

Purity Water & pH
Neutralization Systems
Mark Girgenti





### BURT PROCESS BURT EQUIPMENT

Lab Design: RO/DI High Purity Water & pH Neutralization Systems Mark Girgenti



assive System

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grigle direction freatment was a series of the arreman and the arremans

Active Systems

. Can treat in both directions
. Can treat waste of any strength
. Can treat waste of any strength









RODIF

### System Designs

There are three main styles of pH/waste water treatment.

- Flow Through Systems
- Batch Treatments Systems
- Hybrid Flow/Batch Systems



### **Passive Systems**

- · Single direction Treatment
- Unable to treat strong waste streams

### **Active Systems**

- · Can treat in both directions
- · Can treat waste of any strength



## Active vs. Passive Systems

pH Range

**Active Systems** 





### **Passive Systems**

- Single direction Treatment
- Unable to treat strong waste streams

### **Active Systems**

- Can treat in both directions
- Can treat waste of any strength



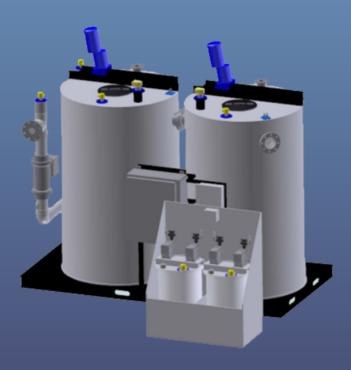
## System Components: Control Schemes

Proportional control is the most common control scheme for pH adjustment systems. It is based on the logarithmic nature of pH and adjusts the chemical addition proportionally to the pH reading or any other waste constituent you can measure in real time.





# Major System Components





### System Components: **Treatment Tanks**

The treatment tanks in a pH adjustment system are designed as continuously stirred-tank reactors (CSTR). They are sized and agitated to create ideal mixing so the pH in the tank is equivalent to the pH leaving the tank.



### **System Components: Tank Agitation**



### **System Components: Chemical Injection**



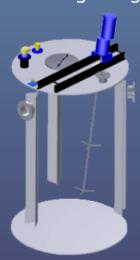
## System Components: Tank Agitation

In tank mixers are the ideal choice for tank agitation due to their capacity.

### Rate of Mixing:

1.5 x tank volume pumping rate required for well mixed solution.

Due to the ideal model of the CSTR, multiple stages are more efficient then one large stage.





## System Components: Chemical Injection

Since a CSTR model allows for uniform pH across the treatment tank, reagent injection must be properly injected into the mixer wash and controlled to avoid swings in pH and to allow for adequate mixing for other reagents. The most common reagents for pH adjustment are sulfuric acid and sodium hydroxide. Additionally, carbon dioxide gas can be used.

### **Important Considerations**

- Turn down for reagent injection proportional to logarithmic pH scale.
- Careful not to oversize to avoid instability in controlling pH.
- Other Reagents adds on a volumetric basis for additional treatment



## Case Study 1 Application: Collegiate Biology Building

### 1st step is develop the flow profile:

The system accepts waste from a 7 floor lab building.

- 100 Lab Sinks
- 50 cup sink

### **Using the Sizing Calculations**

Lab Sink Flow= 1 GPM x 100 Lab Sinks = 100 GPM Cup Sink = 0.5 GPM x 50 Cup Sinks= 25 GPM Fume Hood = 0.25 GPM x 12 Fume hoods= 3 GPM Total Fixture Flow is 128 GPM x 20% diversity factor= 26 GPM Assuming 1 cage washer operating at 8 GPM, TOTAL Flow=34 GPM

### System selection

Based on 34GPM flow rate over a pH differential of 4 from neutral

### 400 Gal. CONTINUOUS FLOW SYSTEM

Flow Through Tank Size Based on 34 GPM and achieve a 15 minute residence time.

34G x 15 Min~ 500 gal. total volume.

Based on review of chemicals in building use and nature of the client the pH range







### 1st step is develop the flow profile:

Flow profile

The system accepts waste from a 7 floor lab building.

Fixture counts include:

- 100 Lab Sinks
- 50 cup sink
- 12 Fume Hoods
- 2 Cage washers

### **Using the Sizing Calculations**

Calculate Flow

Lab Sink Flow= 1 GPM x 100 Lab Sinks = 100 GPM

Cup Sink = 0.5 GPM x 50 Cup Sinks= 25 GPM

Fume Hood = 0.25 GPM x 12 Fume hoods= 3 GPM

Total Fixture Flow is 128 GPM x 20% diversity factor= 26 GPM

Assuming 1 cage washer operating at 8 GPM,

**TOTAL Flow=34 GPM** 



### 2nd Step is determining your waste characteristics

Based on review of chemicals in building use and nature of the client the pH range

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

**Special Waste Considerations:** 

None



### **System selection**

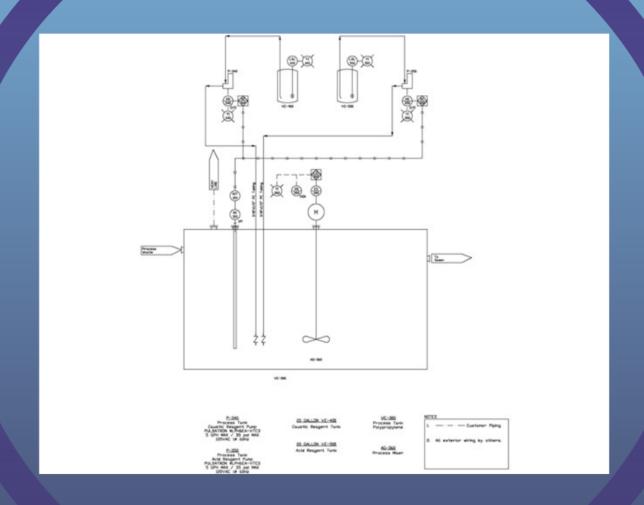
Based on 34GPM flow rate over a pH differential of 4 from neutral

### **400 Gal. CONTINUOUS FLOW SYSTEM**

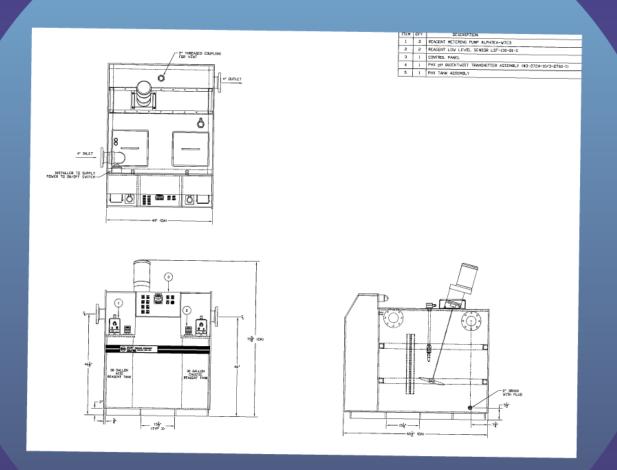
Flow Through Tank Size Based on 34 GPM and achieve a 15 minute residence time.

34G x 15 Min~ 500 gal. total volume.











### **RODI High Purity Water**





### **Water Quality Standards**

ASTM Standards (Types 1-4) (American Society for Testing and Materials)

Parameter	ASTM 1	ASTM 2	ASTM 3	ASTM 4
Conductivity (mS/cm)	0.056	1.0	0.25	5.0
Resistivity (megohm-cm)	18.0	1.0	4.0	0.2
рН				5.0-8.0
TOC (mg/L)	100	50	200	
Sodium (mg/L)	1	5	10	50
Chloride (mg/L)	1	5	10	50
Nitrate (ppm)				
Silica (mg/L)	3	5	500	No limit
Bacteria (cfu/mL)	0.01	0.1	10	



### **Water Quality Standards**

CAP Guidelines (Types 1-3)
(College of American Pathologists)
\*previously known as the National Committee
for Clinical Laboratory Standards\*

Parameter	CAP/NCCLS 1	CAP/NCCLS 2	CAP/NCCLS 3
Conductivity (mS/cm)	< 0.1	< 0.5	< 10.0
Resistivity (megohm-cm)	> 10	> 2.0	> 1.0
рН			5.0-8.0
Silica (mg/L)	< 0.5	< 0.1	< 1.0

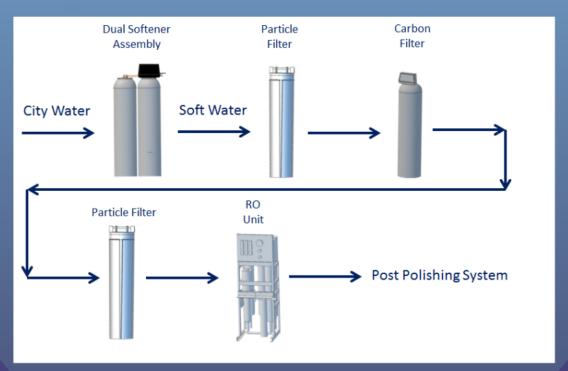


### **BPE's RODI System Basics**

- Pretreatment
- Reverse Osmosis
- Storage Tank
- Recirculation Pump (s)
- Ion Exchange (DI)
- UV (Ultraviolet lamps)
- Final Filter
- Instrumentation
- The Loop (plumbing)

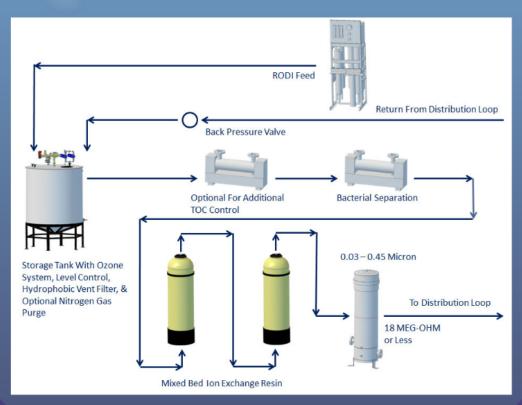


### Pretreatment Train





## Post RO Polishing System in The Loop





### **Design Conditions**

Parameters	Unit	Values
Cl	ppm	6.0
NO3	ppm	0.33
504	ppm	15.2
Ca	ppm	7.2
Mg	ppm	0.7
Na	ppm	22.2
Cu	ppm	0.03
Fe	ppm	0.04
F	ppm	1.0
CO2	ppm	0.03
TOC	ppm as C	1.6
TDS	ppm	58.7
pH (25°C)	-	9.35
Conductivity	μohms-cm	124
Alkalinity	ppm	46
Total Hardness	ppm	21
Free Chlorine	ppm	0.1 - 2.2
Turbidity	NTU	0.7

Parameters	Values (U5 unit)	Values (51 unit)	Remarks
Pre-treatment	80 GPM	18.2 m3/h	(TBD by supplier)
RO Make-up	60 GPM	13.6 m3/h	
Recirculation	125 GPM	28.4 m3/h	@ 90 psig = 6.4 kg/cm2

Parameters	Unit	DI Water
Supply Pressure	psig	70 ±10
Temperature	°F	55 - 77
Resistivity @ 25°C	Mohm-cm	≧ 10
TOC	ppb	≦300
Bacteria	CFU per ml	< 10



### Design Conditions

Parameters	Unit	Values
Cl	ppm	6.0
NO3	ppm	0.33
SO4	ppm	15.2
Ca	ppm	7.2
Mg	ppm	0.7
Na	ppm	22.2
Cu	ppm	0.03
Fe	ppm	0.04
F	ppm	1.0
CO2	ppm	0.03
TOC	ppm as C	1.6
TDS	ppm	58.7
pH (25°C)	-	9.35
Conductivity	μohms-cm	124
Alkalinity	ppm	46
Total Hardness	ppm	21
Free Chlorine	ppm	0.1 - 2.2
Turbidity	NTU	0.7



Parameters	Values (US unit)	Values (SI unit)	Remarks
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Alkalinity	ppm	46
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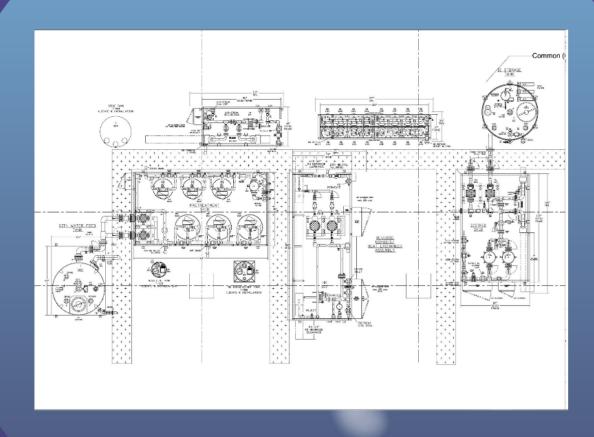
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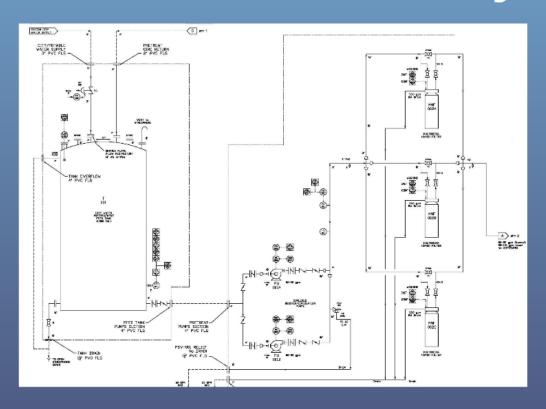
Parameters	Unit	DI Water
Supply Pressure	psig	70 ±10
Temperature	°F	55 - 77
Resistivity @ 25°C	Mohm-cm	≧ 10
TOC	ppb	≦300
Bacteria	CFU per ml	< 10



### RO

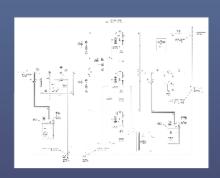








Colone   C	C 100E  806 gum  100 pum (CaCO <sub>2</sub> )  10 kt <sup>2</sup> 24 inches  15 ibs sati fft <sup>2</sup> each  15 ibs sati fft <sup>2</sup> each  25 k garen (16 each)  25 k garen (16 each)  25 k garen copacity  26 garen fft <sup>2</sup> regun  26 garen fft <sup>2</sup> 27 garen  28 garen  29 garen  29 garen  29 garen fft <sup>2</sup> 20 garen fft <sup>2</sup>		
## ## ## ## ## ## ## ## ## ## ## ## ##	## \$600 gam  100 pam (CaCO <sub>2</sub> )  10 ft <sup>2</sup> 28 inches  15 ibs saif (Ti <sup>2</sup> main  15, ibs saif (Ti <sup>2</sup> main  29,000 (grame (Th <sup>2</sup> main)  50,160 gashere  33,444 gashere  30,161 gashere  30,161 gashere  30,161 gashere  30,161 gashere  30 minutes  200 game (Th <sup>2</sup> 300 game (Th <sup>2</sup> )  300 game (Th <sup>2</sup> 300 game (Th <sup>2</sup> )  300 game (Th <sup>2</sup> )  300 game (Th <sup>2</sup> )	Softener Capacity Calcs	Softener Capacity Calcs
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10 th	10 th	80.0 gum	80.0 gpm
24 inches  25 inches  15 iba suit / ft <sup>2</sup> wasin  15 iba suit / ft <sup>2</sup> wasin  15 iba suit / ft <sup>2</sup> wasin  29,300 (grains / ft <sup>2</sup> reptn)  29,300 (grains / ft <sup>2</sup> reptn)  29,300 (grains / ft <sup>2</sup> reptn)  50,160 galtore.  10,5 istal hours in sevice  10,5 istal hours in sevice  10,5 galt disc bit wasin  10,7 garin  10,8 galt disc bit wasin  10,9 garin / ft <sup>2</sup> 20,9 garin  30,0 garin / ft <sup>2</sup> 30,0 gari	24 inches  25 inches  15 ibs suif (ft <sup>2</sup> wasin  15 ibs suif (ft <sup>2</sup> was	100 ppm (GaCO <sub>3</sub> )	150 ppm (CaCO <sub>3</sub> )
15 bs sail / ft <sup>2</sup> wash 29.300 (grams / ft <sup>2</sup> repin) 29.300 (grams / ft <sup>2</sup> repin) 29.3 k-grains capacity 29.5 k-grains capacity 50.162 galtere 33,441 galtere 10.5 (stat hours in service 150 bs sail / regain 600 gal core. Binne 161.3 gal disk binne 161.3 gal disk binne 200 gam 200 gam 200 gam 3.35 ga	15 ba sail (ft <sup>1</sup> wash 29,300 (grams (ft <sup>2</sup> repin) 293 k-grains capacity 293 k-grains capacity 295 k-grains capacity 50,162 gafore 33,441 gafore 10.5 total hours in service 1150 ba sail / regain 600 gal crox. Binne 1013 gal dish binne 1013 gal dish binne 1013 gal dish binne 200 gain 300 gain 111 300 gain / ti <sup>2</sup>	10 11	10 10
28,300 (grains (ff *regar) 29,300 (grains (ff *regar) 29,3 k-grains capacity 20,162 gallore 33,411 gallore 10,5 total hours in service 15,5 bas 41,7 regar) 60,0 gal core. Einne 16,1 gal diste Brince 10,1 gal diste Brince 10,1 gal dister Water 30 minutes	28.300 (grains (ff *repsh) 29.300 (grains (ff *repsh) 29.5 k-grains capacity 29.5 k-grains capacity 50.162 galore 33.411 galore 10.5 total hours in service 150 bs sat / regain 60 gal coro. Birne 161.3 gal diste Birne 101.3 gal dister Birne 101.3 gar 101.3 gar 102.5 gar / til 103.5 gar 103.1 gar	24 inches	24 inches
293 k-guains capacity 293 k-guains capacity 50,162 gallone 23,441 gallone 10.5 total hours in service 150 ba sat / regan 600 gat core. Brine 161.3 gal disk to Brine 161.3 gal disk of Brine 161.3 gar disk of Brine 161.3 gar 161.3 gar 161.3 gar 162.3 gar / ft <sup>2</sup> 163.5 gar / ft <sup>2</sup> 165.5 gar / ft <sup>2</sup> 165.5 gar 165.1	293 k-grains capacity 293 k-grains capacity 29,141 gathers 23,441 gathers 23,441 gathers 23,441 gathers 23,441 gathers 25, bit said / regain 60,0 gat cone, Birne 610,3 gat disk ten Pine 101,3 gar 101,3 gar 101,3 gar 101,3 gar 101,4 ga	15 Res salt / It <sup>a</sup> resin	15 Rs selt / It <sup>1</sup> resin
50,162 gallore 33,441 gallore 10.5 total hours in service 7.0 total hours in service 150 has sail / regars 600 gall core. Brive 1613 gall disk times 600 gall disk times 1013 gal	50.162 gallore 33,441 gallore 10.5 total hours in sevice 7.0 total hours in sevice 150 has sait 7 regars 600 gall core. Brine 161.3 gall disks Brine 161.3 gall	29,200 (gravins (ft <sup>3</sup> resin)	29,200 (grains fit <sup>3</sup> resin)
10.5 total hours in service  150 fas sail / regain 60.0 gal core. Brince 161.3 gal distret Water 101.3 gal distret Water 101.3 gal distret Water 20 mentals 20 gard 3.05 gard 3.	10.5 total hours in service  150 fas sail / regain 60.0 gal core. Brince 161.3 gal distret Water 101.3 gal distret Water 101.3 gal distret Water 20 mentals 20 gard 3.05 gard 3.	293 k-grains capacity	293 k-grains capacity
150 bs sail / regan 60 gat core. Brine 1613 gat dishe Brine 1613 garn 1613 garn 1614 garn 1615 garn 1616 garn 1617 dishe Brine 1618 garn 1618	150 lbs sail / riggin 600 gal cond. Birne 610 gal cond. Birne 611 gal dikter Miner 610 gal dikte Birne 610 gal dikte Birne 610 gal dikter Winer 610 gal dikter Winer 610 gal dikter Winer 610 gard 610 ga	50,162 gallors	23,441 gallors
60.0 gal conc. Binne 161.3 gal dikte Binne 161.3 gal dikter Water 101.3 gal dikter Water 101.3 gal dikter Water 10 minutes 20 minutes 20 minutes 20 garn 3.55 garn 3.55 garn 3.58 garn 3.58 garn 3.59 garn 1tt <sup>2</sup> 33.6 inches 33.7 it <sup>2</sup> 34.6 inches 35.6 garn 1tt <sup>2</sup> 35.5 garn 1tt <sup>2</sup> 35.7 garn	600 gal conc. Birne 161.3 gal dikte Birne 161.3 gal dikter Water 101.3 gal dikter Water 101.3 gal dikter Water 101.7 gal dikter Water 10 minutes 10 minute	10.5 total hours in service	7.0 total hours in service
60.0 gal conc. Binne 161.3 gal dikte Binne 161.3 gal dikter Water 101.3 gal dikter Water 101.3 gal dikter Water 10 minutes 20 minutes 20 minutes 20 garn 3.55 garn 3.55 garn 3.58 garn 3.58 garn 3.59 garn 1tt <sup>2</sup> 33.6 inches 33.7 it <sup>2</sup> 34.6 inches 35.6 garn 1tt <sup>2</sup> 35.5 garn 1tt <sup>2</sup> 35.7 garn	600 gal conc. Birne 161.3 gal dikter Birne 161.3 gal dikter Water 101.3 gal dikter Water 101.3 gal dikter Water 101.3 gal dikter Water 10 minutas 20 gare 3.55 gare 3.55 gare 3.58 gare 3.58 gare 3.58 gare 3.58 gare 3.59 gare 161 300 gare 1	150 he sat / moon	150 lbs salt / moon
161.3 gal dikte Birne 101.3 gal dikter Waser 101.3 gal dikter Waser 101.5 gar dikter Waser 101.5 gar 100 ga	161.5 gal dikte Birne 101.5 gal dikter Waler 101.5 gar dikter Waler 101.5 gar 100 gar 100 gar 100 gar 100 gar 101 100 ga		
10.1.3 gal distret Water  80 minutes  80 minutes  10.0 gam  10.5 g	10.1.3 gal distret Water  80 minutes  80 minutes  10.0 gam  10.5 g		
20 minutes   20 minutes   200 gam   300 gam   10   300 gam	20 minutes   20 minutes   200 gam   300 gam   10   300 gam		
200 gam 200 gam 305 gam 355 gam 355 gam 355 gam 555 gam 555 gam 555 gam 11" 500 gam / ti" 500 gam / ti" 500 gam / ti" 500 gam / ti" 505 gam 755 gam gam 75	200 gam 200 gam 305 gam 355 gam 535 gam 535 gam 535 gam 535 gam 535 gam 535 gam 16" 8.00 gam / fi <sup>2</sup> 395 inches 395 inches 301 fi <sup>2</sup> 201 fi <sup>2</sup> 201 fi <sup>2</sup> 205 gam / fi <sup>2</sup> 8.00 gam / fi <sup>2</sup> 8.00 gam / fi <sup>2</sup> 8.00 gam / fi <sup>2</sup> 15.1 gam 15.1 gam 20.1 gam		
3.55 gam	3.55 gam		
5.35 gare  8.00 gam / ti*  3.00 gam / ti*  3.01 ti*  3.01 ti*  3.01 ti*  3.01 ti*  3.02 gam / ti*  3.02 gam / ti*  3.03 gam / ti*  3.05 gam / ti*	5.35 gare  8.00 gam / ti*  3.00 gam / ti*  3.01 ti*  3.01 ti*  3.01 ti*  3.01 ti*  3.02 gam / ti*  3.02 gam / ti*  3.03 gam / ti*  3.05 gam / ti*		
\$00 gpm / tr' \$00 gpm / tr' \$39.5 inches \$39.5 inches \$39.5 inches \$30.1 tr' \$30.5 tr'	\$00 gpm / tr' \$00 gpm / tr' \$39.5 inches \$39.5 inches \$39.5 inches \$30.1 tr' \$30.5 tr'		
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301 tr <sup>2</sup> 2656 gpm / tr <sup>2</sup> 2656 gpm / tr <sup>2</sup> 500 gpm / tr <sup>2</sup> 500 gpm / tr <sup>2</sup> 500 gpm / tr <sup>2</sup> 15.1 gpm 20.1 gpm	301 tr <sup>2</sup> 2656 gpm / tr <sup>2</sup> 2656 gpm / tr <sup>2</sup> 500 gpm / tr <sup>2</sup> 500 gpm / tr <sup>2</sup> 500 gpm / tr <sup>2</sup> 15.1 gpm 20.1 gpm	5.00 gpm / ft <sup>4</sup>	8.00 gpm / ft <sup>2</sup>
20.56 gpm / ti <sup>2</sup> 20.56 gpm / ti <sup>2</sup> 8.00 gpm / ti <sup>2</sup> 8.00 gpm / ti <sup>2</sup> 8.00 gpm / ti <sup>2</sup> 15.1 gpm 15.1 gpm 20.1 g	20.56 gpm / ti <sup>2</sup> 20.56 gpm / ti <sup>2</sup> 8.00 gpm / ti <sup>2</sup> 8.00 gpm / ti <sup>2</sup> 8.00 gpm / ti <sup>2</sup> 15.1 gpm 15.1 gpm 20.1 g	39.8 inches	39.8 inches
8.00 gpm / ft* 8.00 gpm / ft* 15.1 gpm 15.1 gpm 30.1 gpm 30.1 gpm gpkors./ yr gpkors./ yr gpkors./ yr	8.00 gpm / lt* 8.00 gpm / lt* 15.1 gpm 15.1 gpm 30.1 gpm 30.1 gpm gallors / yr gallors / yr	3.01 H <sup>2</sup>	3.01 H <sup>0</sup>
15.1 gpm 15.1 gpm 30.1 gpm 30.1 gpm gallore/yr gallore/yr	15.1 gpm 15.1 gpm 30.1 gpm 30.1 gpm gallors/yr gallors/yr	26.56 gpm / ti <sup>2</sup>	26.56 gpm / 10 <sup>2</sup>
30.1 gpm 30.1 gpm gallors/yr gallors/yr	30.1 gpm 30.1 gpm gallone/yr gallone/yr	8.00 gpm / tt*	8.00 gpm / ft*
gallone / yr gallone / yr	gallone / yr gallone / yr	15.1 gpm	15.1 gpm
		30.1 gpm	30.1 gpm
- los sat/yr - los sat/yr	- los sat/yr - los sat/yr	gallons / yr	gallors/yr
		- los salt / yr	- los sat / yr

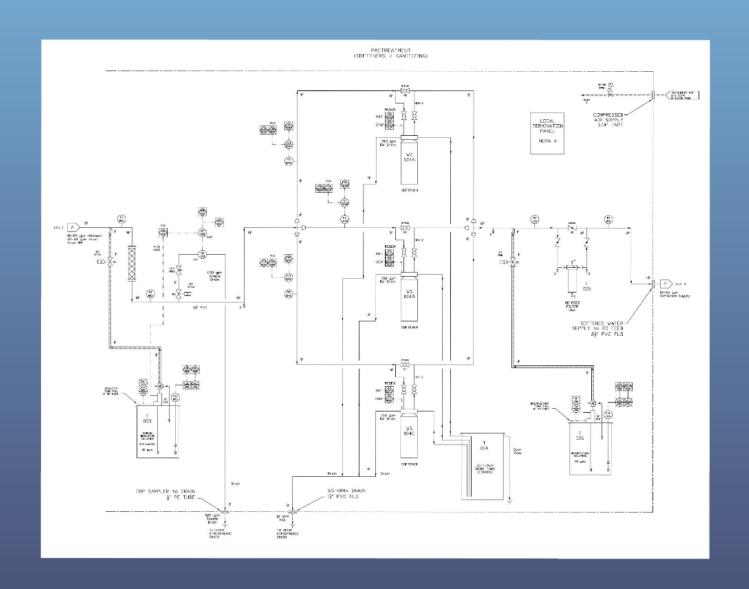




Softener	Capacity Calcs	Softener	Capacity Calcs
	C-100E		C-100E
80.0	gpm	80.0	gpm
100	ppm (CaCO <sub>3</sub> )	150	ppm (CaCO <sub>3</sub> )
10	ft <sup>3</sup>	10	ft <sup>3</sup>
24	inches	24	inches
15	lbs salt / ft <sup>3</sup> resin	15	lbs salt / ft <sup>3</sup> resin
29,300	(grains / ft <sup>3</sup> resin)	29,300	(grains / ft <sup>3</sup> resin)
293	k-grains capacity	293	k-grains capacity
50,162	gallons	33,441	gallons
10.5	total hours in service	7.0	total hours in service
150	lbs salt / regen	150	lbs salt / regen
60.0	gal conc. Brine	60.0	gal conc. Brine
161.3	gal dilute Brine	161.3	gal dilute Brine
	gal dilution Water		gal dilution Water
	minutes		minutes
2.00	apm	2.00	gpm
3.38	01		gpm
5.38			gpm
8.00	gpm / ft <sup>3</sup>	8.00	gpm / ft <sup>3</sup>
39.8	inches	39.8	inches
3.01	ft <sup>2</sup>	3.01	ft²
26.56	gpm / ft <sup>2</sup>	26.56	gpm / ft <sup>2</sup>
8.00	gpm / ft <sup>3</sup>	8.00	gpm / ft <sup>3</sup>
15.1	gpm	15.1	gpm
30.1	gpm	30.1	gpm
	gallons / yr		gallons / yr
	lbs salt / yr		lbs salt / yr









### Sodium Bisulfite (NaHSO<sub>3</sub>) Injection

ENTER THE DATA REQUIRED IN YELLOW

80.0 Flowrate (gpm)
2.50 Feed Cl<sub>2</sub> (Free Chlorine) Concentration (ppm) <sup>2</sup>
757.00 mass flow rate of Cl<sub>2</sub> (mg/min)

35.0% NaHSO<sub>3</sub> Concentration (%)
2271 mg/min Na<sub>2</sub>SO<sub>3</sub> Required

2.47 gal/day of 35.00% NaHSO<sub>3</sub> Required \*or\*
0.103 gal/hr of 35.00% NaHSO<sub>3</sub> Required

Tank Volume (gallons)

12.2 Tank service prior to refilling (days)

### NOTES

- 1 = Based on an estimate of typical city water
- 2 = Design basis provided





### Sodium Bisulfite (NaHSO<sub>3</sub>) Injection

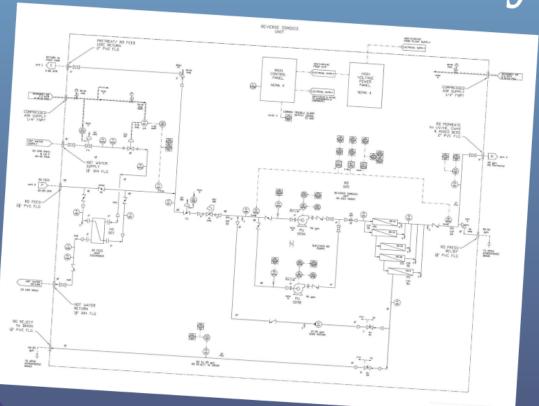
ENTER THE DATA REQUIRED IN YELLOW

	Flowrate (gpm)						
2.50	Feed Cl <sub>2</sub> (Free Chlorine) Concentration (ppm) <sup>2</sup>						
757.00	mass flow i	rate of $Cl_2$	(mg/min)				
35.0%	NaHSO₃ C	oncentratio	n (%)				
2271	mg/min Na	₂SO₃ Requ	ired				
2.47	gal/day of	35.00%	NaHSO <sub>3</sub> Required * <b>or</b> *				
0.103	gal/hr of	35.00%	NaHSO₃ Required				
30	Tank Volun	ne (gallons	)				
	_						
12.2	Tank service	ce prior to r	efilling (days)				

### NOTES

- 1 = Based on an estimate of typical city water
- 2 = Design basis provided









Fred Florence S	and a		WASC NOW	En.	er v Broom	our Flori	64.00		Occupio	Process		
How Water Fle			BODD gos		m i Erro		TROD		(Foreste	Fred	5.06 pt	
Fred Pressure	- 6.74		255.46 grés		of Tompo		95.0			monoritate		
Plow Florer			1.00		of THE		493.16		,	Avenue		
Chem. Desc			Nece		anter of I	Flowers	13	100.1	Ascross		215.27 pt	
Total Active A			44 DOLOGO		curses Pas		14.40	457	Force		1643.0	
Water Cheedle		atom So						2.00	Specific	Enter		NAME OF
			40-1						.,,			
			Fred. P	hed	Booker	Conc	Conc	Prom	Ave	Perm	Bone	Prom
Stage Elem	166 175	V 65b		966	Flore	Flore	Phone	Flow	Flor	Pross	Press	TD6
			(gamé (g	199	(gpm)	(gpm)	gorigi	- japné	(25%	(919)	(prig)	(mg/b
1 89/304		2 3		146	M-DC	68.65	233,79	26.76	15.80	45.00	0.80	2.76
1 MW804		2 3		.39	COS	46.18	218.76	2547	1606	45.00	0.80	4.11
3 RW304	m-sc	1 8	4618 311	.36	OLD.	5600	197.26	15.18	12.21	45.00	0.80	6.93
				Tre Str						7		
_	_	_		ngfui				-		-		
None	Feed	head	After Horseles		Exemples		B	Penner	ic lass: 3 Tre	-		
NH4++ NH1	0.00	0.00	AREY PROCESS	5.00	0.00	0.00	0.80	DOD:	500 1			
K.	3.30	3.70	5.57	149		14.51	0.85	0.09	5.16 51			
Ns.		175.50	363.69				0.89	131	1.29 1.7			
Mir	30.80	are	0.00	0.00	0.80	0.00	0.80	0.00	0.00 0.0			
65	40.00	0.10	615	6.11	0.81	0.40	0.80	000	6.00 61	10		
N:	0.88	0.06	0.00	8.00	0.80	0.00	0.80	0.00	6.00 6.0	16		
Bo	0.85	0.08	0.00	8.08	0.80	0.00	0.80	0.00	E.00 E/	×		
CHI	3.47	3,43	3.74	8,39		17,44	0.01	0.03	0.00			
HCOs.	30.00	9010	44.25	145.59			0.18	0.38	4.55 4.1			
NO	1.80	1.00	145	1.96	3.89		0.88	0.15	£26 £			
0	40.00	215,90	336,35	4/6,10	302,12	R99,80	0.85	1.68	198 15			
P 504	26.30	2,83 38.36	425	58.43	88.05		0.0	0.14	5.04 E/I			
N.H SID2	10.00	10.00	14.90	76.A3			0.04	0.07	510 5			
Berro	0.00	0.00	0.00	45.00	0.00	0.00	0.80	000	2.00 13			
C072	0.24	ora	603	640	0.67		0.80	000	100 1			
TDS		481.16	72040	990,14	1494.31		2.85	4.12	6.90 33			
off.	9.30	9.30	531	9.76	9.27	9.34	9.29	9:27	121 13	(4)		
for WinEE a for Chamical Compa and time and ag an appropriate for	of remain of source plicable la ricittorio roftward	any obligations of the con-	colorinist bounds of BLTY on our patience liability of life from the lies limited Comparation mentioned by me	COME PER PROPERTY AND COME TO AND A AND THE	E. A. FA-ETT Fitnish or other and in licer Chem.	director in director in sep change- scal Corner	nerves, i street for with time, we write:	to ten seas to others as the appli- cedames in no lighting	Plother File ation of the responsible C. X. at a note	Bio Copye information for determine it of contons	then not The bosons or ing whether or case of the	e Blev o rproducti le RYSA

Ex.						
corsciy	Pern Boy (pm)	Pore Tirk (mg/l)	Red Flow (gpm)	Food TDS cong/li	Feed Press (print)	
0.00	4.53	2.04	48.00	720.46	150:46	
0.00	4.59	3,33	43,47			
DJH	4.35	2.74	29.06		236.52	
meny	Perm Bow (gpm)	Porm TDS (mg/t)	5970	(mg/l)	Feed Press (prig)	
0.04						
moscy						
0.06	3.55	5.40	46.00	149631	203.74	
0.08	3.79	6.89	41.65	1918.13	207.94	
0.09	3.24	8.20	39.34	1757.36	303.172	
	moscry nate nate nate nate nate nate nate nate	Pun Rec   (gm)   100   4.5   100   4.5   100   4.5   100   4.5   100	Part   Part			

	Raw Water	Adjusted Feed	Concentrate	
H .	9.30	9.56	9.24	
angelier Submitter Bridge	8.75	-2.07	-1.0t	
RAT & Davis Stability Endos.	1.42	-1.34	-0.77	
lenic Strongth (Melal)	0.01	nni	0.00	
FDS onepti	275.42	481.16	1914.69	
9003	38.00	38.00	115.57	
302	0.02	0.02	0.09	
000	3.47	3.47	17.44	
2/974 (% Salaration)	8:45	rt.me	0.00	
NASO4 (G. Saunaion)	46.65	0.00	0.00	
RSIS4 (S. Saturation)	6.07	0.00	0.00	
TaF2 (% Sammaion)	6149	0.11	6.66	
902 (Sauratio)	4.15	4.15	17.84	
(gOH)2 (S Saturation)	4.09	0.00	0.00	



Case-specific: Case 1 - 60 gpm BW30-400-IG 2:2:1 array 3M

### System Details

Feed Flow to Stage 1	96.00 gpm	Pass 1 Permeate Flow	60.00 gpm	Osmotic Pressure:	
Raw Water Flow to System	80.00 gpm	Pass 1 Recovery	75.00 %	Feed	1 5.06 psig
Feed Pressure	255.46 psig	Feed Temperature	55.0 F	Concentrate	19.67 psig
Flow Factor	1.00	Feed TDS	481.16 mg/l	Average	2.36 psig
Chem. Dose	None	Number of Elements	15	Average NDP	215.27 psig
Total Active Area	6000.00 ft <sup>2</sup>	Average Pass 1 Flux	14.40 gfd	Power	16.42 kW
Water Classification: Surface S	Supply SDI < 5			Specific Energy	4.56 kWh/kgal
Stage Element #PV #Ele	Feed Feed Flow Press	Recirc Conc Flow Flow	Conc Perm Press Flow	Avg Perm	Boost Perm Press TDS
Stage Element #PV #Ele	e Flow Press (gpm) (psig)	Flow Flow (gpm) (gpm)	Press Flow (psig) (gpm)	Flux Press (gfd) (psig)	Press TDS (psig) (mg/l)
1 BW30-400-IG 2	96.00 250.46	16.00 69.65	233.79 26.35	15.81 45.00	0.00 2.35
2 BW30-400-IG 2	69.65 228.79	0.00 46.18	218.74 23.47	14.08 45.00	0.00 4.12
3 BW30-400-IG 1	3 46.18 213.74	0.00 36.00	197.26 10.18	12.21 45.00	0.00 6.92

Pass Streams (mg/l as Ion)										
		Ad	justed Feed	Concentrate			Permeate			
Name	Feed	Initial	After Recycles	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3	Total
NH4+ + NH3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K	3.70	3.70	5.52	7.59	11.40	14.58	0.05	0.09	0.16	0.08
Na	50.00	175.51	262.89	362.10	545.46	699.03	0.69	1.31	2.29	1.20
Mg	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ca	60.00	0.10	0.15	0.21	0.31	0.40	0.00	0.00	0.00	0.00
Sr	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ba	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO3	3.47	3.47	5.74	8.39	13.31	17.44	0.01	0.02	0.03	0.02
HCO3	30.00	30.00	44.35	60.58	90.52	115.57	0.18	0.33	0.55	0.30
NO3	1.00	1.00	1.45	1.96	2.89	3.63	0.08	0.15	0.26	0.14
Cl	60.00	225.92	338.39	466.10	702.12	899.80	0.88	1.68	2.95	1.54
F	2.82	2.82	4.22	5.82	8.76	11,22	0.01	0.02	0.04	0.02
SO4	28.30	28.30	42,41	58.43	88.05	112.88	0.07	0.14	0.25	0.13
SiO2	10.00	10.00	14.98	20.63	31.08	39.84	0.04	0.07	0.10	0.06
Boron	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO2	0.24	0.02	0.03	0.05	0.07	0.09	0.00	0.00	0.00	0.00
TDS	279.42	481.16	720.46	992.14	1494.21	1914.69	2.35	4.12	6.92	3.82
pН	9.30	9.30	9.31	9.30	9.27	9.24	9.29	9.27	9.23	9.28

\*Permeate Flux reported by ROSA is calculated based on ACTIVE membrane area. DISCLAIMER: NO WARRANTY, EXPRESSED OR IMPLIED, AND NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, IS GIVEN. Neither FilmTec Corporation nor The Dow Chemical Company assume any obligation or liability for results obtained or damages incurred from the application of this information. Because use conditions and applicable laws may differ from one location to another and may change with time, customer is responsible for determining whether products are appropriate for customer's use. FilmTec Corporation and The Dow Chemical Company assume no liability, if, as a result of customer's use of the ROSA membrane design software, the customer should be sued for alleged infringement of any patent not owned or controlled by the FilmTec Corporation nor The Dow Chemical Company.



Design Warnings

-None-

conditions and applicable laws may differ from one location to another and may change with time, customer is responsible for determining whether products are appropriate for customer's use. FilmTec Corporation and The Dow Chemical Company assume no liability, if, as a result of customer's use of the ROSA membrane design software, the customer should be sued for alleged infringement of any patent not owned or controlled by the FilmTec Corporation nor The Dow Chemical Company.

### **Design Warnings**

-None-

### Solubility Warnings

-None-

### Stage Details

Stage 1 Element I	Recovery	Perm Flow (gpm)	Perm TDS (mg/l)	Feed Flow (gpm)	Feed TDS (mg/l)	Feed Press (psig)
1	0.09	4.53	2.01	48.00	720.46	250.46
2	0.10	4.39	2.33	43.47	795.32	244.06
3	0.11	4.26	2.74	39.08	884.32	238.52
Stage 2 Element I	Recovery	Perm Flow (gpm)	Perm TDS (mg/l)	Feed Flow (gpm)	Feed TDS (mg/l)	Feed Press (psig)
1	0.12	4.04	3.33	34.82	992.14	228.79
2	0.13	3.91	4.05	30.79	1121.83	224.79
3	0.14	3.78	5.04	26.87	1284.57	221.46
Stage 3 Element I	Recovery	Perm Flow (gpm)	Perm TDS (mg/l)	Feed Flow (gpm)	Feed TDS (mg/l)	Feed Press (psig)
1	0.08	3.55	5.96	46.18	1494.21	213.74
2	0.08	3.39	6.89	42.63	1618.13	207.59
3	0.08	3.24	8.00	39.24	1757.28	202.12

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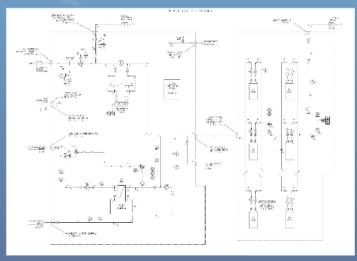
Permeate Flux reported by ROSA is calculated based on ACTIVE membrane area. DISCLAIMER: NO WARRANTY, EXPRESSED OR IMPLIED, AND NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, IS GIVEN. Neither FilmTec Corporation nor The Dow Chemical Company assume any obligation or liability for results obtained or damages incurred from the application of this information. Because use conditions and applicable laws may differ from one location to another and may change with time, customer is responsible for determining whether products are appropriate for customer's use. FilmTec Corporation and The Dow Chemical Company assume no liability, if, as a result of customer's use of the ROSA membrane design software, the customer should be sued for alleged infringement of any patent not owned or controlled by the FilmTec Corporation nor The Dow Chemical Company.

### **Scaling Calculations**

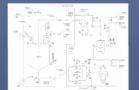
	Raw Water	Adjusted Feed	Concentrate
pН	9.30	9.30	9.24
Langelier Saturation Index	0.73	-2.07	-1.01
Stiff & Davis Stability Index	1.42	-1.34	-0.77
Ionic Strength (Molal)	0.01	0.01	0.03
TDS (mg/l)	279.42	481.16	1914.69
HCO3	30.00	30.00	115.57
CO2	0.02	0.02	0.09
CO3	3.47	3.47	17.44
CaSO4 (% Saturation)	0.43	0.00	0.01
BaSO4 (% Saturation)	46.66	0.00	0.00
SrSO4 (% Saturation)	0.07	0.00	0.00
CaF2 (% Saturation)	63.43	0.11	6.69
SiO2 (% Saturation)	4.15	4.15	17.14
Mg(OH)2 (% Saturation)	4.09	0.00	0.00

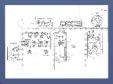
To balance: 165.92 mg/l Cl added to feed.



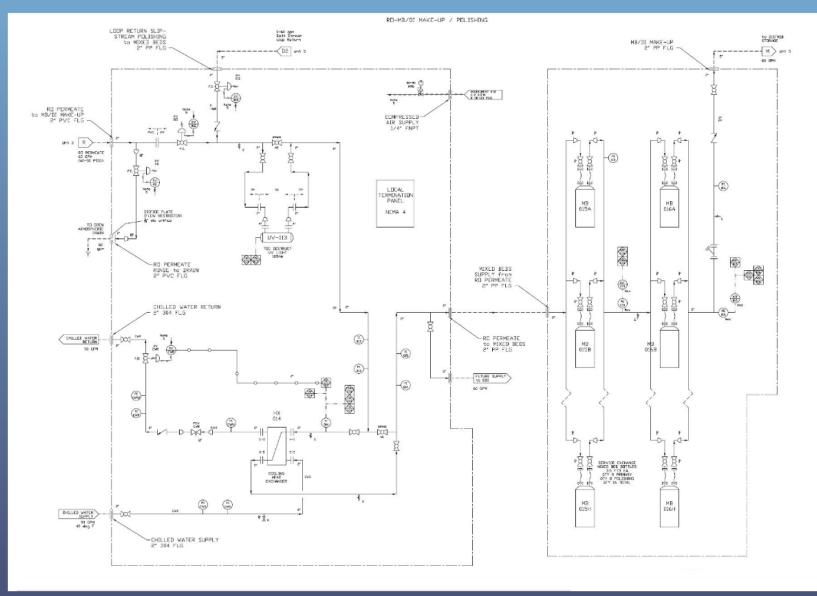


**RODI Case Study** 

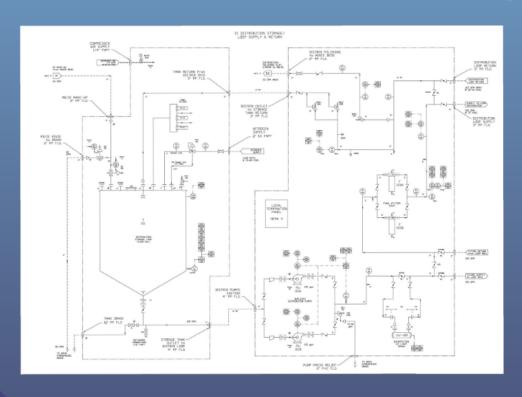




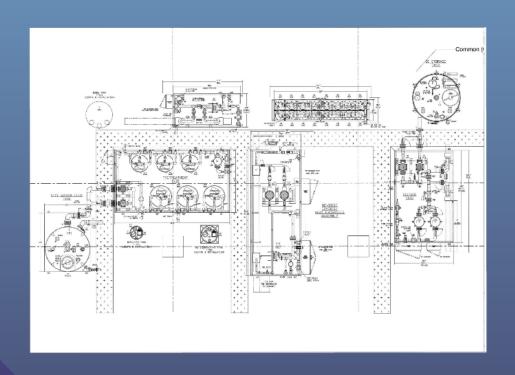














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