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Water Usage Reduction at Food Processing Facility

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Problem Statement

Burke Corporation is one of the largest companies in Nevada, Iowa and they make processed foods specifically pizza topping. Burke also uses 25% of the city's fresh water supply. The company spends 875,000 dollars each year and uses 65,385,000 gallons of water. Burke wants to reduce these costs and in turn be more environmentally friendly. One of the bigger issues noticed is that to heat up one of their pipes they are running hot water over it. This wastes water and also creates a slip and fall hazard.

Disciplines

Bioresource and Agricultural Engineering | Industrial Technology

Department of Agricultural and Biosystems Engineering (ABE)

TSM 416 Technology Capstone Project

Water Usage Reduction at Food Processing Facility

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Client: Burke Corporation, 1516 South D Ave, Nevada, IA, 50201, www.burkecorp.com

- Kevin Joos, Maintenance & Engineering Manager, kejoos@burkecorp.com.
- Alex Sitzmann, Industrial Engineer, ATSitzmann@burkecorp.com.

1 PROBLEM STATEMENT

Problem Statement

Burke Corporation is one of the largest companies in Nevada, Iowa and they make processed foods specifically pizza topping. Burke also uses 25% of the city's fresh water supply. The company spends 875,000 dollars each year and uses 65,385,000 gallons of water. Burke wants to reduce these costs and in turn be more environmentally friendly. One of the bigger issues noticed is that to heat up one of their pipes they are running hot water over it. This wastes water and also creates a slip and fall hazard.

Business Case Statement

A. Burke Corporation uses 25% of the City of Nevada's fresh water every year for the process of food application.

B. The problem is not very extensive in terms of safety, but however, the water consumption is too high.

C. The problems we are dealing with specifically occur in the heating of the pipe that passes processed food and then water running through the heat exchangers for the ovens.

D. Water reduction is always a good area to reduce costs and also being more environmentally friendly. When Burke Corporation uses less fresh water that water can be redistributed to other parts of the city that also might need it.

E. This problem is important to address to Burke Corporation and the city of Nevada because of the total amount of water being used by the one company.

2 GOAL STATEMENT

- **Main Objective(s) and Specific Objectives**
  The main objective is to reduce water usage in the target area. The primary focus is to reduce or eliminate the water usage that is being directed over the four-inch sanitary pipe during the production of high viscosity product such as beef.
- **Specific objectives include**:
  - Develop a new solution to heat the four-inch sanitary pipe.
  - Reduce or eliminate water usage.
- **Rationale**
  - Reduce water usage of the target area by at least 50%
  - Increase the ergonomics of the four-inch sanitary pipe area.

3 PROJECT PLAN/OUTLINE

A. Methods/Approach

- **Reference Material(s)**
  - We have visited with Dr. Hoff (Hoff, 2018) to gather more information regarding the heat transfer of flowing water and a heating wrapped blanket.

Data collection:

- The data necessary to complete this project includes: product throughput (lbs/hr), temperature of meat pump delivery piping, temperature of meat emulsion, flow rate of hot water on 4” sanitary pipe, flow rate of water in oven floor coolers, cost of water, cost of electricity, and cost of natural gas. This data will either be gathered from our client contacts, or we will set up a way to collect the data ourselves.

- **Skills**:
  - To understand and develop a solution, we will have to use our problem-solving skills specifically regarding heat transfer and quality improvement. While there is not a core technology course focusing on heat transfer, such as thermodynamics, we have gained some fundamentals of heat and energy transfer through classes such as Chemistry, Physics, Fundamentals of Technology, and Fluid Power. Recalling the content covered throughout those classes, along with further research, we will be able to develop an understanding of the problem. When it comes to analyzing the current process and being able to justify our solution, we will be able to use our statistics and quality skills covered in coursework. Other courses that may potentially come

useful for this project include Electricity, Lean Manufacturing, and AutoCAD/Inventor.

- **Solutions**:
  - The proposed solution was developed by initially brainstorming a few ideas and gaining crucial client feedback from a meeting at the beginning of the semester. We learned from the meeting that the heating blanket was something our client had looked into in the past and is something we could pursue as a potential option. The solutions we came up with were not to be implemented but rather evaluated by our client. The industrial heating blanket was successful in the original project scope of reducing water and being within a three year payback period but wasn't meeting our client's standards in terms of actually working. So we were then instructed to revise our solution and look more into a closed loop water heating system.
- **Organization:**
  - Our team will be meeting at least once a week. We will be sending out emails to our client weekly for communication purposes
  - Every week we have to submit a weekly report which outlines the duties for each member of the team
  - Define Project, Solution Development, Solution Design, Standard Operating / Installation Procedures
  - Open communication is our biggest thing. This might be our project but this is not our company and in the end, this is whatever is for the company's best interests.
  - We dealt with setbacks with our project by openly moving forward with whatever our client that was best.

B. Results/Deliverables

- The main deliverables of this project are as follows:
  - Maximum product throughput before and after (capacity increase if any)
  - Estimated annual maintenance cost for the solution
  - Annual savings with the solution(s)
  - Sustainability analysis of the solution
  - Durability
  - Cleanability
  - Ergonomic efficiency

Our key recommendations for implementing a solution based on our decision matrix, heat transfer calculations, and client feedback would be to implement a solution similar to the double walled pipe they have set up already. It reduces water and has been proven to work. One of the main concerns with the heating jacket was that it would not transfer enough heat through the pipe to help product flow efficiently based on the power consumption information provided by our contact at PowerBlanket (see Appendix for heat transfer). Our project was not completed as planned, but we have gathered valuable information for the next team to continue on with.

Follow up steps include gathering as much data as possible as the current double walled system. It could basically be recreated. As far as developing this current solution into something more efficient we would recommend looking into a way to recycle the water as opposed to having it go through the drain.

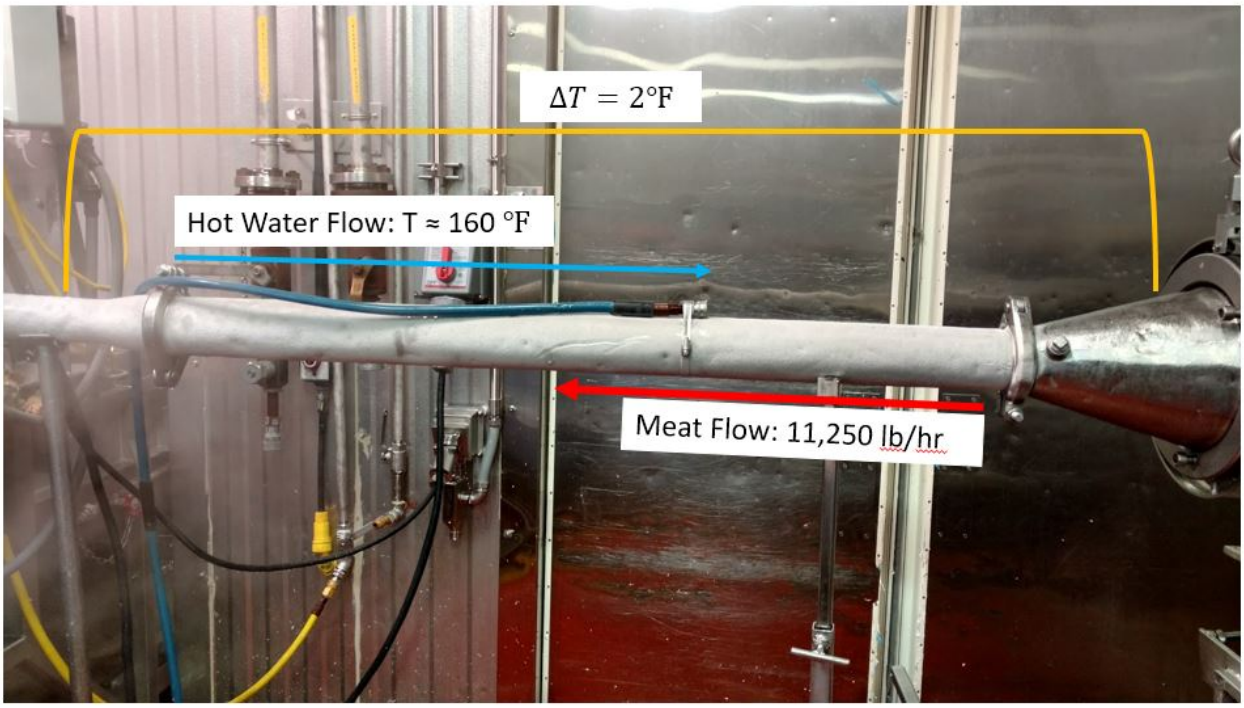
4 BROADER OPPORTUNITY STATEMENT

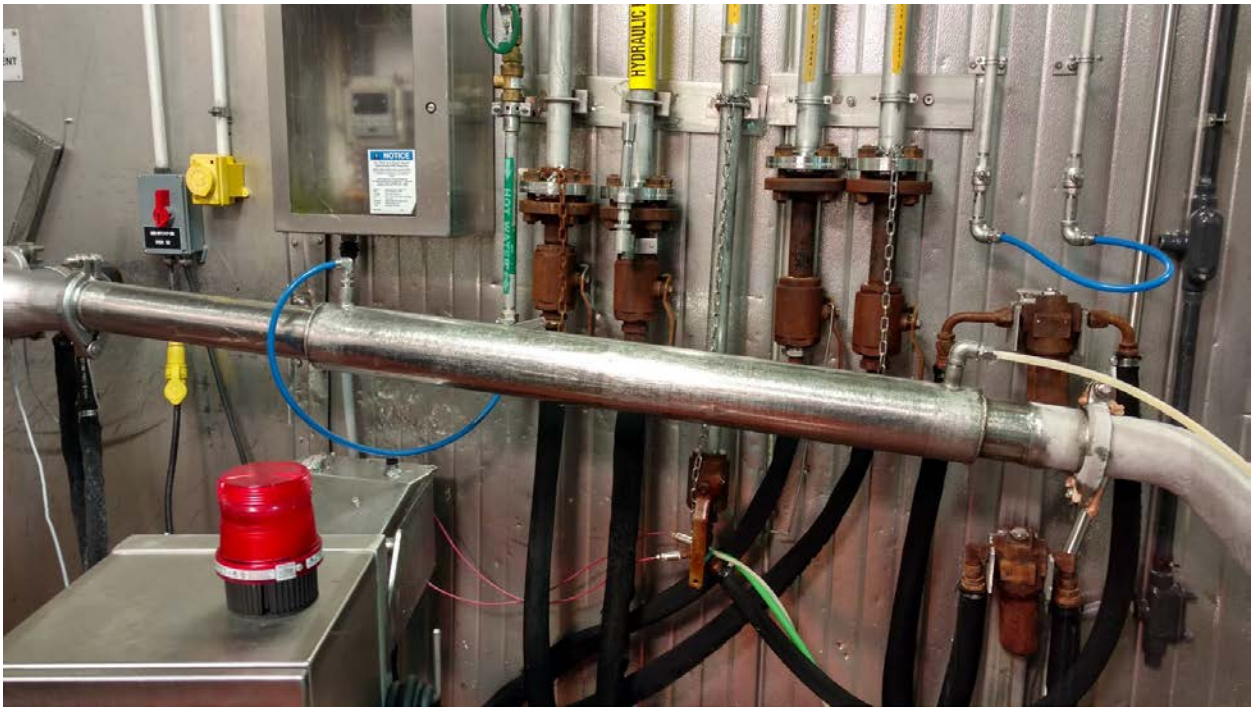
This project appeals to the public because of the amount of water that can be saved and used for other things in the city such as hospitals or homeless shelters. Our project helps serve the community by saving the environment, improving energy efficiency and improving quality of life. Many companies are experiencing the same problems in terms of using too much fresh water. Our solutions could potentially help other companies reduce water as well. Any industry that uses fresh water, even more specifically for food application. Companies are willing to spend great amounts in order to reduce their water consumption. This is an investment that will save the company money and also look good publicly for their image.

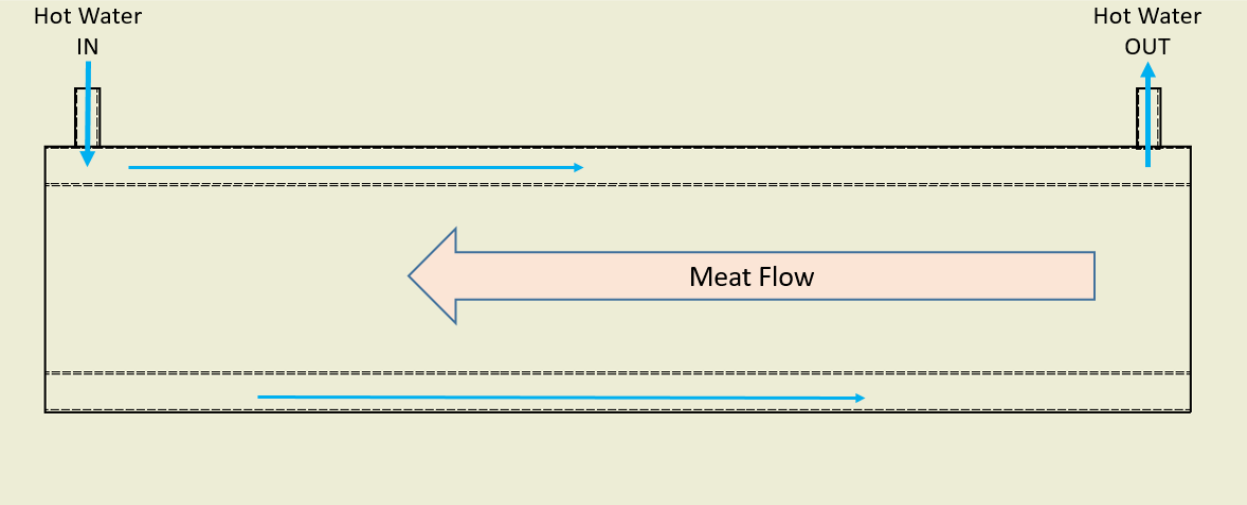
5 PROJECT SCOPE

A. Hot water is used to heat 4" sanitary pipe.
B. Recycle water for other uses before it gets passed into waste.
C. Ending of project scope is subject to change as the process moves forward considering how many options there are for reducing water in a large facility like Burke.

6 GRAPHICAL ABSTRACT







7 REFERENCES

S. Hoff, personal communication, March 21, 2018

8 APPENDIXES

Product	Line Item Description	Quantity	Sales Price	Discounted Price	Total Price
CUSTOM-001	4" dia x 26" length Pipe Heater (see Description for technical specifications)	1.00	$710.00	$710.00	$710.00
CUSTOM-002	4" dia x 55" length Pipe Heater (see Description for technical specifications)	1.00	$946.00	$946.00	$946.00
CUSTOM-003	4" dia x 72" length Pipe Heater (see Description for technical specifications)	1.00	$1,002.00	$1,002.00	$1,002.00
Engineering Fee	One-time engineering design and drawing costs	1.00	$250.00	$250.00	$250.00

Shipping and Handling	$132.00
Grand Total	$3,040.00

Cost Analysis of Closed Loop System

Chemical Savings/Month	70.50
Water Savings/Month	710.10

Electric Cost Increase/Month	15.81
Net Savings/Month	764.78

Chemical Savings/Year	939.94
Water Savings/Year	9468.02
Electric Cost Increase/Year	189.77
Net Savings/Year	10218.19

Estimated Product Life (months)	36
Monthly Capital Interest Rate	0.05
Initial Investment	1118

Total Watts	Hours/Year	kWh/Year
1440	2280	3283.2

Water Use/Year (gal)	Water Cost/Year	Chemical Cost/Year
686088	9468.02	939.94

Hours of Operation/Day	Days of Operation/Week	Weeks of Continuous Operation/Year
19	3	40

Month	Adjustment Calculation	Cash Inflow	Adjusted Savings
1	1.004074124	764.78	761.68
2	1.008164846	764.78	758.59
3	1.012272234	764.78	755.51
4	1.016396357	764.78	752.45
5	1.020537281	764.78	749.39
6	1.024695077	764.78	746.35
7	1.028869811	764.78	743.32
8	1.033061554	764.78	740.31
9	1.037270375	764.78	737.30
10	1.041496343	764.78	734.31
11	1.045739528	764.78	731.33
12	1.05	764.78	728.36
13	1.05427783	764.78	725.41
14	1.058573088	764.78	722.47
15	1.062885846	764.78	719.53
16	1.067216175	764.78	716.61
17	1.071564145	764.78	713.71
18	1.07592983	764.78	710.81

19	1.080313302	764.78	707.93
20	1.084714632	764.78	705.05
21	1.089133894	764.78	702.19
22	1.09357116	764.78	699.34
23	1.098026504	764.78	696.51
24	1.1025	764.78	693.68
25	1.106991721	764.78	690.87
26	1.111501743	764.78	688.06
27	1.116030138	764.78	685.27
28	1.120576983	764.78	682.49
29	1.125142353	764.78	679.72
30	1.129726322	764.78	676.96
31	1.134328967	764.78	674.22
32	1.138950363	764.78	671.48
33	1.143590588	764.78	668.76
34	1.148249718	764.78	666.04
35	1.152927829	764.78	663.34
36	1.157625	764.78	660.65

Sum of Adjusted Savings	Minus Initial Investment
$ 25,560.02	$ 24,442.02

Sum of Non-Adjusted Savings	Minus Initial Investment
$ 27,532.19	$ 26,414.19

Breakeven Point:	ROI
2 months	21.86

Cost Analysis of Heating Blanket

Chemical Savings/Month	78.33
Water Savings/Month	789.00
Electric Cost Increase/Month	8.02
Net Savings/Month	859.31

Chemical Savings/Year	939.94
Water Savings/Year	9468.02
Electric Cost Increase/Year	96.20232
Net Savings/Year	10311.75768

Estimated Product Life (months)	36
Monthly Capital Interest Rate	0.05
Initial Investment	3040

Total Watts	Hours/Year	kWh/Year
730	2280	1664.4

Water Use/Year (gal)	Water Cost/Year	Chemical Cost/Year
686088	9468.02	$939.94

Hours/Day Operation	Days/Week	Weeks of Continuous Operation/Year
19	3	40

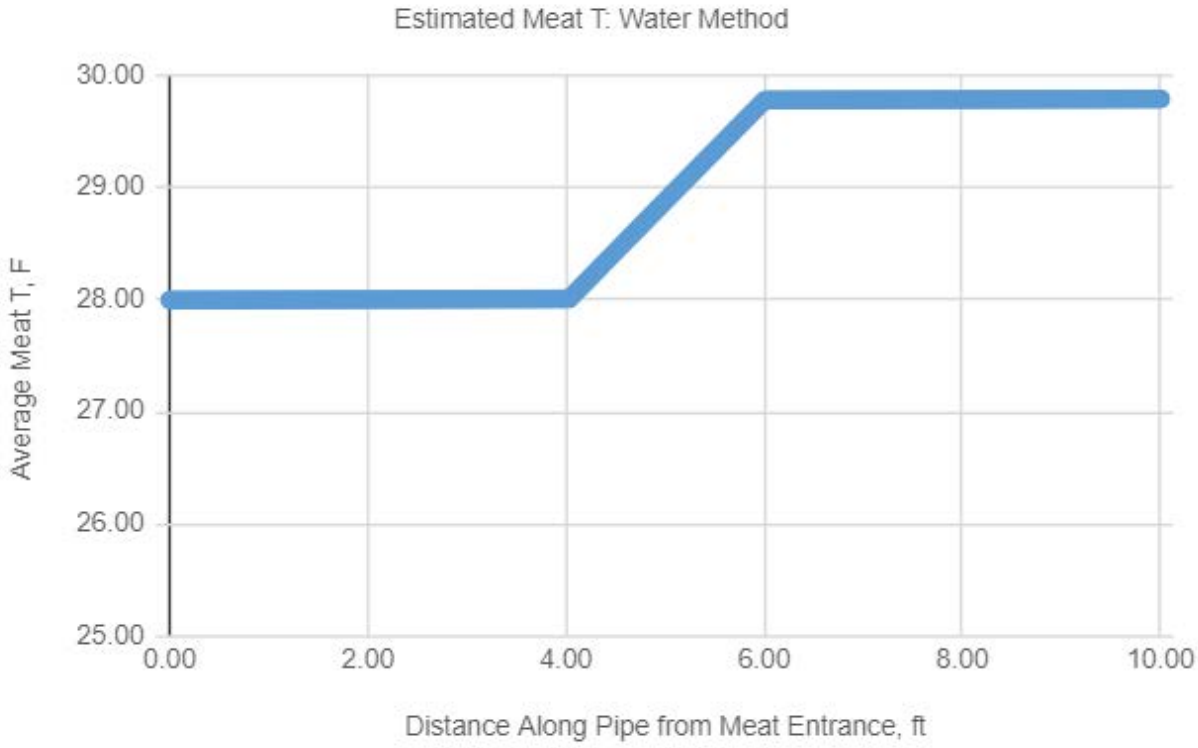
Month	Adjustment Calculation	Cash Inflow	Adjusted Savings
1	1.004074124	859.31	855.83
2	1.008164846	859.31	852.35
3	1.012272234	859.31	848.90
4	1.016396357	859.31	845.45
5	1.020537281	859.31	842.02
6	1.024695077	859.31	838.60
7	1.028869811	859.31	835.20
8	1.033061554	859.31	831.81
9	1.037270375	859.31	828.44
10	1.041496343	859.31	825.08
11	1.045739528	859.31	821.73
12	1.05	859.31	818.39
13	1.05427783	859.31	815.07
14	1.058573088	859.31	811.77

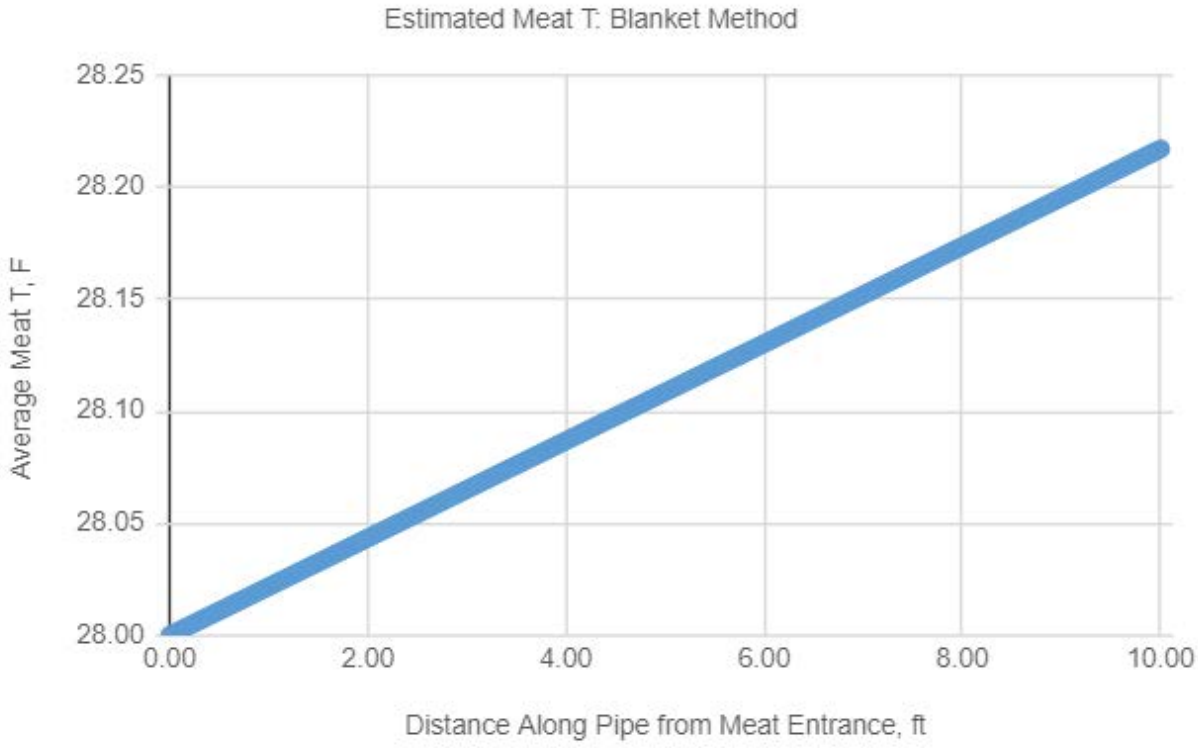
15	1.062885846	859.31	808.47
16	1.067216175	859.31	805.19
17	1.071564145	859.31	801.92
18	1.07592983	859.31	798.67
19	1.080313302	859.31	795.43
20	1.084714632	859.31	792.20
21	1.089133894	859.31	788.99
22	1.09357116	859.31	785.79
23	1.098026504	859.31	782.60
24	1.1025	859.31	779.42
25	1.106991721	859.31	776.26
26	1.111501743	859.31	773.11
27	1.116030138	859.31	769.97
28	1.120576983	859.31	766.85
29	1.125142353	859.31	763.74
30	1.129726322	859.31	760.64
31	1.134328967	859.31	757.55
32	1.138950363	859.31	754.48
33	1.143590588	859.31	751.42
34	1.148249718	859.31	748.37
35	1.152927829	859.31	745.33
36	1.157625	859.31	742.31

Sum of Adjusted Savings	Minus Initial Investment
$ 28,719.34	$ 25,679.34

Sum of Non-Adjusted Savings	Minus Initial Investment
$ 30,935.27	$ 27,895.27

Breakeven Point	ROI
4 months	8.45


Estimated Meat T: Water Method
30.00
29.00
28.00
27.00
26.00
25.00
Average Meat T, F
0.00
2.00
4.00
6.00
8.00
10.00
Distance Along Pipe from Meat Entrance, ft


Estimated Meat T: Blanket Method
28.25
28.20
28.15
28.10
28.05
28.00
Average Meat T, F
0.00
2.00
4.00
6.00
8.00
10.00
Distance Along Pipe from Meat Entrance, ft