Erasmus +

STEPS

Prevention Polution in Food Industry

WP3.2 Open lecture

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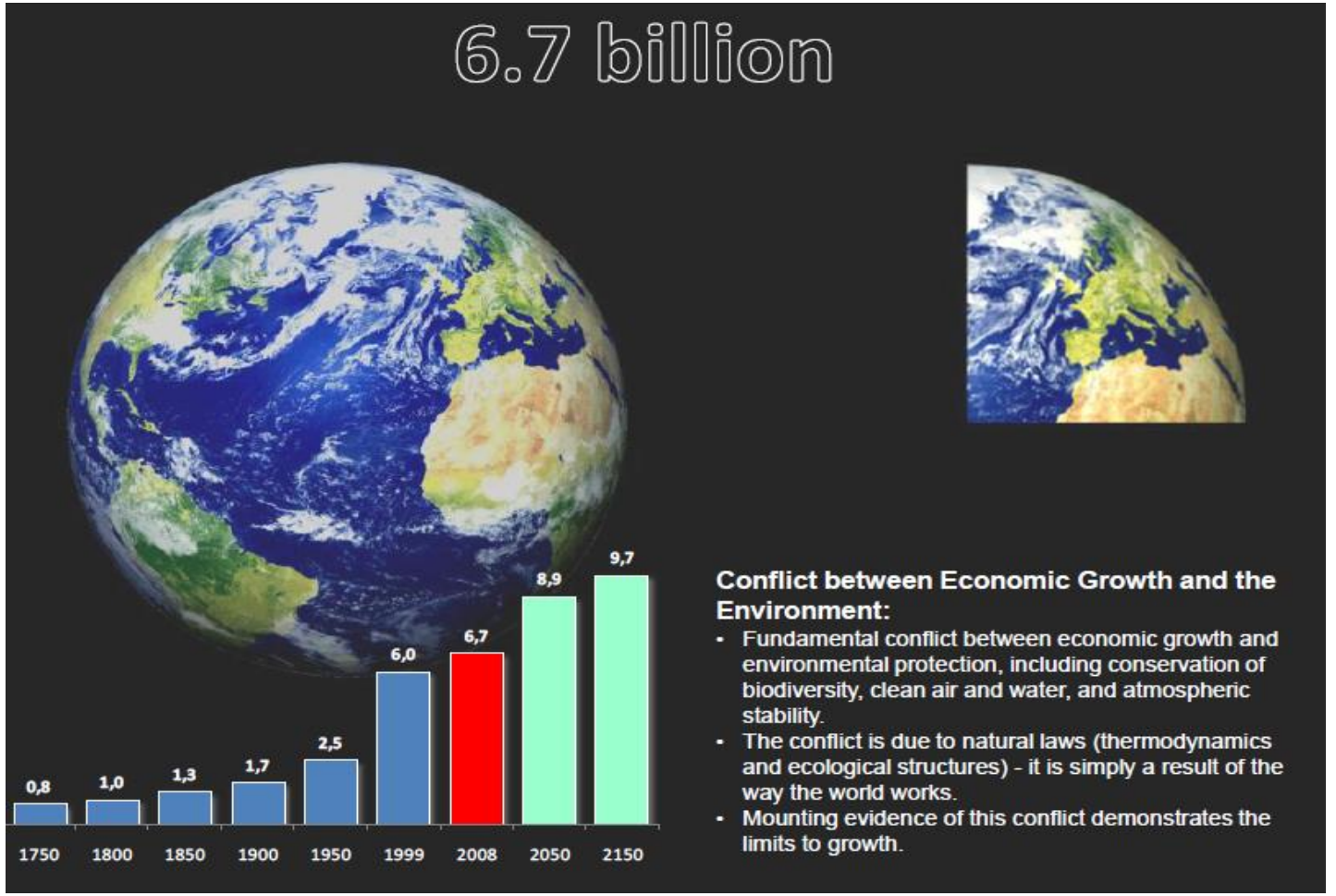
Polution in Food Industry
Key Factors

- **Water consumption**
- **Energy consumption**
- **Wastewater**
- **Waste**
- **Atmospheric emissions**
- **Noise**

Polution in Food Industry
Air polution

Polution in Food Industry
Air polution



Polution in Food Industry
Air polution

New York, Terneuzen and Florida
will be gone by 40 -90 years

New York - Manhattan animation – "if the Greenland ice melts"

Polution in Food Industry
Air polution

Future development of food prices will be effected by climate change

Polution in Food Industry
Waste and Waste watter

- For industrial development, the subcategories consist of:
- **a) Substances that are toxic, persistent and liable to bioaccumulation.**
- **b) Heavy metals.**
- **c) Organohalogen compounds.**
- **d) Radioactive substances.**
- **e) Nutrients and suspended solids.**
- **f) Hazardous wastes.**

Polution in Food Industry
Waste and Waste watter

- **The most important sources of BOD in the industrial wastewater stream are:**
- **a) Manufacture of food and beverages; slaughtering, preparation and preservation of meat; manufacture of dairy products; canning and preservation of fruit and vegetables; canning, preservation and processing of fish, crustaceans and similar foods; manufacture of vegetable oils and fats; sugar factories and refineries; distillation; wine production; beer manufacture; etc.**
- **b) Manufacture of textiles; wool processing and cotton processing.**
- **c) Tanneries and the leather finishing industry.**
- **d) Paper and paper-pulp industry.**
- **e) Phosphatic fertilizers industry.**
- **f) Pharmaceutical industry; basic substances (fermentation and extraction processes).**
- **g) The chemical industry, in case of specific types of chemical products, which contain BOD in their effluent wastewater (detergents, etc.).**

COD or Chemical Oxygen Demand is the total measurement of all chemicals (organics & in-organics) in the **water** / **waste water**; **BOD** is a measure of, the amount of oxygen that require for the bacteria to degrade the organic components present in **water** / **waste water**

Polution in Food Industry
Waste and Waste watter

- In general, the food processing industry has a raw waste effluent before treatment that is extremely high in soluble organic matter. The amounts of waste and the quantity of organics and solids discharged from processing operations depend a great deal upon the type of individual processing steps and water use and reuse in each plant. There is a great variation in waste load from plant to plant depending upon the layout of the plant and the manner in which foods are handled.

Polution in Food Industry, Waste and Waste watter

- ***Cannery Wastes****:* The greatest source of liquid waste in food canning is normally from the fruit and vegetable washing facilities. Other sources of waste come from the peeling operations and contain large volumes of suspended matter – primarily organic in nature and from washing equipment, utensils, cookers, etc., as well as washing of floors and general food preparation areas. BOD loads vary depending on the type of the canned product and types of undergoing operations. For apple canning, BOD varies from 1600 to 5500 ppm, for apricots from 200 to 1000 ppm, for mushrooms from 70 to 800 ppm, for tomatoes from 200 to 4000 ppm. This wide variation in BOD concentrations is attributable to the volume of water used.
- ***Poultry wastes:*** A great deal of poultry waste is created in the killing of chicken, which permits the bleeding of the poultry. The blood of chickens is reported to contain more than 90,000 ppm BOD. The composition of combined poultry plant wastes are characterized with a BOD in the range of 150 to 2400 ppm. Another source of waste is manure and unconsumed feed along with water used to wash the cages and the entire storage floor area. The cleaning of cages before they are put on trucks and returned to the farms is another major source of pollution.
- ***Meat packing wastes:*** Liquid waste generated from meat packing industry is largely organic in character with a BOD load in the range of 400 to 3000 ppm. The volume and organic content of meat wastes vary appreciably according to the type of operation and the degree of by-product recovery practice. Some plants are involved only in the slaughter and therefore fall into slaughterhouses, where animals are killed and the meat is dressed for distribution. As in the case of the poultry operation, the blood from the killing operation is excessively high, approximately 100,000 ppm BOD, and must be handled separately in order to avoid excessive pollution in the sewer. Another major problem in the slaughterhouses is the paunch manure. The combined plant BOD is generally in the range of 650 to 2200 ppm.

Polution in Food Industry
Waste and Waste watter

- ***Dairy food wastes:*** In the dairy food industry, most plants consist of several operations and the types of waste vary accordingly. Among these operations, there may be receiving stations, bottling plants, creameries, ice cream plants, cheese plants, and condensed and dried milk product plants. As in the rest of the food industry, controlled product losses reduce potential waste pollution problems. The approximate quantities of BOD vary from 0.1 to 1 kg (100-1000ppm) per ton of milk.
- ***Beet sugar wastes:*** Beet sugar refineries create wastewater that is extremely high in dissolved organic matter. The largest amount of wastewater will come from the fluming and washing operations of the beet and contains suspended beet fragments, stems, roots, leave and dissolved organic matter. The waste stream has a significant BOD with a minimum value (in case the beets are in a good condition) of 200 ppm. The BOD load does, however, vary significantly, depending if the beets are decomposed because of freezing and other factors, and based on the process used in the beet processing operations. BOD is present in the wastewater resulting from the extraction of sugar from the beets, which is known as pulp screen water.
- ***Brewery wastes:*** Beer brewery wastewater is extremely high in dissolved organic matter. The waste stream has a significant BOD with a concentration, which may reach 7000 ppm. The BOD load does require pretreatment before discharge. The treatment process comprises screening followed by primary settlement. The brewery waste is deficient in nutrients; therefore, it will be necessary to pass the effluent stream in a trickling filter before allowing the waste stream into final settlement basins.

Polution in Food Industry
Waste and Waste watter

- ***Fermentation and distillation wastes:*** Wine fermentation wastewater is high in dissolved organic matter. The waste stream has a significant BOD with a concentration of over 2000 ppm. The BOD load does require pretreatment before discharge. The treatment process comprises screening to remove the larger suspended solids, such as grape skins, followed by aerated balancing prior to passing the effluent wastewater stream in a trickling filter, and then final settlement. The aeration process will require the use of diffused air flotation.
- ***Yeast wastes:*** Yeast wastewater is high in dissolved organic matter. The waste stream has a significant BOD with a concentration of over 2000 ppm. The BOD load does require pretreatment before discharge. The treatment process comprises screening to remove the larger suspended solids followed by aerated balancing, and then final settlement.

MAIN ENVIRONAMENTAL ASPECTS IN THE DAIRY SECTOR

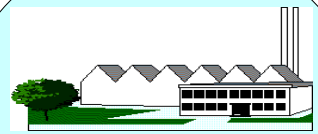
1.ACIDIFICATION
2.EUTROPHICATION
3.EMISSION OF GREENHOUSE GASES
4.CONSUMPTION OF FOSSIL ENERGY
5.CONSUMPTION OF ELECTRICITY
6.USE OF TOXIC SUBSTANCES (weed killers, insecticides and fungicides)

FARM PRODUCTION OF MILK

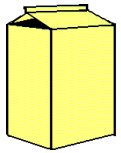
1.EMISSION OF GREENHOUSE GASES
2.CONSUMPTION OF FOSSIL ENERGY

TRANSPORT OF MILK

1.EMISSION OF GREENHOUSE GASES
2.EMISSION OF PHOTOCHEMICAL OXIDANTS
3.WASTEWATERS EFLUENT
4.GENERATION OF SOLID WASTE
5.CONSUMPTION OF FOSSIL ENERGY
6.CONSUMPTION OF ELECTRICITY
7.USE OF TOXIC SUBSTANCES (chemical agents)



DAIRY INDUSTRIES

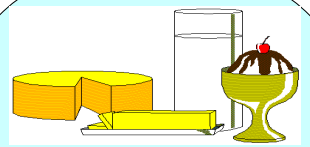


Manufacturing of dairy products packaging

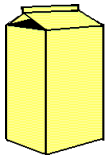
TRANSPORT OF PACKAGED PRODUCTS

1.EMISSION OF GREENHOUSE GASES
2.CONSUMPTION OF FOSSIL ENERGY

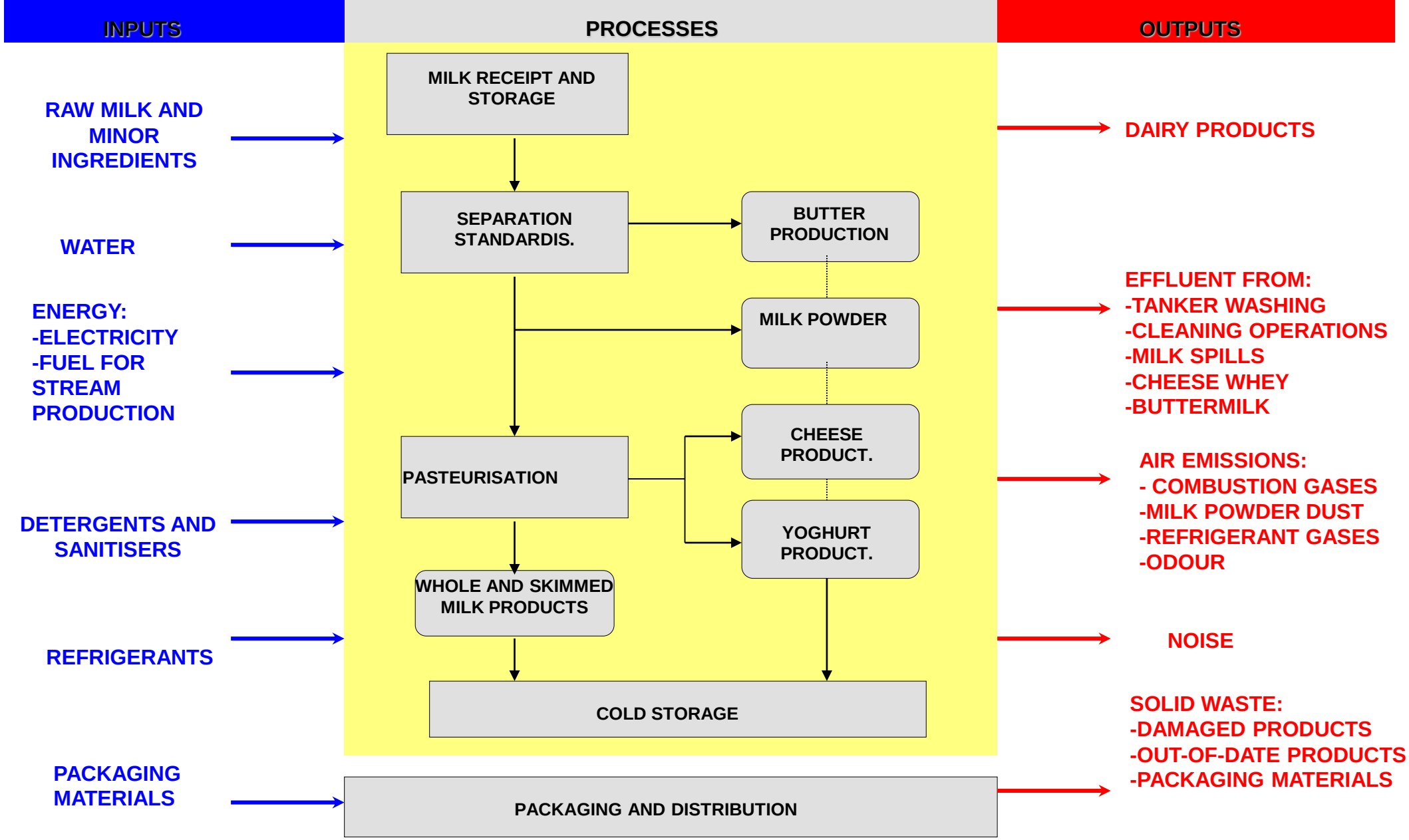
1.GENERATION OF SOLID WASTE
2.EMISSION OF GREENHOUSE GASES
3.CONSUMPTION OF FOSSIL ENERGY
4.CONSUMPTION OF ELECTRICITY



MARKET AND CONSUMER



Burning, disposal and recycling of packaging


INPUTS
PROCESSES
OUTPUTS
RAW MILK AND MINOR INGREDIENTS
WATER
ENERGY: -ELECTRICITY -FUEL FOR STREAM PRODUCTION
DETERGENTS AND SANITISERS
REFRIGERANTS
PACKAGING MATERIALS
MILK RECEIPT AND STORAGE
SEPARATION STANDARDIS.
BUTTER PRODUCTION
MILK POWDER
CHEESE PRODUCT.
YOGHURT PRODUCT.
PASTEURISATION
WHOLE AND SKIMMED MILK PRODUCTS
COLD STORAGE
PACKAGING AND DISTRIBUTION
DAIRY PRODUCTS
EFFLUENT FROM: -TANKER WASHING -CLEANING OPERATIONS -MILK SPILLS -CHEESE WHEY -BUTTERMILK
AIR EMISSIONS: - COMBUSTION GASES -MILK POWDER DUST -REFRIGERANT GASES -ODOUR
NOISE
SOLID WASTE: -DAMAGED PRODUCTS -OUT-OF-DATE PRODUCTS -PACKAGING MATERIALS

WATER CONSUMPTION

PRINCIPAL USES → CLEANING PROCESS EQUIPMENT AND WORK AREAS

TYPICAL RATES OF CONSUMPTION → 1.3-2.5Lwater/kg of milk intake

ENERGY CONSUMPTION

PRINCIPAL USES

- COMBUSTION OF FOSSIL FUELS (80%) → GENERATION OF STREAM AND HOT WATER FOR HEATING PROCESSES
- ELECTRICITY (20%) → RUNNING ELECTRIC MOTOR, REFRIGERATION, LIGHTING, ETC.

TYPICAL RATES OF CONSUMPTION → 0.1-0.4KWh/L of milk intake

Product	Consumption of water	Associated processes	Consumption of energy	Associated processes
Milk	Low	Heat treatment Packaging	High	Filtration/Clarification Standardisation Heat treatment Homogenisation Packaging
Butter	Low	Pasteurisation Whipping-Churning	Medium	Pasteurisation Deodorisation Maturation Whipping-Churning Packaging
Cheese	Medium	Salting	Medium	Coagulation Cutting and whey drained out Moulding-Pressing Drying Maturation
Yoghurt	Low		Low	Incubation Packaging

EFFLUENT DISCHARGED

CAUSED BY:

- HIGH LEVELS OF WATER CONSUMPTION
- MILK LOSSES

PROPERTIES  TYPICAL COMPOSITION

- ⇨ HIGH ORGANIC LOAD
- ⇨ FLUCTUATIONS IN pH
- ⇨ HIGH LEVELS OF NITROGEN AND PHOSPHORUS
- ⇨ FLUCTUATIONS IN TEMPERATURE

COD (mg O2 /L)= 1800 ± 600
BOD (mg O2 /L)= 1100 ± 600
Total nitrogen (mg/L)= 60 ± 25
Total phosphorus (mg/L)= 130 ± 100
pH= 2-10.5
Fat (mg/L)= 200 ± 100
Dried matter (g/L)= 2.5 ± 1
Suspended matter (mg/L)= 530± 250

AIR EMISSIONS

CAUSED BY:

- COMBUSTION OF FOSSIL FUELS
- USE OF REFRIGERATION SYSTEMS BASED ON CFC

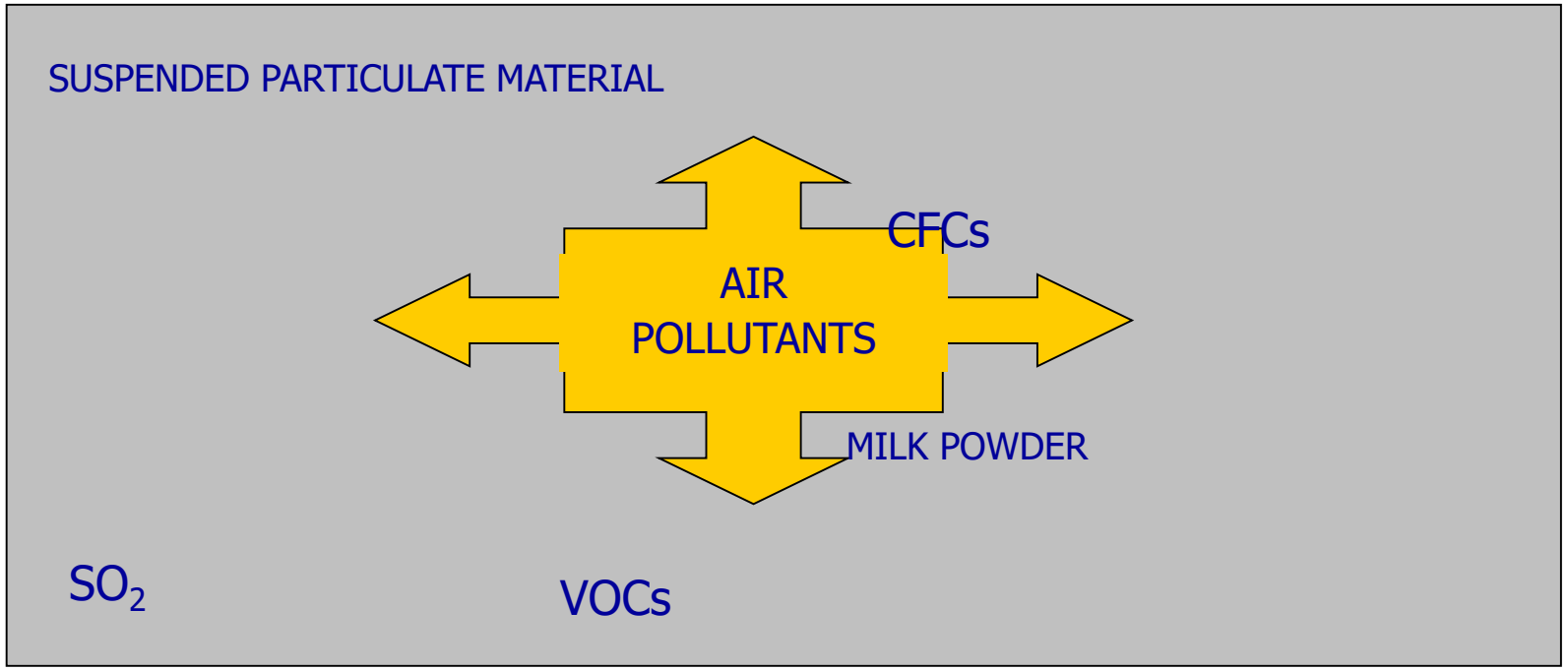
•Chlorofluorocarbons (CFCs), is synthetic substances used as refrigerants. They have been controlled by the Montreal Protocol since 1987 because of their ozone depleting potential and high global warming potentials

•VOC (volatile oranic compoinds, connected with condensator)

CO_x

NO_X

PRINCIPAL AIR POLLUTANTS



SOLID WASTE

CAUSED BY:

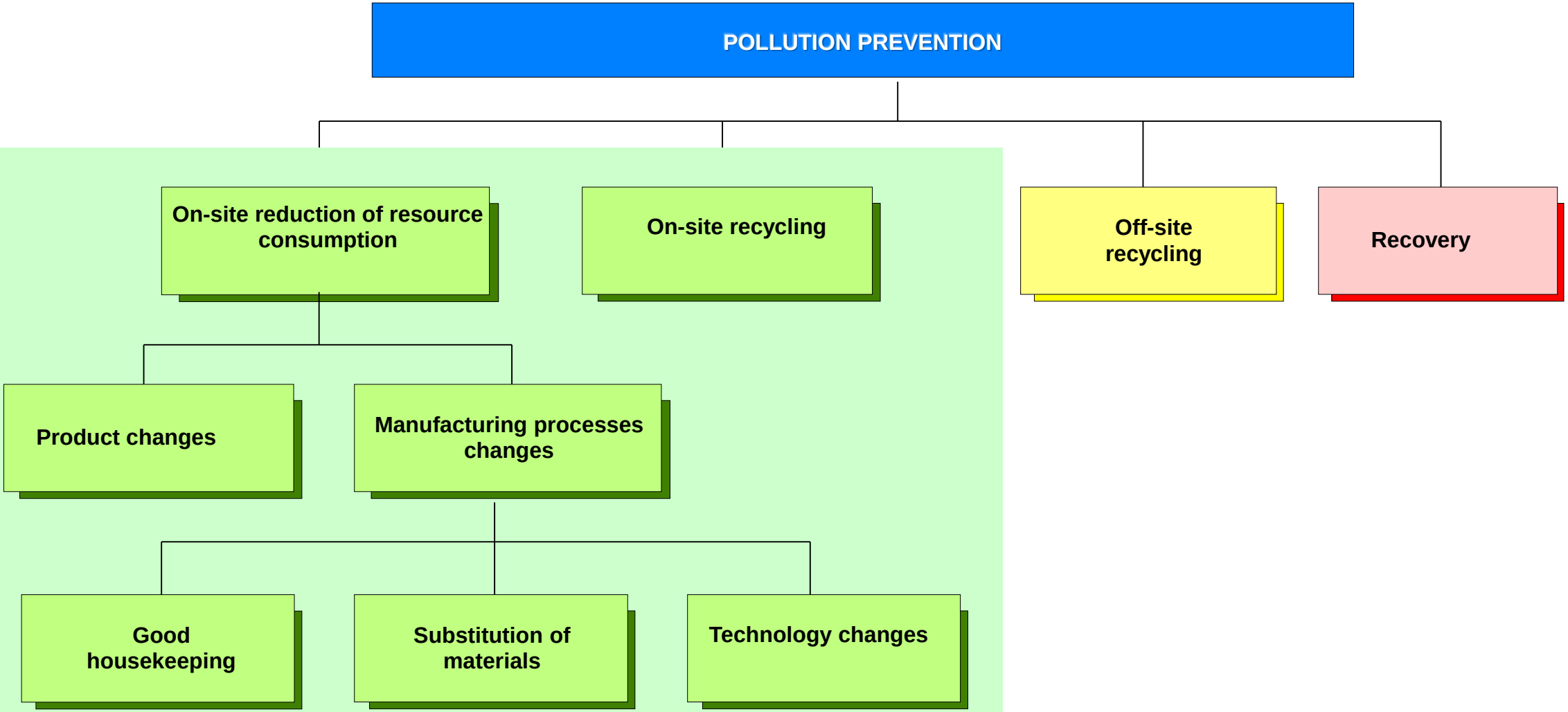
- BREAKAGES AND PACKAGING MISTAKES
- CLEANING AGENTS PACKAGING
- GENERATION OF CLARIFICATION SLUDGE
- USED FILTERS

SOURCES OF SOLID WASTE GENERATION

PRODUCT	LEVEL OF SOLID WASTE GENERATION	ASSOCIATED PROCESSES
Milk	High	Filtration/Clarification Separation -Standardisation Packaging
Butter	High	Packaging
Cheese	Low	
Yoghurt	High	Packaging

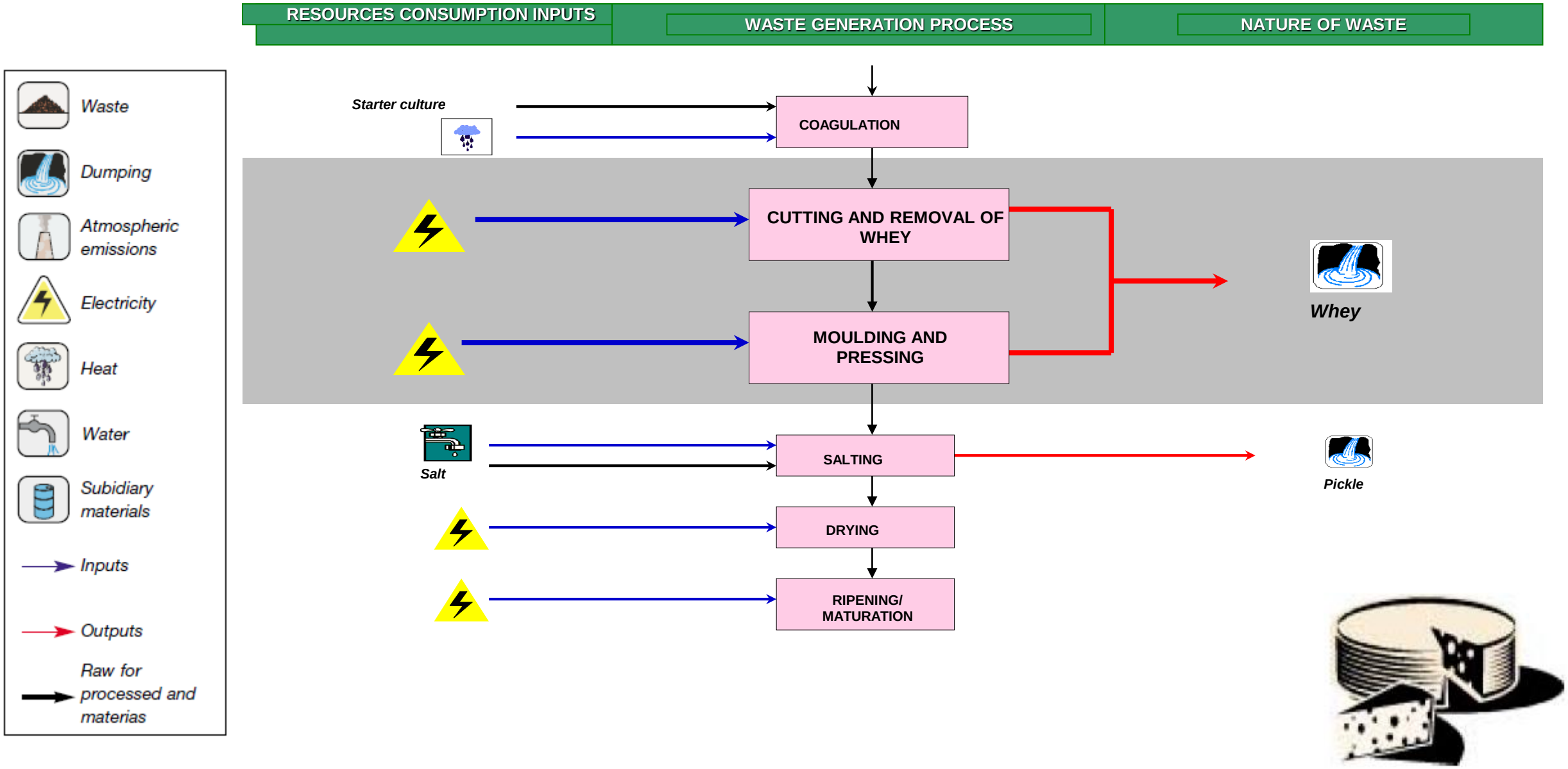
POLLUTION PREVENTION OPPORTUNITIES (PPO) IN THE DAIRY SECTOR

POLLUTION PREVENTION AND POLLUTION REDUCTION AT SOURCE



RECOVERY AND INCREASE IN VALUE OF CHEESE WHEY

1. INPUTS AND OUTPUTS



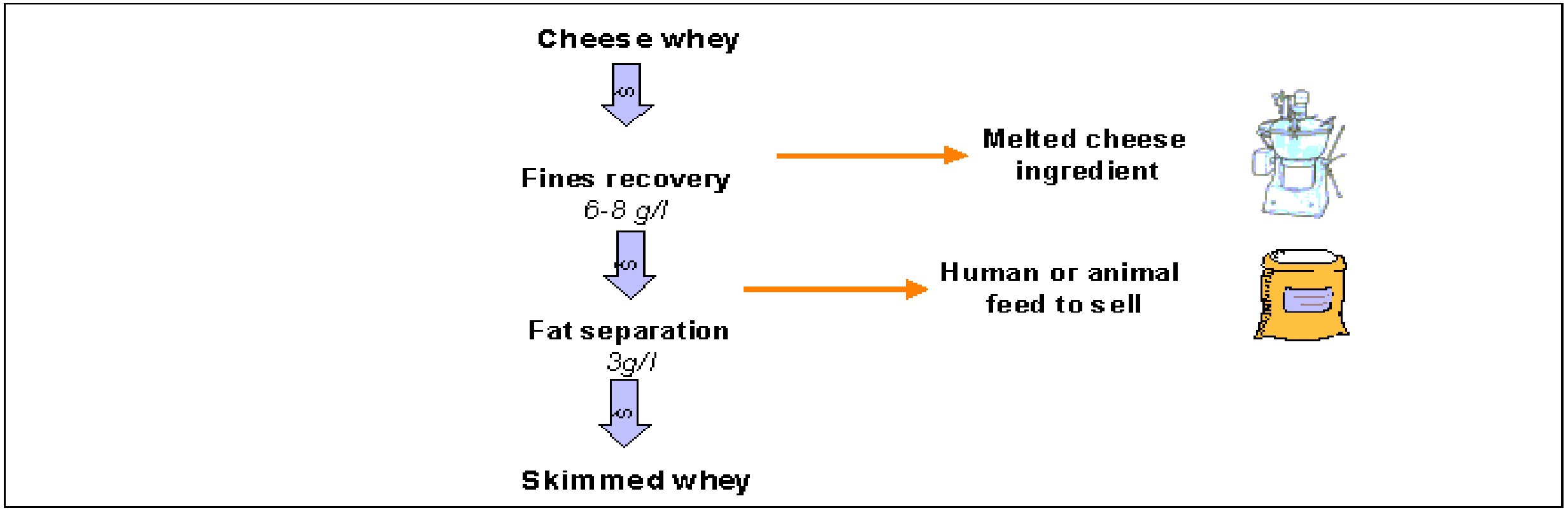
2. ENVIRONMENTAL ISSUE

- The major environmental issue associated with the cheese-making process is the disposal of whey.
- The quantity of whey discharged is nine times greater than cheese volume.
- High organic load: typical COD effluent concentration is about 60.000mg O2/L.

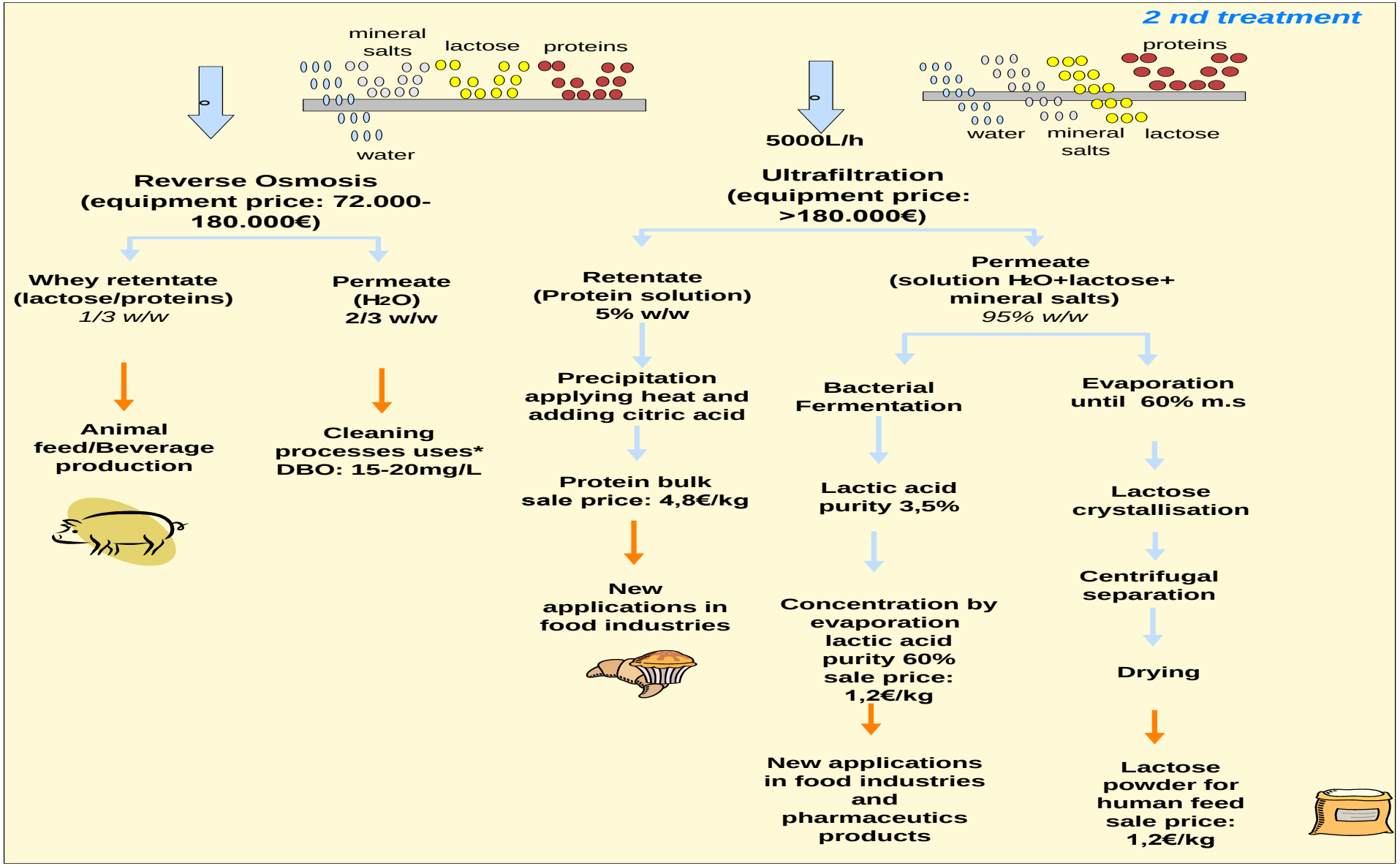
3. PPO

- Classification: On-site recycling.

First treatment:



Second treatment: high volume of whey

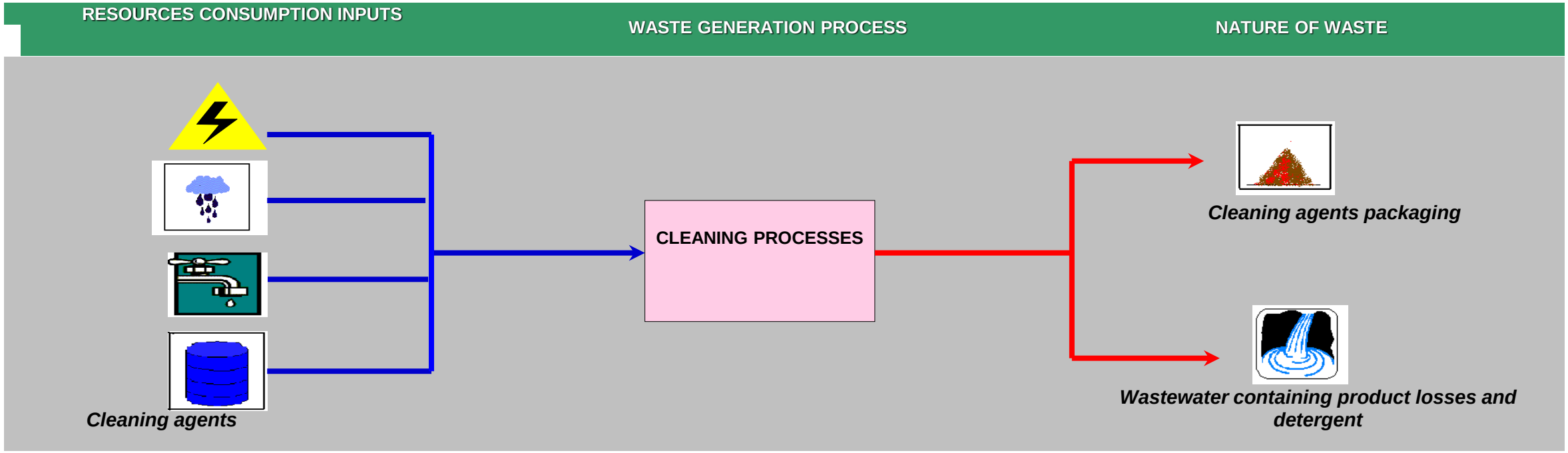


4. ECONOMICS AND ENVIRONMENTAL EVALUATION

- ☺ Cost savings from reducing the load of the wastewaters
- ☺ Additional revenue from by-products sale
- ☺ Reduction of organic load and conductivity effluent discharged
- ☺ Reduction of liquid effluent volume discharged.
- ☺ Increase in value of waste flow.
- ☹ Staff training cost
- ☹ Capital cost to invest in new technology

IMPROVED OPERATION PROCEDURE IN CLEANING PROCESSES

1. INPUTS AND OUTPUTS



2. ENVIRONMENTAL ISSUE

- ⇨ High levels of water consumption.
- ⇨ The pollution load of cleaning wastewaters is considerable, due to the presence of milk fat and proteins as well as detergents and disinfectants.
- ⇨ Discharge of phosphorus-based and nitrogen-based compounds due to the use of cleaning agents

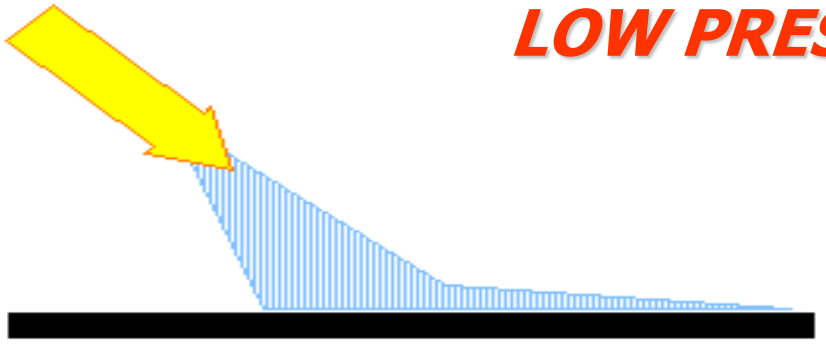
3. PPO

- ⇨ Classification:On-site reduction of resources consumption. Good housekeeping.

- ⇨ Identified PPO

Low-pressure cleaning systems vs. High-pressure cleaning systems

LOW PRESSURE CLEANING SYSTEMS



Operative characteristics:

- Pressure value: 6,8 Kg/cm2
- Cleaning agent: Foamed layer

Advantages:

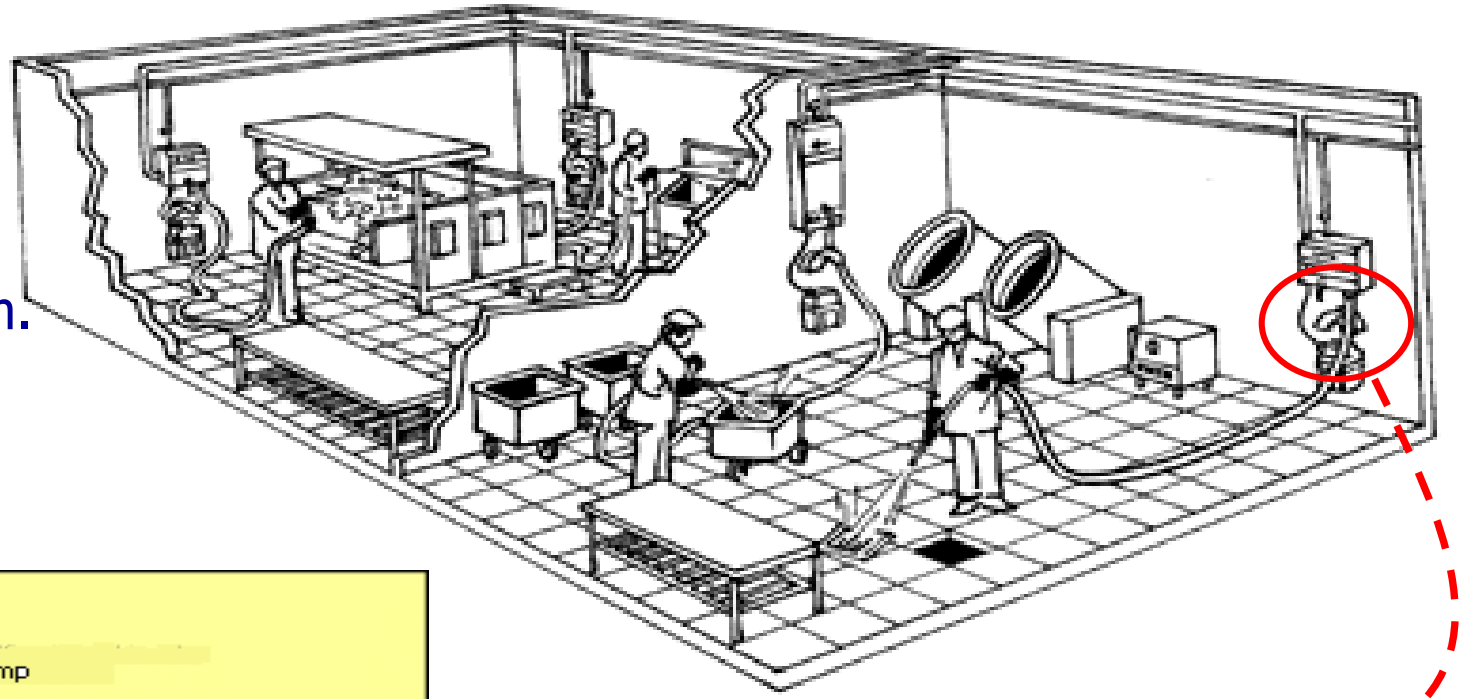
- High efficiency system to carry out and remove the adherent dirt
- Available system when the spillage must be avoided, small rooms or equipment that required wet cleaning processes
- Production of a high quality foam
- Equipment is cheaper than high pressure equipment
- Simple-operative system
- Avoidance of aerosols generation and reduction of spillage

Disadvantages:

- Water consumption is higher than water consumption in high pressure cleaning operations.

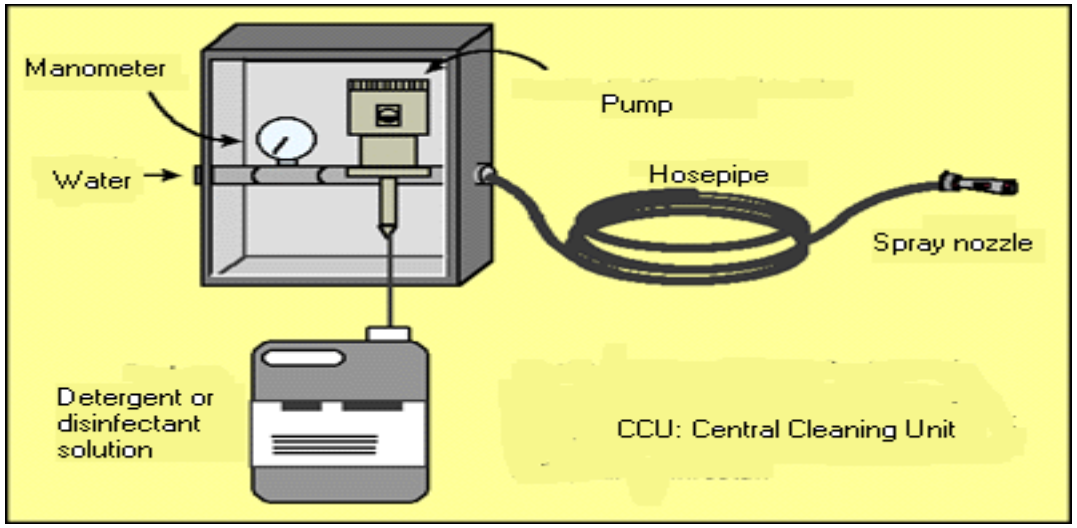
Application:

- ⇨ Equipment and production area



Low pressure cleaning system.

Supply water from Central Pumping Unit to Central Cleaning Units



Dosage equipment

HIGH PRESSURE CLEANING SYSTEMS

Operative characteristics:

- Pressure value: 68 Kg/cm2
- Cleaning agent: pressurize water/solution

Advantages:

- Available system to remove the adherent dirt, impurities or any other foreign or undesired matter
- Available system to remove the inside fissure adherent dirt
- High efficiency at short-distance

Disadvantages:

- ⇨ Equipment should be damaged due to the high pressure applied
- ⇨ Generation of dirt dispersion and spillage due to the high pressure applied
- ⇨ Hard-operative system
- ⇨ Generation of hazardous aerosols
- ⇨ Production of a poor quality foam
- ⇨ High temperature losses depending on applying distance

Application:

- ⇨ Walls and out-site areas

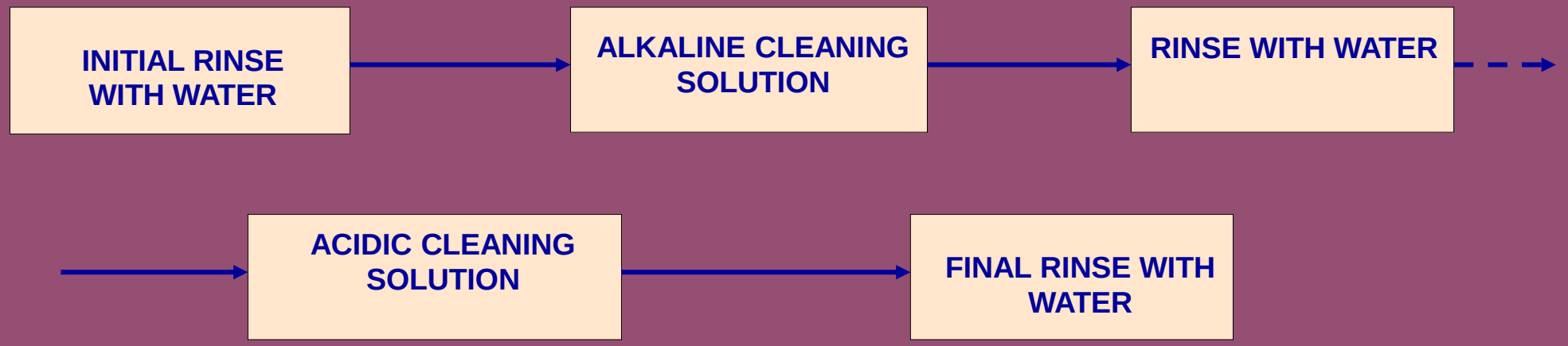
Other opportunities for reducing water consumption:

- Use of continuous rather than batch processes to reduce the frequency of cleaning.
- Implementation of automated cleaning-in-place (CIP) systems for cleaning to control and optimise water use.
- Installing fixtures that restrict or control the flow of water for manual cleaning processes.
- Using high pressure rather than high volume for cleaning surfaces.
- Reusing relatively clean wastewaters (such as those from final rinses) for other cleaning steps or in non-critical applications.
- Installing meters on high-use equipment to monitor consumption
- Pre-soaking floors and equipment to loosen dirt before the final clean.
- Using compressed air instead of water where appropriate.
- Reporting and fix leaks promptly.

4. ECONOMICS AND ENVIRONMENTAL EVALUATION

- ☺ Cost savings from reducing the water consumption
- ☺ Cost savings from minimising cleaning agents consumption
- ☺ Cost savings from reducing waste treatments
- ☺ Reduction of water consumption
- ☺ Reduction of wastewaters volume
- ☺ Reduction of effluent load, basically by avoidance of the use of phosphorus-based and nitrogen-based cleaning agents.
- ☺ Staff training cost

STEPS IN A USUAL CLEANING SYSTEM



STEPS IN A “ONE-SHOT” CLEANING SYSTEMS

CALCULATION EXAMPLE

	Traditional			One shot		
Phase	Time (min)	Consump.	units	Time (min)	Consump.	units
Rinsing	10	3,3	m^3	10	3,3	m^3
Alkali	40	5	kg			
Rinsing	15	5	m^3	20	7,5	kg
Acid	20	4	kg			
Rinsing	15	5	m^3	10	3,3	m^3

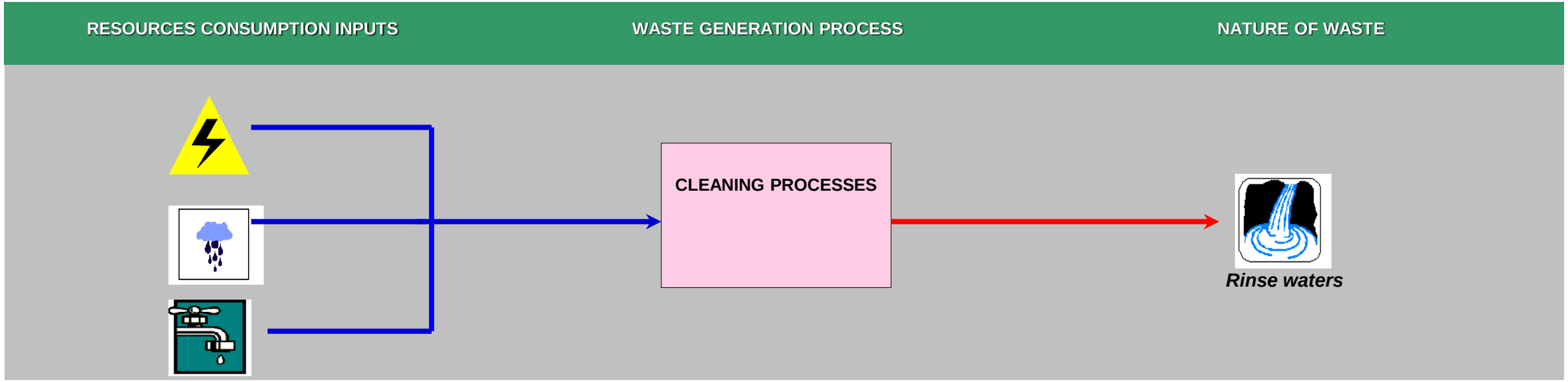
Total water consumption (m^3)	13,3	6,6
Total cleaning time (min)	100	40
Total cleaning products consumption (kg)	9	7,5

4. ECONOMICS AND ENVIRONMENTAL EVALUATION

- ☺ Reduction of water consumption
- ☺ Improvement in the utilisation of cleaning solution
- ☺ Reduction of energy consumption
- ☺ Reduction of wastewaters effluent discharged (50-60%)
- ☺ Reduction of emissions generation
- ☺ Avoidance of the use of phosphorus-based cleaning agents.
- ☺ Reduction of cleaning time

OPTIMISATION OF HOT WATER PRODUCTION PROCESS

1. INPUTS AND OUTPUTS

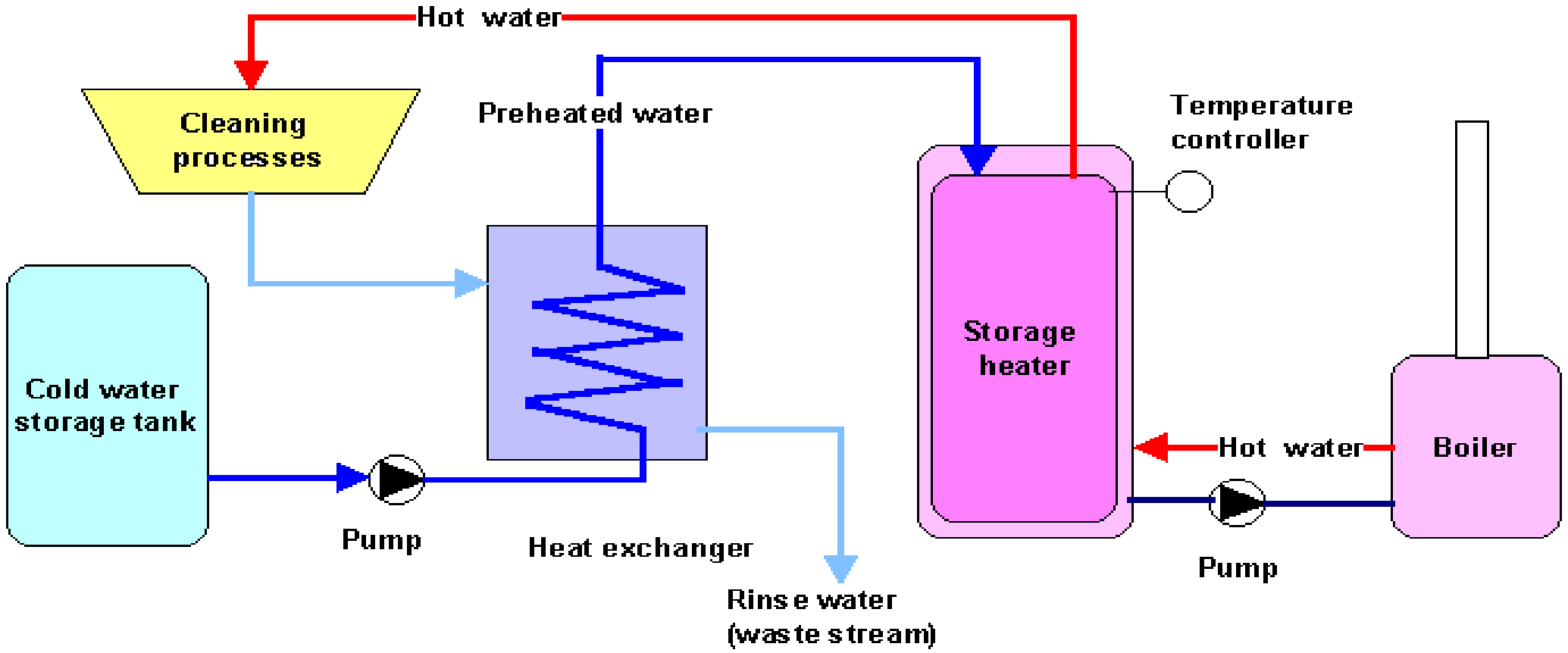


2. ENVIRONMENTAL ISSUE

- The cleaning processes require a large quantities of hot water to maintain hygienic conditions.
- Air pollutants emission from the combustion of fossil fuels.

3. PPO

- ⇨ Classification: On-site recycling.
- ⇨ Identified PPO: Optimisation of hot water production process

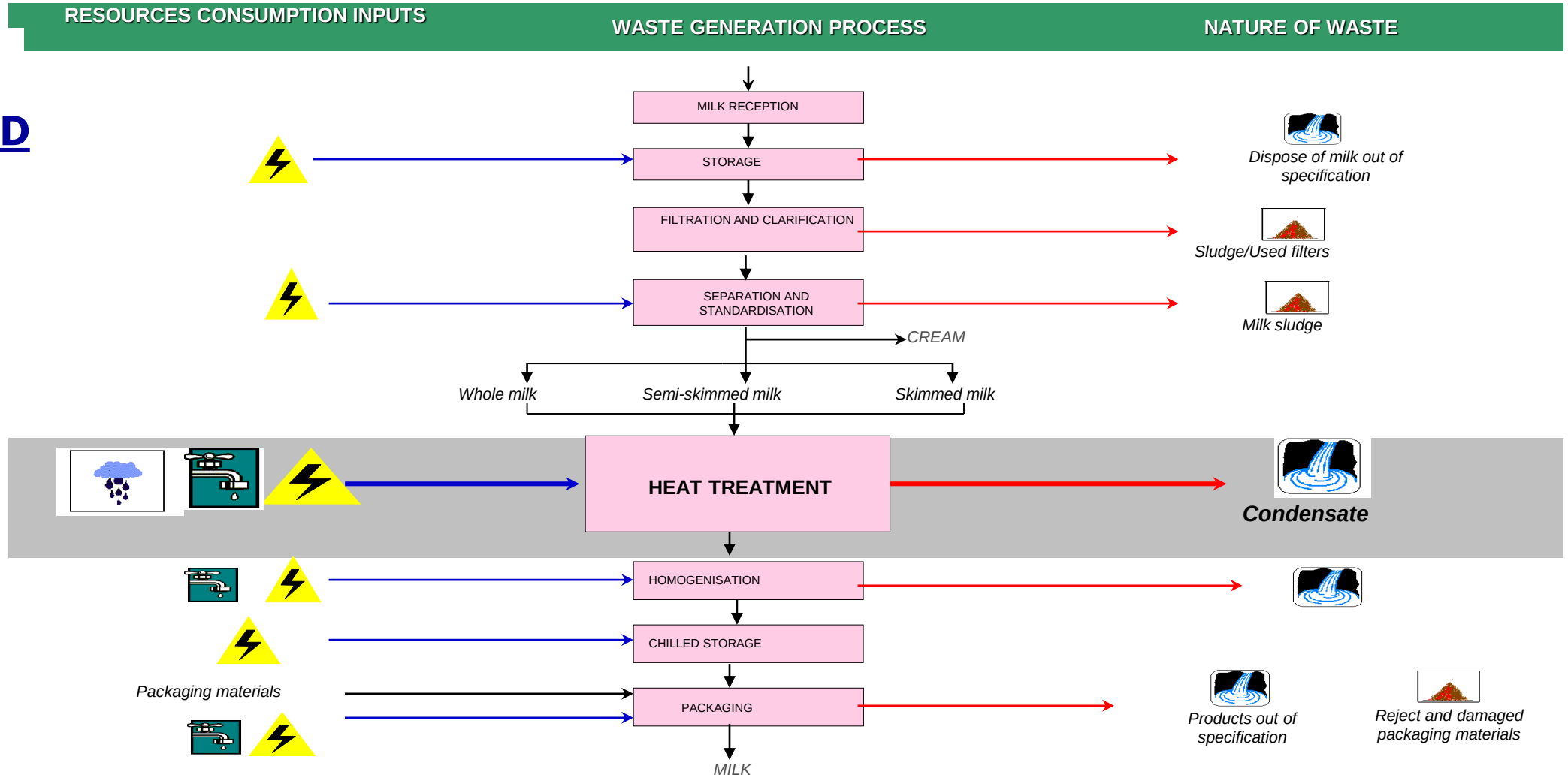


4. ECONOMICS AND ENVIRONMENTAL EVALUATION

- ☺ Reduction of energy consumption
- ☺ Reduction of air emissions
- ☹ Capital cost to invest in new process equipment

REDUCTION OF ENERGY CONSUMPTION IN HEAT TREATMENTS

1. INPUTS AND OUTPUTS



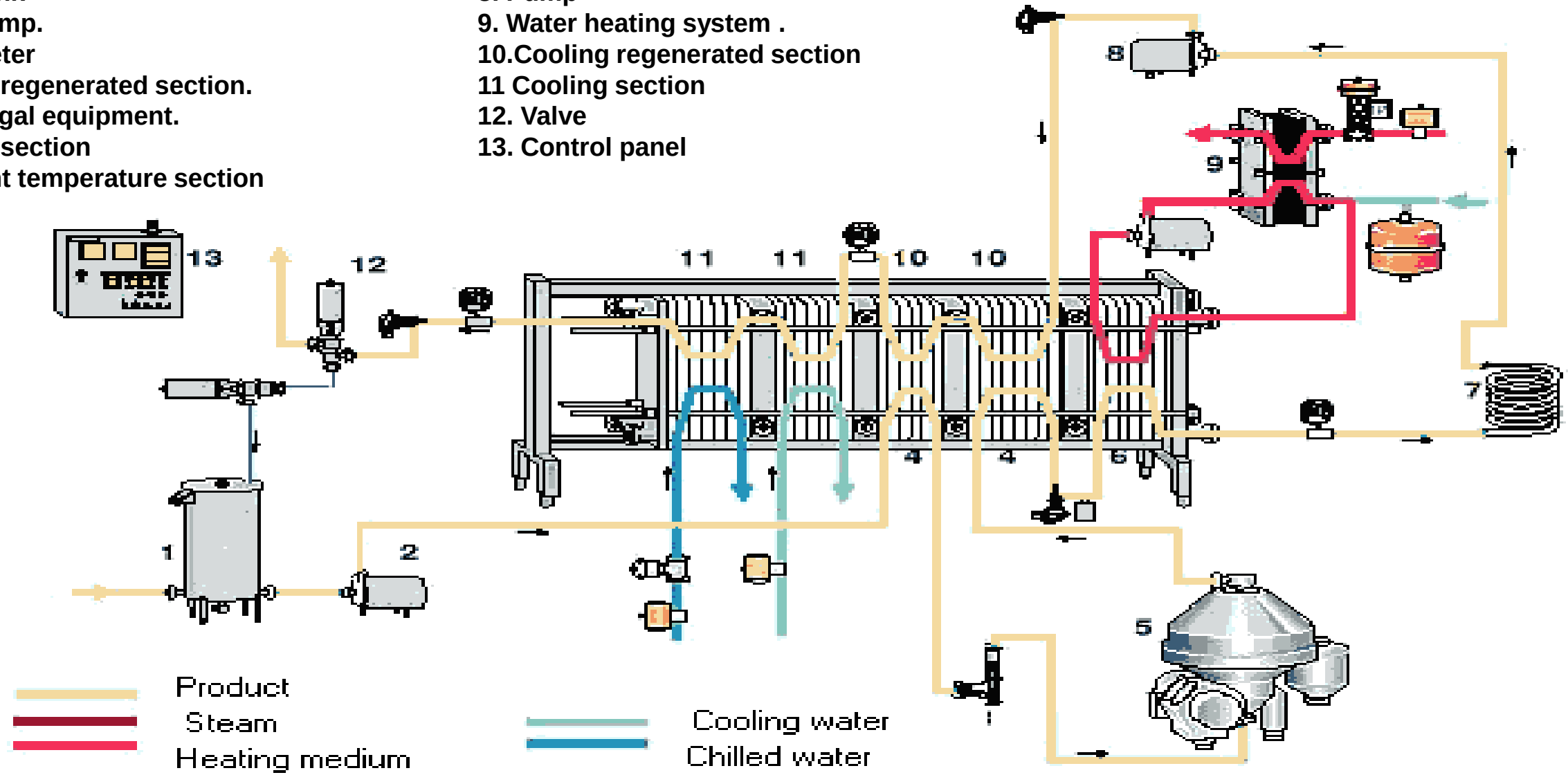
2. ENVIRONMENTAL ISSUE

- The cleaning processes require a large quantities of hot water to maintain hygienic conditions.
- Air pollutants emission from the combustion of fossil fuels.

3. PPO

- Classification: On-site reduction of resources consumption. Technology changes
- Identified PPO: Energy consumption optimization and improving the energy-efficient of heat treatment through the implementation of heat recovery systems

1. Level tank
2. Feed pump.
3. Flow meter
4. Heating regenerated section.
5. Centrifugal equipment.
6. Heating section
7. Constant temperature section
8. Pump
9. Water heating system .
10.Cooling regenerated section
11 Cooling section
12. Valve
13. Control panel



CALCULATION EXAMPLE

- Temperatures:
  - Low temperature 4
  - High temperature 74
  - Temperature gap 70
- Working schedule:
  - h/day 3
  - days/year 222
  - Flow (l/h) 10000
- Energies:
  - Milk density (kg/l) 1
  - Milk specific heat (kcal/kg ºC) 1
  - Fuel cost (€/l) 0,36
  - Fuel heat power (kcal/l) 6000
  - Energy cost (€/kWh) 0,1021
  - Energy cooling power (frig/kWh) 2500
- Equipment:
  - 85% recovery system cost (€) 36000
  - 92% recovery system cost (€) 42000

CALCULATION EXAMPLE

% Recovery	85,0	92,0
Heat supplied by cooling product (ºC)	59,5	64,4
Heat to be supplied by cooling devices (ºC)	10,5	5,6
Fuel consumption (l/h)	17,5	9,3
Energy consumption (kWh/h)	42,0	22,4
Heating yearly cost (€)	4196	2238
Cooling yearly cost (€)	2856	1523
Total yearly costs (€)	7052	3761

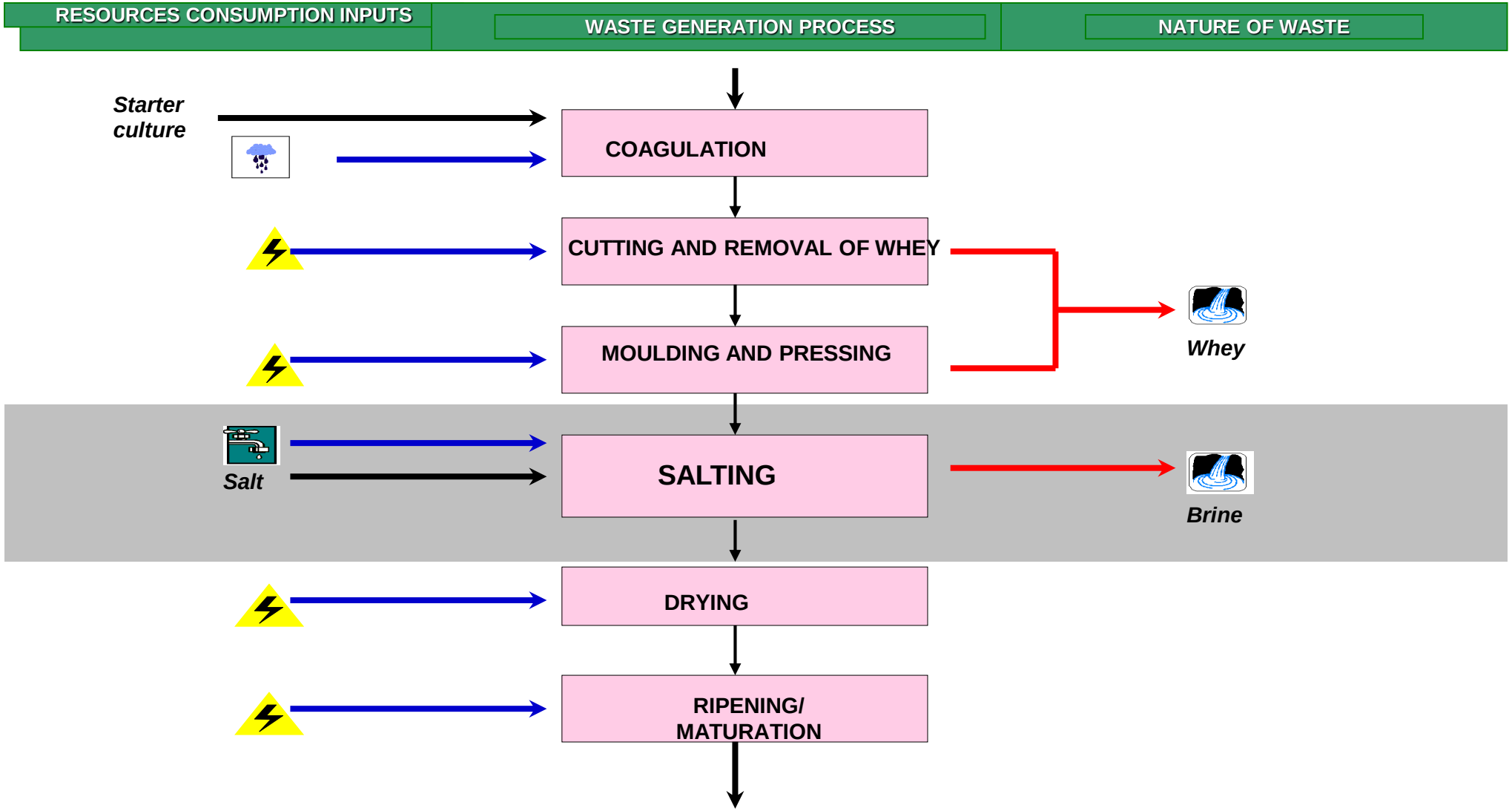
Yearly costs difference (€)	3291
Extra payback period (years)	1,8

4. ECONOMICS AND ENVIRONMENTAL EVALUATION

- ☺ Reduction of energy consumption
- ☺ Reduction of air emissions
- ☹ Capital cost to invest in new process equipment

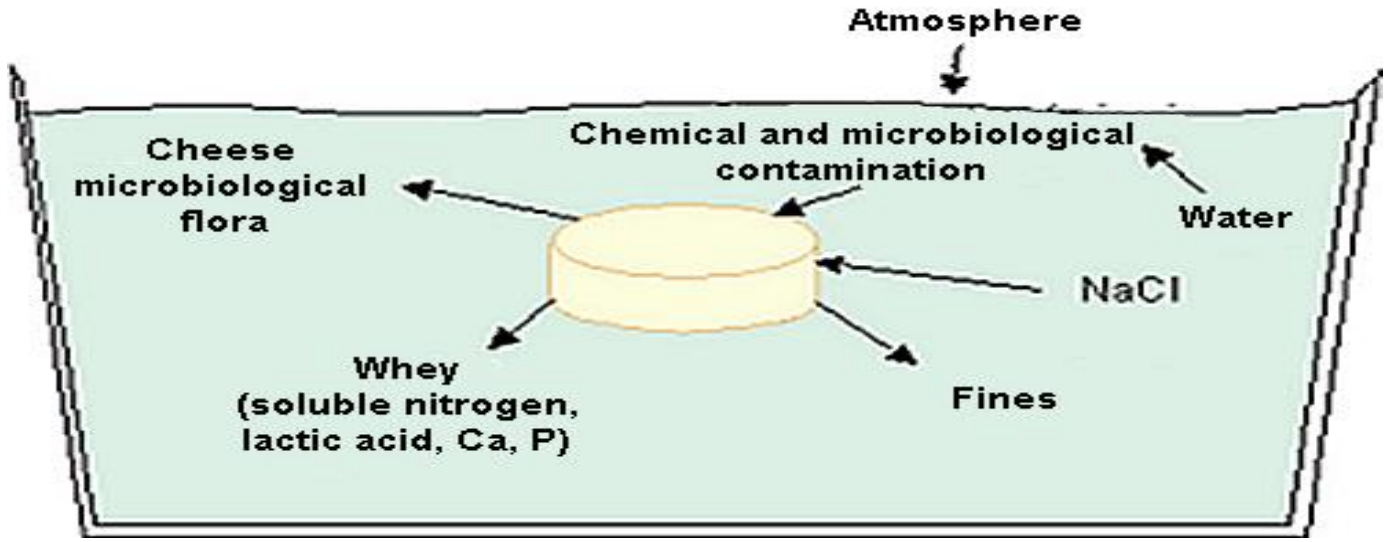
RECOVERY OF BRINE

1. INPUTS AND OUTPUTS



2. ENVIRONMENTAL ISSUE

- One of the most important environmental aspects of cheese making is the disposal of brine, due to its high salt content.



3. PPO

- Classification: On-site recycling.
- Identified PPO: use of techniques that allow reuse of brine through a treatment that guarantees the hygienic and operational optimal conditions

- Possible hygienic treatments:
  - UV irradiation
  - Pasteurization
  - Membrane technologies
- Operational treatment:
  - Salt supply

4. ECONOMICS AND ENVIRONMENTAL EVALUATION

- ☺ Reduction of water consumption
- ☺ Reduction of salt consumption
- ☺ Reduction of waste water volume and treatment costs
- ☹ Cost of buying, and maintaining equipment

USE OF ENVIRNOMENTAL CRITERIA IN NEW PRODUCT DEVELOPMENT

1. ENVIRONMENTAL ISSUE

- To take into consideration environmental aspects at the moment of developing a new product allows to reduce or prevent its effects on environment when it is launched to the market.

2. PPO

- Classification: On-site reduction.
- Identified PPO: to carry out an environmental study during the new product development process in order to supply enough information to reduce future generated environmental aspects.

- Possible contents of the study:
  - Description: previous analysis of the existent product, from which improvement will derive
  - Prospecting: illustrative determination of the environmental effects that a change in the process may have
  - Evaluation: once the design has been developed to detailed level, it is possible to determine precisely the environmental improvements of the new process
  - Communication: it is important to communicate the results both internally (workers) and externally (Administration, consumers) to obtain a positive and encouraging reaction.

3. ECONOMICS AND ENVIRONMENTAL EVALUATION

- ☺ Reduction of raw materials, energy and water consumption
- ☺ Reduction of packaging materials consumption
- ☺ Reduction of wastes treatment costs
- ☺ Benefits from recovery of by-products
- ☺ Public image of the company
- ☹ Cost of the study

Thank you for your attention!

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