Rainwater Harvesting Design

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Abstract. In this paper we present a new system for gathering and utilizing rainwater for uses in an industrial capacity. The main idea is to capture, transport, store, and filter rainwater and feed cooling systems within the factory. The design consists of four major components: PVC piping for transportation, a 10,000 Gallon water tank for storage, membrane and UV filtration units and a pump. The design was simulated and tested and results show that the system will have a cost of $23,000 including installation, which translates into a payback period of 18 months

Key words: Rainwater-Harvesting, Industrial Cooling, Environmental Alternatives

1 Introduction

The purpose of the project was to design a rainwater harvesting system for CAMTEC Linamar. At present, CAMTEC Linamar uses 1307m3 of water per year, primarily for manufacturing processes. This water is purchased from the City of Guelph potable water supply at a cost of approximately $2000 dollars per month. CAMTEC Linamar wishes to replace the majority, if not all of this water with harvested rainwater.

The design was based on the following constraints and criteria. An overall cost not exceeding $30,000 together with a payback period of under 12 months, quality of water meeeting current reverse osmosis (RO) unit, as well as a PH between 7.2 and 8.5, ease of installation as it relates to the plants operation, reliability of the system once installed, and a time constraint stating the system design should be completed by April 4th, 2008. The reliability of the system is perhaps the most important criterion we focused on. The system is not to shutdown on its own at any point without an appropriate warning.

Several rainwater harvesting systems are employed throughout the world for uses such as industrial cooling, toilet flushing and in some cases drinking. The state of the science involves an automated first flush system which diverts a predetermined amount of water to waste as the first few minutes of rainfall catch all the contaminants in the air. Also, more advanced systems involve a membrane filtration apparatus, which filters the rain water to a desired quality depending on the application. The system designed by NEXUS Consulting will employ the above principles, but will also be innovative due to its simplicity. The system will be gravity fed from a small number of drains, and will therefore have a relatively low materials and installation cost, while still meeting the clients needs.

2 Conceptual Design / Methodology:

The design consists of three main stages. Stage one is the collection stage, here water is gathered during rainfall utilizing existing drains on the rooftop. Stage 2 is the transportation stage; here the water passes through a first flush system and then proceeds through pipes via gravity to storage tanks. Stage 3 is the storage and filter stage, here the water is stored and filtered for future use. As water is needed for coolant it is pumped out of the tank and fed through two filters.

2.1 Overall Design:

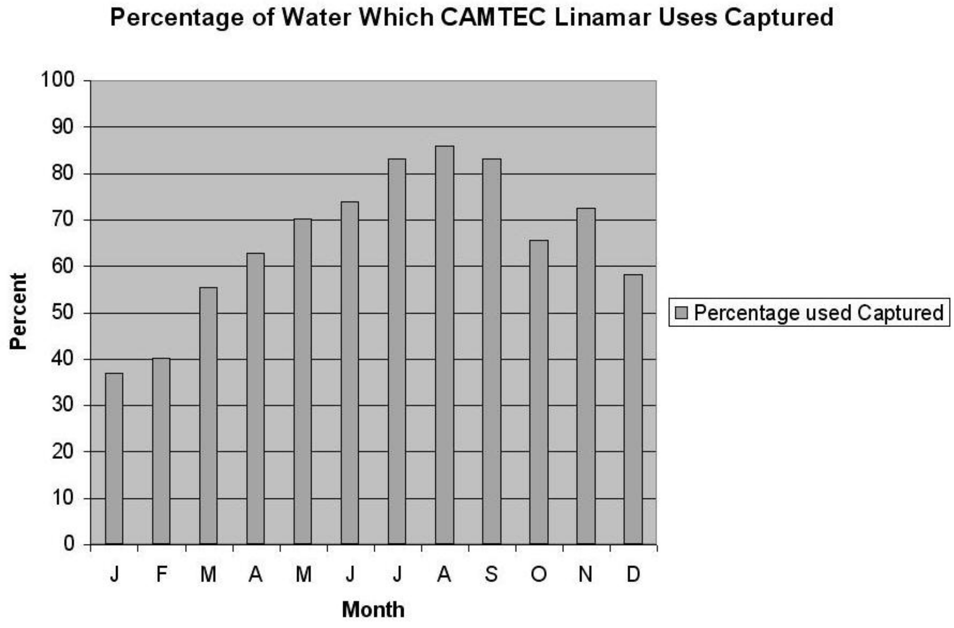
The major components of the design can be classified into 7 categories. These are collection, transportation, first flush, storing, pumping and filtering. For collection the existing roof drains were utilized, PVC pipes were used for transportation, for storage 10,000 gallon vertical poly storage tanks were used, for pumping a HP, single stage submersible water pump is used, and finally for the filtering we used a Turbo Clean hydraulic auto-flush sediment filter in conjunction with a 110V UV System.

2.2 Major Components

Existing drainage system is connected to a 10,000 Gallon Vertical Poly Storage tank by 4 PVC piping in a rectangular pattern along the roof utilizing gravity for flow. A first flush system is employed at each existing drain, which is then connected to the PVC connection pipes. After the water is stored in the vertical tank, a submersible water pump is connect in series with a Turbo Clean Hydraulic Auto-Flush Sediment Filter and Sterilight S24Q UV System, which is then connected to the existing RO unit.

3 Discussion

Due to the geometry of the roof and the spatial limitations of the factory only half of the roof was used in our design, this translated into a surface collection area of 12,000 m2, and was determined to be the best option for our rainwater collection design. This resulted in an estimated 650m3 of rainwater per month and a return period of roughly 18 months. Errors in our calculations can



be attributed to inconsistent rainwater assumptions (due to the nature of rainfall) as well as an overestimation of snowmelt collected. Future research should look into the benefits of using a centrifugal pump over a submersible pump, as well as more in depth simulation regarding local annual snowmelt and evaporation.

The rainwater collection efficiency of the system is seen in Figure 1. As seen, there is a significant difference in the percentage of precipitation capable of being used between the winter and summer months. Due to this, the cost saving ability of the system is reduced during the winter months.

Product	Cost($)
Vertical Poly Storage Tank (10,000 Gallon)	4988.06
Submersible Water Pump	587.65
Autoflush Sediment Filter	3119.13
Sterilight UV System	1198.28
PVC Piping (Assorted Lengths)	1898.64

Table 1.

The final cost of the complete systems major components is estimated to be $11,791.76. This price list excludes installation and future maintenance.

Based on cost estimates of parts and labour, the return period will be 6 months longer then our constraint specified. Since installation is a set cost, the only way to reduce cost to meet the constraint is to reduce the price in parts by using cheaper materials, such as less efficient filtration units and pumps. Table 1 illustrates the cost of the individual major components of the design for the rainwater harvesting system. It clearly shows that the storage tank and filters are the most expensive components. As it was concluded that a more efficient, long lasting filtration system is more desirable then a cheaper alternative, the only feasible cost alternative is a reduction in tank size, which could potentially reduce the overall cost by up to $2000. However, this would reduce the maximum storage capacity of the system and decrease the amount of water saved by the system. Therefore, it was concluded that the 50% increase in the payback period is justified.

4 Acknowledgement

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