Installation plan for an Automatic Fresh Water Ball Valve for the Dairy Unit Flush Tank at California Polytechnic State University

A Senior Project

Presented to

the faculty of The Agriculture Education and Communications Department

California Polytechnic State University, San Luis Obispo

In Partial Fulfillment

of the Requirements for the Degree

Bachelor of Science

By

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Spring 2014

Abstract

The purpose of this senior project was to plan for the installation of an automatic fresh water valve at the Dairy Unit at California Polytechnic State University. This new valve will replace the existing manual gate valve that repeatedly overfills the tank. The data and research was completed in order to assess the projects feasibility and installation needs. This project outlines the steps needed to be taken in order to install the valve, as well provides a detailed explanation on why this installation is pertinent.

Acknowledgements

Without the professional dairy installation knowledge of Cliff Rowley this project would not have been possible. Your guidance and expertise are greatly appreciated and I remain holding the upmost respect for you and the steps you have completed to ensure I have a bright future. You are a true role model for your work ethic and the great job you do as my father.

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Chapter 1

Introduction

The author of this senior project will produce enough information for the installation of an air powered water valve on the flush tank at the Dairy Unit at the California Polytechnic State University (Cal Poly Dairy Unit). The research will be with the how the automatic valve will work with the current pressure switch to turn the valve on and off, as well as how it will increase the efficiency of the tank itself.

Statement of the Problem

With the use the manual gate valve that is currently used when filling the flush tank with fresh well water, the occurrence of overflow is very much a problem. Being a manual valve and not connected to the pressure switch that would otherwise shut the waste water off, the only way to know that the tank if full with fresh water is when the tank itself overflows. This overflow results not only in the waste of fresh water, but also creates mud and standing water that is not ideal in keeping the cleanliness of the dairy. The problem has made it necessary to install a valve that is automatically shut off when the tank is full.

Importance of the Project

California's dairy industry accounts for the highest grossing commodity (milk and cream) in the state. At almost 7.6 billion dollars, California is also the top dairy producing state in the US. (Hoskins, 2012) The Cal Poly Dairy Unit provides this industry with a vast amount of employees that are well trained in everything about the dairy world. To keep the integrity of the

Cal Poly Dairy Unit, it must work as efficiently as possible. The overflow of water not only wastes the water itself but could potentially drain out to the creek nearby and disturb some sensitive habitats. Although this has not ever been an issue, it is important to make sure this will never happen.

Purpose of the Project

The purpose of this project is to research on how to install an air operated water valve on the current tank as well as connect it to the current pressure switch for shut off.

Objectives of the Project

The objectives of this project are as follows

- To research the installation techniques for the air operated water valve
- Provide the steps necessary to install the air operated water valve and connect it to the current pressure shut off switch
- To assess the increase in efficiency that the new valve has on the flush tank operation.

Definition of Important Terms

- *Valve* - a device for controlling the passage of fluid through a pipe or duct, esp. an automatic device allowing movement in one direction only.
- *Dairy* - the business of a dairy farm, concerned with the production and treatment of milk and cream and the manufacture of butter and cheese.

- *Efficiency* - the ratio of the useful work performed by a machine or in a process to the total energy expended or heat taken in.
- *Air Pressure* - the force exerted by air, whether compressed or unconfined, on any surface in contact with it.
- *Pressure switch* - a form of switch that closes an electrical contact when a certain set pressure has been reached on its input. The switch may be designed to make contact either on pressure rise or on pressure fall.
- *Waste Water* - Water that has been used, as for washing, flushing, or in a manufacturing process, and so contains waste products
- *Fresh Well Water* - ground water: underground water that is held in the soil and in pervious rocks

Hypothesis

The author of this project believes that the installation of an air powered water valve that is connected to the current pressure switch will solve any of the overflow issues that currently exists when filling the flush tank with well water. This installation will increase the efficiency of the workers as well and will get rid of any water waste.

Summary

This senior project discusses the installation of an air powered water valve that will be automatically shut off by the current pressure switch. To do this the author has researched the installation process needed to install the valve as well as connect to the pressure switch. In order to asses all information researched, these topics were collected into this senior project.

Chapter Two

Review of Literature

The dairy industry, along with many other agriculture production businesses, are continuously searching to become more efficient. The decreased supply and increased prices of agriculture inputs results in less of a profit margin for businesses. One area of concern that can be made more efficient is labor. By installing an actuated water valve for the fresh water fill on the flush tank at the Cal Poly Dairy Unit, labor for the that would otherwise be used for the manual valve can be eliminated or used for something else, making that worker more efficient with their time.

Cal Poly Dairy Unit

The Cal Poly Dairy Science department is a nationally recognized dairy teaching facility that bases its operations on the universities “Learn By Doing” motto. The unit provides students with “hands-on experience in many areas of production, processing, and products technology, including research and development at the graduate level, while teaching the history, science, theories and recent developments in the classroom.” (Department, 2012). The building itself cost 4.5 million dollars and includes a double 10 parallel as well as two classrooms, a computer lab, nutrition and physiology laboratory, a microbiology laboratory, and a computer system dedicated to software for dairy management practices. Students have the opportunity to operate all aspects of the dairy from managing the calves to milking to feeding (Department, 2012).

Common Manure Handling Techniques

Dairy cows eat a lot; therefore produce a large amount of manure. According to a study done by the University of Wisconsin-Extension, that number is about 120lbs a day, or 21.9 tons per year for a dairy cow weighing 1400 pounds (Wisconsin-Extension, 2010). In the dairy industry there are three main types of manure handling techniques to remove this manure from where the dairy cows eat and sleep and the United States Environmental Protection Agency lists these out for us. The first is the most simple and this is manual scraping. Here a tractor or skid steer is used to manually scrap the manure from the barn alleyways and deposit it at the end of the barn. One other way to remove manure is with an automatic ally scraper where a plough is driven by cable or pulley from one end of the ally to the other automatically. The third kind, and the kind equipped at the dairy, is the flush system. This system utilizes a sloped, grooved alleyway that is flushed with water to wash out the majority of the manure. Flush systems are usually used with a tank at the high end of the slope that delivers a large amount of water, making the flush system the most efficient (EPA, 2012).

Water Valves

A water valve is defined as “a mechanical device that controls the flow of liquid” (Merriam-Webster, 2013). There are many types of water valves that are used commonly in many different applications. As stated in the Occupational Educational Resource website, these types can include, but are not limited to, gate, butterfly, plug, ball, globe, check, and backflow valves (Resource, 2010). Valves are commonly operated manually by a handle or valve key attached to the top of the valve. They can also be automatically driven by use of a *power driven operator* used to turn the valve. The power driven operator may be an electric motor, a hydraulic

motor, or an air driver device. These automatic drivers can be operated by a person or be driven from a distance by a computer or switch that tells it to turn (Resource, 2010).

California Labor

The Cal Poly Dairy Unit typically hires its students at minimum wage. At the current time of this project in 2013 in California, minimum wage is at 8 US dollars per hour. Under Governor Jerry Brown, a bill was passed to raise minimum wage to 10 US dollars per hour by January 2016 (Department of Industrial Relations, 2013). With this fairly large increase in pay, the Cal Poly Dairy will need to become as efficient as possible in order to decrease labor costs and increase profits.

When considering the laborer on the dairy that is responsible for the filling of the flush tank with fresh water, using a manual valve does not use their time wisely. The tank is filled at least four times a day with it being used twice every shift and there are two shifts a day. These four fillings would take the employee about an hour per day combined. Eight dollars an hour for one hour accounts for almost 3,000 dollars a year for wasted time spent waiting for the tank to fill up. The installation of an air actuated valve eliminates this time spent by the employee.

Water Use Efficiency

Efficiency is not only necessary when considering labor on the dairy but also with the use of water. The water used on the Cal Poly Dairy Unit is all pumped onsite from ground water aqueducts. According to a study done by the US Department of the Interior, heavy groundwater use by California's large agriculture uses since 1900 has resulted in groundwater aquifer depletion (Konikow, 2013). This supports the fact that the Cal Poly Dairy needs to use their

water efficiently in order to reduce this groundwater depletion to a minimum as the dairy is not the only one to pump from the same aquifer.

Summary

There are many factors considered when dealing with installing the automatic fresh water valve. The main one being a labor and the efficiency that would entail when having an automatic valve installed compared to the manual gate valve. This will decrease the input labor cost to the Cal Poly Dairy and will result in increased profit. The replacement of the manual valve will also help with California's water crisis as it will not waste as much water from overfilling the tank.

Chapter Three

Methods

The purpose of this senior project was to plan the replacement of the manual gate water valve on the flush tank at the Dairy Unit at California Polytechnic State University (Cal Poly Dairy Unit) with an automatic valve operated by a pressure switch. In order to replace the current flush fill valve set up for the Cal Poly Dairy Unit's flushing system, it was necessary to consult the main faculty managing the dairy and create an agreed upon design for the new automatic water valve. Insight was needed when it comes to the needs of the new system and educated the author on any installation requirements throughout the process. Following consultation, the author also consulted an industry expert to finalize the design and water valve requirements for this particular valve set up. This industry expert is someone who has built and dealt with diary flush systems in the pass and knows the requirements.

Within this report is the cost estimate of the project. This includes the cost of miscellaneous parts and the valve itself along with the cost of labor. This parts list will come from the detailed design drawing of the project and all new parts that are needed to complete it. The drawing was based on measurements made by the author beforehand on the current manual valve set up. The proceeding photos display the current setup of the manual valve set up and its components.

Faculty Consultations

There were two main Cal Poly faculties that were consulted for this project concerning the installation of the automatic water valve. Rich Silacci, manager of the Cal Poly Dairy Unit

and Dairy Science lecturer, provided insight on the how the current water valve system works and how it affects the flushing of manure. Silacci also provided industry insight on possible designs for the new automatic valve and how they would affect the system.

Ben Faulkner, the current herdsman at the Cal Poly Dairy, deals with the flush systems on a daily basis and provided information on what the current system lacks and what the new system needs. Faulkner's expertise on the elements of the Cal Poly Dairy will be helpful in the planning of the installation of the valve.

Mario Rivera is the current plumbing supervisor for the Cal Poly campus. Rivera is a professional when it comes to the installation and repair process needed for above ground plumbing. His professional advice and assistance will be use in the planning of the installation of the valve.

Other Consultations

Cliff Rowley, a product specialist at Delaval Dairy Equipment Company based out of Turlock, has designed, built, and serviced dairies across California for the last 20 years. Rowley provided pertinent information on what design characteristics are needed to install an automatic flush system. He also very knowledgeable when it comes to connecting such a system to the current pressure switch located on the flush tank.

Cost Estimate

For this cost estimate, all labor will be done by the author for free or currant employees of the Cal Poly Dairy Unit so they will not be included in the proceeding cost table.

Item	Amount	Price per unit	Total
2" Automatic Copper Water Valve Normally Closed	1	583	583
3" to 2" Copper T	2	109.1	218.2
2" Copper Ball Valve	3	79.95	239.85
2" Copper Union	2	62.4	124.8
2" Copper 90 degree Elbow	2	16.55	33.1
2" Copper Pipe	5 feet	79.1	79.1
3/4" Electrical Conduit	40 ft	6.95	27.8
3/4" Electrical Conduit Sweep	8	5.95	47.6
12 Gauge wire	100 ft	30.95	30.95
Total			1384.6

Table 1-This table show the cost estimate of needed parts for the valve replacement.

Design/Drawing

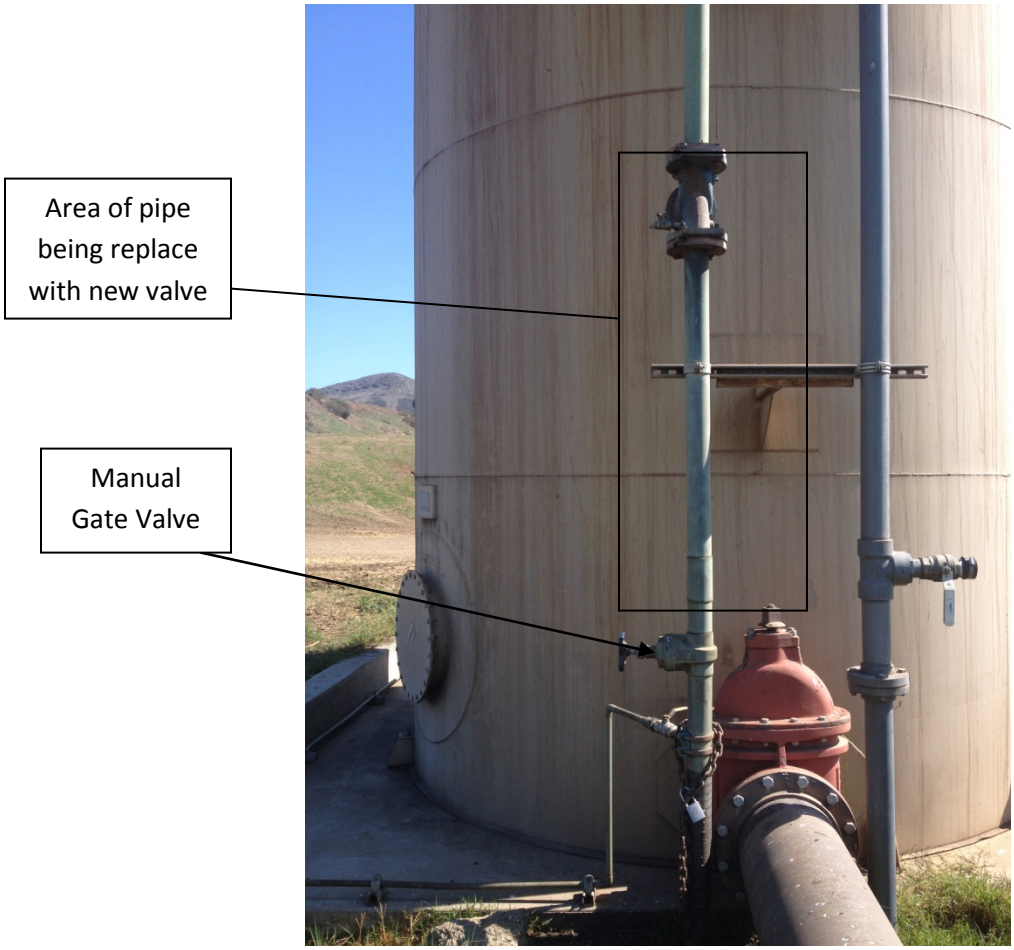

Figure 1. This is an image of the valve and area to be replaced.

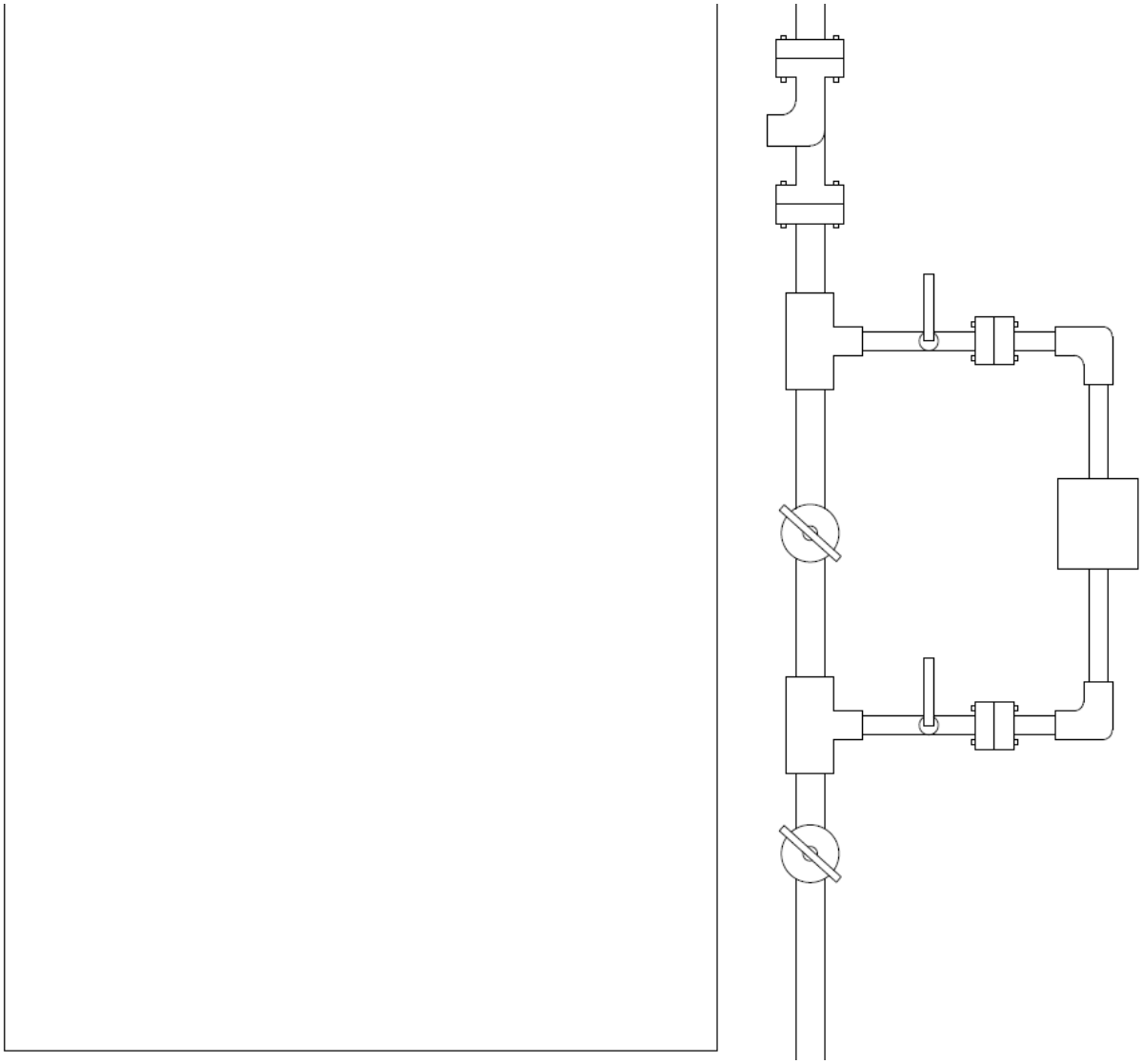

Figure 2. This AutoCad drawing is of the finish project.

Summary:

The valve in for the flush tank at the Cal Poly Dairy Unit will be replaced with an automatic ball valve ran by the already existing pressure switch. This automatic valve will control the filling of fresh well water into the tank. Some faculty and diary industry experts will be used in assistance with the project's completion. Once completed the valve will function without the need of human operation.

Chapter 4

Results and Discussion

This chapter includes the step by step process needed to remove the current valve system and install the new one. The diagrams and pictures will illustrate the steps that need to be completed and will help clarify any steps needed.

Step 1: Removal of the old system

To remove the valve set up that is currently on the flush tank, first make sure the manual gate valve is fully closed. Then loosen the four bolts holding the upper flow control valve. Be careful as the water being held in the copper pipe above will begin to leak out, allow the water to drain completely before continuing. After the pipe is drained, use a saw to cut just above the manual gate valve, but be sure to leave enough copper pipe to solder a coupler on in the installation process. See Figure 1.

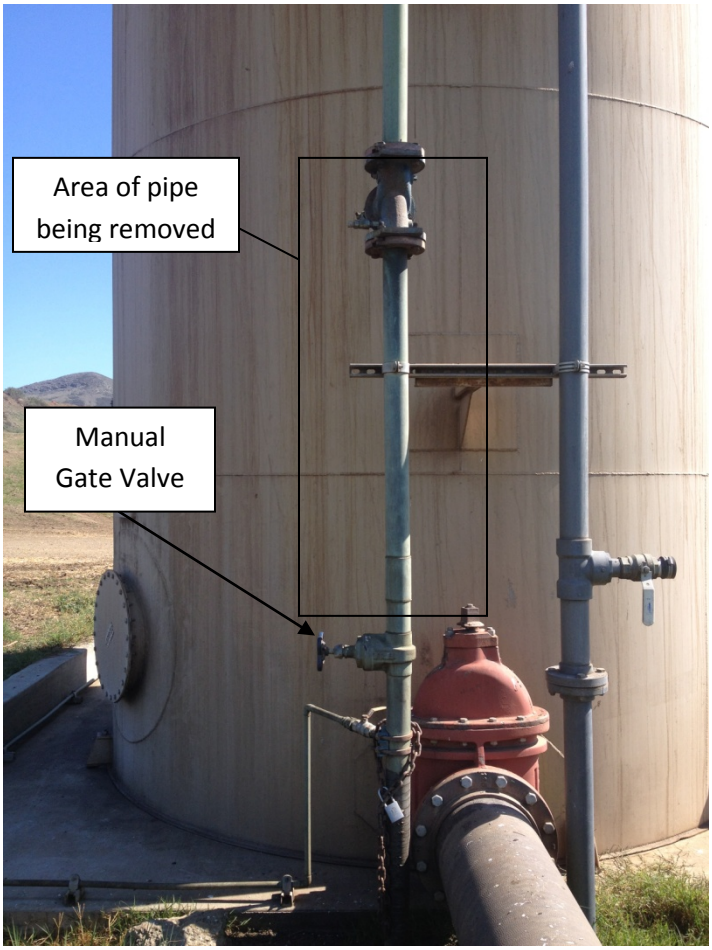

Figure 1

Step 2: Automatic Assembly Build

To begin installation, it is more effective to build some of the assembly in a work area beforehand. To do this, start by assembling the automatic valve assembly. This will later on be removable if the valve ever needs to be serviced or replaced. To do this, you will need two couplers, two elbows, the automatic valve, and a length of pipe. Solder two sets of coupler, pipe, and elbow assemblies first, and then attach the valve. Doing it in this order will allow you to make sure the pipes and couplers are lined up straight with each other before you attach it in the following steps. See Figure 3.

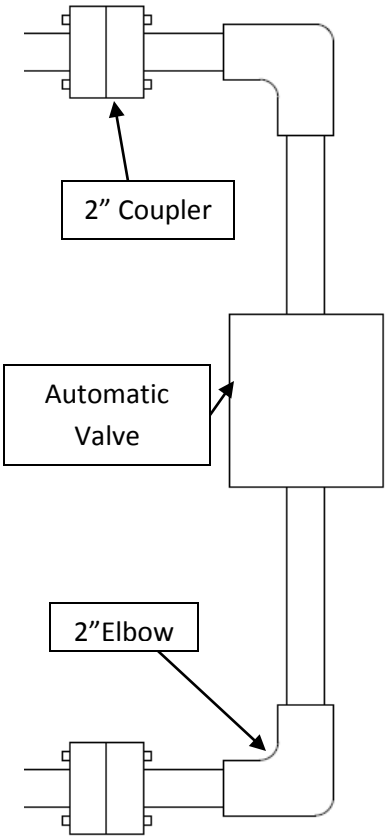

Figure 3. Automatic Valve Assembly

Step 3: Beginning installation

In order to install this valve and still have a simple gate valve assembly as a backup, it is necessary to install three valves in order to shut off the new automatic assembly. To start, solder a 3-inch reducing T above the old remaining gate valve. Attach a 3-inch gate valve above that with another reducing T valve. Make sure the 2 reducing T valves are lined up straight in order to attach the automatic valve assembly later on. From here you can attach the older

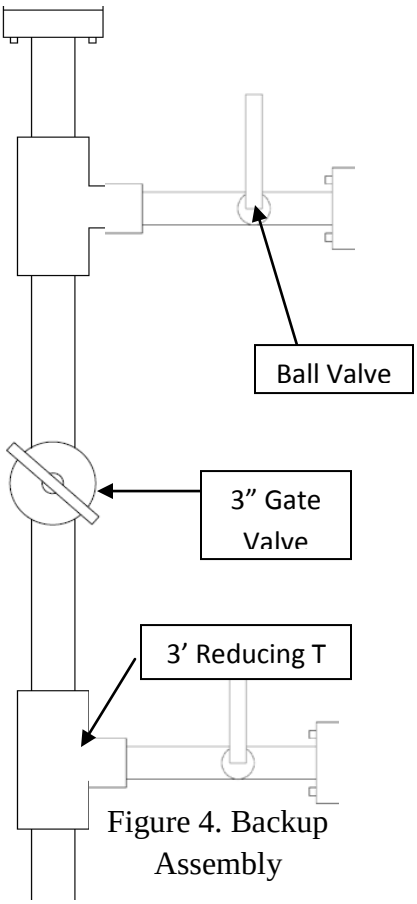

Figure 4. Backup Assembly

flow control valve above and this will complete this assembly. See Figure 4.

Step 4: Remaining coupler Installation

Assemble 2 sections of 2-pipe, 2-inch ball valve, and the other side of the coupler that was assembled in the automatic valve assembly. Once soldered together, you can then solder these to the 2 reducing T's previously installed. See Figure 5.

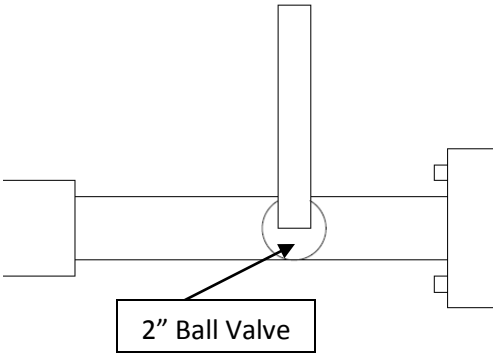

Figure 5. Coupler and Ball Valve Assembly

Step 5: Final installation

To complete the installation you may need someone to help you. Take the first completed automatic valve assembly and carefully lift it to align the top and bottom couplers. As one person holds the assembly, the other will install the gasket and bolts to the top coupler, making sure not to tighten the bolts completely yet. Then install the bolts and gasket to the bottom coupler. When you are positive that the two gaskets are aligned and it will seal well, tighten the bolts completely, torque them to the coupler manufacturer specifications. See Figure 6.

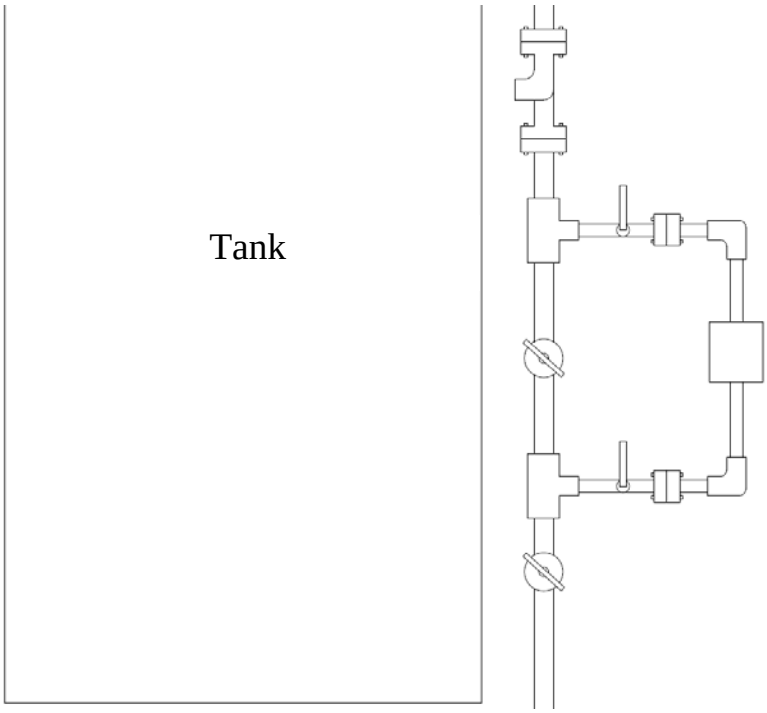

Figure 2. Completed Plumbing Assembly

Step 6: Electrical

To wire the automatic valve would be fairly simple. There is already a pressure control sensor installed on the flush tank so you will just need to tie into that. After turning off all power, install the electrical conduit to follow the same path as the existing conduit. This will lead you straight to the electrical box that houses the pressure valve. You will only need to pull two wires though this conduit as the automatic valve is normally close and only needs power to open. A black wire should be used as the power wire with a white wire as a neutral. There are electrical connectors already on the pressure control sensor that are coordinated with a power line and neutral line, attach theses to the black and white wires. Then attach the wires to the automatic valve in the same coordinated electrical connections. Close the two doors for the electrical box as well as the cover for the automatic valve.

Step 7: Test

To make sure the assembly works with no leaks, turn the lower gate valve supplying water to the assembly open. Make sure the upper gate valve is closed along with the lower ball valve. Check for leaks. Now open the lower ball valve and check for leaks again. Turn on the power to the electrical board and manually trip the pressure control sensor and make sure it opens the automatic valve. Open the upper ball valve and the tank should then be filling with fresh well water. Observe the filling and if the automatic valve closes once the tank is full, then you have successfully installed the valve. Make sure to do one last observation for any water leaks.

Chapter 5

Summary, Recommendations, Conclusion

Summary

This automatic fresh water valve installation plan was established in order to correct the problem of the overflowing fresh waster flush tank at the California Polytechnic State University Dairy Unit. In addressing today's declining water availability as well as the concern of water runoff, it is important for the flush tank to remain efficient. Efficiency also pertains to the labor force of the Cal Poly Dairy unit and this automatic valve will save valuable time and money. The specific plan of action completed based on the consultation of industry professionals as well as the research and labor done by the author. This plan covers the step by step process needed to install an automatic fresh water valve on the flush tank.

Recommendations

The following recommendations should be considered before completing the plan of action of installing the automatic valve.

1. Make sure the California Polytechnic State University head of above ground plumbing is there when the valve is installed.
    a. This recommendation is based on the fact that the installer might not have the necessary experience to do it correctly. The professional plumber will be able to help the installer and this will also let the plumber know how it was installed in order for him to service or maintain the unit later.
2. Asses the strength and condition of the flush tank beforehand

    a. The tank that is being filled up is getting fairly old. The reclaimed flush water made it deteriorate faster than normal and the top of the tank is rusting out. In order to have the installation of the automatic valve worth it, it is necessary to make sure that the flush tank will last a sufficient time.

3. Help organize a budget for the party in charge of paying for the installation and part.
    a. The cost of the valve itself is expensive. In order for the Cal Poly Dairy Unit to pay for it, it needs to be within their allotted budget. It may also have to be proven to be a beneficial asset to the dairy in order to get approved.

Conclusion

Researching, creating, and developing an installation plan for the automatic fresh water valve at Cal Poly was a success. If installed correctly, the automatic valve will meet the objectives outlined in Chapter 1 as well as make the Cal Poly Dairy Unit more efficient. Each aspect of the research and installation was adequately addressed and developed to make the project effective and feasible. The installation plan and budget is set up in order to allow for tolerances in size and price. The valve plan may be altered slightly but the assembly should be done as demonstrated in Chapter 4.

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