REUSAGE OF RAINWATER SYSTEM FOR PRODUCTIVE MEANS

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ABSTRACT

The reusage of rainwater avoids its utilization where it isn't needed: utilization in sanitaries, irrigation and productive means. It makes sense to not waste a scarce natural resource and this is the embrace focus of this study. For PCS, this is an opportunity that is justified by the company policy about environmental issues. Considering the CETESB recommendations about the rainwater that fall in the PCS productive area in São Vicente, SP, the project aims the gathering , the control and reusage of rainwater for productive means that allows, not only to attend the CETESB recommendations, but also the obtention of environmental gain. It has been used the rooftops of the productive area, and the floor area that define the microhidrological basin. Some specific contaminants are considered: fecal coliforms, dust and particulate material. It has been concluded that the major poluents are concentrated in the first 20 minutes, such as: SS, DQO, SO_x, NO_x, and Heavy Metals. About the rainwater on the rooftop, the DQO varied between 400-2000 mg DQO/m^2. The project allows the utilization of 30% of rainwater for productive means. This fact shows the environmental gain potential, in the case of this plan being applied by other industries.
Key words: rainwater utilization, environment, technology.

1. INTRODUCTION

Water is a limited and precious resource. Although about 3/4 of Earth surface is covered with water, of this total, only 3% is fresh water. However, 80% of that amount of fresh water is frozen on the polar icecaps or in glaciers, or in very deep ground water, which means only 20% of the total volume of fresh water of the planet is found immediately available for man. The inequal distribution of water around the distintc regions of the planet makes this resource scarce in many countries. In Brazil the rainwater is abundant in most of the regions. However, its misuse, waste, and the pollution of rivers, lakes and ground water, threaten the supply and raise the cost of treated water in the public system, specially in the major urban centers. In there, the situation is aggravated by the soil impermeabilization problem that not only diminishes the aquiferous recharge, but also causes flood in times of intense rain. Such problems made that the United Nations (UN) considered water, the main theme of the 21 century. The protection of potable water must be assured to garantee that it won't become a luxury product only accessible to a layer of the society. We need water, this won't change.

Rainwater captation is a practice very diffused in countries like Australia and Germany where new systems are being developed, allowing the captation of water in a simple and effective way with a good cost-benefit relation. The utilization of rainwater brings the following relevant advantages: avoids the utilization of potable water where it isn't needed, reusage of rainwater that falls on the microhidrological basin of contaminates areas or industries, utilization in sanitary systems, irrigation, among others. It makes sense, ecologically and financially to not waste a scarce natural resource of all the area of embrace of the study.

For PCS, this is an opportunity justified by the company Environmental Policy on environmental issues regarding its practices and local activities. Having the Environmetal Policy of PCS as the starting point, it includes the Environmental Administration as a premise for the decisions over actions directly related with production and productivity.

Considering the recommendations of the Environmental Control Agency of the State (CETESB – Santos), about the need to reserve, control and discard rainwater that fall on the productive area of PCS of Brazil in São Vicente, SP.

PCS chose to develop and implant a project that aims the gathering and reusage of rainwater for productive means. This plea will allow, not only to attend the CETESB recommendation, but also the obtention of environmental gains that ca be quantified and tracked by proper sustaintability indicators.

The quality of the water can be seem under four steps (TOMAZ, 2003):

1) Before reaching the ground;
2) After running on the rooftop;
3) Inside the reservoir;
4) In the utilization point.

The first step is the quality of the rainwater before reaching the ground. The second is the quality of the water after falling on the rooftop or impermeabilized area (eg.: courtyard). The third step is when the rainwater is stored in a reservoir, where it might have deposition of sediments or solids at the bottom. The fourth step is when the water reached its reutilization point such as, industrial means.

The objective of this work is to determinate the main physical-chemical variables that interfere in the utilization of collected rainwater in the industry PCS-Fosfatos do Brasil Ltda. for productive means.

2. MATERIAL AND METHODS

The study for the implementation of rainwater reutilization system for productive means, in the industry PCS-Fosfatos do Brasil Ltda was conducted in the municipality of São Vicente, SP, in the industry's annex with an contribution area of 17000m^2. In the PCS' case, for the reusage of rainwater, it must be used the rooftops of the productive area, as well as the floor areas that define the microhidrological basin. Some specific contaminants are considered, such as: feces of birds, pigeons, rats and other animals, dust and particulate material derived from the productive process containing fosfates, leaves of trees, among others (Tomaz, 2003). According to Terry (2001) the volume of rain tha must be considered as contaminated, and depending on its finality, must be rejected, due to the degree of contamination represent the first 2mm, because they present the contaminants in some expressive concentration. Marks (2001) advises to reject the first 1mm of rain. He also mention that in Australia (climate similar to Brazil) the rainwater must be used for non-potable means such as the use in sanitary basins, gardens, and industrial prductive means.

Studies performed in China (Ganghi, et al. 2001) verified that the concentration of poluents is a function os the duration of the rain. From the graphics obtained by the researchers, it has been concluded that in the first 20 minutes are concentrated the major poluents such as: Solids in Suspension (SS), Chemical Demand of Oxigen (DQO), Sulfates (SO_x), Nitrates (NO_x) and heavy Metals. This have already been researched in the United States where the first 20 minutes were used for the dimensioning of the reservoires with the purpose of retaining the difused pollution.

In a residential zone they obtained 2000mg DQO/m^2 and 1700mg SS/m^2 with rainwater that runs on a highway. About rainwater on rooftops, they came to the conclusion that the DQO varies between 400-2000mg DQO/m^2. They've researched for six months and concluded that in a general way the pH of the rain varies from 4.5 to 5.8, and after running on a n ordinary rooftop it increases to the average of 6.5. About the consideration over what can be considered as rain, Kumar (2001), in India, considered rainy days those bigger than 2.50mm. According to Heesink, et al, 2001, in the 9th International Conference of Rainwater Captation, which happenen in Brazil in 1999, he gives special importance to the quality of the captation of rainwater.

The captation can be done in three steps, acording to Figure – 3.1.
a) Captation only;
b) Rainwater captation and pre-filtering;
c) Rainwater captation, pre-filtering, and treatment

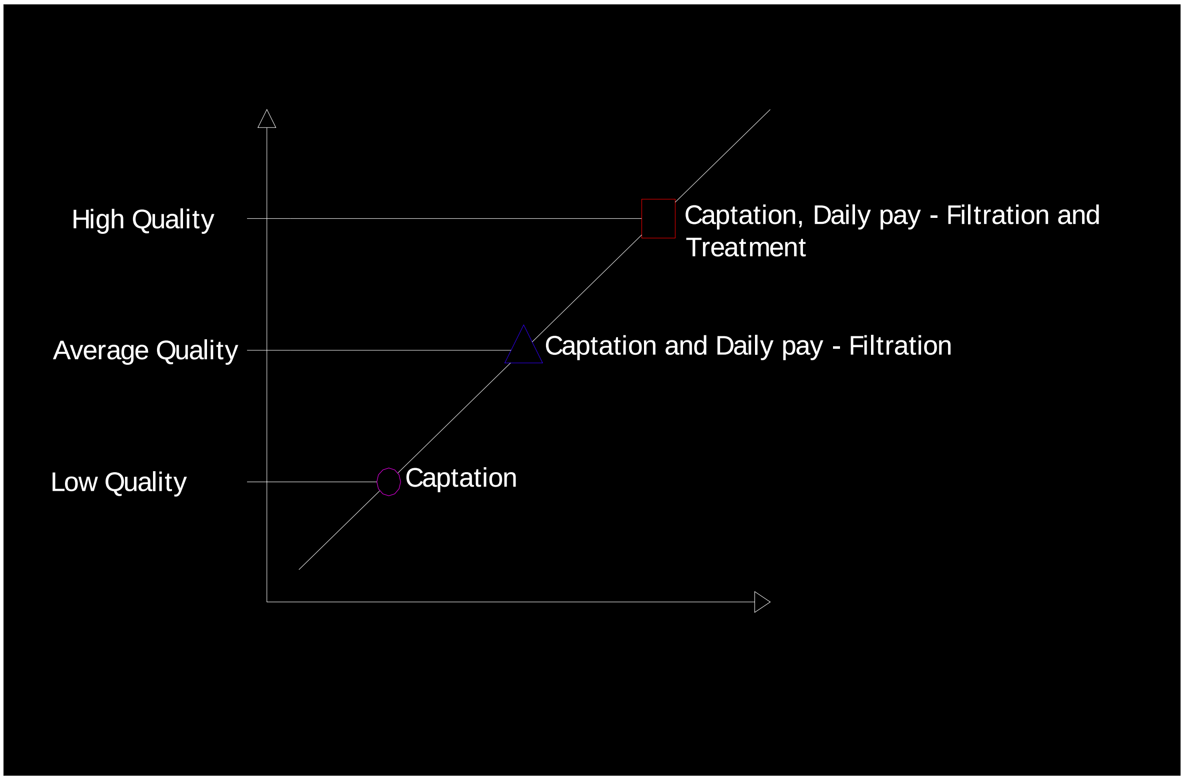

Figure 1. Steps of Rainwater Captation

With the purpose of executing the project of Rainwater Reusage for Productive Means, PCS started the work in July of 2005, with a research about the precipitation of rainfall historical indicators around the region of São Vicente, SP. It has been considered the most relevant data for the purpose of the project (2000 – 2005), since the region has official records since 1934 (DAEE).

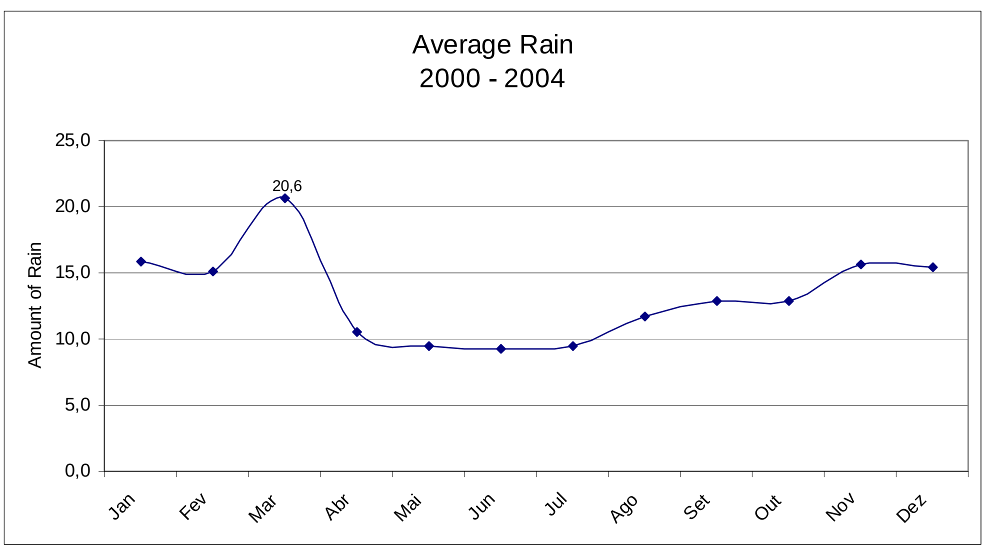

Figure 2. Average Precipitation of Rainfall Indicator

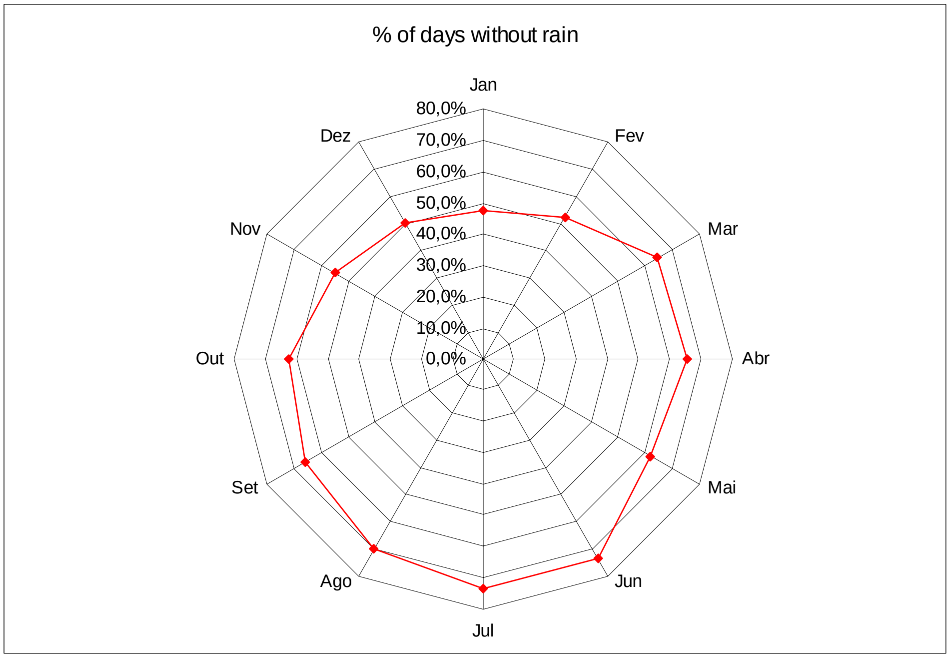

Figure 3. Percentage of Days Without Rain

Numbers refering to Pouring Values point to a Historical Average of 20.6mm/m^2 as of March; equivalent to a full day. That is as much as 20.6L/m^2/day. Taking into account that the area in question is of 17000m^2, it has:

2.1 Outflow

$$Q = 20{,}6 \text{ L/m}^2\text{/d} \times 17.000\text{m}^2 \,.\, 10^{-3} \text{ m}^3\text{/L} = 350{,}2 \text{ m}^3\text{/d} = 14{,}6 \text{ m}^3\text{/h}$$

- Relação de Áreas da Microbacia:

$A_1 = 10{,}82 \text{ m}^3\text{/h}$

$A_2 = 3{,}78 \text{ m}^3\text{/h}$

2.2 Storage Capacity

Amongst PCS' instalations, there are three available tanks, which were used for residuary alcaline water storage, when the productive process used Hydrated Lime.

The three tanks are interconnected and located near production, in a Containment Bay, as shown by the factory's location map.

Considering the tanks total holding capacity (136m^3), it has:

$$\theta = \frac{V}{Q} = \frac{136}{14{,}6} \Rightarrow \theta = 9{,}3h$$

This time taken into account therefore, as consecutive hours along the whole day. If we consider the intention of storing only the first hour of pouring, given that the 20 first minutes, alone, are enough to collect the contaminated rainwater, then the number of days that match available storage space would be:

$$\theta = \frac{136\ m^3}{14{,}6\ \frac{m^3}{d}} = 9{,}3\ \text{dias}$$

$$\therefore$$

$$14{,}6\ \frac{m^3}{h} \times \frac{1h}{d} = \frac{136\ m^3}{14{,}6\ \frac{m^3}{h} \times \frac{1h}{d}}$$

2.5 Dimensioning of the Reception Boxes

Considering there are two distinct contribution areas, two Reception Boxes were defined:

Reception Box 01 - AREA A1:

The contributing outflow of Area A1 is 10,82m³/h for, θ = 1h of rain, therefore:

V_1 = 10,82m³/h x 1h = 10,82m³

V_1= 12m³ (chosen volume)

Dimensions: Length: 6,00m

Width: 2,00m

Useful Height: 1,10m

Recption Box 02 - AREA - A2:

Taking into account that Area A2 has a smaller rainwater contribution (QA2 = 3,78m³/h), respective volume could also be smaller when compared to Reception Box 01.

However, there is an available box at the site, with $12m^3$ (retangular) that could be used, to collect A2's contribution and also to receive, through pumping, Reception Box 01 contribution; and thus:

V_2 = 12m³

Dimensions: Length: 6,70m

Width: 1,50m

Useful Height: 1,20m

Reception Box 02 will also be used for redirecting rainwater for Reservatory Tanks, making the water available for reusage in Industrial production.

2.6 Pumping System

The pumping system consists of two pumps installed in one of the Reception Boxes:

Pump Specification:

Outflow: 6m³/h

Revetment: specific for protection against abrasion and corrosion

Number of Pumps: 02 unities
Potency: 3 CV (220V, tri-phased).

Eletric Panel:

- Panel Box;
- Eletric Wiring and Connection;
- **Botoeiras e Comandos**;
- Grounding;
- Level Ball Control;
- **Horímetro**;
- Timer;
- Other Panel Instruments.

2.7 Rainwater Drainage

• Rooftop water will be collected by 152.4mm (6.) tubes, and then redirected to a concrete and masonry gutter (0.4mm x 0.4mm), to be built along the side wall of the factory's North wing building;

• Courtyard Water (external area) will be collected by boxes 01 and 02 as per levelling of the factory's impermeable area;

• Water form the rear part of the factory will be drained through a gutter, running along the wall, and ending in the emissary canal, which leads to the receiver's body;

• Outflow channels: excess rainwater, which is of no interest to the process and carries no pollution, is eliminated through outflow channels alongside the wall, leading to the receiver's body.

2.8 Operational Control Itens

Table 1. Operational Control Itens

Item	Freqüência		
	Diária	Semanal	Mensal
Inspeção Visual			
pH			
Presença de Areia			
Limpeza de Areia			

2.9 Resume Chart

Tabela 2. Resume Chart

Área total de Contribuição	17.000 m²
Caixa de Recepção 01	12 m³
Caixa de Recepção 02	12 m³
Tanques reservatório (03)	136 m³
Bombas (02)	6 m³/h

2.10 System Diagram

Figure 4. System Diagram – Reusage of Rainwater

3. RESULTS AND DISCUSSION

For PCS' Rainwater Reusage in productive Process, specific mass balance (regarding the water) is negative, meaning, industrial water is used in the process. Thus water comes from an artesian well and production's direct usage is approximatelly ($Q_p = 5m^3/h$).

Considering the hypothesis of using 30% of the rainwater ($Q_r = 1.5m^3/h$), we have the time of reusage (θ_r):

V = volume acquired in a day
Qr = reusage outflow
θ r = reusage time
θ r = V/Qr = 14.6/1.5 = 9.73 h (reusage of rainwater in the productive process).
Therefore, in case one decides tor aise the amount of water stored (larger reserves), one could raise the ratio of reusage, e.g.: from 30% to 50%, depending on the mass balance and quality control during the fabrication process.

4. CONCLUSIONS

- **Benefíts:**

The following benefits are expected from the implantation of the project:

• Answering, fully, of CETESB recommendations regarding environment contamination via rainwater;

• Substantial environmental gains, as much for the receiver's body (Class 2 river), by eliminating the risk of acid rain contamination and dragging of individual substances;

• Opportunity of recycling process' losses (PO_4);

• Answering of PCS' guidelines and environmental policy.

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