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Rinse Tank Salinity Automation

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Rinse Tank Salinity

Automation

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Spring 2020

Abstract

Manufacturing processes are often consisted of many different processes and sub-processes. Each of these carries its own level of importance and impact to the overall picture. In this particular sub-process, salt is rinsed from a product via a rinse tank: a tank whose salinity may not exceed a certain level and whose temperature must not fall below a certain level. This setting is a prime opportunity to implement an automated control system to allow these parameters to be met with upmost efficiency. With potential savings in excess of $20,000 per year and an estimated payback period of 8 weeks, the project has proved while providing quality, ergonomic, and economic benefits for the company as well as improving the overall manufacturing process.

Chapter 1: Introduction

1.1 Background

The rinse tank system utilized in this portion of the process takes a product that is covered in salt and rinses it clean with heated water, producing a brine solution. The percent solution of this brine is important to the manufacturing sub-process. More specifically, it is important that this salt concentration not become too high. The current function of this system consists of a line operator opening a ball valve on the bottom of the rinse tank. To lower the salinity an appreciable amount, a large amount of solution must be drained. When solution is drained, fresh water is pumped into the tank causing the temperature of the tank to also drop considerably. The goal of the project is to drain solution at a rate not exceeding the rate at which the tank heaters can heat the solution, and at the same time draining it at a rate that is fast enough to maintain a desired salinity.

When the salinity reaches a predetermined concentration the measuring device will send an output to an electronically controlled solenoid valve and begin draining the tank, lowering its level and allowing fresh water to enter, thus lowering the salt concentration. In addition to a maximum concentration, the tank is subject to a temperature constraint. Fresh water cannot be added to the tank at a rate greater than that which the tank's heaters can heat it to the desired temperature set point.

1.2 Literature Search

Literature on both the subjects of thermodynamics and chemistry were desired. The questions raised by the ability of the tanks heaters to heat the water required the use of references used in both Thermodynamics II and Heat Transfer. References in chemistry were required to properly determine the measuring capability of the salinity meter already in place and to determine how the change in salinity would relate to the change in composition.

A resource manual for the Foxboro Model 875EC was obtained to in order to fully understand its operation and how to best utilize its functions and outputs.

1.3 Principles of Operation

The 1st law of thermodynamics and Bernoulli's Principle is utilized.

1.4 Product Definition

The salinity of the system increases due to a constant input of salt. The salinity is measured by a Foxboro Salinity Model 875EC, a device capable of digital outputs based on an analog signal input. The Foxboro meter can be programmed to provide digital on/off relay outputs based on the reading of the meter. Additionally, the meter provides a built-in hysteresis function that allowed for the output to turn on when set point 1 (5.05%) was reached, and for the output to remain on until setpoint 2 (5.00%) was reached. This programming replaced the originally designed hysteresis circuit. The outputs operate an orifice restricted solenoid valve on the bottom of the tank. This orifice allows for a controlled rate of discharge.

Chapter 2: Conceptual Design

In order for the system to function as desired, the following parameters are to be met: The temperature shall remain greater than 150°F with a setpoint of 170°F, the salinity of the system shall not deviate more than +/- 0.02% from the setpoints programmed into the Foxboro Salinity Meter. When setpoint 1 is reached, water will be drained from the tank for the purpose of reducing the salinity of the system. An orifice of some kind will be utilized to regulate the rate at which will allow us to remain within the two parameters specified above. Materials utilized for the plumbing will have to be able to withstand the relatively high heat and corrosive environment. Due to the unique properties of the salt in use (from now on referred to as "salt"), a study of how the chemical properties of the salt in use compares to the chemical properties of sodium chloride, the chemical that the existing meter is calibrated to measure. The results of this study will allow a more accurate theoretical discharge rate to be derived.

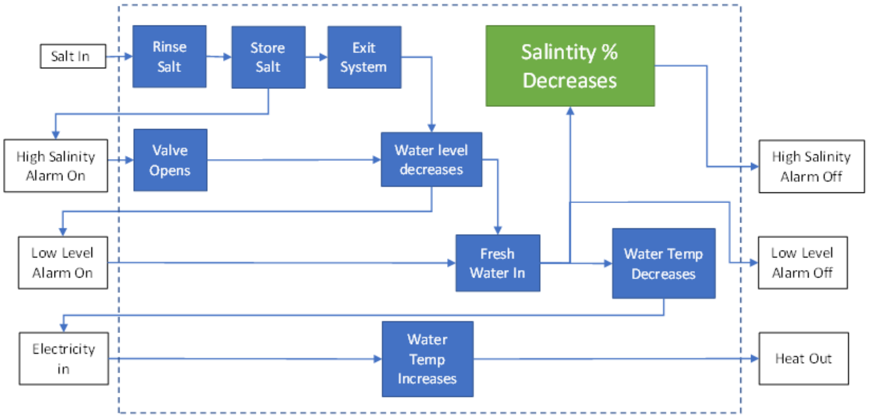


Figure 1: Logic behind the control system's theory of operation shown by the above function structure diagram

Chapter 3: Embodiment Design

In the Embodiment Design phase, adherence to the embodiment rules and principles was determined considered. The principles of self help, redundant arrangement, and indirect safety were utilized to the greatest degree. For this design, one of the paramount design factors was its longevity coupled with an ease of maintenance. As you can see in “Figure 4”, the valve used to expel the salinity was placed at the bottom of the tank, thus utilizing the external force gravity to achieve the desired result. Alternate design could have involved pumps of various types, however, the addition of a pump to the design would have added yet another degree of complexity as well as increasing the project’s cost. The principle of redundant arrangement was utilized to ensure that even if the system were to malfunction, its end purpose could still be achieved. Additionally, on the signal transmission side system, a relay was added to the circuit. This relay protects the meter’s internal relay preventing any kind of short that should happen to arise, be it in the solenoid or circuitry, from harming the meter’s internal relay. If a short were to occur, the added relay would fail, preventing any further damage and presenting a rather inexpensive ($1.50) repair. The simplest and most intuitive way to go about this was to add a ball valve and a tee to the valve assemble, as seen in “Figure 3.” Under normal operation, the valve remains closed, but in the event that any part of the system malfunctions, solution can always be drained from the tank in order to maintain the desired salinity. One last notable principle has to do with the most important topic: safety. While this system presents a very low risk for injury anything is possible, and steps must be taken to mitigate any risk present. When the system dumps solution it is at least 160°F, which hot enough to cause burns. Three steps are taken to prevent burn risk. First, the valve assembly is located at the bottom of the tank ensuring the expelled solution is far from the operator’s normal work area, minimizing the possibility that an operator will come into contact with the solution. Second, as shown in “Figure 5” the electrical enclosure that houses the majority of the circuitry involved with this system includes an external indicator light. This light is clearly labeled and is illuminated whenever the circuit is energized, meaning solution is being expelled. The operator knowing that hot solution is being expelled without gaining access to the actual valve assembly provides valuable knowledge to the operators where safety is concerned. Lastly, the electrical enclosure itself is a safety measure taken to ensure that operators cannot come into contact with live electrical circuitry. The box is washdown resistant allowing it to be maintained and cleaned by the same procedures as the assembly line.

For material selection, the high heat and corrosive environment dictated that a brass material would be utilized. While surface finish may not be maintained, its functionality will not be compromised by the conditions. Additionally, given that the Foxboro meter has a working output voltage of 24V, it was determined that the voltage used in the circuit and valve would also be 24V.

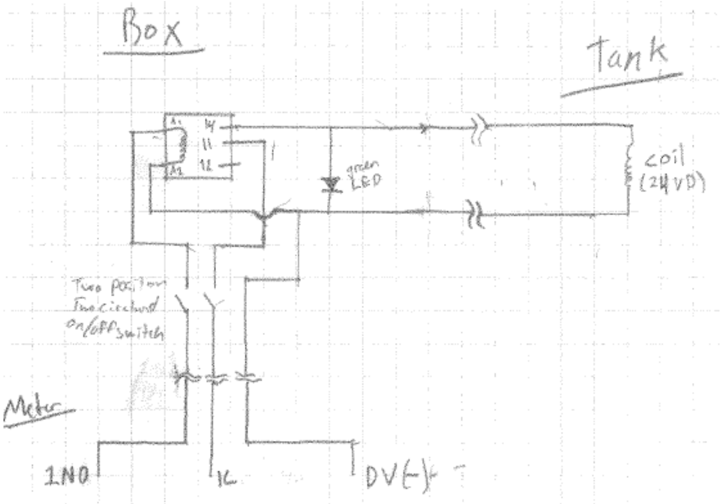
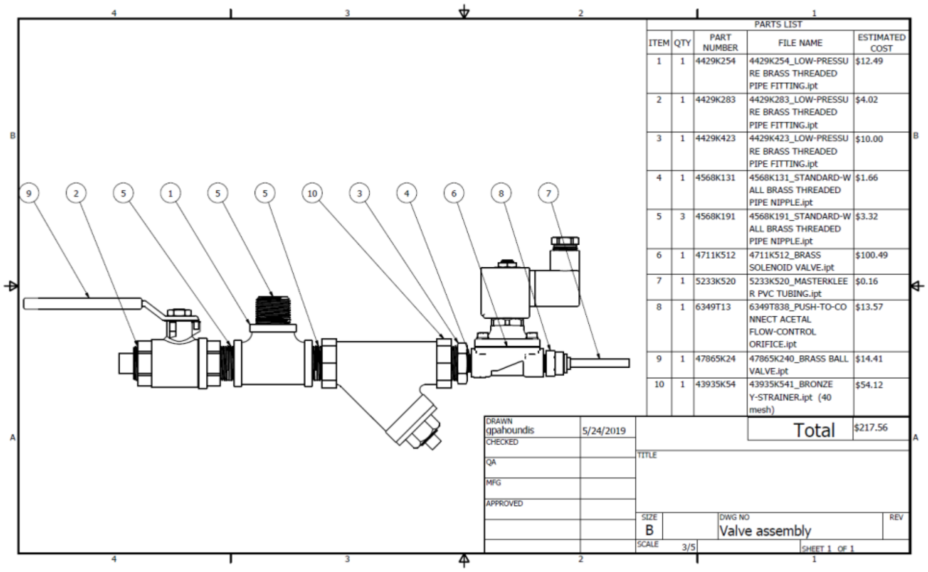


Figure 2: The three subsystems of the control system, the meter, signal transmission (box), and valve.



PARTS LIST				
ITEM	QTY	PART NUMBER	FILE NAME	ESTIMATED COST
1	1	4429K254	4429K254_LOW-PRESSURE BRASS THREADED PIPE FITTING.ipt	$12.49
2	1	4429K283	4429K283_LOW-PRESSURE BRASS THREADED PIPE FITTING.ipt	$4.02
3	1	4429K423	4429K423_LOW-PRESSURE BRASS THREADED PIPE FITTING.ipt	$10.00
4	1	4568K131	4568K131_STANDARD-WALL BRASS THREADED PIPE NIPPLE.ipt	$1.66
5	3	4568K191	4568K191_STANDARD-WALL BRASS THREADED PIPE NIPPLE.ipt	$3.32
6	1	4711K512	4711K512_BRASS SOLENOID VALVE.ipt	$100.49
7	1	5233K520	5233K520_MASTERKLEER PVC TUBING.ipt	$0.16
8	1	6349T13	6349T838_PUSH-TO-CONNECT ACETAL FLOW-CONTROL ORIFICE.ipt	$13.57
9	1	47865K24	47865K240_BRASS BALL VALVE.ipt	$14.41
10	1	43935K54	43935K541_BRONZE Y-STRAINER.ipt (40 mesh)	$54.12
			Total	$217.56

Figure 3: Valve detail

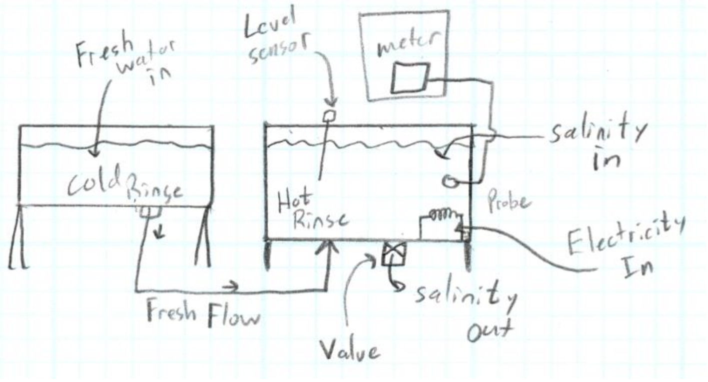


Figure 4: overview of entire rinse tank system

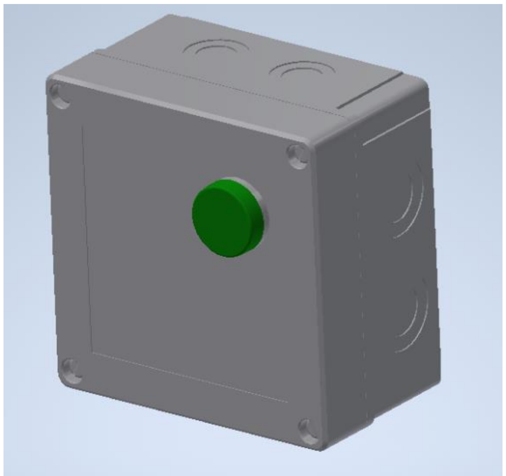
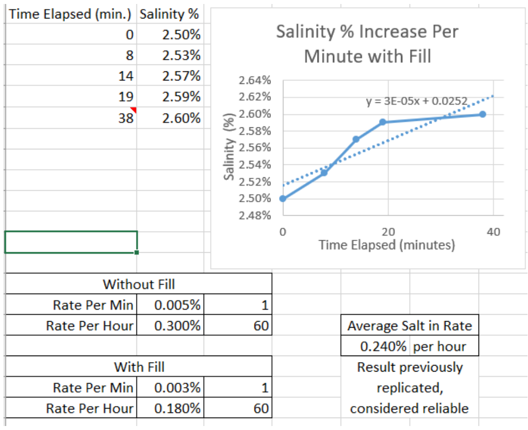


Figure 5: The electrical enclosure selected

Chapter 4: Detail Design

For the design of this system the rate at which the salinity increase, or salinity rate, first had to be found. Since the Foxboro meters were already in place, they were used and the units of the data gathered were in percent solution. Due to confidentiality, the density of the salt in use cannot be specified, including the associated calculations. To maintain this, the volume of the tank, will not be disclosed in this report. With this in mind, we begin by using the percent increase to find the volume of salt that enters the system per hour.



Time Elapsed (min.)	Salinity %
0	2.50%
8	2.53%
14	2.57%
19	2.59%
38	2.60%

Without Fill		
Rate Per Min	0.005%	1
Rate Per Hour	0.300%	60

With Fill		
Rate Per Min	0.003%	1
Rate Per Hour	0.180%	60

Average Salt in Rate	
0.240%	per hour

Result previously replicated, considered reliable

Figure 6:Detail on data gathered to determine Salinity rate

$$Volume\ of\ tank\,\frac{\times\ \%\ increase}{hour} = \frac{gallons\ salt}{hour}$$

With this information, as well as knowing that percent weight of the salt and percent volume of the salt are essentially equal, using the total volume of the tank, we find the minimum amount of water in gallons we need to expel per hour to maintain desired salinity.

$$\frac{\frac{gallons\ of\ salt}{hour}}{\%\ salinty} = \frac{gallons\ solution}{hour}$$

After careful calculations and testing, it was found that the gallons solution per hour that had to be expelled were 6.2 GPH. With this Figure we can now determine the rate at which the tank can be heated. We know that the heaters combine for an output of 24 kJ/s. The input temperature of the water is 10°C and the final temperature is 76°C. Assuming water has a specific heat capacity of 4.184 J/kg°C we have the following:

$$\frac{Q}{c \times \Delta T0} = \frac{kg\ solution}{second}$$

$$\frac{24\ kJ/s}{4.184\ \frac{kJ}{kg°C} \times (76 - 10)°C} = \frac{0.0869\ kg}{second}$$

Now we adjust this Figure to represent gallons of water heated per hour:

$$\frac{.0869\ kg}{sec} \times \frac{1\ gallon\ H_2O}{3.79\ kg} \times \frac{3600\ sec}{1\ hour} = \frac{82.5\ gallons}{hour}$$

With this, we now have both our flow requirements and flow restriction and can proceed to our orifice design. We know that the total head of the tank with respect to the orifice is 26 inches and the required flow rate is 0.103 GPM. The formula for calculating orifice diameter shown below can now be utilized assuming a K value of 0.62, signifying a simple orifice as shown in “Figure 6.”

$$d = \sqrt{}(\frac{Q}{19.63 \times K \times \sqrt{h}})$$

$$.04\ in = \sqrt{}(\frac{.103}{19.63 \times .62 \times \sqrt{26}})$$

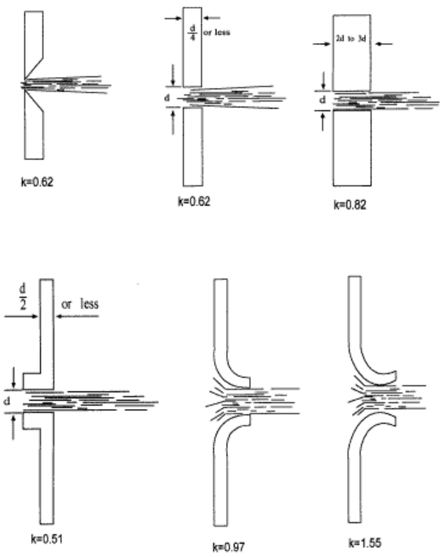


Figure 7: Summary of possible "K" values

With this information, an orifice of diameter .125 inches is selected. This is to allow for any increase in capacity that may need to occur at any point in the future. To ensure that this orifice size does not exceed our maximum flow rate of 1.375 GPM, we calculate the theoretical flow rate of a .125” orifice with a head pressure of 26” and a “K” value of .62. We do this by rearranging the above equation as follows:

$$Q = 19.63 \times d^2 \times \sqrt{h}$$

$$7.97\ GPM = 19.63 \times 0.125^2 \times \sqrt{26}$$

While this exceeds our maximum flow rate, it is important to remember that the valve will not remain open constantly during operation, rather it will be open in impulses. With this in mind, the valve will have to be open a maximum of ≈10 minutes per hour to allow for adequate heating.

With the valve subsystem design in tow, we now move to the electrical and meter side of the control system. After careful deliberation, a hysteresis type of control was deemed most appropriate for this system. The Foxboro meter will measure the salinity by measuring the electrical conductivity of the solution via a sensor. This particular meter is calibrated to measure sodium chloride however the chemical properties of the salt in use and sodium chloride are quite similar, and for the purpose of this control system the readings that the meter produces are more than adequate. The meter has the capacity to produce two different alarms (AL1 and AL2) based on two different set points. Likewise, these setpoints can be programmed to turn on and off a set of two outputs. Originally, it was not known that the Foxboro 875EC had an internal hysteresis function and thus and system of relays was designed, detailed in "Figure 8."

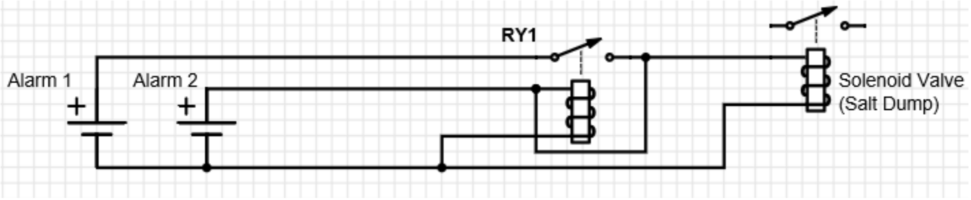


Figure 8:Hysteresis circuit originally utilized

The circuit functions off of the two alarm outputs by the meter. Let's assume Setpoint 1 (SP1) is less than Setpoint 2 (SP2), as well as that when SP1 is reached AL1 is energized and that when SP2 is reached AL2 is energized. When AL1 is energized, voltage is applied to RY1, but nothing happens as RY1 is not closed. When AL2 is energized RY1 is closed, allowing current to flow to the solenoid valve and open it. Now that the valve is open solution is being expelled, the salinity begins to decrease and AL2 is no longer energized. Even when AL2 is no longer energized RY1 remains closed due to the relay being fed by its own contacts. Once the salinity becomes lower than SP1, AL1 is no longer energized and the solenoid valve closes. This cycle continues as such and provides protection against excessive cycles with short cycle times.

After the protype was installed, the manufacturer responded with a copy of the meter’s instruction manual which detailed that the meter had had an internal hysteresis function that was perfect for our application. This being the case, the custom circuit was replaced with a simple relay circuit detailed in “Figure 2.”

For the physical components, as mentioned above, bronze was a selected material. All plumbing components were ordered from the McMaster-Carr catalog and all wiring was done in house. A Y-strainer was installed in series with the solenoid valve to prevent any debris or particulates from compromising the valve. A Y-strainer was also chosen based on the fact that they are easy to maintain, and due to the fact that the filter is already a plant standard.

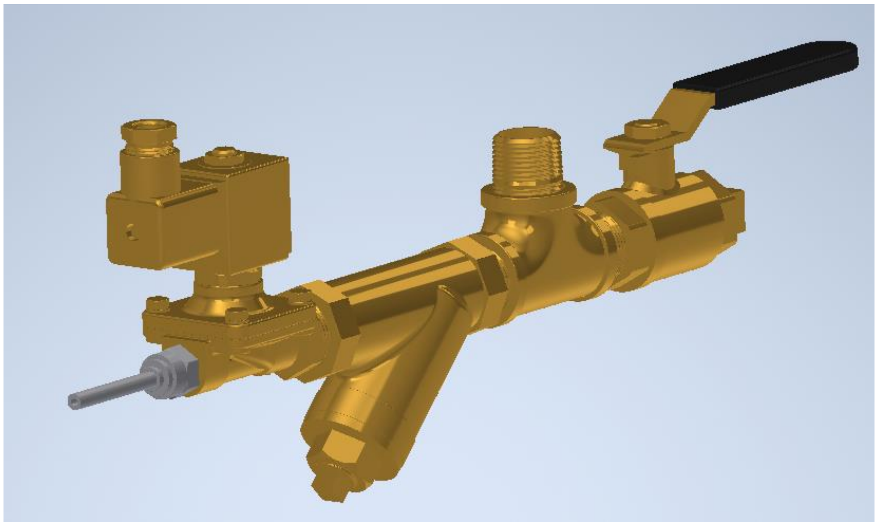


Figure 9: Isometric view of the valve's 3D model

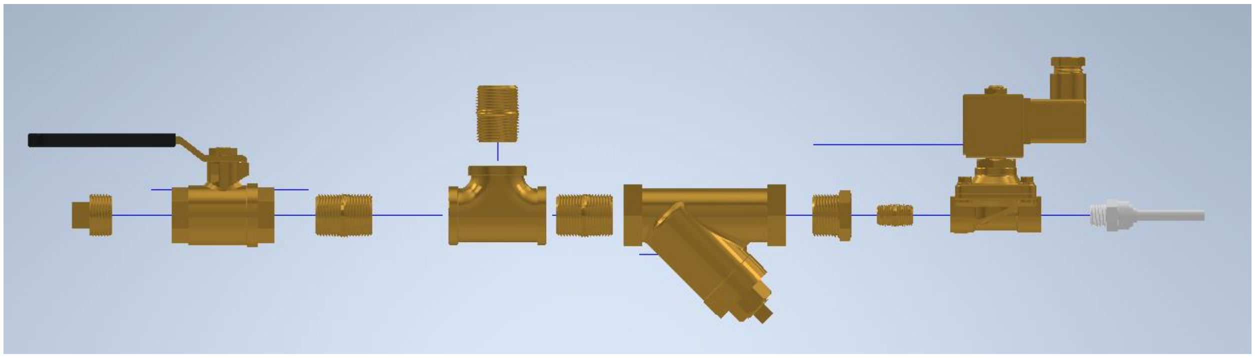
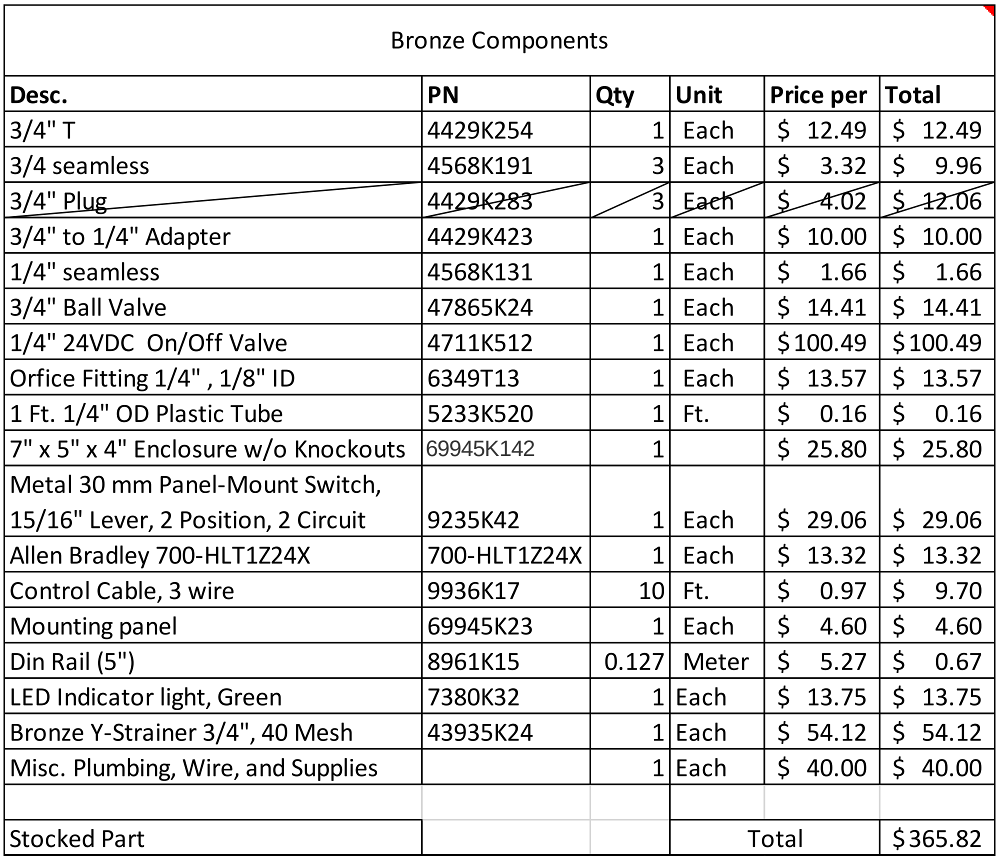


Figure 10: Exploded view of the valve assembly



Bronze Components

Desc.	PN	Qty	Unit	Price per	Total
3/4" T	4429K254	1	Each	$ 12.49	$ 12.49
3/4 seamless	4568K191	3	Each	$ 3.32	$ 9.96
~~3/4" Plug~~	~~4429K283~~	~~3~~	~~Each~~	~~$ 4.02~~	~~$ 12.06~~
3/4" to 1/4" Adapter	4429K423	1	Each	$ 10.00	$ 10.00
1/4" seamless	4568K131	1	Each	$ 1.66	$ 1.66
3/4" Ball Valve	47865K24	1	Each	$ 14.41	$ 14.41
1/4" 24VDC On/Off Valve	4711K512	1	Each	$ 100.49	$ 100.49
Orfice Fitting 1/4" , 1/8" ID	6349T13	1	Each	$ 13.57	$ 13.57
1 Ft. 1/4" OD Plastic Tube	5233K520	1	Ft.	$ 0.16	$ 0.16
7" x 5" x 4" Enclosure w/o Knockouts	69945K142	1		$ 25.80	$ 25.80
Metal 30 mm Panel-Mount Switch, 15/16" Lever, 2 Position, 2 Circuit	9235K42	1	Each	$ 29.06	$ 29.06
Allen Bradley 700-HLT1Z24X	700-HLT1Z24X	1	Each	$ 13.32	$ 13.32
Control Cable, 3 wire	9936K17	10	Ft.	$ 0.97	$ 9.70
Mounting panel	69945K23	1	Each	$ 4.60	$ 4.60
Din Rail (5")	8961K15	0.127	Meter	$ 5.27	$ 0.67
LED Indicator light, Green	7380K32	1	Each	$ 13.75	$ 13.75
Bronze Y-Strainer 3/4", 40 Mesh	43935K24	1	Each	$ 54.12	$ 54.12
Misc. Plumbing, Wire, and Supplies		1	Each	$ 40.00	$ 40.00
Stocked Part			Total		$ 365.82

Figure 11: Bill of materials (BOM) complete with itemized cost and total cost per unit

Prototype testing for this system went relatively smooth, encountering only one snag with the initial implementation. For the theory of operation to be sound, the solution must only leave through the valve assembly. The solution was, however, being carried out of the tank by means of the product exiting the tank, thus depositing it into the cold rinse tank (refer to “Figure 4”). This presents a problem because of the following: the only point at which the salinity is measured is at the entrance to the hot rinse tank. If salinity is allowed to accumulate in the cold rinse tank, whose volume is but a fraction of the hot rinse tank, the result will be a large amount of unmetered salinity in the cold rinse tank while salinity in the hot rinse tank remains low. In addition, the cold rinse tank only expels water when a low-level alarm occurs in the hot rinse tank. If solution from the hot rinse tank is carried to the cold rinse tank, the cold rinse tank will overflow long before a hot rinse low level alarm occurs. To solve these two problems two blower nozzles at the exit of the hot rinse tank, a device previously abandoned, was implemented. These blower nozzles (see “Figure 12”) blow any beaded water that the product would carry into the cold rinse tank from the product so that it may remain in the hot rinse tank. This allows the salt to remain in the hot rinse tank allowing it to be measured, expelled, and controlled.

Figure 12: Blower nozzles utilized to limit the amount of hot rinse solution that is carried from the hot rinse tank

Chapter 5: Discussion

The purpose of this project was to accomplish the automatic control of the salinity of a system of rinse tanks. Along the way we hoped to provide a more ergonomic setting for the operators while also providing economic benefit for the company with water and electricity savings. As far as the automatic control of the salinity, the project was a complete success. With the unit operational the salinity is controlled with an accuracy of +/- 0.01%, limited only by the resolution of the Foxboro meter. The Y strainer added in series with the valve accomplished its task of preventing any particulates from reaching the valve, rendering it unusable. Choosing that particular Y-strainer also had advantages because its filter is an item already stocked by the plant, meaning no further arrangement had to be made for the maintenance of the filter. The embodiment design items addressed were all flawlessly executed. Using gravity to eliminate the need for a pump slashed both upfront and operating cost. With the addition of the ball valve to the valve assembly, draining the tank manually remains a simple task. Additionally, it provides an avenue to manual salinity control should the automatic system fail. Keeping the area that the solution is expelled clear of the line operator's work area, as well as providing an indicator light alerting the operator as to when the 170°F solution is leaving the tank. For the case of economics, the control system provided an approximately 8-week payback period with an estimated yearly savings of $2,463 per line. This is made possible by an estimated difference of 85,700 gallons of water per year, per line, and an estimated savings of 25,000 kW*hr per year, per line.

Chapter 6: Conclusions

In this project we addressed and provided for the need to automatically control the salinity of a rinse tank system. We analyzed the scope of the project and arrived at a methodically produced solution that utilized principles from both conceptual and embodiment design methods. After almost 4,500 hours of proven operation with little to no maintenance intervention required, the design can safely be deemed a successful.

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Appendices

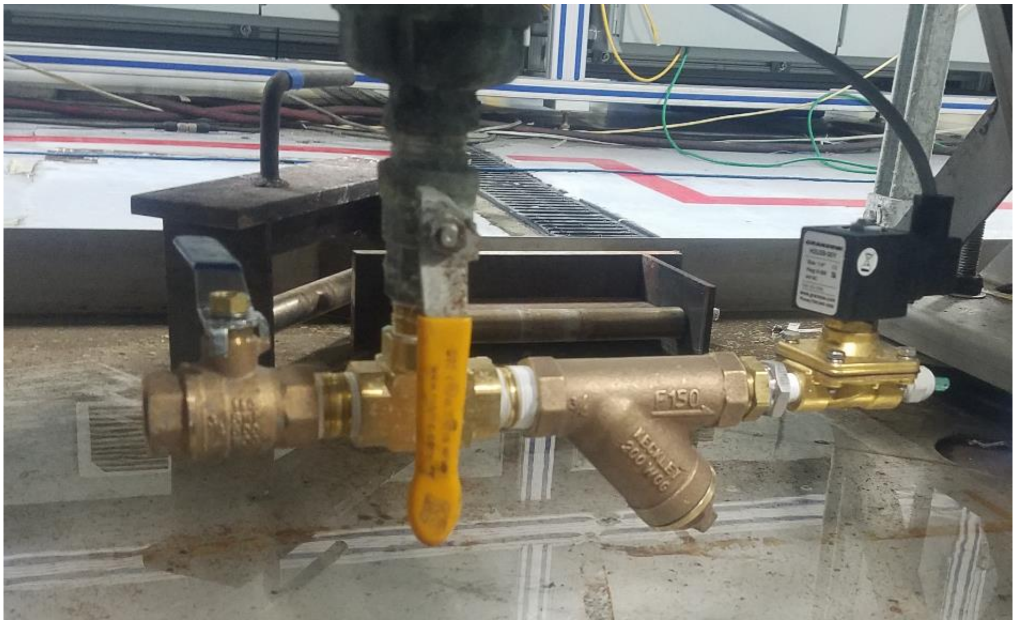
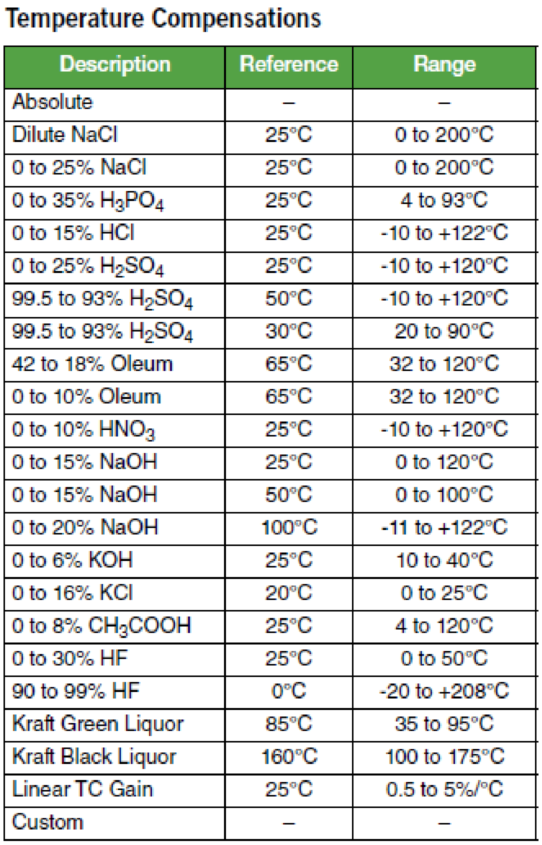


Figure 13: The valve assemble in place on the assembly line.

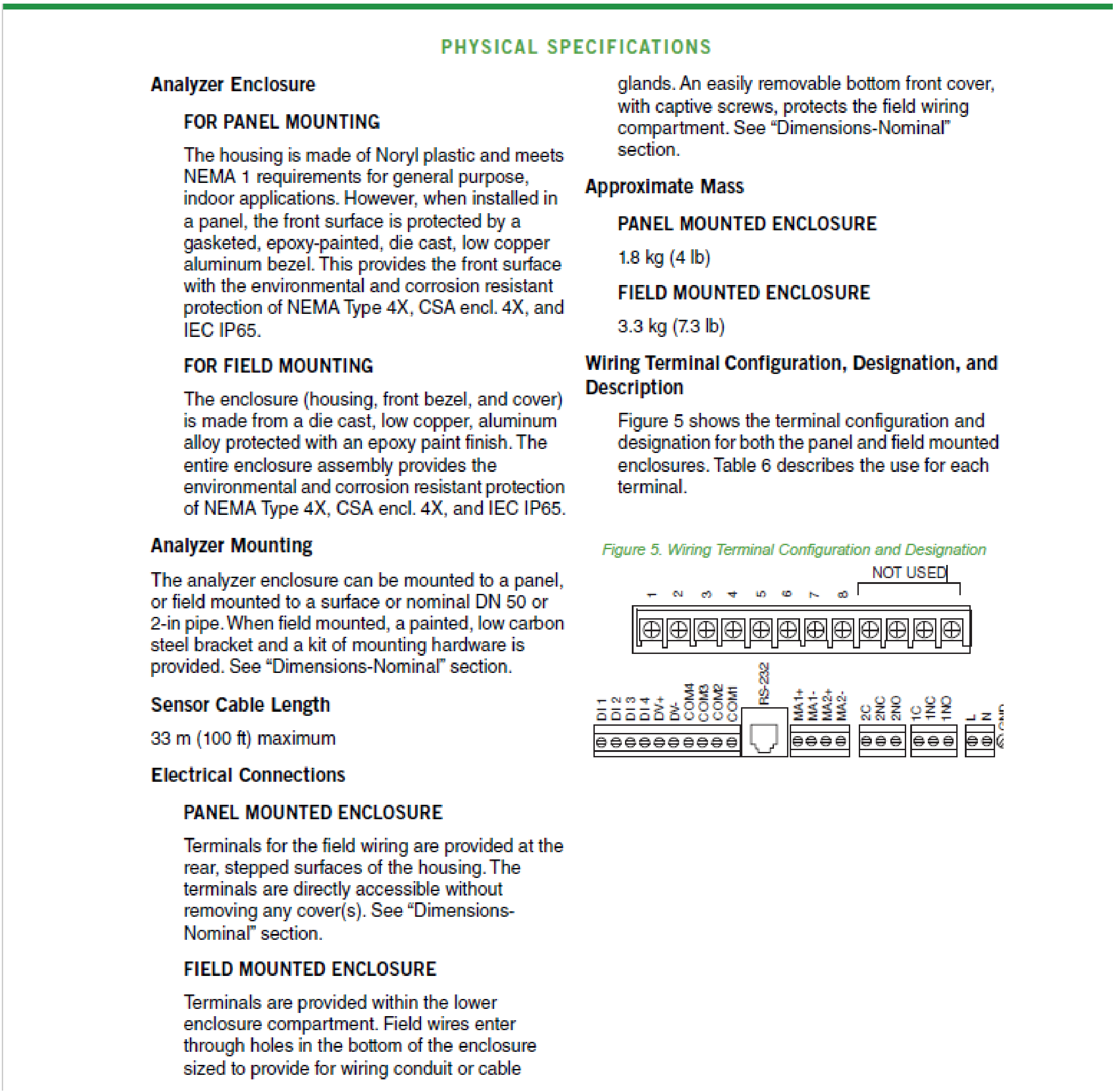


Temperature Compensations

Description	Reference	Range
Absolute	–	–
Dilute NaCl	25°C	0 to 200°C
0 to 25% NaCl	25°C	0 to 200°C
0 to 35% H_3PO_4	25°C	4 to 93°C
0 to 15% HCl	25°C	-10 to +122°C
0 to 25% H_2SO_4	25°C	-10 to +120°C
99.5 to 93% H_2SO_4	50°C	-10 to +120°C
99.5 to 93% H_2SO_4	30°C	20 to 90°C
42 to 18% Oleum	65°C	32 to 120°C
0 to 10% Oleum	65°C	32 to 120°C
0 to 10% HNO_3	25°C	-10 to +120°C
0 to 15% NaOH	25°C	0 to 120°C
0 to 15% NaOH	50°C	0 to 100°C
0 to 20% NaOH	100°C	-11 to +122°C
0 to 6% KOH	25°C	10 to 40°C
0 to 16% KCl	20°C	0 to 25°C
0 to 8% CH_3COOH	25°C	4 to 120°C
0 to 30% HF	25°C	0 to 50°C
90 to 99% HF	0°C	-20 to +208°C
Kraft Green Liquor	85°C	35 to 95°C
Kraft Black Liquor	160°C	100 to 175°C
Linear TC Gain	25°C	0.5 to 5%/°C
Custom	–	–

Figure 14:Displays ranges of the meter with respect to different solutions

The following are pertinent excerpts from the Foxboro Salinity Meter manual:



PHYSICAL SPECIFICATIONS

Analyzer Enclosure

FOR PANEL MOUNTING

The housing is made of Noryl plastic and meets NEMA 1 requirements for general purpose, indoor applications. However, when installed in a panel, the front surface is protected by a gasketed, epoxy-painted, die cast, low copper aluminum bezel. This provides the front surface with the environmental and corrosion resistant protection of NEMA Type 4X, CSA encl. 4X, and IEC IP65.

FOR FIELD MOUNTING

The enclosure (housing, front bezel, and cover) is made from a die cast, low copper, aluminum alloy protected with an epoxy paint finish. The entire enclosure assembly provides the environmental and corrosion resistant protection of NEMA Type 4X, CSA encl. 4X, and IEC IP65.

Analyzer Mounting

The analyzer enclosure can be mounted to a panel, or field mounted to a surface or nominal DN 50 or 2-in pipe. When field mounted, a painted, low carbon steel bracket and a kit of mounting hardware is provided. See “Dimensions-Nominal” section.

Sensor Cable Length

33 m (100 ft) maximum

Electrical Connections

PANEL MOUNTED ENCLOSURE

Terminals for the field wiring are provided at the rear, stepped surfaces of the housing. The terminals are directly accessible without removing any cover(s). See “Dimensions-Nominal” section.

FIELD MOUNTED ENCLOSURE

Terminals are provided within the lower enclosure compartment. Field wires enter through holes in the bottom of the enclosure sized to provide for wiring conduit or cable glands. An easily removable bottom front cover, with captive screws, protects the field wiring compartment. See “Dimensions-Nominal” section.

Approximate Mass

PANEL MOUNTED ENCLOSURE

1.8 kg (4 lb)

FIELD MOUNTED ENCLOSURE

3.3 kg (7.3 lb)

Wiring Terminal Configuration, Designation, and Description

Figure 5 shows the terminal configuration and designation for both the panel and field mounted enclosures. Table 6 describes the use for each terminal.

Figure 5. Wiring Terminal Configuration and Designation

Table 5. Wiring Terminal Designation and Description (See Figure 5)

Sensor Connections	
Terminal Designation	Terminal Description
1	Primary Sensor Drive
2	Primary Sensor Drive
3	Sensor Screen (Shield)
4	Sensor Return
5	Sensor Return
6	RTD Return
7	RTD Drive
8	RTD, Cable Length Compensation[a]
[a] Most Foxboro sensors contain 2-wire temperature compensation elements, in which case, terminal 8 is not used.	
DI 1, 2, 3, 4	Digital Inputs
DV+, DV-	Power Source for Digital Inputs
COM 1, 2, 3, 4	Digital I/O Communications
MA1+, MA1-	Analog Output 1
MA2+, MA2-	Analog Output 2
1C, 1NC, 1NO	Alarm 1
2C, 2NC, 2NO	Alarm 2
L	Power, Line
N	Power, Neutral
GND	Power, Ground

Alarm Outputs

Mechanical Relay – Two independent, isolated, Form "C" contacts rated 2 A at 30 V dc, 5 A at 250 V ac noninductive. With ATEX and IEC certifications, the ratings are 2 A at 30 V dc and 5 A at 160 V ac. Inductive loads, such as a motor or solenoid, can be driven with external surge absorbing devices across contact terminations. Contacts are not powered by the 875 analyzer.

Displayed Data

Each of the two lines of the display area can be configured to present:

- Temperature Compensated Conductivity
- Absolute Conductivity
- Temperature
- Chemical Concentration
- Analog Output Channel 1 or 2
- Scan Mode - any of the above parameters at adjustable viewing cycles

Measurement Display Units

µS/cm, mS/cm, mS/m, S/m, °C, °F, mA, g/L, oz/gal, ppt (parts per thousand), and ppm (parts per million)

Measurement Damping

Adjustable to None, 5, 10, 20, 40, or 120 seconds, where None is analyzer base response time.

Data Storage

Configuration, calibration, and operating parameters stored in nonvolatile memory for >5 years.

Operating Modes

- On-Line Measurement – Continuously outputs measurement data to front panel display and serial communication port
- On-Line Status – Provides current information
- Off-Line Calibration – Ability to calibrate analyzer full scale for primary measurements and temperature
- Off-Line Configuration – User can configure all ranges, units of measure, alarms, analog outputs, and other parameters
- Hold

Background Self-Diagnostics

ANALYZER

- Checksum and EEPROM on Power Up
- Code Space Checksum and CRC on Power Up, and approximately every 5 minutes thereafter
- Stack Checking - Continuous
- Watchdog Timer - Continuous

SENSOR

- Automatic Temperature Compensator Open
- Automatic Temperature Compensator Short
- Liquid Leakage into Sensor

OTHER

- 4 to 20 mA Output Out-of-Range
- Temperature Compensation Out-of-Range
- Measurement Out-of-Range

Logbook Function (Also see Previous "History Log" Section)

Events such as warning messages, calibrations, and configuration activity stored in nonvolatile memory. Time-of-day and date stamped with each stored event. Storage accommodates 100 events.

Firmware Download

Analyzer's operating firmware is downloadable to Analyzer via the RS-232 serial communication port using a utility executed on the user's PC. See Model Code Optional Selection "-F", Windows-based Configurator Utility Software.