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Environmental Pollution Prevention Project

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Office of Environment and Natural Resources
Bureau for Global Programs
United States Agency for International Development

# POLLUTION PREVENTION PRE-DIAGNOSTIC ASSESSMENT
# PEPSI-INDUSTRIALIZADORA GUARANI S A
# PARAGUAY

Pre-Diagnostic Report

Prepared for

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The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of the U S Agency for International Development

The pollution prevention audit/pre-assesment reported herein was conducted by the E2P3-OIKOS & EP3/Paraguay-team The primary purpose was to make a pre-diagnostic assesment to identify a pollution prevention opportunities, that could justify to carry on a PPDA at INDUSTRIAS LACTEAS GUARANI-Paraguay

This technical report was prepared for Hagler Bailly Consulting, Inc and EP3/Paraguay Offices, by Fausto Peñafiel of the Ecuador Environmental Pollution Preventio Project (E2P3) at OIKOS

Other contributions include Carlos Moretuzzo and Carolina Zayas who provided their expertise identifying pollution prevention opportunities at the facility Danilo Diaz provided their expertise in cross-checking calculations giving technical ideas and preparing the report in the EP3 format

At the plant, it was received full support and assistance of Carlos Ortellado General Manager, Juan R Recalde, Chemist-yogurt production chief Silvestre Allende ice cream production chief Special thanks to the Industrial Union for serving as the umbrella organization for EP3 in Paraguay

# TABLE OF CONTENTS


**CHAPTER 1 EXECUTIVE SUMMARY**

**CHAPTER 2 OBJECTIVES**

2 1 Assessment Objectives
2 2 Report Objectives

**CHAPTER 3 BACKGROUND INFORMATION**

3 1 Company Background
3 2 Plant and Process Description
3 3 Other Issues

**CHAPTER 4 ANALYSIS AND RECOMMENDATIONS**

4 1 Rinsing of brand new plastic bottles
4 2 Washing of re-used glass and REF-PET bottles
4 3 Using sterile air instead of carbon dioxide to keep pressure in the filling machines
4 4 New-project Stack gases cleaning-$CO_2$ self production

**CHAPTER 5 CRITICAL RATIO ANALYSIS**

5 1 Pre-rinsing of brand new plastic bottles
5 2 Rinsing after caustic operation of glass and REF-PET plastic bottles
5 3 Carbon dioxide usage

**CHAPTER 6 CONCLUDING REMARKS**

**LIST OF EXHIBITS**

Table 1 Summary of Pollution Prevention Opportunities
Table 2 Current usage of rinsing water after caustic degreasing
Table 3 Future usage of rinsing water after caustic degreasing
Table 4 Capacity of the washing machine tanks for caustic degreasing and caustic concentration in each bath
Table 5 Caustic usage to prepare virgin caustic bath

# CHAPTER 1

# EXECUTIVE SUMMARY

PEPSI-INDUSTRIALIZADORA GUARANI S A , is a soft drink bottling mill located in Avenida Madame Lynch 781-Asuncion-Paraguay An average of 2 300 000 liters of soft drinks are bottled per month Glass bottles (45%), plastic non-REF-PET bottles (1%) and plastic REF-PET bottles (54%) are used in an average of 9 200 000 units per month The facility policy is pursuing better industrial practices in order to optimize the water consumption, and reduce chemicals and carbon dioxide usage

The overall pre-assessment identified some pollution prevention options that can save a total estimated USD 177 470 per year (USD 14 789/m) The savings are focused in the following areas USD 15 078 per year on pumping well water and water treatment USD 73 436 per year on recycling the bottles rinsing water to the shipping boxes machine (it will be fixed soon according with management), USD 75,280 per year on carbon dioxide usage and USD 13,676 per year on energy recuperation through recycling the condensated water to the boiler An estimated total investment of USD 12 450 leads towards an average pay back period of 1 month (USD 12 450/USD 14 789/m)

Within the actions identified by the assessment, all of them are reasonable appropriated for a short-term investments The pay back periods for the recommendations ranges from immediate pay back to 8 months giving an average of 1 month, which seems to be verv attractive for the decision making level There is a special recommendation pointed out as a New Project/Stack gases cleaning-$CO_2$-Self production This project might save USD 83,400 per year Its pay back period is about 14 4 months

The Recommendations try to encourage people to move forward looking for the best results It has to be mentioned that some recommendations are related one to another therefore to achieve the potential savings pointed out on this report it is necessary to follow the suggested sequential order

Table 1 on the following page ranks the assessments findings in order of the unit operation processes

## TABLE 1 SUMMARY OF POLLUTION PREVENTION RECOMMENDATIONS

| Section Number | Pollution Prevention Recommendation | Environmental Benefits | Cost to implement (US$) | Annual Benefits USD$ | Payback Period (months) |
|---|---|---|---|---|---|
| 4 1 Rinsing of new plastic bottles (#1) | Lowering the flow rate by 40% and recycling the rinsing water | Reducing the waste load to the environment | 1,150 | 1,656 | 8 3 |
| 4 2 Washing of re-used glass and REF-PET bottles (#2) | Setting up the flow rate of the washing machines as follows Washing machine # 1 and 2 9 $m^3/h$ Washing machine # 3 3 $m^3/h$ This will give to the washing system an input of 9 360 $m^3/m$ | Reducing the waste load to the environment | 0 | 13 422 | Immediate |
| 4 2 Washing of reused galss and REF-PET bottles (#2) | Recycling the 9 360 $m^3/m$ of wasted water to the shipping boxes washing machine | Reducing the waste load to the environment<br>Reducing the chemical load to the environment | 2 800 | 73 436 | 0 5 |
| 4 3 Carbon dioxide as a level keeper in the filling machines (#3) | Using sterile air instead of carbon dioxide | Non benefit | 3 000 | 75 280 | 0 5 |
| 4 4 Boiler (#4) | Recycling the condensated to a stainless steel tank and from here to the boiler | Environment will not be affected by high temperature condensated | 6 000 | 13,676 | 5 3 |
| TOTAL | | | 12 950 | 177 470 | 1 |
| 4 5 New project-Stack gases cleaning-$CO_2$-Self production | Installing the system of stack gases cleaning, based up on the affinity of the mono-ethanol amine for the carbon dioxide The $CO_2$ is then purified with potassium permanganate | Reducing the fumes to the environment | 100 000 | 83 400 | 14 4 |

# CHAPTER 2

# OBJECTIVES

## The EP3 Project

The Agency for International Development (AID) is implementing an environmental pollution prevention project (EP3) worldwide EP3 is designed to operate directly with industry groups to provide technical assistance in pollution prevention waste minimization and clean technologies Technical assistance is delivered in the form of 1) diagnostic studies of selected industries conducted by US and local experts, 2) recommendations on measures to minimize pollution through the use of clean technologies 3) training and information on EP3 practices 4) tours by local experts to the US to meet with their industrial counterparts that have successful pollution prevention measures and 5) dissemination of effective experiences in the program

The EP3 project is being implemented worldwide through the services of a contractor Hagler Bailly Consulting, Inc in addition to 16 sub-contractors The EP3 Project uses the services of paid or pro-bono experts and environmental and regulatory experts from the US Environmental Protection Agency (EPA)

For the Paraguay case, EP3 activities are carried on under the name of EP3 Paraguay in collaboration with the Industrial Union of Paraguay

## The EP3 Assessment

The objective of the EP3 assessments is to clarify cleaner production options which (1) reduce the quantity of raw materials, chemicals and water used in the manufacturing process and thereby reduce industrial pollution and worker exposure to toxic substances, (2) demonstrate the environmental and economic value of cleaner production practices and (3) improve manufacturing competitiveness and product quality

The assessment focuses on the technical aspects of pollution prevention and is not intended to be a comprehensive evaluation of the safety and health impacts or considerations of the plant's operation The assessment also does not address general business and management practices such as accounting procedures data gathering, and data analysis This report provides information on how to achieve and maintain pollution prevention changes at the facility and serves as a first step in developing a sustainable pollution prevention program at the facility

# CHAPTER 3

# BACKGROUND INFORMATION

## 3 1 COMPANY BACKGROUND

PEPSI-INDUSTRIALIZADORA GUARANI S A is a soft drink bottling facility It bottles the following trade mark soft drinks Pepsi, Mirinda Guarana Mirinda Naranja Seven-up, Tonic Water Paso de los Toros, Kandy Pomelo and Mineral Water It employs 100 production workers, 40 administrative and 200 sales people The company is located in Asuncion and its capital share is 100% local Its production capacity is 3 286 000 liters/month The current average production is 70% its capacity, which means 2 300 000 liters/month It is planned to rise the production up to 25% more by the end of March 1997 (2 875,000 liters/month)
The facility is interested in participating in the EP3 program because its manufacturing plant might save USD 177 470 per year

## 3 2 PLANT AND PROCESS DESCRIPTION

The main unit operations are described below

3 2 1 Soft drinks made on the basis of artificial concentrates

- 3 2 1 1 Syrup preparation
- 3 2 1 2 Water carbonating and syrup dosage
- 3 2 1 3 Bottles washing
- 3 2 1 4 Washing of shipping boxes
- 3 2 1 5 Bottling

3 2 2 Soft drinks made on the basis of natural juices (Kandy Pomelo)

- 3 2 2 1 Pomelo fruit peeling
- 3 2 2 2 Peeled pomelo milling and screening
- 3 2 2 3 Pomelo pulp freezing and storage

From the above operations pollution prevention opportunities were detected in the following production steps

(1) Brand new plastic bottles rinsing (NON-REF-PET AND REF-PET)

(2) Glass and REF-PET bottles washing, after caustic operation
(3) Shipping boxes washing
(4) Carbonizing and syrup dosage to the brand soft drink

## 3 3 OTHER ISSUES

### 3 3 1 Water

Water is obtained from two well water 120 meters deep Also the facility gets an average of 2,600 $m^3$ water/m, from Corposan, at a cost of USD 1 460/m (USD 17 520/y) The plant manager is planning to drill a third well water Two well water pumps with capacities of 10 $m^3$/h and 20 $m^3$/h each, run 24 hours At a pumping efficiency of 75% the wells water flow rate is 540 $m^3$/d, giving a total inflow to the process of 14 040 m /m Therefore the water monthly inflow including Corposan purchases is 16 640 $m^3$/m

Major water consumption is distributed as follows

| | |
|---|---|
| - Soft drink | 2 300 $m^3$/m |
| - Rinsing of plastic new bottles | 393 $m^3$/m |
| - Washing of glass and REF-PET bottles after caustic | 12,480 $m^3$/m |
| - Steam (95% quality 60% boiler efficiency) | 1 200 $m^3$/m |
| - Caustic baths (20% make up) | 30 $m^3$/m |
| TOTAL | 16 403 $m^3$/h |

### 3 3 2 Energy Issues

PEPSI-INDUSTRIALIZADORA GUARANI S A has not installed the condensers system consequently during September 1996 they paid an extra charge of USD 3 682 which includes energy consumption above the base line (demand) plus penalty The power factor for this month showed a value of 0 98

# CHAPTER 4

# ANALYSIS AND RECOMMENDATIONS

This chapter discusses the pollution prevention opportunities that were identified by the Oikos-E2P3-and EP3/Paraguay-technical team at this facility It describes the recommendations and provides information on costs benefits obstacles and other issues that are related to their implementation

## 4 1 RINSING OF BRAND NEW PLASTIC BOTTLES

***Current situation***

New plastic bottles are first rinsed with fresh water in a rinsing machine before filling Rinsing water flows at a rate of 350 $cm^3$/second Water goes to the sewer

***Recommendations***

- Reducing the water inflow rate from 0 35 liters/second down to 0 25 liters/second (40% less)

- Filtering the running water storing and recycling it on a monthly basis

***Results***

This will avoid waste of water and also will reduce the pollutant load to the environment

***Calculations, Assumptions and Savings***

Average production = 3 200 000 liters/month
Percentage distribution per size was given by management On this basis an average of monthly usage of bottles was estimated

| MATERIAL | SIZE ($cm^3$) | PERCENTAGE (%) | LITERS | BOTTLES |
|---|---|---|---|---|
| Glass | 250 | 4 37 | 100 453 | 401 810 |
| Glass | 285 | 19 65 | 451,893 | 1,807 570 |
| Glass | 1000 | 14 52 | 333 903 | 1 335 610 |
| Glass | 500 | 6 12 | 140 703 | 526 810 |
| Non-Ref-PET | 1500 | 1 43 | 32,833 | 131,330 |
| Ref-PET | 500 | 31 98 | 735,483 | 2 941 930 |
| Ref-PET | 1600 | 14 52 | 333 903 | 1,335 610 |
| Ref-PET | 2000 | 7 43 | 170 833 | 683 330 |
| TOTAL | | 100 00 | 2 300,000 | 9 200 000 |

Cross-check on the basis of the filling automatic machines capacity

| | |
|---|---|
| Speed | 400 bottles/min |
| Machines | 3 |
| Working time | 12 hours/day 26 day/month |
| Assumed efficiency | 41% |
| Current production | 9,210 240 Bottles/month |

By assuming 41% efficiency the current production estimated on bottling capacity fits with the current production supplied by the facility

Cross-check calculations on the basis of the washing machines speed

| LINE | MATERIAL | SIZE ($cm^3$) | SPEED | TIME | WASHING | EFFICIENCY |
|---|---|---|---|---|---|---|
| 1 | Glass | 250 | 300 | 12 | 2 808 000 | 50% |
| 2 | Glass | 1,000 | 250 | 12 | 1,404 000 | 50% |
| 3 | Glass | 1 000 | 200 | | | |
| | REFILL-PET | 500 | 200 | 24 | 5 016 960 | 67% |
| | REFILL-PET | 1 600 | 150 | | | |
| | REFILL-PET | 2,000 | | | | |
| TOTAL | | | | | 9 228 960 | |

For the line 3 it was taken into account the REFILL-PET/500 cm because it represents the highest proportion of the production for this line By assuming the efficiencies shown

above, it is obtained a close relation between the amount of bottles filled and the amount washed

Once figures have been cross-checked further calculations will be based on 4 107 800 glass bottles per month (45%), 131 330 non-refill-PET bottles per month (1%) and 4,960,870 refill-PET bottles per month (54%) Total plastic bottles account for 5 092 200 per month

Fresh water consumption at rinsing ($R_o$)

$R_o$ = (0 35 l/sec)(3 600 sec/h)(12 h/d)(26 d/m)(12 m/y)($m^3$/1 000 l) = 4 717 $m^3$/y or 393,120 liters/month

It is not known neither the number of new plastic bottles nor the number of recycled plastic bottles Therefore it is assumed 50% of the total as the brand new plastic bottles and the remainder 50% as recycled plastic bottles Then water consumption per new plastic bottle might be

New plastic bottle water consumption = (393 120 l)(1/2 546 100 bottles)(1000 $cm^3$/l)
= 154 4 $cm^3$/bottle

<u>Savings</u>

Adjusted flow rate ($R_1$)

(0 21 l/sec)(3 600 sec/h)(12 h/d)($m^3$/1 000 l) = 9 $m^3$/d

This volume of water has to be filtered and stored in a 10 $m^3$ cistern and reused next day and the operation will be repeated through all month and then discarded Thus the estimated daily usage is in fact a monthly consumption Therefore the water optimized consumption will be

$R_1$ = (9 $m^3$/m)(12 m/y) = 108 $m^3$/y

Water Savings = $R_o$ - $R_1$ = (4 717 $m^3$/y) - (108 $m^3$/y) = 4,609 $m^3$/y

Pumping savings ($M_1$) = (4 609 $m^3$/y)(0 45 kWh/$m^3$)(USD 0 0411/kWh) = 85 USD/y

Cost of treatment of well water was not given by management therefore for the purposes of this report it was assumed this cost as equal to the 60% of the cost of water supplied by CORPOSAN USD 0 34 /$m^3$ (1 460 USD/2 600 $m^3$ x 60%)

Water treatment savings ($M_2$) = (4 609 $m^3$/y)(USD 0 34/$m^3$) = 1 571 USD/y

Total savings ($M_1$ + $M_2$) = USD 1 656/y or USD 138/m

Investment

Capital cost

| | | |
|---|---|---|
| Cement tank (10 $m^3$) | USD | 500 00 |
| Filter | USD | 200 00 |
| Pump | USD | 300 00 |
| Piping | USD | 150 00 |
| TOTAL | USD | 1 150 00 |

Pay back period = USD 1 150/138 USD/m = 8 3 months

***Obstacles to Implementation***

This recommendation does not present any particular obstacle to be implemented

***Schedule of Implementation***

The recommendation could be implemented as soon as possible

## 4 2 WASHING OF REUSED GLASS AND REF-PET BOTTLES

***Current situation***

Glass and REF-PET bottles are degreased into caustic solution baths of different concentrations Then they are rinsed with ambient temperature water A volume of 12 480 m of fresh water per month is used for rinsing glass bottles and REF-PET bottles after caustic operation This water consumption gives a ratio of 5 43 liters of water per liter of soft drink

***Recommendation***

- Setting up the rinsing flow after caustic degreasing of the washing machines as follows

  Washing machine 1 and 2 9 $m^3/h$ washing machine 3 3 $m^3/h$ The total water consumption will be 9 360 $m^3/m$ The ratio of usage will be 4 10 liters of water per liter of soft drink that is a proved international rate for this operation

- Recycling the 9 360 000 liters per month (22 5 $m^3/h$) of used water for shipping boxes washing This water contains residual dragout caustic from the caustic baths and it is adequate for this purpose

***Results***

- Cost savings on water usage water pumping and lowering the pollutant load to the environment

- Chemical savings

***Calculation, Assumption and Savings***

Table 2 Current usage of rinsing water after caustic degreasing

| Units | WASHING M #1 | WASHING M #2 | WASHING M #3 | TOTAL |
|---|---|---|---|---|
| $m^3/h$ | 12 | 12 | 4 | |
| h/d | 16 | 16 | 24 | |
| $m^3/d$ | 192 | 192 | 96 | |
| d/m | 26 | 26 | 26 | |
| $m^3/m$ | 4,992 | 4 992 | 2,496 | 12 480 |
| $m^3/y$ | 59 904 | 59 904 | 29 952 | 149 760 |
| | | | l water/l product | 5 43 |

Table 3 Future usage of rinsing water after caustic degreasing

| Units | WASHING M #1 | WASHING M #2 | WASHING M #3 | TOTAL |
|---|---|---|---|---|
| $m^3/h$ | 9 | 9 | 3 | |
| h/d | 16 | 16 | 24 | |
| $m^3/d$ | 144 | 144 | 72 | |
| d/m | 26 | 26 | 26 | |
| $m^3/m$ | 3,744 | 3 744 | 1,872 | 9 360 |
| $m^3/y$ | 44 928 | 44 928 | 22 641 | 112 320 |
| | | | l water/l product | 4 10 |

*Savings*

**a)** Due to low rate water input to the washing machines

Pumping savings ($M_3$) due to low input rate

$M_3$ = (0 45 kWh/$m^3$) (149 760-112,320) ( $m^3$/y) (USD 0 0411/kWh) = USD 692/y

Water treatment savings ($M_4$)

$M_4$ = (149,760-112,320) ($m^3$/y) (USD 0 34/$m^3$) = USD 12,730/y

Pay back period Immediate

**b)** Due to bottles rinsing water recycling to shipping boxes machine

Pumping savings

(9 360 $m^3$/m)(0 45 kWh/$m^3$)(USD 0 0411/kWh)(12 m/y) = 2 077 USD/y

Investment

- Capital Cost
  - Two Pumps USD 600
  - Cistern 100 m USD 2 000
  - Piping USD 200
  - TOTAL USD 2 800

- Operating cost
  - Depreciation (10 y) USD 280 /y
  - 2 pumps (0 75 kW) (3 400 h) (0 041 USD/kWh) = USD 210/y

- Net savings ($M_5$) = 2 077-280-210 = USD 1 587/y or USD 132/y

- Water treatment savings ($M_6$)

$M_6$ = (112 320 $m^3$/y) (USD 0 34/$m^3$) = USD 38,189/y

**c)** Caustic savings ($M_7$)

Calculation of the sodium hydroxide dragout from the caustic bath to the rinsing water

above, it is obtained a close relation between the amount of bottles filled and the amount washed

Once figures have been cross-checked, further calculations will be based on 4 107 800 glass bottles per month (45%), 131,330 non-refill-PET bottles per month (1%) and 4,960,870 refill-PET bottles per month (54%) Total plastic bottles account for 5 092 200 per month

Fresh water consumption at rinsing ($R_o$)

$R_o$ = (0 35 l/sec)(3 600 sec/h)(12 h/d)(26 d/m)(12 m/y)($m^3$/1 000 l) = 4 717 $m^3$/y or 393,120 liters/month

It is not known neither the number of new plastic bottles nor the number of recycled plastic bottles Therefore it is assumed 50% of the total as the brand new plastic bottles and the remainder 50% as recycled plastic bottles Then water consumption per new plastic bottle might be

New plastic bottle water consumption = (393 120 l)(1/2,546,100 bottles)(1000 $cm^3$/l)
= 154 4 cm $^3$/bottle

<u>Savings</u>

Adjusted flow rate ($R_1$)

(0 21 l/sec)(3 600 sec/h)(12 h/d)($m^3$/1,000 l) = 9 $m^3$/d

This volume of water has to be filtered and stored in a 10 $m^3$ cistern and reused next day and the operation will be repeated through all month and then discarded Thus the estimated daily usage is in fact a monthly consumption Therefore the water optimized consumption will be

$R_1$ = (9 $m^3$/m)(12 m/y) = 108 $m^3$/y

Water Savings = $R_o$ - $R_1$ = (4,717 $m^3$/y) - (108 $m^3$/y) = 4,609 $m^3$/y

Pumping savings ($M_1$) = (4,609 $m^3$/y)(0 45 kWh/$m^3$)(USD 0 0411/kWh) = 85 USD/y

Cost of treatment of well water was not given by management therefore for the purposes of this report it was assumed this cost as equal to the 60% of the cost of water supplied by CORPOSAN USD 0 34 /$m^3$ (1 460 USD/2 600 $m^3$ x 60%)

Water treatment savings ($M_2$) = (4 609 $m^3$/y)(USD 0 34/$m^3$) = 1,571 USD/y

Total savings ($M_1$ + $M_2$) = USD 1 656/y or USD 138/m

Investment

Capital cost

| | | |
|---|---|---|
| Cement tank (10 $m^3$) | USD | 500 00 |
| Filter | USD | 200 00 |
| Pump | USD | 300 00 |
| Piping | USD | 150 00 |
| TOTAL | USD | 1,150 00 |

Pay back period = USD 1,150/138 USD/m = 8 3 months

***Obstacles to Implementation***

This recommendation does not present any particular obstacle to be implemented

***Schedule of Implementation***

The recommendation could be implemented as soon as possible

## 4 2 WASHING OF REUSED GLASS AND REF-PET BOTTLES

***Current situation***

Glass and REF-PET bottles are degreased into caustic solution baths of different concentrations Then they are rinsed with ambient temperature water A volume of 12 480 $m^3$ of fresh water per month is used for rinsing glass bottles and REF-PET bottles after caustic operation This water consumption gives a ratio of 5 43 liters of water per liter of soft drink

***Recommendation***

- Setting up the rinsing flow after caustic degreasing of the washing machines as follows

  Washing machine 1 and 2 9 $m^3/h$ washing machine 3 3 $m^3/h$ The total water consumption will be 9 360 $m^3/m$ The ratio of usage will be 4 10 liters of water per liter of soft drink, that is a proved international rate for this operation

- Recycling the 9 360 000 liters per month (22 5 $m^3/h$) of used water for shipping boxes washing This water contains residual dragout caustic from the caustic baths and it is adequate for this purpose

***Results***

- Cost savings on water usage, water pumping and lowering the pollutant load to the environment

- Chemical savings

***Calculation, Assumption and Savings***

Table 2 Current usage of rinsing water after caustic degreasing

| Units | WASHING M #1 | WASHING M #2 | WASHING M #3 | TOTAL |
|---|---|---|---|---|
| $m^3/h$ | 12 | 12 | 4 | |
| h/d | 16 | 16 | 24 | |
| $m^3/d$ | 192 | 192 | 96 | |
| d/m | 26 | 26 | 26 | |
| $m^3/m$ | 4,992 | 4,992 | 2,496 | 12 480 |
| $m^3/y$ | 59,904 | 59 904 | 29 952 | 149 760 |
| | | | 1 water/1 product | 5 43 |

Table 3 Future usage of rinsing water after caustic degreasing

| Units | WASHING M #1 | WASHING M #2 | WASHING M #3 | TOTAL |
|---|---|---|---|---|
| $m^3/h$ | 9 | 9 | 3 | |
| h/d | 16 | 16 | 24 | |
| $m^3/d$ | 144 | 144 | 72 | |
| d/m | 26 | 26 | 26 | |
| $m^3/m$ | 3 744 | 3,744 | 1 872 | 9 360 |
| $m^3/y$ | 44 928 | 44 928 | 22 641 | 112 320 |
| | | | 1 water/1 product | 4 10 |

Table 4 Capacity of the washing machine tanks for caustic degreasing (liters) and caustic concentration in each bath

| TANKS # | WASH MACH #1 | CAUSTIC (% W/V) | WASH MACH #2 | CAUSTIC (% W/V) | WASH MACH #3 | CAUSTIC (% W/V) |
|---|---|---|---|---|---|---|
| Tank 1 | 7,100 | 2 0 | 7,100 | 2 0 | 30 900 | 1 7 |
| Tank 2 | 7 600 | 3 0 | 7 600 | 3 0 | 30 900 | 1 7 |
| Tank 3 | 23 750 | 1 5 | 23,750 | 1 5 | | |
| TOTAL | 38,450 | | 38,450 | | 61 800 | |

Table 5 Caustic use to prepare virgin caustic bath (Kg)

| | WASHING MACHINE #1 | WASHING MACHINE #2 | WASHING MACHINE #3 | TOTAL |
|---|---|---|---|---|
| Tank # 1 | 142 | 142 | 525 | 809 |
| Tank # 2 | 228 | 228 | 525 | 981 |
| Tank # 3 | 356 | 356 | | 712 |
| TOTAL (Kg) | 726 | 726 | 1 050 | 2 502 |

As it is seen 2 502 Kg of caustic are used to prepare 138 700 liters of caustic degreasing baths at the concentrations shown in the previous data PEPSI has reported an average usage of 4,250 Kg of caustic per month Therefore it is concluded that a monthly 1 748 Kg of caustic (4,250 Kg - 2 503 Kg) are use for making up the spent degreasing baths

Caustic baths are discarded every 6 months Since every month 4 250 Kg of caustic are used to raise up the strength of the spent caustic solutions theoretically 4 250 Kg of sodium hydroxide are dragout from caustic bath to rinsing bath Therefore the residual sodium hydroxide content in the rinsing bath might be

| | |
|---|---|
| Optimized total rinsing bath | 9 360 000 l/m |
| Sodium hydroxide dragout | 4 250 Kg/m |
| Residual caustic in the rinsing bath | 0 045% weight/volume |

PEPSI does not need to add sodium hydroxide to the shipping boxes washing machine system because the water coming from the bottles washing machines might have 0 045% weight/volume caustic concentration Therefore the chemical savings might be

$$M_7 = (4\ 250\ \text{Kg/m})(\text{USD } 0\ 66/\text{kg})(12\ \text{m/y}) = \text{USD } 33\ 660/\text{y}$$

Pay back period

(USD 2 800/((1 587 + 38,189 + 33 660)USD/y)/12 m/y = 0 5 months

***Obstacles to Implementation***

This recommendation also does not present any obstacle to be implemented

***Schedule for Implementation***

It could be done during overall maintenance planning to avoid dead time

## 4 3 USING STERILE AIR INSTEAD OF CARBON DIOXIDE TO KEEP PRESSURE IN THE FILLING MACHINE

***Current situation***

Carbon dioxide is used to keep pressure in the filling machines

***Recommendation***

Using sterile air instead of carbon dioxide to keep pressure in the filling machines

***Results***

Carbon dioxide savings

***Calculations, assumptions and Savings***

PEPSI consumes an average of 70 MT of carbon dioxide per month A 70% is used to carbonate the soft drinks and the remainder is consumed to keep the pressure level of the filling machines

- Gross savings
  (70 MT/m)(30%)(USD 315/MT)(12 month/y) = USD 79 380/y

- Investment

Capital cost

| | | |
|---|---|---|
| - Sterile air Whole system | USD | 3 000 |

Operating major cost

| | | |
|---|---|---|
| - Depreciation | US | 300/y |
| - Maintenance | USD | 300/y |
| - Labor | USD | 3,600/y |
| - Total operating cost | USD | 4,200/y |

Net Savings ($M_8$) = (79 480 - 4,200) USD/y = USD 75,280/y or USD 6 273/month

Pay back period = USD 3,000/6 273 USD/m = 0 5 month

***Obstacles to implementation***

The main obstacle is the purchasing of a suitable system

***Schedule for implementation***

The implementation has to be planned according to the annual workplan budget

## 4 4 CONDENSATED

***Current situation*** A peak of 4,000 pounds steam per hour is used in a) the three bottles washing machines to warm up the caustic baths (45 65 and 75 °C) b) 6 jacketed syrup tanks (four 10 000 liters each and two 20 000 liters each) and c) the $CO_2$ tank to avoid freezing None of the condensated is recycled

***Recommendation*** Recycling the condensated to the boiler

***Results***

- Financial savings
- Lowering the pollutant load to the environment

***Calculations, Assumptions and savings***

Gross savings

Steam consumption

(4 000 pounds/h)(12 h/d)(26 d/m)(12 m/y) = 14 976 000 pounds/year

By recycling the condensate to the boiler savings might be

(14 976,000 pounds/y)(306 BTU/pound)(1/150 000 BTU/gal)(USD 0 50/gal) =

= USD 15 276/year

Investment

- Capital cost
  - Stainless steel tank (30 $m^3$) USD 5,000

- Valves manometers piping USD 1 000

- Operating cost
  - Maintenance USD 1,000/y
  - Depreciation USD 600/v

Net savings ($M_9$)

$M_9$ = (15,276 - 1,600)USD/y = USD 13 676/y or USD 1 140/month

Pay back period = USD 6 000/1 140 USD/month = 5,3 months

***Obstacles to Implementation***

There is not any obvious obstacle to implement this recommendation

***Schedule for Implementation***

It has to be according to the annual workplan budget

## 4 5 NEW PROJECT (CO2 SELF PRODUCTION)

***Current Situation***

Carbon dioxide is purchased to a local supplier at a cost of USD 0 32/Kg

***Recommendation***

Carbon dioxide could be obtained through a cleaning operation of the stack gases The operation is based on the affinity of the mono-ethanol-amine to capture the carbon dioxide and then it is necessary a purifying step of the carbon dioxide by using potassium permanganate

***Results***

- Financial benefits
- Lowering the pollutant load to the environment

***Assumptions, Calculations and Savings***

Calculations were done on the basis of the 70% monthly consumption assuming that the 30% will be eliminated by installing the sterile air system in the filling machines to keep the pressure level Therefore the future $CO_2$ demand will be

$$(70\%)(70\ MT/m) = 49\ MT/m$$

$CO_2$ production capacity (60% boilers efficiency)

(200 Kg/hour)(16 hours/day)(26 days/month)(1/1 000 Kg/MT)(60%) = 50 MT/month

Soft drink production will be raised up, as it was pointed out before and then it will be necessary to extent the working time of the boilers from 12 hours/day to 16 hours/day

Cost of production by cleaning the stack gases

From working experience in field, the $CO_2$ cost production by cleaning the stack gases (including cost of fuel labor, boilers maintenance depreciation) is about USD 0 08/Kg According to domestic costs in Paraguay and taking a reasonable safety factor this cost can easily achieve 0 15/Kg The estimated production cost might be

(50 MT/month)(1 000 Kg/MT)(USD 0 15/Kg) = USD 7 500/month

Current cost in plant through a local supplier

(50 MT/month)(1,000 Kg/MT)(USD 0 32/Kg) = 16 000 USD/month

Gross savings

(16,000 - 7 500) USD/month = USD 8 500/month or USD 102 000/year

Investment

- Capital cost
  Stack gases cleaning whole system USD 100 000

- Operating Cost

| | | |
|---|---|---|
| - Maintenance | USD | 5 000/year |
| - Depreciation | USD | 10 000/year |
| - Labor | USD | 3,600/year |
| Total | USD | 18 600/year |

NET SAVINGS ($M_{10}$)

$M_{10}$ = (102,000 - 18 600) USD/year = USD 83 400/year or USD 6 950/month

Pay back period

PBP = USD 100,000/USD 6 950/month = 14 4 month

### *Obstacles to Implementation*

The whole system has to be imported

### *Schedule for Implementation*

It should be planned according to annual workplan

# CHAPTER 5

# CRITICAL RATIO ANALYSIS

Critical ratio analysis offers a way of examining the efficiency of any unit operation or an entire production process The critical ratio expresses material or energy used per unit manufactured It can be used to compare the efficiency of the plant being assessed with those of other facilities/plants in the same industrial sector Comparing critical ratios can help reveal those unit operations which have a good potential for improvements through pollution prevention measures A smaller numerical value of the critical ratio indicates a more efficient operation

Even if no outside data is available on the Best Industrial Practice (BIP) value for a particular process, the critical ratio is still valuable It gives the operations manager a means of quantifying current use of energy or materials in terms of production This figure can then form the baseline from which to gauge the impact of improvements made to the process

The assessment identified the critical ratios described below

## 5 1
## -- CRITICAL RATIO NO 1 PRE-RINSING OF BRAND NEW PLASTIC BOTTLES

This critical ratio is defined as Volume of fresh water per brand new plastic bottles in the rinsing operation

***Current Industrial practice***

(393 120 000 $cm^3$/m)/(2 546,100 plastic bottles/m) =

= 154 4 $cm^3$ of water/plastic bottle

After waste minimization the future value will be

***Optimized Industrial practice***

9,000 000 $cm^3$/2 546 100 = 3 5 cm /plastic bottle

## 5 2

## -- CRITICAL RATIO NO 2·RINSING AFTER CAUSTIC OPERATION OF GLASS AND REF-PET BOTTLES

The critical ratio is defined as Volume of fresh water used in the rinsing operation of glass and REF-PET bottles after caustic degreasing per volume of end product

***Current Industrial practice***

(12,480,000 liters of water/month)/(2 300,000 liters of soft drink/m) =

= 5 43 l of water/l soft drink

***Optimized industrial practice***

(9 360 000 liters of water/m)/(2,300 000 liters of soft drink) =

= 4 10 l of water/l soft drink

## 5 3

## CRITICAL RATIO NO 3 CARBON DIOXIDE USAGE

The critical ratio is defined as the weight of carbon dioxide per volume of soft drink

***Current Industrial practice***

(70 000 Kg $CO_2$/month)/(2 300 000 l/month) = 0 0304 Kg CO /l soft drink

Optimized Industrial practice

(49 000 Kg $CO_2$/month)/(2 300 000 l/month) = 0 0230 Kg $CO_2$/l soft drink

# CHAPTER 6

# CONCLUDING REMARKS

## WHAT IS POLLUTION PREVENTION?

**Pollution Control** focuses on handling and treating wastes after they have been generated Given the global trend towards stricter controls over industrial effluents solid waste and air emissions, this traditional approach is becoming increasingly expensive and only adds to the product cost without adding to its value or quality In contrast to pollution control **pollution prevention** focuses on minimizing or eliminating waste at its source As a result of waste minimization and improved process efficiency investments in pollution prevention or clean production measures yield financial savings and often have payback periods of less than one year

The financial, environmental and other benefits of a comprehensive pollution prevention program include

* achieving the efficient use of raw materials
* improving process efficiency and reducing production costs,
* reducing the amount of waste that must be treated and disposed of
* reducing the design capacity and thus the capital cost of waste treatment systems
* reducing the operations cost of the waste treatment systems,
* reducing the disposal costs for solid and liquid wastes
* facilitating compliance with environmental regulations,
* reducing liability from the discharge or disposal of wastes
* improving the energy efficiency of production processes
* improving product quality by gaining a better understanding and control of the production processes
* improving worker s health and safety by minimizing exposure to harmful substances
* improving the public image of the facility

The general requirements for the implementation of a comprehensive pollution prevention program include

* modifying current production processes to improve materials use and reduce waste generation,

* improving the control and monitoring of waste-related parameters in production processes,
* fostering the reuse of process wastes and energy efficiency
* improving workers' training on proper equipment operation and process control
* improving general housekeeping practices in the facility
* investing in cleaner production equipment instead of end-of-pipe treatment systems

The specific benefits and requirements of the pollution prevention opportunities identified for this facility during the course of the EP3 audit are summarized in Chapter 1

## TAKING ACTION

The objective of the EP3 program is to foster the implementation of pollution prevention measures in the participating facilities In order to achieve this goal Oikos-E2P3 and EP3/Washington will continue to provide technical support and guidance to facilitate the implementation of the proposed recommendations

One of the keys to a successful pollution prevention program is establishing a comprehensive action plan to guide the preparation implementation and monitoring of process modifications Below is a checklist of the main steps that are generally included in such action plans

1 Establish a core group of plant staff to evaluate the options provided in this report Review the data and calculations determine if any information was misconstrued by the audit team and if necessary make the appropriate adjustments to the report s calculations and results
2 Prioritize the recommendations in accordance with their potential value to your facility and ease of implementation
3 Conduct a detailed technical and economic evaluation of the selected options Obtain price quotations for the required equipment or plant modifications Ask appropriate questions such as Is training necessary first? Will production need to be stopped? Will the vendor provide acceptable service? Will the change create other environmental problems?
4 Solicit employees input and ideas on the selected recommendations
5 Develop an implementation schedule
6 Implement the recommendations and provide the required training to the personnel
7 Establish a mechanism to measure the effects of the implemented recommendation and pollution prevention progress within the plant Track relevant accounting information such as waste treatment and disposal costs, water and sewer costs energy and raw materials consumption and costs
8 Establish routine auditing procedures to ensure that the standard operating practices are respected Rotate the auditing duties among all process operators
9 Regularly evaluate the facility s operations to identify ways to increase productivity and reduce materials water and energy use