GAC Filters for More Than Just TOC Removal

City of Phoenix

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Deer Valley and 24th Street WTP's

Benefits of GAC Filters

- Excellent Filtered Water Turbidity…providing the filter influent zeta potential is optimized

- Good for Short Term TOC Reductions

- Great for Long Term Chlorite Reductions

- Great for Long Term THM Reductions in the Reservoir Effluent and Distribution System When Practicing Pre-Oxidation
Initial Implementation of GAC Filters at the Deer Valley WTP Was Not Easy

- Deer Valley Started up Brand New Actiflo and GAC Filter Processes Simultaneously.

- Actiflo Effluent Filterability Issues
  - Actiflo Anionic Polyacrylamide Polymer Created Extreme Negatively Charged Effluent, which caused High Filter Effluent Turbidity.
  - Actiflo Cationic Polyacrylamide Polymer Created Excellent Filtered Water Turbidity, but Caused Extreme Filter Plugging Problems.

- Actiflo Effluent Ideal Chemical Combination
  - Cationic DADMAC Polymer (Diallyldimethylammonium Chloride) Prior to Actiflo, Anionic Emulsion Actiflo Polymer, and Post Actiflo Ferric

![Deer Valley WTP GAC Filter Effluent NTU's at Start Up of Actiflo Process](chart.png)

The Anionic Polymer Created Poorly Filterable Negatively Charged Water
Deer Valley Hourly NTU's During a Turbidity Event
GAC Filters Can Limit Turbidity Breakthrough
if Zeta Potentials are Optimized
Turbidity Recap
Actiflo and GAC Filters

- Turbidity Breakthrough Possible—Very Negative Zeta
  - Ferric and Anionic Polyacrylamide Polymer at Actiflo
  - Additional Ferric On Filters

- Extremely Plugged Filters
  - Ferric and Cationic Polyacrylamide Polymer at Actiflo

- Finally Figured It Out – Good Turbidity Removal and Filter Run Times
  - Cationic DADMAC Polymer prior to Actiflo to help Zeta P.
  - Ferric and Anionic Polyacrylamide Polymer at Actiflo
  - Additional Ferric On Filters
Deer Valley WTP GAC Media TOC Exhaustion Curve

Sand Ballasted Flocculation Eff TOC PPM
Combined Filter Eff TOC PPM

Deer Valley WTP – 4 Regen Filters Placed In Service
.31 PPM TOC Reduction

Sand Ballasted Flocculation Eff TOC PPM
Combined Filter Eff TOC PPM

Raw TOC

Placed 4 Regenerated Filters in Service at 216 Average Filter Run Days
2 On-line at a Time
2 Duty - 2 Standby
.31 ppm TOC Reduction

Plant Shutdown

Placed 4 Regenerated Filters in Service at 303 Average Filter Run Days
1 On-line at a Time
1 Duty - 1 Standby

GAC Filters Exhausted at 11 Months

Combined Filter Eff TOC PPM

Combined Filter Eff TOC PPM
Deer Valley WTP – 2 Regen Filters Placed In Service

0.21 PPM TOC Reduction

Placed 2 Regenerated Filters in Service at 363 Average Filter Run Days
1 On-line at a Time
(1 Duty - 1 Standy)

0.21 ppm TOC Reduction
Increased Ferric from 20 to 30 ppm for better TOC removal

24th Street WTP GAC Media TOC Exhaustion Curve

GAC Filters Exhausted from a TOC Removal Perspective at 4.5 Months
TOC Recap

• All 18 of Deer Valley’s GAC Filters Were Considered Exhausted from a TOC Removal Perspective at 7.5 Calendar Months. (117 average filter run days based on actual filtration time)

• All 16 of 24th Street’s GAC Filters Were Considered Exhausted from a TOC Removal Perspective at 4.5 Calendar Months.
Deer Valley WTP - Filter Eff and EPDS Chlorite Residuals go to Zero When Chlorite Applied to the GAC Media Goes to Zero

GAC Media Does NOT Leach Chlorite

24th Street WTP GAC Media Chlorite Exhaustion Curve

GAC Filters Chlorite Adsorption Levels Off at 10 Months
Chlorite Recap

• Deer Valley’s GAC Media Still Removes Chlorite from .6 to less than .2 ppm After 27 Months of Usage (6 regenerations)

• 24th Street’s GAC Media Still Removes Chlorite from .6 to less than .3 ppm After 20 Months of Usage (0 regenerations)

• Once the Applied Chlorite on top of the GAC Media is Removed, the Chlorite Leaving the GAC Media is Removed (GAC does not leach chlorite)

---THM Reduction Intro---

Why are Municipalities Starting to Use Pre-chlorination / Pre-oxidation Prior to GAC

• 30% - 40% THM Reductions at the Reservoir Effluent as Well as the Far Reaches of the Distribution System.

• Iron / Manganese Oxidation Prior to Filtration

• Very Economical

• Can Reduce GAC Regeneration Frequency (Big $)
Deer Valley 2011 TTHM's
Mixed Oxidants vs Chlorine Dioxide Bt Itself

Deer Valley GAC Filters 2011 - 2013 THM Breakthrough Curve
GAC Media Still Continues to Remove THM's
Deer Valley's GAC Filters 2013 THM Breakthrough Curve

Typical TOC, Chlorite, Chlorine, and THM's Applied to GAC Media While Practicing Pre-Oxidation / Mixed Oxidants
24th Street GAC Filters 2012 through 2013 THM Breakthrough Curve

GAC Media Will Leach THM's - Unlike Chlorite

24th Street EPDS THM Speciations Under Mixed Oxidant, Ferric Chloride, & PAC Variations

Mixed Oxidant (Cl₂ & ClO₂ at 1:1)
Mixed Oxidants OFF (CO₂ by itself)
Ferric at 20 ppm
Ferric 10 PAC OFF
PAC at 7 ppm
Turned PAC OFF
Cut Ferric 20 to 10 ppm
Increased Ferric from 10 to 20 ppm
Mixed Oxidants Still ON
Mixed Oxidants Back ON

Mixed Oxidants OFF
Ferric 10
PAC OFF
Turned PAC ON at 7 ppm

EPDS Total THM
EPDS Bromodichloromethane
EPDS Dibromochloromethane
EPDS Bromoform
EPDS Chloroform
24th Street Chloroform through Plant Process
Chloroform No Longer Removed through GAC – Small Impact on EPDS THM's

Mixed Oxidants (Cl₂ & ClO₂ at 1:1)
Ferric at 20 ppm
PAC at 7 ppm
Mixed Oxidants OFF (ClO₂ by itself)
Cut Ferric 20 to 10 ppm
Turned PAC OFF

Mixed Oxidants Back ON
Ferric 10
PAC OFF

Mixed Oxidants Still ON Increased Ferric
from 10 to 20 ppm
Turned PAC ON at 7 ppm

24th Street - Chloroform Percentage of TTHM Through Process
EPDS Chloroform Percentage Changed Due to Mixed Oxidants vs ClO₂ By Itself

Mixed Oxidants (Cl₂ & ClO₂ at 1:1)
Ferric at 20 ppm
PAC at 7 ppm
Mixed Oxidants OFF (ClO₂ by itself)
Cut Ferric 20 to 10 ppm
Turned PAC OFF

Mixed Oxidants Back ON
Ferric 10
PAC OFF

Mixed Oxidants Still ON Increased Ferric
from 10 to 20 ppm
Turned PAC ON at 7 ppm

Individual THM Percent of Total THM

0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%
100%
24th Street Bromoform through Plant Process
Bromoform is Still Removed through GAC – But Small Impact on EPDS THM’s

- Mixed Oxidants (Cl₂ & ClO₂ at 1:1)
- Ferric at 20 ppm
- PAC at 7 ppm

- Mixed Oxidants Back
- Ferric 10
- PAC OFF

Mixed Oxidants OFF (ClO₂ by itself)
Cut Ferric 20 to 10 ppm
Turned PAC OFF

Increased Ferric from 10 to 20 ppm
Turned PAC ON at 7 ppm

EPDS Bromoform
Comb Flt Eff Bromoform
Final Sed Eff Bromoform

24th Street - Bromoform Percentage of TTHM Through Process
EPDS Bromoform Percentage Mainly Unchanged

- Mixed Oxidants (Cl₂ & ClO₂ at 1:1)
- Ferric at 20 ppm
- PAC at 7 ppm

- Mixed Oxidants OFF
- Ferric 10
- PAC OFF

Mixed Oxidants Back
Increased Ferric
Cut Ferric 20 to 10 ppm
Turned PAC ON

EPDS Bromoform
Comb Flt Eff Bromoform
Final Sed Eff Bromoform
**24th Street Bromodichloromethane through Plant Process**

Bromodichloro is No Longer Removed through GAC – But it has a Large Impact on EPDS THM’s

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**Graph:**

- **Y-axis:** PPM
- **X-axis:** Dates from 4/2/13 to 8/6/13
- **Graph Elements:**
  - Mixed Oxidants (Cl₂ & ClO₂ at 1:1)
  - Ferric at 20 ppm
  - PAC at 7 ppm
  - Mixed Oxidants OFF (ClO₂ by itself)
  - Ferric 10
  - PAC OFF
  - Mixed Oxidants BACK ON
  - Ferric 10 Increased from 10 to 20 ppm
  - PAC OFF at 7 ppm

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**Table:**

- **Columns:**
  - 24th Street
  - Bromodichloromethane Percentage of TTHM Through Process
  - EPDS Bromodichloro Percentage
- **Rows:**
  - **Final Sed Eff Bromodichloromethane**
  - **Comb Flt Eff Bromodichloromethane**
  - **EPDS Bromodichloromethane**

**Legend:**

- **Final Sed Eff Bromodichloromethane**
- **Comb Flt Eff Bromodichloromethane**
- **EPDS Bromodichloromethane**

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**Text:**

Individual THM Percent of Total THM

EPDS Bromodichloro Percentage Mainly Unchanged
24th Street Dibromochloromethane through Plant Process

Dibromochloro is Still Removed through GAC – And has the Largest Impact on EPDS THM’s

Mixed Oxidants (Cl₂ & ClO₂ at 1:1)
Ferric at 20 ppm
PAC at 7 ppm
Mixed Oxidants OFF (ClO₂ by itself)
Cut Ferric 20 to 10 ppm
PAC OFF
Mixed Oxidants Back ON
Ferric 10
PAC OFF
Turned PAC OFF
Mixed Oxidants Still ON
Increased Ferric from 10 to 20 ppm
PAC ON at 7 ppm
Increased Ferric
Turned PAC ON at 7 ppm

24th Street - Dibromochloromethane Percentage of TTHM Through Process
EPDS Dibromochloro Percentage Changed Due to Mixed Oxidants vs ClO₂ By Itself
Recap - THM Reductions from Pre-Oxidation Prior to GAC

- 30% - 40% THM Reductions at the Reservoir Effluent as Well as the Far Reaches of the Distribution System.
- Dibromochloromethane and Bromodichloromethane are Reduced the Most.
- Dibromochloromethane and Chloroform Exchange Their Percentage of the TTHM with Each Other. Chloroform Goes Up and Dibromochloromethane Goes Down.
- GAC Media will leach THM’s – Unlike Chlorite

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Finish Line – Data Overload

Questions ????