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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
INDUSTRIAS LACTEAS GUARANI
PARAGUAY

Pre-Diagnostic Report

Prepared for

Hagler Bailly Consulting Inc
1530 Wilson Boulevard , Suite 900
Arlington VA 22209-2406
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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

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

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CHAPTER 1

EXECUTIVE SUMMARY

A prediagnostic assessment was carried out at LACTEOS GUARANI S A facility to identify pollution prevention opportunities

Water consumption in the reception area is about 96 liters/box It could be lowered by 90% and the optimized ratio will be about 10 liters/box

Water savings on cooling operation of jacketed reactors could be raised up to 100% Therefore water savings on both operations might allow an optimized ratio of 4 liters of water per liter of product

Savings for about USD 480/year in well water pumping costs are possible by implementing the water recycling recommendations This savings could be substantially higher if the water would not be free Nevertheless these recommendations impact on the environment since the flow stream will reduced by 68% which means 2 122 cubic meters of well water which will not be discharged to the nearby river Besides if Lacteos Guarani would decide to build a waste treatment plant, the optimized flow stream would make feasible to reduce the capital investment and operating cost by at least 50% (USD 100 000)

By recycling the chemical products, previous filtration and strength adjustment savings might be about USD 7 200 per year Additionally the benefit of pollutant load reduction will be significant

The current energy ratio is 412 Kcal/liter of product By recycling the condensed water it was estimated savings of 20% which gives a yearly savings of USD 2 330 since the mill will be able to lower the purchases of "briquettes' and fuel oil Therefore the new caloric energy ratio will be 330 Kcal/liter Besides there is an environmental benefit since no hot water will be discharged to the river

Overall savings account for USD 9 945/y (or USD 829/m) and the total investments are USD 2 720 Therefore the average pay back period shows a value of 3 3 months

The recommendations try to encourage industrials 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 technical report it is necessary to follow the suggested sequential order

Table 1 , on the following page ranks the assesment findings in order of the unit operation

Table 1 Summary of pollution prevention Recommendations

Section Number	Pollution Prevention Recommendation	Environmental benefits	Cost to implement (USD$)	Annual Benefits (USD$)	Payback period (months)
5 1 1 Washing of the ice-cream and and yogurt shipping boxes	Washing the shipping boxes by using the high pressure adjustable spray flow guns	1 000	The finacial benefit was included in the savings of cooling water	Reduce the effluent flow (562 m^3/m) and the pollutant load	
5 1 2 Cooling of the jacketed yogurt reactor	Recycling the cooling water for any usage	360	480 (5 1 1 & 5 1 2) plus the investment cost and operating cost reduction of the waste treatment plant, by at least 50% (USD 100,000)	Reduce the effluent flow (1,560 m^3/m)	9
5 2 Degreasing	Recycling the spent caustic solution	minimum	1 584	Lower the load to the environment	Inmediate
5 2 Sanitation	Recycling the spent HNO_3 solution	Minimum	2,208	Lower the load to the environment	Inmediate
5 2 Sanitation	Recycling the spent iodoforo solution	Minimum	3,408	Lower the load to the environment	Inmediate
5 3 Steam usage	Recycling the condensed	1,360	2,330	Hot water wil not be discharged to the environment	7

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 Thechnical 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 succesfully implemented pollution prevention measures and 5) dissemination of effective experiences in the program

The EP3 program is being implemented world wide through the services of a contractor Hagler Bailly Consulting,Inc

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 pre-assesment

The objective of this prediagnostic is to determine whether company is a suitable candidate for a Pollution Prevention Diagnostic Assesment

The pre-assessment will underline recommendations that would reduce the effluent flow reduce water intake and optimize the process to lower the usage of raw materials assure the BOD reduction in the outgoing streams and improve the quality of the end product

CHAPTER 3

BACKGROUND

3 1 General data

Lacteos Guarani is a dairy mill, which mainly produces yogurt 7 500 liters /day and ice-cream, 450 liters/day Working days are 26 days per month therefore the mill shows an average monthly production of 195 000 liters of yogurt and 11 700 liters of ice-cream

Fresh milk is brought from the mill's own farm, and powder milk is imported from Argentina Brazil (NIDO), Uruguay and New Zealand Fresh milk costs about USD 0 32/liter and reconstituted milk costs about USD 0 29/liter (Exchange rate 2 050 Guaranies/USD)

Water is obtained from a well water 120 m deep Water is pumped to a 150 000 liters tank capacity at a rate of 2 78 liters/second A 3 HP pump runs for 10 hours a day to fill the tank from where water is pumped to the process It is estimated a daily water consumption of 120 000 liters, which means an average of 3 120 cubic meters/month Well water is only chlorinated up to 2 PPM chlorine whether it is fed either to the processes or to the boilers with no previous water softening treatment Water is almost free being only involved the pumping cost

The mill employs 40 workers and 3 administrative They work one shift 10 hours/ shift starting at 5 am

The mill owns two 20 MT steam capacity boilers each but only one runs at once and both run only during the period of high production demand (November December and January) As fuel 3 500 Kg of wooden chips and 8 400 liters of fuel oil per month are fired Chips cost about USD 0 05/Kg and fuel cost is about USD 0 09 per liter

The mill pays an average electricity bill of USD 3 500 per month It has been installed a condensers system which is saving around USD 500 per month by setting the power factor in a value of 0 9

As far as effluent concerns all the streams coming from rinsing and washing of tanks fresh milk reception washing area washing of the retail sales trucks (10 for yogurt and 5 refrigeration trucks for ice-cream) storm water and water from the services join in one unique stream which goes at last to an arroyo'

3 2 Mill current specific data

3 2 1 Water consumption mass balance on a daily basis (liters/day)

Diagrams 1 and 2 describe washing and rinsing operations The following table

summarizes the current water consumption (liters/day)

Usage

1	Powder milk reconstitution	7 500
2	Washing at reception of fresh milk containers and shipping boxes	24 000

Yogurt making

3	Cooling water for the jacketed yogurt reactor (90 to 45 Celsius)	60 000
4	Cooling water (45 to 5 Celsius)	2 500
5	Rinsing of blending tanks	2 500
6	Minor chemical rinsing	135

Ice cream making

7	Washing of pasteurizing tanks	3 500
8	Minor chemical rinsing	67

Trucks

9	Washing of 15 trucks, which belong to the plant (200 lit/each)	3 000
10	Boiler	2 000
11	Services (200 lit/worker/day)	8 000
12	Floor washings and cleaning	2 000
13	Losses (pipe leaks) and unknown usage might account for	4,800
Total Input		**120,000**

Water consumption averages 3 120 cubic meters per month from which the highest proportion of the total water usage is due to the containers and shipping boxes at

reception and cooling water at the jacketed yogurt reactors Therefore it accounts for a total of 84 cubic meters/day (24 m^3/day + 60 m^3/day) and 2 184 cubic meters per month

Water is pumped to a 150 000 liters capacity tank A level control system is connected so that as the tank is half filled the pump automatically stops running

3 2 2 Processes

The mill runs two production lines (see fig 1) The unit operations are described below

3 2 2 1 Yogurt

- Powder milk reconstitution
- Milk-ingredients blending
- Pasteurizing
- Cooling from 90 down to 45 Celsius
- Cooling from 45 down to 5 Celsius
- Flavoring-blending
- Packing and maturation
- Sales

A semi-automatic machine is used to fill the plastic packages which are fed manually to the machine It was seen some product losses during the dosage It might be due to lack of filling machine maintenance or due to plastic containers hard to be loosen when the filling operation takes place

3 2 2 2 Ice-cream

- Fresh milk filtering
- Pasteurizing at 90 Celsius
- Cooling
- Ingredients mixing and blending
- Maturation
- Manual filling when fruits or flakes are added
- Semi-automatic filling when no fruits or flakes are added

3 2 3 Production

Yogurt is packed in a 350 g/pack and 140 g/pack For the package of 350 g it has been established a minimum yield of 2 85 packs per Kg final product and for the pack of 140 g it has been established a minimum yield of 7 15 packs/Kg of final product

From the current data it was known that a yield of 8 816 filled packs (350 g) were obtained from the 3 000 liters of yogurt (discounted the fruits added) and 18 425 packs (140 g) were obtained from the 2 500 Kg of yogurt (considering no fruits added) Therefore there is an extra weight due to the fruits added that is explained below

350 g/pack

(8,816 packs x 0 350 Kg/pack)	= 3,086 Kg
Yogurt free of fruits	= 3 000 Kg
Fruits added	= 86 Kg
Yield (8,816 packs/3,000 Kg)	= 2 94 packs/Kg

140 g/pack

(18,425 packs x 0 140 Kg/pack)	= 2,580 Kg
Yogurt free of fruits	= 2,500 Kg
Fruits added	= 80 Kg
Yield	= 7 37 packs/Kg yogurt

It is possible from this data to apply a factor to estimate the monthly production of yogurt including the extra weight of fruit but since the production includes yogurt with nothing added it will be referred to a raw yogurt Therefore a monthly average production of 195,000 liters of yogurt is reported Besides the mill produces 11 700 liters of ice-cream

3 2 4 Chemicals consumption

Lacteos guarani chemicals consumption is shown in table 2

Table 2 Chemicals consumption and cost

CHEMICAL	CONSUMPTION (Kg/month)	COST (USD/month)	%
NaOH	500	330	20 8
HNO3	60	460	28 9
IODOFORO (l)	100	710	44 7
DETERGENT (l)	200	90	5 7
	TOTAL	1 590	100 0

Iodoforo consumption accounts 44 7% of the total chemical consumption A total of USD 8,520 per year are spent (Guaranies 17,500,000) This chemical is used just once overnight and then it is discarded to the sewer with no previous residual bactericide power check

The caustic baths are recycled 3 times (usage once a day) and then discarded The HNO3 solution is used just once a day and then discarded

3 3 Plant current specific data on energy

3 3 1 Boilers

The plant owns two boilers 20 MT steam capacity each The fuel consumption and its

cost is given in table 3

Table 3 Average fuel consumption and cost

FUEL	CONSUMPTION	COST	TOTAL COST (USD/Month)
Chips	3 500 Kg/m	USD 0 05/Kg	175
Fuel oil #6	8 400 l/m	USD 0 09/l	756
		TOTAL	931

Bunker accounts for 81 2% of the total fuel consumption

Steam is used mainly in the pasteurizing operations and to wash the fresh milk containers Washing water and condensed water at about 70 Celsius is discarded to the sewer This practice causes energy losses and also the environment is affected due to the high temperature

3 4 Effluents

The effluents can be classified in the following streams

- Production flow
- Condensed water
- Storm water and
- Services

The streams coming from the different sections join all together in just an unique flow which goes to the sewer In such conditions the following analysis have been reported

Table 4 Chemical analysis on effluents

Parameter	Yogurt	Ice-cream	Pasteurizing	Washing water
pH	5 0	5 0	10 0	6 0
COD (mg/l)	62 000	10 000	1 940	40 0
BOD5 (mg/l)	36 750	8,875	750	12 0
Grease (mg/l)	8 852	2,020	154	16 0
TSS (mg/l)	11 472	5 486	646	263 0
SS (mg/l)				
15 min	0 0	350	0 0	0 0
30 min	0 0	350	0 0	0 0
60 min	0 0	350	0 0	0 0

This analysis was reported by the Instituto Nacional de Tecnologia y Normalizacion (NTN) on March 19th 1996

CHAPTER 4

CRITICAL RATIO ANALYSIS

4 1 Water

4 1 1 Water used for the shipping boxes

Water used = 24 000 l/dav
Washed shipping boxes = 250 shipping boxes/day

Current water used = 24 000 l/250 boxes = 96 liters/box

It appears that water usage per box is very high

4 1 2 Water used for the cooling jacketed yogurt reactor

Calculations and assumptions

Water used only for washing and rinsing

Total water consumption	= 120,000 liters/dav
Water used for powder milk reconstitution	= 7 500 liters/day
Water used only for washing/rinsing/steam	= 112 500 liters/dav

Since vogurt production accounts for the 94 35% the ratio water usage for production will be referred to it Besides the majority of this resource is used in the vogurt production

Water used only for washing/rinsing/steam = 112 500 liters water/7 500 liters production = 15 0 liters water/liters vogurt

4 2 Chemicals usage

4 2 1 Iodoforo

Since Iodoforo usage accounts in terms of costs for about 45% the ratio will be calculated on the cost basis rather than on the basis of amount

Yogurt and ice-cream production (7 950 liters/day)(26 days/month) = 206 700 l/m
Iodoforo consumption cost USD 710

Iodoforo = USD 710 Iodoforo/206 700 liters = USD 0 0034/liters of product

4 2 2 Caustic and nitric acid

The ratio also will be estimated on the cost basis, rather than on the quantity

Ratio = USD 790/206 700 liters = 0 004 USD/liters

4 3 Ene gy

It was not possible to get the data on steam consumption So energy consumption per production unit and energy savings due to the condensed recycling will be estimated on the basis of fuel consumption

Energy supplied by the 'briquettes'	8 75 x 10^6	Kcal/month
Energy supplied by the fuel oil	76 44 x 10^6	Kcal/month
Total energy input	85 x 10^6	Kcal/month

Energy per production volume (E)

E = 85 x 10^6 Kcal/206 700 liter = 412 Kcal/liter

CHAPTER 5

RECOMMENDATIONS

5 1 Water savings

5 1 1 On ice-cream and yogurt shipping boxes

Wash the shipping boxes by using the high pressure adjustable spray guns instead of the conventional hoses A savings of 90% water could be achieved by this means Therefore the new water consumption optimized ratio might be

2400 liters/250 boxes = 10 liters/box

Calculation and assumptions

From experiences outside Paraguay the mentioned guns cost USD 1 000 each

There is no financial savings in this particular case due to the free cost water situation However savings on pumping energy are estimated all together in the next point Besides there is a positive impact from the environmental stand point

Difficulties

There are no difficulties since there is a strong commitment of the manager to make changes which benefit the operations and the environment

Schedule

Just after the PPDA

5 1 2 On cooling water

Recycle the 60 000 liters of warm water coming from the jacketed yogurt reactors and reuse it as washing water for the chemical solutions and even for the powder milk reconstitution This water is good enough clean for this purpose
By implementing recommendations pointed out in 5 1 1 and 5 1 2 the optimized water consumption ratio might be

(112 500 liters of water for washing/rinsing/steam - 21,600 liters water used for shipping boxes - 60 000 liters of cooling water of the jacketed reactors) = 30 900 liters/day

Optimized water usage per volume finished product = 30 900 l water/7 500 l yogurt
= 4 1 liters of water/liter of yogurt

This ratio has dropped ffrom 15 liters water/liter yogurt down to 4 1 liters water per liter vogurt

Calculation and assumptions

a) Water savings

A volume of 60 000 liters/day(1 560 cubic meters/month) of clean water could be saved Since water is in theory free there is no savings involved in this particular case

b) Energy savings

Taking into consideration the water savings pointed out in 5 1 1 and 5 1 2 the pumping energy savings are

Savings = (960 kWh/month)(0 0411 USD/kWh)(12 m/y) = 480 USD/y

Savings in terms of pumping energy are low due to the low cost of the energy nevertheless there is an environmental benefit since reduce the organic load to the environment Besides the benefit is the reduction of the size of the waste treatment plant and the investment cost reduction and the operating cost reduction

c) Investment

Water can be partially pumped back to a two 10 000 liter capacity tanks and the remainder to the 150 000 liter capacity tank or the whole volume to the 150 000 liter capacity tank Therefore the only costs involved are

Tanks	USD	0
Plastic piping	USD	200
Valves and other accessories	USD	100
Labor	USD	60
Total cost	USD	360

d) Waste treatment plant

The mill has a quotation for a waste treatment plant for about USD 200 000 By implementing recommendations 1 and 2 it could be saved at least 50% of the investment capital and operating cost

Difficulties

There is not any difficulty since all the work is just a plumbing job

Schedule

Right after the PPDA

5 2 On chemicals

Recycle the chemicals such as caustic HNO_3 and Iodoforo spent solutions previous filtering and strength adjustment The spent solutions could be recycled for a month and then discarded

Calculations and assumptions

Taking into consideration the make up some losses and the usage itself the savings could be about 40%

Savings = (USD 1 500/m)(40%)(12m/y) = USD 7 200/y

Strength of caustic and HNO_3 spent solutions could be checked by using an indicator and measuring pH Besides a visual inspection has to be done for cleanness

For iodoforo strength a daily samples could be titrated for iodine residual On this result basis it could be fixed the right amount of virgin Iodoforo concentrated that has to be added on a daily basis to rise up the bactericide solution concentration
Another way to do so is preparing a series of samples packed with product coming from tanks which have been hold with virgin solution and spent solution Then by measuring for bacterial growth or visual inspection for swollen after storage at room temperature it can be established the requirement for a virgin solution

Difficulties

None

Schedule

Right after the PPDA

5 3 On condensed water

Recycle the condensed steam to the boiler

Calculation and assumptions

It was not possible to get the data on steam consumption So savings due to the condensed recycling on the basis of energy input are estimated and have to be double checked with real data The total energy used is 85 19 x10 ° Kcal/month The 10 29 % of this energy is supplied by the 'briquettes' and 89 73% is supplied by oil #6

By recycling the condensed to the boiler about 20% of the energy is saved It is estimated cost savings about USD 2,330/y As the condensed water is coming at 80 Celsius degree there is a temperature gradient (80-27 Celsius) saved by doing the condensed recycling

Therefore estimated savings undertake this temperature gradient

Thus the expected energy ratio might be 330 Kcal/liter of product

Investment

To implement this recommendation it is required a piping line and a pressure tank to avoid the flashing effect The feeding tank has to be improved because it is opened and some energy will be lost

CAPITAL COST

Stainless steel tank (2 000 liters capacity)	USD	1 000
Black steel piping	USD	150
Accessories	USD	150
Labor	USD	60
Total	USD	1 360

Cost-benefit analysis on the feasibility of 100% "briquettes" analysis

Cost by using 100% briquettes	USD	1704/m
Current using briquettes and fuel oil	USD	931/m
Excess	USD	773/m

This calculation shows that for this mill from the economic stand point it is not worthy to use only briquettes However since there are considerable amount of available briquettes in country it might be suggested to rise up its usage up to 50%

Difficulties

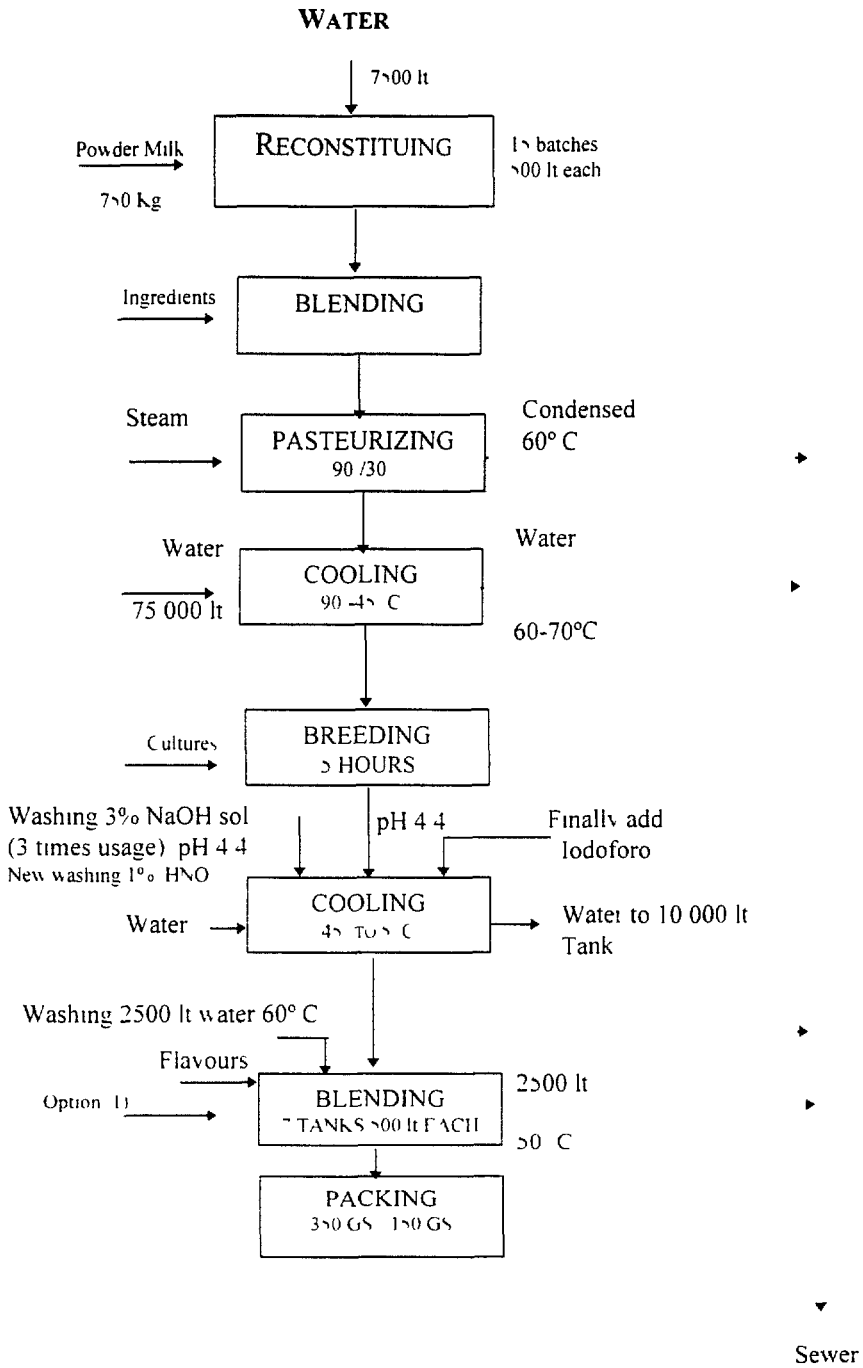
It is required a more detailed study on this alternative organic fuel usage specially considering domestic environmental issues

Schedule

Right after the PPDA on the basis of a scheduled planning with previous recommendations

Lacteos Guarani

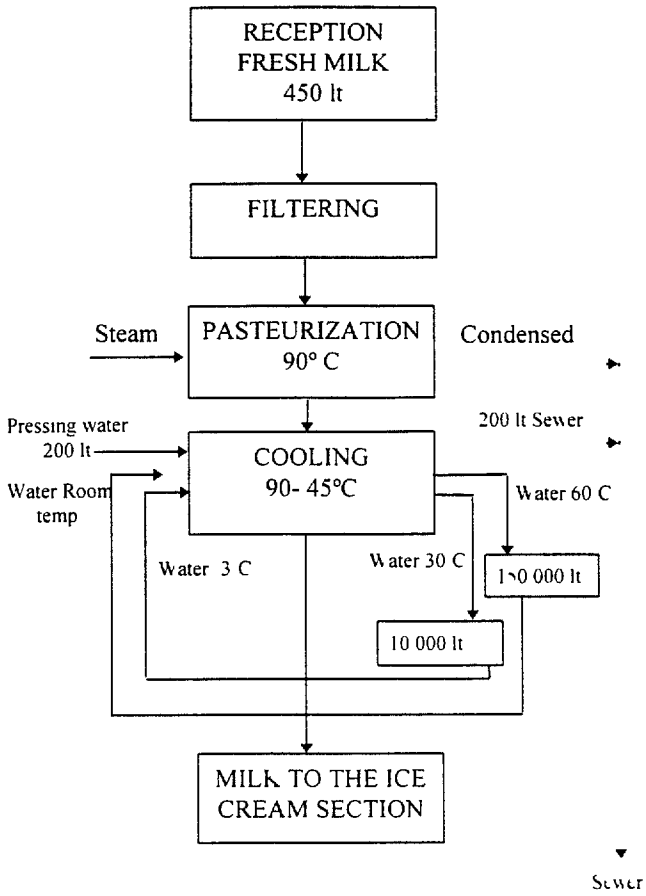
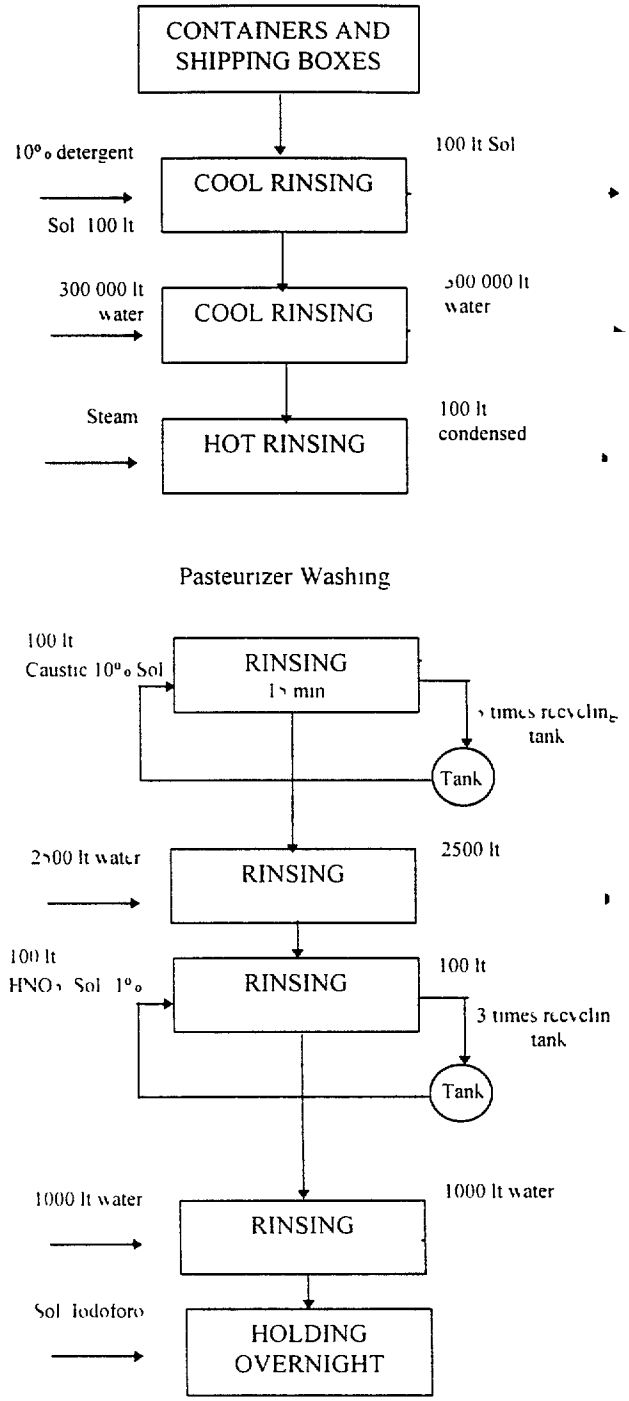
YOGHURT LINE
One day production basis (lt/d)



Lacteos Guarani

ICE CREAM LINE

PRODUCTION OPERATIONS



WASHING OPERATIONS