



Feed Water Reduction in Industrial Water Purification Systems

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Water Purification System

- Power Generation
- Semiconductor
- Pharmaceutical
- General Applications
 - Consumer Products
 - Plating
 - Electronics
 - Food & Dairy
 - Etc.

Water Purification System Components

- Multimedia Filtration Units
- Activated Carbon Units
- Water Softeners
- Deionization Units
- Reverse Osmosis Units
- Organic Scavengers
- Ultrafiltration Units
- Continuous Electrodeionization

Water Purification System

Wastewater Generation (Feed Water Demand)

- Multimedia Filtration Unit **Backwash**
- Activated Carbon Unit **Backwash**
- Water Softener **Backwash, Regeneration, and Rinse**
- Deionization Unit **Backwash, Regeneration, and Rinse**
- Reverse Osmosis Unit **Waste Flow**
- Organic Scavenger **Backwash, Regeneration, and Rinse**
- Ultrafiltration Unit **Waste Flow**
- Continuous Electrodeionization **Waste Flow**

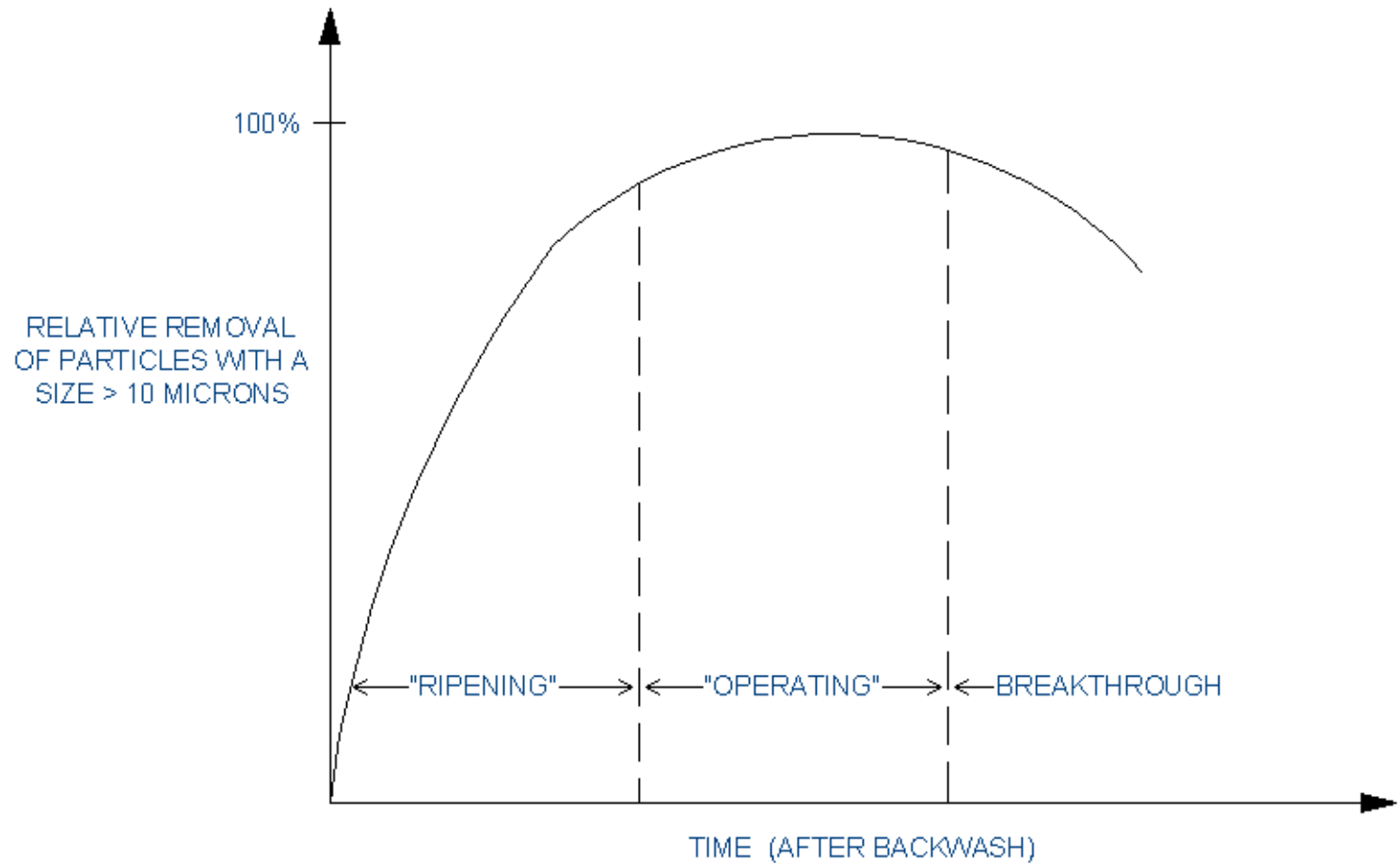
Selection of Unit Operations – Waste and Feed Water Reduction

- **Multimedia Filtration Unit**
Backwash
- **Ion Exchange/Deionization**
Backwash, Regeneration, and
Rinse
- **Reverse Osmosis Unit** **Waste Flow**

Multimedia Filtration Unit **Operation** & **Backwash**

- Operation
 - Units backwashed too frequently
 - Frequency does not allow “ripening”, a process that increases the particulate removal capability of a unit, to occur
 - Backwash should be based on pressure drop through the filter bed not the elapsed time that backwash was performed

FIGURE A - Ripening of a Multimedia Filtration Unit



Multimedia Filtration Unit **Operation** & **Backwash**

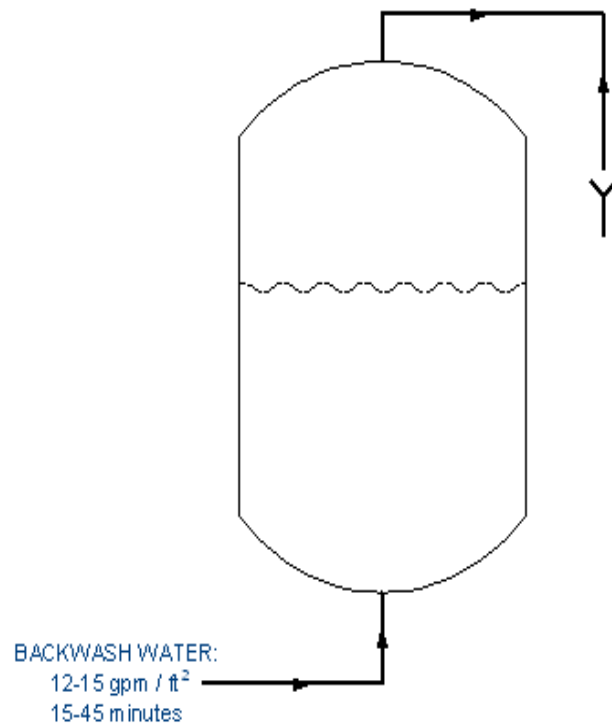
- Classical Backwash
 - Backwash is conducted at 12-15 gpm per square foot of cross sectional bed area (70°F backwash water)
 - Duration of the backwash operation is generally 20-45 minutes
 - A post backwash “settle” step and final rinse (6 gpm per square foot of cross sectional bed area) are performed

Multimedia Filtration Unit **Operation** & **Backwash**

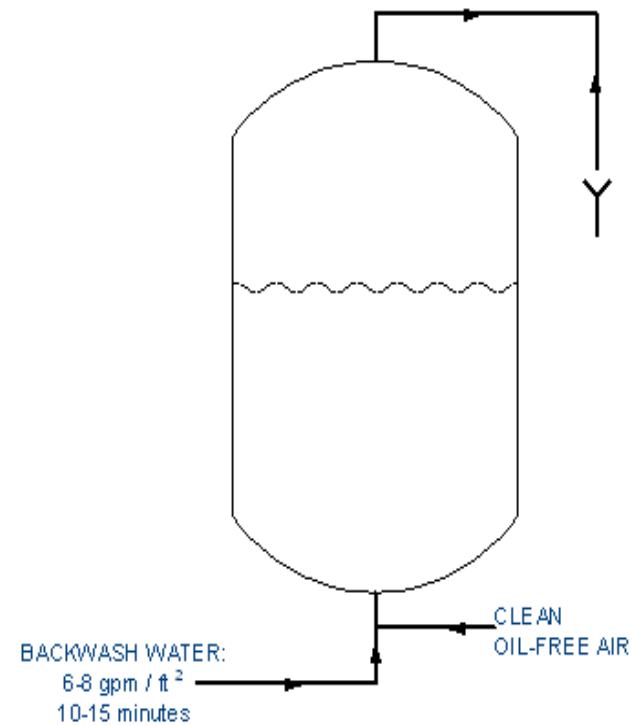
- Reduced Waste Backwash
 - Backwash is conducted at 6-8 gpm per square foot of cross sectional bed area (70°F backwash water) with “air scour”
 - Duration of the backwash operation is generally 10-15 minutes
 - A post backwash “settle” step and final rinse (6 gpm per square foot of cross sectional bed area) are performed

FIGURE B - Air Scouring of a Multimedia Filtration Unit During Backwash

CONVENTIONAL BACKWASH



BACKWASH WITH AIR SCOURING



Multimedia Filtration Unit **Operation** & **Backwash**

- Projected Feed Water and Wastewater Reduction for Backwash of a 48" Diameter Unit
 - Minimum = 1500 gallons/backwash
 - Maximum = 5100 gallons/backwash
 - Minimum Annual = 160,000 gallons
 - Maximum Annual = 550,000 gallons

Ion Exchange and Deionization System Operation & Regeneration

- Classical Operation
 - Vast majority of both water softening and deionization systems operate with downward flow and downward regeneration (“co-current”)
 - This process is highly ineffective since it essentially results in the “poorest” regenerated resin at the bottom of the bed, the location of discharge.

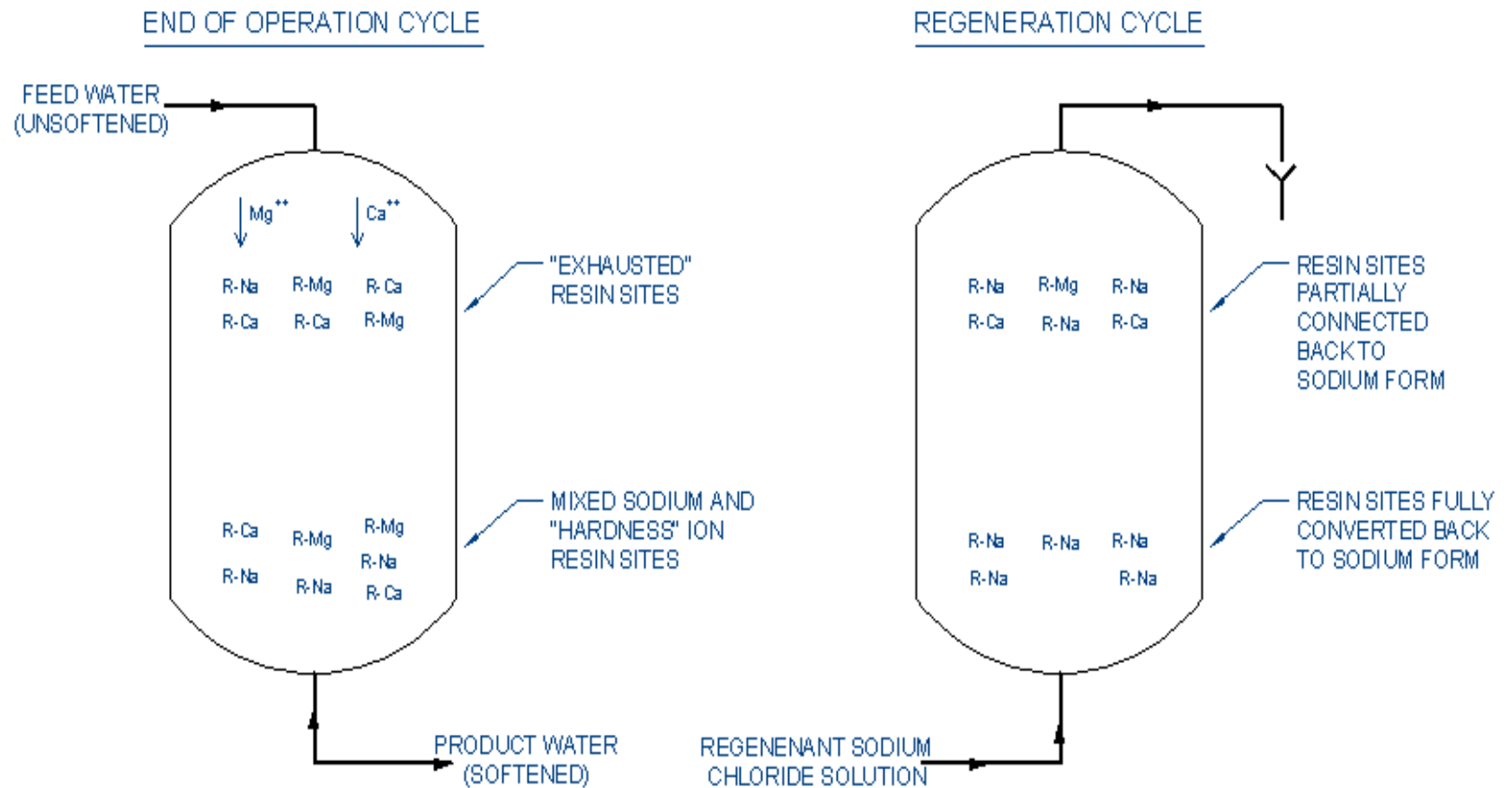
Ion Exchange and Deionization System Operation & Regeneration

- Classical Operation (continued)
 - As a result of classical co-current regeneration ionic “breakthrough” (or “hardness breakthrough”) occurs when the ion exchange capacity of the bed is not fully utilized.
 - This increases the frequency of regeneration and the use of feed water/waste water for backwash, regeneration, displacement (slow) rinse and final (fast) rinse.

Ion Exchange and Deionization System Operation & Regeneration

- Enhanced Operation and Regeneration
 - Countercurrent operation can not only reduce the volume of feed water and wastewater generated but also increase product purity, extend the time period between regeneration and decrease regenerant chemical requirements by as much as 50%.
 - Countercurrent operation employs downward flow during operation and upward flow of regenerant chemicals.
 - The technology requires a “fixed” bed which can be achieved by several methods.

FIGURE C - Fixed Bed Ion Exchange



Ion Exchange and Deionization System Operation & Regeneration

- Projected Feed Water and Wastewater Reduction for Operation and Regeneration of a 48" Diameter Two-Bed Deionization Unit
 - Minimum = 4400 gallons/regeneration
 - Maximum = 5430 gallons/regeneration
 - Minimum Annual = 440,000 gallons
 - Maximum Annual = 543,000 gallons

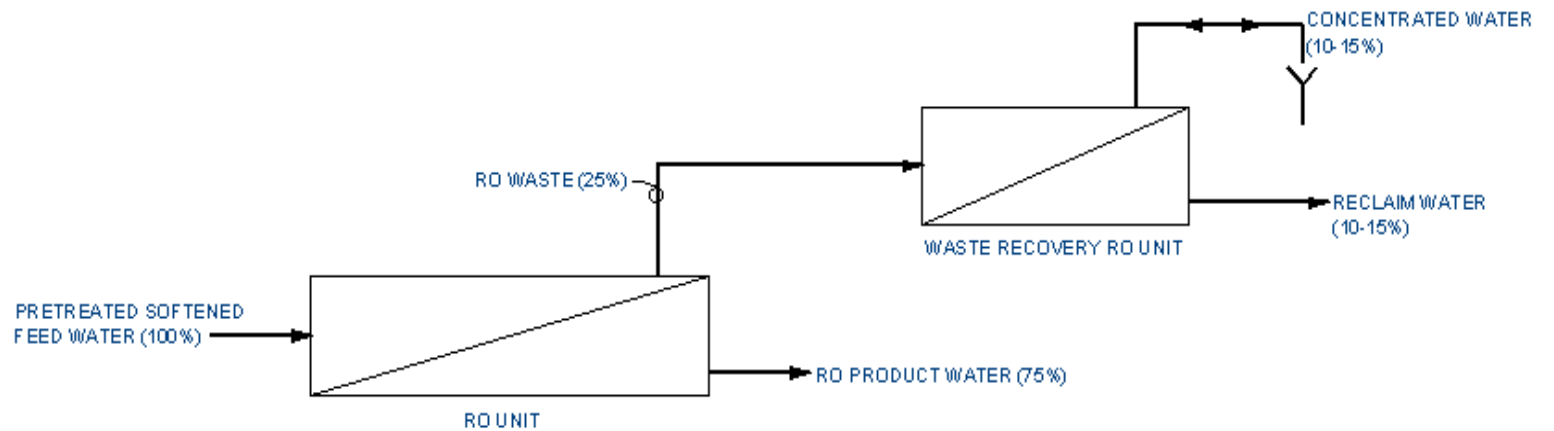
Reverse Osmosis Unit Operation

- Classical Operation
 - Recovery of pretreated feed water = 75%
 - Pretreated water generally treated by multimedia filtration, water softening, and activated carbon adsorption.
 - 25% of feed water directed to waste without recovery or reclaim

Reverse Osmosis Unit Operation

- Enhanced Operation
 - Pretreated wastewater fed to second reverse osmosis unit.
 - Wastewater recovery reverse osmosis unit operated at 50% recovery.
 - Recovered feed water (softened with low TDS level) fed back to “blend tank with raw feed water at the beginning of the system. Hypochlorite addition may be required.

FIGURE D - Recovery of RO Wastewater



Reverse Osmosis Unit **Operation**

- Projected Feed Water and Wastewater Reduction for Operation of a 100 gpm RO Unit at 12 hour/day demand:
 - Minimum = 12,000 gallons/day
 - Maximum = 20,000 gallons/day
 - Minimum Annual = 4,375,000 gallons
 - Maximum Annual = 5,400,000 gallons



Thank you!