Conversions of single bed strong base anion units to Stratified Anion at various Pulp and Paper Mills in Canada

By
Don Downey and Claude Gauthier
Purolite Canada

USA
Telephone: (1) 610-668-9090
Fax: (1) 610-668-8139
Email: info@puroliteusa.com

Europe
Telephone: +44 1443 229334
Fax: +44 1443 227073
Email: sales@purolite.com

Asia Pacific
Telephone: +86 571 876 31385
Fax: +86 571 876 31385
Email: pultalan@purolitechina.com

Process Summary

Stratified anions consist of a layer of weak base resin over a layer of strong base resin in the same vessel. Considerations for converting standard strong base anions to a stratified operation are:

- Weak base resin develops approximately twice the operating capacity (OC) Vs strong base resin at the same caustic dosage. Example, at 5 lb/ft^3-R of NaOH, WBA resin develops 28 Kgr/ft^3 OC compared to 14 Kgr/ft^3 OC for SB resin.
- The WBA resin costs approximately 20% more per unit volume, but the increased caustic efficiency offsets the cost within 6 to 8 months. Overall caustic usage for a typical demineralizer plant can be expected to decease by 25%.
- Increased capacity means decreased regen frequency. There is an inherent risk associated with doing the regens, hot caustic is moving around, lines connected to in-service vessels are pressurized with caustic, the vessels have to be rinsed after regeneration prior to going into service, and each of these factors can, potentially, cause a pH excursion in the boilers. Simply reducing the regen frequency will reduce the risk exposure.
- The weak base resin is an excellent organic trap. Used in the stratified bed the WBA will remove a large portion of the organics leaving more OC in the SBA resin for SiO_2 and CO_2 exchange. This reduces organic fouling of the strong base resin, lowering the need for routine brine squeezes.

Locations Converted

Bowater, Thunder Bay ON, January 1999.

The river water supply influent quality to Bowater is highly variable with respect to TOC and turbidity levels. The dosage levels of alum for the clarifiers vary as result adding significant ionic loading to the anion units. Bowater was spending approximately $290,000 annually on caustic for the WTP.

The original design basis for the Graver co-current regenerated anion units, which are 8' Ø x 8' straight side containing 220 ft^3 Type I strong base anion resin. Based on a NaOH dosage of 4lb/ ft^3 the rated capacity for the SBA unit was 280,000 USG.

By changing the anion unit over to a strata bed unit utilizing 80 ft^3 of weak base anion resin and 120 ft^3 of strong base anion resin, the new throughput is 400,000 USG and an annual savings of $ 145,000 per year of caustic.

UPM-Kymmene Miramichi, Miramichi NB, April 2004

The river water supply influent quality to the UPM mill is highly variable with respect to TOC and chloride levels. The loading to the anion units ranges from 14ppm FMA to a high of 38 ppm. The plant spends approximately $260,000 on high purity caustic for the WTP.

The original design basis for the Glegg split-flow regenerated anion units, which are 9'-6" Ø x 8'-6" straight side containing 285 ft^3 Type I strong base anion resin. Based on a NaOH dosage of 5lb/ ft^3 the rated capacity for the SBA unit was 910,000 USG. Because of high organic fouling the SBA resin performance drop to less than 50% throughput within the first 3 months of operation. Frequent brine cleaning was needed to maintain 500,000 USG of throughput. The brine cleaning added an additional $50,000 to the systems operation cost.

By changing the anion unit over to a strata bed unit utilizing 100 ft^3 of weak base anion resin, to take up the organic load, and 185 ft^3 of strong base anion resin, the throughput retuned to + 900,000 USG and an estimated annual savings of $ 110,000 per year of caustic.

Weyerhaeuser, Dryden ON, July 2004

The river water supply influent quality to the mill water treatment plant is highly variable with respect to TOC, SiO2 and turbidity levels. The clarifiers are vary un-reliable, adding significant ionic loading to the anion units. The plant spends approximately $280,000 on caustic for the WTP.

The original design basis for the Gaco co-counter regenerated anion units, which are 9' Ø x 8' straight side containing 240 ft^3 Type I strong base anion resin. Based on a NaOH dosage of 4lb/ ft^3 the rated capacity for the SBA unit was 920,000 USG. Because of high organic fouling the SBA resin performance drop to less than 50% throughput within the first 3 months of operation. Frequent brine cleaning was needed to maintain 500,000 USG of throughput. The brine cleaning added an additional $50,000 to the systems operation cost.

By changing the anion unit over to a strata bed unit utilizing 100 ft^3 of weak base anion resin, to take up the organic load, and 140 ft^3 of strong base anion resin, the throughput returnned to +900,000 USG and an estimated annual savings of $ 50,000 per year of caustic.

Kimberly Clark, New Glasgow NS, October 2004

The river water supply influent quality to the mill is highly variable with respect to TOC and turbidity levels. The significant ionic loading to the anion units ranges from a low of 12 FMA to a high of 60 ppm FMA (43 ppm average). The plant spends approximately $120,000 on high purity caustic for the WTP.

The original design basis for the Ecodyne split flow regenerated anion units, which are 7' Ø x 6' straight side containing 90 ft^3 of WBA and 80 ft^3 of Type I strong base anion resin. Based on a NaOH dosage of 5.7lb/ ft^3 the rated capacity for the SBA unit was 540,000 USG. During the many years of operation the WBA resin from all three beds had been backwashed out and the units where top up with a variety of strong base anion resin. This resulted in an average throughput of 200,000 USG.

By returning the anion unit back to a strata bed unit utilizing 90 ft^3 of weak base anion resin and 260 ft^3 of strong base anion resin, the new throughput is 600,000 USG and an estimated annual savings of $ 45,000 per year of high purity caustic.

Daishowa-Marubeni, Peace River AB, March 2005

The river water supply influent quality to the Peace River mill water treatment plant is highly variable with respect to colour and turbidity levels. The dosage levels of alum for the clarifiers vary as result adding significant ionic loading to the anion units ranging from a low of 16 FMA to a high of 75 ppm FMA (43 ppm average). The plant spends approximately $ 120,000 on high purity caustic for the WTP.

The original design basis for the Glegg co-counter regenerated anion units, which are 9' Ø x 9' straight side containing 220 ft^3 Type I strong base anion resin. Based on a NaOH dosage of 5lb/ ft^3 the rated capacity for the SBA unit was 388,000 USG. The regenerant collector was turned up and moved to the upper bracket to allow for an additional 115 ft^3 of SBA resin to be added to the unit. The SBA units produce 1,100,000.

USA
Telephone: (1) 610-668-9090
Fax: (1) 610-668-8139
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Europe
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Email: sales@purolite.com

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Fax: +86 571 876 31385
Email: pultalan@purolitechina.com

By changing the anion unit over to a strata bed unit utilizing 90 ft^3 of weak base anion resin and 260 ft^3 of strong base anion resin, the new throughput is 1,527,000 USG and an estimated annual savings of $ 30,000 - $ 50,000 per year of high purity caustic.

Operation changes needed to avoid problems with conversion of single bed anion to stratified units.

- **AVOID LOSS OF THE LIGHTER WBA Resin -** WB resin has a much lower density than SB and so, the backwash rate needs to be reduced to about 1/3 of present setting. For 75^0F, this would be < 3.0 USGPM/ft^2.
- Since most colloidal matter is captured in the primary cations, the subsurface and or backwash step could be skipped. If high-pressure differential across the resin bed is encountered then re-start the subsurface and or backwash steps.
- Monitor the interface between the SB and WB. The WB resin is macroporous (opaque) while the SB is a gel so the interface layer should be very apparent. A change of 10% in the interface level will lower the performance of the stratified bed significantly
- The reduced caustic rinsed to the sewer from less frequent anion regenerations could result in a low effluent pH resulting in a need to feed caustic. If it was a chronic problem, add some of the caustic back into regens by increasing the regenerant dosage.
- On rare occasions the reduced volume of SB resin could result in higher silica leakage. For this concern an adjustment of the ratio of SBA to WBA may be necessary.

****** Please see attached Pulp and Paper Ion Exchange Survey Form ******

Pulp and Paper Ion Exchange Survey Form

Required Minimum Information

Date		Customer	
Contact		Location	

1. INFLUENT SOLUTION SPECIFICATION

1.1 Origin	
1.2. Pretreatment	

1.3 Influent Analysis

Cations		Unit	Anions		Unit	Others		Unit
Ca			HCO_3			CO_2		
Mg			CO_3			SiO_2		
Na			Cl			Conductivity		
K			SO_4			pH		
Fe			NO_3			Temperature		
Others			Others			TOC		
T.C.			T.A.			Organics		

1. DESIGN INPUT DATA

2.1. Flow rate per train		USGPM
2.2. Running time		Hours
2.3. Net run		Gallons

USA
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Email: sales@purolite.com

Asia Pacific
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Fax: +86 571 876 31385
Email: pultalan@purolitechina.com

2. TREATED WATER QUALITY

3.1. Conductivity		µS/cm
3.2. Resistivity		MOhm
3.3. Sodium		ppb
3.4. Silica		ppb
3.5. Total Hardness		meq/l
3.6. Alkalinity		meq/l
3.7. Nitrate		ppm
3.8. Others (specify)		

Existing Operation Information

3. Strong acid cations

Diameter (inches)		Straight side (inches)	
Flow rate (USGPM)		Resin volume (ft^3)	
Regeneration mode (co current, split flow, or counter current)		Throughput (gallons)	
Acid requirements per regeneration (lb)		Acid used for regeneration (H_2SO_4, or HCl)	

4. Degasifier

Diameter (inches)		Flow rate (USGPM)	

5. Strong base anions

Diameter (inches)		Straight side (inches)	
Flow rate (USGPM)		Resin volume (ft^3)	
Resin type or manufacturers model number		Caustic regeneration temperature (^{0}F)	
Regeneration mode (co current, split flow, or counter current)		Throughput (gallons[3])	
Caustic requirements per regeneration (kg)			

6. **Regeneration sequence**

SAC	Flow rate – USGPM	Time - minutes	SBA	Flow rate –USGPM	Time - minutes
Subsurface wash			Subsurface wash		
Backwash			Backwash		
_____ % Acid inject			Bed preheat _____ ^{0}C		
_____ % Acid inject			_____ % Caustic inject		
Acid displace			Caustic displace		
Fast rinse			Fast rinse		

Required Minimum Information - metric

Date		Customer	
Contact		Location	

2 INFLUENT SOLUTION SPECIFICATION

1.1 Origin	
1.2. Pretreatment	

7.3 Influent Analysis

Cations		Unit	Anions		Unit	Others		Unit
Ca			HCO_3			CO_2		
Mg			CO_3			SiO_2		
Na			Cl			Conductivity		
K			SO_4			pH		
Fe			NO_3			Temperature		
Others			Others			TOC		
T.C.			T.A.			Organics		

7. DESIGN INPUT DATA

2.1. Running time		Hours		
2.2. Flow rate per train		m^3/h		USGPM
2.3. Net run		m^3		Gallons

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ION EXCHANGE RESINS

8. TREATED WATER QUALITY

3.1. Conductivity		µS/cm
3.2. Resistivity		MOhm
3.3. Sodium		ppb
3.4. Silica		ppb
3.5. Total Hardness		meq/l
3.6. Alkalinity		meq/l
3.7. Nitrate		ppm
3.8. Others (specify)		

Existing Operation Information

9. Strong acid cations

Diameter (mm)		Straight side (mm)	
Flow rate (m^3/hr)		Resin volume (m^3)	
Regeneration mode (co current, split flow, or counter current)		Throughput (m^3)	
Acid requirements per regeneration (kg)		Acid used for regeneration (H_2SO_4, or HCl)	

10. Degasifier

Diameter (mm)		Flow rate (m^3/hr)	

11. Strong base anions

Diameter (mm)		Straight side (mm)	
Flow rate (m^3/hr)		Resin volume (m^3)	
Resin type or manufacturers model number		Caustic regeneration temperature (^{0}C)	
Regeneration mode (co current, split flow, or counter current)		Throughput (m^3)	
Caustic requirements per regeneration (kg)			

13. Regeneration sequence

SAC	Flow rate - m^3/hr	Time - minutes	SBA	Flow rate - m^3/hr	Time - minutes
Subsurface wash			Subsurface wash		
Backwash			Backwash		
_____ % Acid inject			Bed preheat _____ ^{0}C		
_____ % Acid inject			_____ % Caustic inject		
Acid displace			Caustic displace		
Fast rinse			Fast rinse		