarification to the Leopold® Clari-DAF® System at Greenville, South Carolina

The Greenville Water System draws water from three sources—Table Rock Reservoir on the South Saluda River, Poinsett Reservoir on the North Saluda River and Lake Keowee. Table Rock and Poinsett Reservoirs are both located in the foothills of the Blue Ridge Mountains in northern Greenville County. The source waters were so clear that for over 70 years the water from the mountain reservoirs was unfiltered and only treated with chlorine. In the mid 1980s, the Adkins Filtration Plant was built with Lake Keowee as its source water, utilizing conventional settling basin clarification technology for 30 MGD design capacity. This plant was expanded in 2003 to increase capacity to 60 MGD using the same settling basin clarification technology. Increasing regulations required all surface water systems to be filtered, so in July of 2000 a new state-of-the-art filter plant was placed in service to provide filtration for all of the water drawn from the Table Rock and Poinsett reservoirs. This new Table Rock/North Saluda filter plant, designed at 75 MGD, uses a Leopold® Clari-DAF® system for clarification in the treatment scheme.

Background

The Adkins Filter Plant uses coagulation, sedimentation, filtration, and disinfection to treat the source water. Alum is used as the coagulant along with sodium hydroxide (caustic) for pH adjustment. Chlorine, combined with ammonia, is used for disinfection, while a zinc polyphosphate is added for corrosion control.

Fluoridation is provided to promote healthy teeth. The Table Rock/North Saluda Filter Plant uses the flotation process, rather than sedimentation, for particle removal. The remaining processes and chemicals used are similar to those at the Adkins Plant. The raw water quality of the two plants is very similar, with low turbidity, low hardness and low alkalinity. The average water quality data for raw, clarified and finished water for the two-year time period of August, 2003 through July, 2005 is listed in Table 1 below.

	Parameter	Adkins	TR/NS
Raw	pH	6.55	6.55
	Alkalinity (mg/L)	8.89	6.95
	Temp (°C)	21.70	19.20
	Hardness (mg/L)	5.00	4.20
	Turbidity (NTU)	1.20	0.49
Clarified	Turbidity (NTU)	0.37	0.20
	Chlorine (mg/L)	1.70	0.20
Finished	pH	7.10	7.45
	Alkalinity (mg/L)	10.70	8.70
	Temp (°C)	21.40	19.00
	Hardness (mg/L)	5.25	4.40
	Turbidity (NTU)	0.04	0.05
	Chlorine (mg/L)	2.65	2.60

Table 1

There is a significant difference in the footprint required for the processes at each facility. Table 2 compares them.

	Adkins	TR/NS
Plant Area (ft^2)	147,342	31,908
Plant Flow (MGD)	60*	75

Table 2

* Plant can operate at a higher flow if required.

The footprint for processing 60 MGD by the conventional settling basin system at Adkins is 147,342 ft^2. This results in a requirement of 2,456 ft^2 per million gallons of water processed; however, the existing footprint can deliver 90 MGD resulting in a requirement of 1,637 ft^2 per million gallons of water processed. The total area for processing 75 MGD through the DAF system at Table Rock/North Saluda is 31,908 ft^2. This results in a requirement of 425 ft^2 per million gallons of water processed.

The average chemical dosage for the two-year time frame of August, 2003 through July, 2005 is listed in Table 3.

Parameter	Adkins	TR/NS	Diff.	% Diff.
Alum (mg/L)	11.1	11.4	(0.3)	(3)
Caustic (mg/L)	12.7	9.1	3.6	28
Chlorine (mg/L)	7.7	3.2	3.5	45
Aq Ammonia (mg/L)	1.4	0.6	0.8	57

Table 3

Given the fact that the raw water turbidity was lower at Table Rock/North Saluda, it would be expected that the alum coagulant dosage would be higher. The lower the turbidity, the harder it is to clarify the water and subsequently the higher the inorganic coagulant dosage. However, the reduction at Table Rock/North Saluda is due to the fact that flotation can effectively remove smaller diameter solids. Some of the increased caustic feed at Adkins can be attributed to the higher alum feed that depresses the pH for coagulation. The increased chlorine and ammonia feed at Adkins is due to the fact that a higher clarified combined residual is maintained through the clarification process at Adkins in order to meet CT requirements.

Filter performance data listed in Table 4 was collected from one filter at Adkins and one filter/train at Table Rock/North Saluda (three total filters) for the August, 2003 to July, 2005 timeframe.

Parameter	Adkins	TR/NS
Surface Area (ft^2)	1342	792
Total Volume (MG)	21.59	16.817
Average Filter Run (hr.)	126	118
Average Backwash (gal.)	294,458	269,125
Unit Filter Runtime Volume (MG/ft^2)	17,697	20,984
Backwash (%)	0.77 - 2.41	0.88 - 2.42

Table 4

Filters #1, #4, and #9 at Table Rock/North Saluda averaged significantly higher unit filter run times volume (18.6%) than Filter #6 at Adkins.

The average in-plant water usage rates for the same period are compared in Table 5.

Parameter	Adkins	TR/NS	Diff.	% Diff.
% In-Plant Use	9.47	3.84	5.63	59.45

Table 5

There is a major difference and, therefore, an associated cost savings due to reduced in-plant water usage. The overall cost of water accelerates with higher figures due to the fact that the in-plant usage is water that has already been processed and, therefore, has an associated multiplied cost. Some of the difference is the result of shorter filter runs and additional backwash water required to wash the filter. In addition, some of the difference is associated with the sludge content of the solids removed from the Adkins conventional settling basin (less than 0.5%) vs. the Clari-DAF unit solids thickening (to 2+ %) for removal from the Table Rock/North Saluda flotation clarification process. The Adkins Leopold® CT2® submerged sludge collector consumes 2.6 million gallons of water per cycle per day.

By selecting the Clari-DAF process, the land footprint requirement is reduced by 82.7%.

Table 6 compares the expenses incurred and the total water production at each treatment plant for the 2-year timeframe of August, 2003 through July, 2005.

Parameter	Adkins	TR/NS	Diff	% Diff
Total Flow x 10^6 (Gal)	10,664	22,918	+12,254	+53
Treatment Expense ($)	1,892,941	1,727,882	-165,059	-8.7
$/1000 gallons	0.18	0.08	-0.10	-56

Table 6

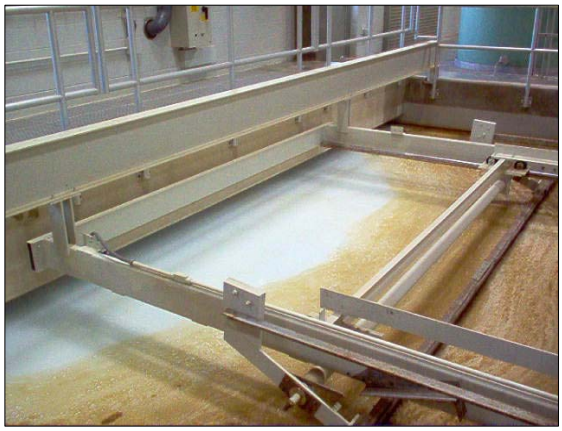
Again, there is a major reduction (56%) in cost per thousand gallons at the Table Rock/North Saluda Plant.

Conclusion

In consideration of similar raw water conditions, with the capability of producing effluent water below MCL (Maximum Contaminant Level) along with the potential of efficient sludge handling, selecting the Clari-DAF system as a replacement for standard sedimentation technology has resulted in significant chemical and operating cost savings:

- The footprint required per million gallons is one sixth the size
- The chemical consumption is lower
- Unit filter runtime volumes are 18% longer
- The total cost per 1000 gallons is 56% lower
- In-plant water usage is 59% lower

Exterior view.



The Clari-DAF system at work.

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