A Rainwater Harvesting System for an Industrial Facility in Guelph

Matthew Hall, Jeremy Muller, and Eric Hodgins

Abstract. A rainwater harvesting system for Linamar's CAMTEC manufacturing plant has been designed. This rainwater system will replace a large portion of the plant water usage. The design includes a network of piping to capture precipitation from the roof, and a pipe network to direct water to a holding cistern. This water will then be filtered and stored in a network of larger cisterns which will be consumed by the reverse osmosis unit feeding the manufacturing processes. The design was analyzed and it was found that an annual savings of approximately $1000 is achievable due to reduced purchasing of city-supplied water.

Key words: Rainwater harvesting, water filtering, water storage tanks.

1 Introduction

CAMTEC requires a rainwater harvesting that will reduce water costs and have a reasonable payback period. This rainwater harvesting is designed to meet the following constraints listed:
The water quality must be at a suitable level for CAMTEC's manufacturing processes. The system also needs to work with the current infrastructure of the plant, with regards to its reverse osmosis filtration system. The system must also conform to all regulations in the Ontario Building Code. The design must also be equipped with overflow protection as well as ensuring that the system does not restrict the flow of water from the roof to prevent damage or excessive flooding.The system must have automatic top-up in the event that rain collection is less than rain consumption. The system must also be place d in the current coolant recycling system area located on the second floor mezzanine.
The major assumptions used in the design are:
Equal volumes of rain flow into all roof drains. The runoff coefficient for a flat gravel roof is 0.5 .

All rainwater harvesting systems have a collection process, which conducts roof runoff to the water storage tanks. When needed, the water is then filtered further and distributed. The approach taken to finalize the design was first understandiong the layout of the CAMTEC plant, and understanding the major components of the current drainage system and possible locations to install system tanks. Determining the rainwater collected and comparing to storage and piping costs allowed the optimal system to be chosen based on return on investment(ROI)) and payback period of the overall rainwater harvesting system.

2 Conceptual Design/Methodology

2.1 Overall design

The rainwater harvesting system collects water from the roof of the CAMTEC plant. The use of estimations of precipitation found in Guelph were analyzed and averaged to find amount of rainfall that will enter the roof of the plant over the course of a year. The analysis provided important data which was used to optimize the overall system.
The overall design of the system performs as follows. The water collected from the roof will flow through a network of pipes and enter an initial water collection storage tank. From this initial tank, water will be pumped through a 20 micron filter, followed by a 5 micron filter. The water will then be distributed to 5 tanks which will all be interconnected to insure that water is evenly distributed throughout all tanks. Finally before the water enters the CAMTEC reverse osmosis unit, the water will pass through an ultraviolet (UV) filter followed by a hot water heater. This will eliminate all bacteria entering the reverse osmosis unit. Finally, the treated rainwater will be distributed throughout the plant for CAMTECs cooling processes or non-potable water uses.

2.2 Major components

The major components of our design consist of piping which will lead rainwater to the storage tanks, filters and pumps.

3 Detailed Design

3.1 Piping System

The piping system will be suspended from the CAMTEC roof where the rainwater will be gravity fed towards the water storage tanks. The piping system will consist of 32 drain collections which will be arranged to minimize costs.The piping system also includes a network of overflows from the holding cisterns to allow proper functionality in the event that rainfall is too large.

3.2 Water Storage Tanks

There will be 5 new 2500 gallon water cisterns installed on the second floor of the CAMTEC plant, which currently contains the coolant recycling system. The 2500 gallon tank currently not in use will also be incorporated into our design to reduce costs. The first initial tank will operate as an initial collection tank. When this water reaches a certain level, the pump will be activated by a modulated float controlled air valve to filter the collected water, followed by the filtered water entering the 5 main collection tanks. Overflows will also be placed on the initial collection tank as well as the main storage tanks in the event that rainfall is too large or the main storage tanks cannot handle any more filtered water. There is also a float controlled valve on the tank connected to Guelph's softened city water to automatically control water level top up in the event that the rainfall consumption does not meet the demands of the RO unit.

3.3 Filtering System

Water entering the reverse osmosis unit must be free of sediment and bacteria. The filtration process designed will consist of industrial sized micron filters and an ultraviolet filter. The collected rainwater enters an initial water holding tank,followed by the water being pumped through the micron filters and then to the main storage tanks. The micron filters will be arranged in series with a step down from a 20 micron filter to a 5 micron filter. This will allow larger particles to be captured by the initial filter to prevent the 5 micron filter from becoming plugged and unusable. These filters have a capacity of 150 GPM of rainwater given a pressure of 20 PSI, and will allow no sedimentation to enter the remaining storage tanks. When the water is needed at the reverse osmosis unit, the water will be pumped at no more than 5 gallons per minute through an ultraviolet filter. This will eliminate any threats of bacteria entering the reverse osmosis machine.

3.4 Pumps

The system design will contain two pumps. There will be one pump located after the initial tank which contains the initially captured rainwater. The second pump will be placed after the remaining tanks and before reverse osmosis unit. The first pump will be a pneumatic pump which will pump the rainwater at maximum 150 gallons per minute through the micron filters. This will maximize rainwater flow to the rest of the water storage tanks. The other pump will be an electrical pump which will supply a constant flow to the reverse osmosis machine of 5 gallons per minute.

4 Discussion

The estimated total cost of the system is approximately $35,000 with a payback of 5.5 years. The sytem is designed to optimize return on investment as well as yearly savings. Some errors in our design could be the amount of precipitation that will actually reach the water tanks. This is mostly due to to the fact that a loss coefficient of 0.5 is applied to all precipitation. Larger rainfalls will provide a lower loss coefficient, since the pecentage of precipitation lost to evaporation and other factors will decrease. Future recommendations would be to determine more precise rain loss coefficients to further optimize the design, as well as a means of filtering out particles largeer than 20 microns, without reducing the flow of the water collected. This will ensure that the filters will not become plugged and hinder the performance of the system.

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