# Preliminary Water Audit in a Petroleum Refinery

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***Abstract*- This paper focuses on water audit carried out in a petroleum refinery. Information was obtained on unit-wise, day-wise and month-wise consumption and losses of fresh water. The study also aimed at identifying losses of water at minute scale and the measures to be taken for minimizing losses and optimizing water usage. The data were thoroughly analyzed and recommendations have been made to realize significant water and money savings.**

**Keywords— Water Audit; Refinery; Water Management; Water Conservation; Recycle**

## 1. Introduction

Water audit is an effective management tool for achieving conservation of water in industries by minimizing losses and optimizing various uses. Water auditing leads not only to save fresh water but also the financial expenditure. Compared to other industries, oil refineries have had relatively few concerns about water usage. However, the situation is fast changing. When refinery capacity increases, the water requirements are bound to increase multi-fold, but with the same source of supply and limited water allocation. Hence every refinery has to review its present water consumption areas and identify water conservation measures. The present work is envisaged to estimate optimum water requirement of a refinery by conducting a systematic water audit and preparing a report that consists of improvements in the water savings. Earlier, water used to be seen as a low-cost resource to refineries, and was used inefficiently. However, as the statutory standards became more stringent and costs for wastewater treatment increased exponentially along with the cost for makeup water, the industry now-a-days became more aware of expenses towards cost of water. In addition, large amounts of energy are used to process and move water through the refinery. Hence, saving of water obviously leads to additional saving of energy. The alarming situation of water demand, especially in India was highlighted by several agencies of national and international importance [1-2]. Briscoe and Malik [3] examined and reviewed the present water availability and usage in India. As per estimates approximately almost 30% to 40% of the water is wasted through the distribution system in urban communities. It is understood that an estimated saving of 10 to 30% of water saving is possible by recycling, process modification and controlled evaporation. A compulsory time bound water conservation program should be implemented for all municipal authorities to reduce wastage/ leakage in distribution system to bring it to within 10% from the existing 30 to 55%. Duong and Saphores [4] presented the obstacles for reuse of waste water. In some parts of the world the water audit is taken up even at individual home level [5] and at institute level [6]. It is clear that through water balance and water auditing fresh water can be saved for present and future needs [7-9]. Therefore, an attempt has been made in the present study to conduct the preliminary water auditing in a petroleum refinery which is one of the major consumers of water [10].

## 2. Water Utilization in a Typical Petroleum Refinery

Both fresh water and sea water are used in the petroleum refinery. Fresh water is used as process water, drinking water and service water. Table 1 gives the details on fresh water consumption on hourly basis.

**Table 1.** Consumption of fresh water

| S. No | Unit | Consumption in $m^3/h$ |
|---|---|---|
| 1 | De Mineralised Plant 2 | 102 |
| 2 | De Mineralised Plant 3 | 158 |
| 3 | Reverse Osmosis De Mineralised Plant 4 | 152 |
| 4 | Clean Fuels Project units | 92 |
| 5 | Drinking water (Includes housing colony) | 86 |
| 6 | Bearing Cooling Water make up | 33 |
| 7 | Evaporation loss | 18 |
| 8 | Flue gas Desulphurisation quench water-I | 12 |
| 9 | Flue Gas Desulphurisation quench water-II | 11 |
| 10 | Diesel Hydro Treating unit | 11 |
| | Total Consumption | 675 |

## 3. Water Audit

The following elements for water audit are considered in the present study: (i) total amount of fresh water supplied, (ii) water delivered, (ii) water loss and (iv) suggested measures to address water loss.

### *3.1. Fresh Water Consumption*

The present water audit focused essentially on supply and consumption of fresh water. Fresh water is used as process water, drinking water and service water. The day wise fresh water consumption and receipts for April 2016 has been shown in Figure 1. Similarly monthly consumption and receipts data have been presented in Figure 2. A close examination of these figures reveals fluctuations in both consumption and receipts on daily as well as monthly basis. The reason for these fluctuations can be explained as following. It is understood that these variations are due to the varied steam requirements of different processes from time to time, due to drift losses in bearing cooling towers, vapour losses through stack gases, water leaks through pump seals, variations in cleaning and washing requirements and type of crude processed.

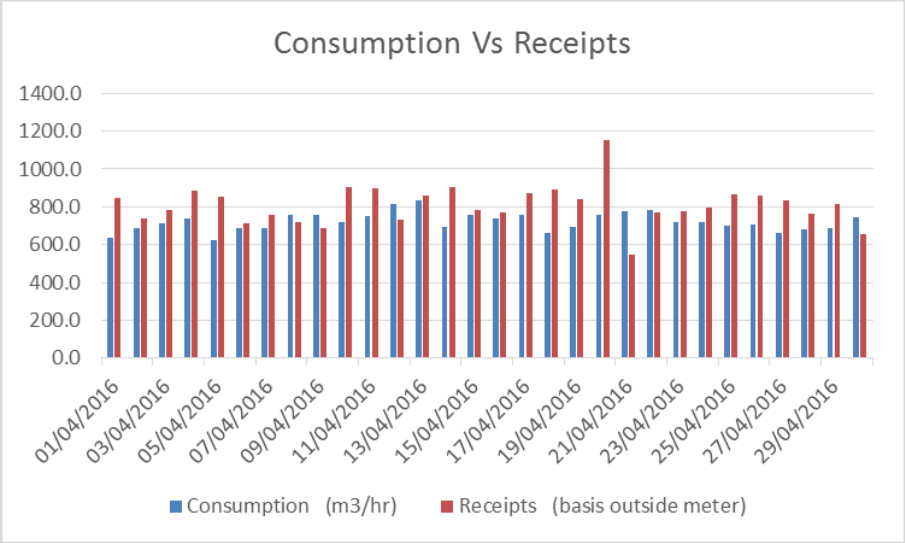


**Figure 1.** Day wise fresh water consumption vs receipts in $m^3/h$

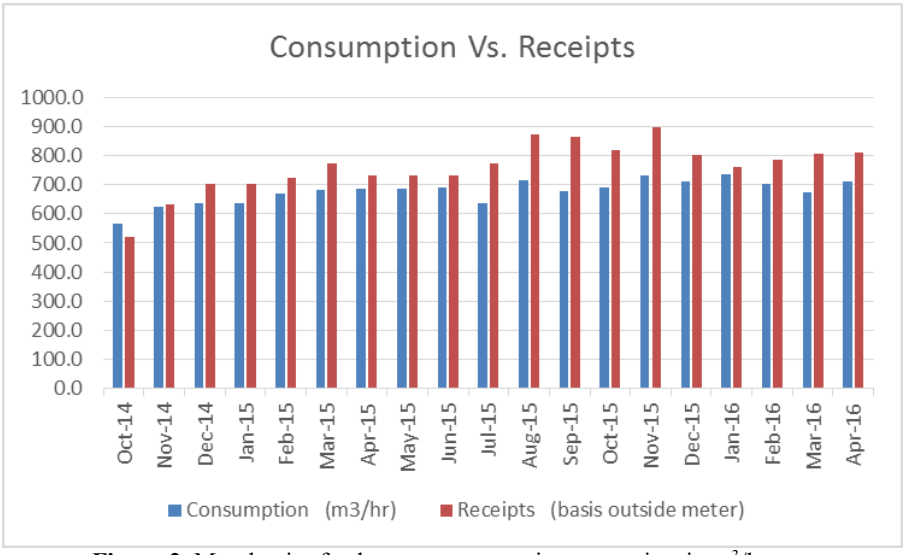


**Figure 2.** Month wise fresh water consumption vs receipts in $m^3/h$

*3.2. Water Losses*

Figures 3 and 4 show the daily and monthly losses of fresh water in refinery respectively. These losses are due to (i) evaporation from open water storage reservoir, (ii) leakage as water vapor from steam traps, steam vents, open sewers, and open-roofed waste water treating plant equipment, (iii) leakage from water headers, flanges, valves , pump seals etc., (iv) side stream filter backwash, (v) poor recovery of water from process units like desalters, (vi) leaks from pipe fittings and flanges, (vii) drift losses, tower evaporation losses, blow down losses from cooling towers, (viii) boiler blow down losses and (ix) steam leaks, pipe line leaks, steam traps in offsite and onsite areas and (x) outlet water from effluent treatment plant.


**Figure 3.** Day wise fresh water losses in $m^3/h$

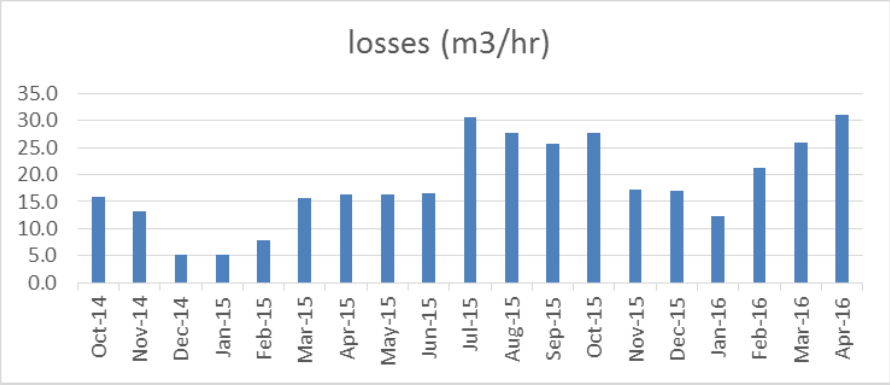


**Figure 4.** Month wise fresh water losses in $m^3/h$

*3.3. Important Observations from Physical Inspection*

The following observations were made from physical inspection. These were very important since they suggest areas that could be attended immediately regarding water conservation. (i) The drift losses from cooling towers were high that lead to more quantity of makeup water requirement and also affect the performance of the cooling tower. (ii) Many of the steam traps were malfunctioning. Since the vented steam was from demineralized water and also possessed heat energy, the loss of steam would be costly. Possible options for recovering this demineralized water as well as heat energy available in the steam need to be examined. (iii) Rain water harvesting facilities were not available at all the buildings. (iv) Evaporation losses from water storage reservoir was high. (v) Leakages from flanges, valves, pump seals etc. were observed. (vi) Recycling of effluent treatment plant outlet was not done.

## 4. Suggested Water Conservation Methods

It is suggested to reduce the drinking water consumption by (i) reducing supply hours, (ii) by installing self-closing taps, (iii) by using electronic hand wash system, and (iv) by using foam spray taps. The industrial water consumption may be reasonably reduced by reducing the consumption by good house-keeping and also by recycling and reuse of waste water for secondary purposes like cooling, flushing, gardening etc.

It is suggested to recycle and reuse drain from clarifloculator of raw water treatment plant, bearing cooling water, stripped sour water, and steam condensate, domestic effluent after treatment and ETP effluent. Use of storm water, installation of recharge well, rain water harvesting, zero-water discharge system etc., also helps in better water management.

## 5. Conclusions

The present water audit carried out for a typical refinery identified various areas for water conservation. If the suggestions were implemented the following benefits can be realized.

- Significant reduction in the quantity of purchased water
- Reckonable saving in makeup water processing and energy costs
- Reduced effluent flow rate

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