Process Management to Obtain a Cleaner Production in Discrete Manufacturing

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Abstract

In the national scene and the imminent presence of the water crisis in Brazil, it becomes mandatory to debate of environmental issues in the production environment as well as in its various sectors of activity. Human interference leads to a scarcity of natural resources caused, in most cases, poor management of these resources and the lack of proper management of waste generated in all processes. This article presents a case study of the implementation of a cleaner production methodology (CP) through the management processes of the existing workflows in a cleaning products company, aimed at implementing practical solutions to reduced consumption of water. These solutions, which include changes in the physical structure of the machines, alongside a joint work with the PPC and other areas involved, combining market strategies and productivity in order to reduce the setups of machines and use of water resources.

Keywords: *Sustainability, Cleaner, Water Resources Production.*

1. Introduction

Talk about environmental issues in the production environment becomes compulsory, in its different sectors of activity. The human interference direct a scarcity of natural resources scenario caused, in most cases, by poor management of these resources and the lack of proper management of waste generated in all processes.

The applications of the resources found across the planet are linked to the past of humanity, in the archaic and manipulative way that society draw the necessary inputs for survival, as well as inputs for the very concentrated wealth in the minority of the people. After the Industrial Revolution, the development was accompanied by advances in technology, where big centres have become inviting investment. However, along with this growth has come the possibility of scarcity of natural resources available to man and the environment that surrounds it (Rensi & SCHENINI, 2006).

Over the years, the results of this shortage were to unevenly distributed as the natural resources available to man, such as water, minerals (construction and industrial), vegetation (wood, crops, etc.) and other inputs required for the plus manufacture and capitalist production. In this scenario, companies are beginning to see how its performance in the middle intervene with the survival of human beings and how they can contribute in a positive way, to extend the availability of basic

resources, including yourself handling and contamination of atmospheric air, which is nonetheless a main resource for humans. This new vision initially comes as imposing some standards to be met by legislation or law (federal, state or municipal). Gradually, companies that excel in environmental requirements and implement "cleaner" ideas to market become more competitive. These organizations are beginning to use the word sustainability in their advertisements or marketing their brands, associating that particular company cares about the environment and humanity itself.

Therefore, business strategies, which until then were restricted to the Economic issues, such as competitiveness, efficiency, profitability, etc., are to be made in their environmental variables concerns, becoming then incorporate them vital to the production processes (Severus, Olea, Milan & Dorion, 2009). One of the alternatives to introduce sustainable ideas to the market would be through cleaner production , which benefits not only the companies who adopt it, as well as employees, essential for the compliance of the work routines and maintaining the applied ideas focusing on reducing losses and increased corporate profitability. This differentiates the company in its segment, due to increased production efficiency with applications of cleaner ideas for their production lines.

This work directs to the formation of a new concept in a discrete manufacturing industry, with a study of the implementation of a new methodology to reduce water use in sanitizing production reactors. This sets a challenge for the company, as the main composition and main raw material needed to manufacture these products is water. However, using the process mapping tool, can be "dry" some sub-processes and develop a new concept for the production, making it more effective 'delivery of products to customers and more efficient in its management of industrial resources.

2. Theoretical framework

2.1. Overview

The Brazilian industry has sought to provide the water supply through the reuse of water in its processes, as well as the search for secondary alternatives. Reuse techniques have been used to increase the availability of water for the industry, action that in addition to providing its inclusion in a sustainable context may be a forerunner factor of the initiative of the management of waste from industry, besides the significant reduction the waste of raw material and increase economic benefits. Additionally the industrial supply is the third largest water use in the country in terms of water withdrawals and the fourth in terms of consumption, according to the ANA (Agencia Nacional de águas). Among the sectors of industry, the manufacture of chemicals is the fourth largest consumer of water sector (ANA, 2013).

Environmental concerns have changed their focus as the scientific and technological knowledge has evolved, as well as the way of life on them and the consequences of human production for excellence was developed. (BACHELET, 1995; Moreira, 2001). Even if one has advanced considerably awareness regarding environmental issues, population growth directly affects the natural resource base. A progressive advance in the implementation of the management of water resources by industries is necessary, and the first action to take is the formation and awareness of human resources in this area, to spread this ideal. Be the industry the cause of any change on the environment, whether adverse or beneficial, wholly or partially resulting from activities, products. In order to mitigate these impacts, the creation of an environmental management system becomes crucial. So regardless the absence of an environmental certification, the industry must include its organizational structure practices and procedures to meet an environmental policy. Preventive and control actions measures should be included in the management of water and environmental resources.

2.2. Sustainable development

More than two decades ago, Our Common Future (Our Common Future - the Brundtland Report) popularized the concept of sustainable development, which presented a new way of thinking about the relationship between the economy and the environment. The main message was that economic growth should no longer involve damage to the environment. Although the concept has been spread globally and has become a slogan for policy makers, politicians, academics, businesses and non-governmental organizations, raised much controversy. This failure may be largely due to the persistent perception that, in the end, environmental protection always focuses on the economic performance and so there is always a trade-off.

Sustainable development is not restricted to environmental aspects, also encompasses the social, economic and technological areas. Besides making it necessary an interim participation of society as a whole including covering cultural and political perspectives.

According to the Brundtland report - Our Common Future (1991): governments and multilateral institutions are becoming increasingly aware of the impossibility of separating the issues relating to economic development issues relating to the environment; many forms of development erode the environmental resources on which it should support, and the deterioration of the environment can harm economic development. Brundtland report - Our Common Future (1991, p.3)

All types of organizations are increasingly concerned to achieve and demonstrate sound environmental performance by controlling the impact on the environment, its activities, products and services, taking into account their environmental policies and objectives. This is done in the context of increasingly stringent legislation, the development of economic policies and other measures to promote environmental protection, and the general increase in seizure of stakeholders on environmental issues, including sustainable development (ISO 14001.2003) .

The concept of sustainable development comes from the idea that humanity ensures meeting their present needs thereby these actions will not undermine future generations. Thus, the main task within this framework of sustainable development is the development of committed efforts to identify improvement opportunities within your process, to ensure the supply of resources and raw materials also for the future, thus providing, as the Brundtland report, a new era of economic growth.

Thus, it is expected of international environmental management standards that provide organizations with the guidelines for the scope of an effective environmental management system, based on sustainable development, so it can also be integrated with other management requirements, to assist organizations to achieve environmental and economic goals.

2.3. Cleaner production

Cleaner technologies are generic techniques for implementation of cleaner production including maintenance practices, process optimization, substitution of raw materials, new technologies and new projects. In addition to preserving environmental values, purpose of Cleaner Production tool is to prevent inefficient use of raw materials and reduce operating costs, treatment and disposal - UNEP (United Nations Environment Program).

Cleaner Production according to UNEP TIE (Division of Technology, Industry and Environment) which coined the term in 1989, Cleaner Production is the continuous application of an integrated preventive environmental strategy to processes, products and services to increase production efficiency and reduce risks to humans and the environment. The Cleaner Production is a proactive philosophy that anticipates and provides for possible impacts and can be applied not only to production processes but also throughout the life cycle of a product, from the design phase through the phase consumption to

final disposition. Aims to conserve sources of raw materials, elimination of toxic raw materials and reducing waste and emissions.

According to (Fusco, 2002, p.265) the application of Cleaner Production concepts implies the reduction of waste / waste generated in the development of a product that causes less environmental impacts at the end of their life cycle. When an institution chooses to adopt the concept of Cleaner Production (CP) must be previously understood that the CP is profitable, however, requires investments of capital and time. The participation of people in the CP process is a crucial factor for the success of the process, especially for those who are directly linked to the "shop floor" because they are involved with the development and production activities. According Vilela Junior, A. and Demajorovic, J (2006, p.65) professionals involved with routine operations, are those who have the knowledge about the products, materials and processes. They are who can easily identify and evaluate opportunities for improvement and propose actions to implement them. Fitting the managers of the process monitoring of action for further analysis of the feasibility of proposed actions. The implementation of CP is important, mainly including those related to safety it works to reduce risk to the worker. The adoption of CP improves the company's position on its suppliers, customers, society and environmental authorities.

3. Methodology

This work was developed starting from the management processes of the existing workflows in a cleaning products company. For this task, they were divided into 4 parts:

- Knowledge of the file on the spot - the process has been identified and mapped for the subsequent application of cleaner technology. Thus, the ECO Time was developed about processes mapping techniques and identification of the major gap into the activities;
- Division of ECO Time - ECO Time was divided into two managements: the first one is to identify improvements that provision of the identified process stopped and the second one would have a focus on the study of a future process with data from the previous flow;
- Defining the new value stream - The final management would come with a new process, based on the need to reduce the use of water and emission of harmful pollutants and waste to the environment.
- Deployment of new technology - To perform implementation were set some guidelines that will be exposed in the case study, and the new tendency for the process to become more self-sufficient.

4. Procedure to be studied

4.1. Principle

In the filling process of cleaning products on a production line, there are several waste generators. Water, excess product packaging, bottles, many residues that could be reused by production line or your losses could be minimized.

Among these wastes are washings setup in a production line. A classic example would at first be running on a production line one sanitary product version of blue. In a second step, depending on market demand and production schedule, one must potting one sanitary product yellow. The procedure in the filling line is to drain any product via hose with water and relocate the waste generated in containers (drums the call), usually with a volume of 1000 litters. These drums are usually taken to a company that can treat it by chemical and organoleptic composition. Some of them there is no final destination and are sometimes need to be incinerated, causing an extra cost.

4.2. Quantitative Analysis of inputs and outputs of the process

We conducted the initial study of the inputs lines of washing and disposal of their waste in the actual shop floor. Therefore, we carried out the quantitative survey of everything that goes in and what comes out of this flow. The product of this study led to the construction of a primary table and a flow chart of the activities exerted operators, including waste and their storage destinations for the environment.

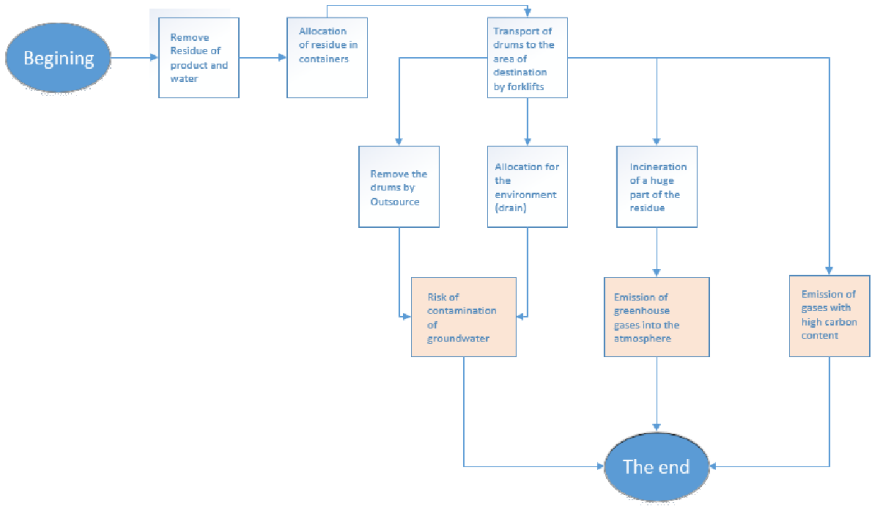

Fig. 1. Flowchart of the process (before the implementation of Cleaner Production)

5. Implementation of the Methodology Cleaner Production - Case Study

5.1. Knowledge of the new process

The ECO Team conducted several analyzes among which were designed new ways for a new process value stream. As flow explored previously, there was no reuse of the product generated dressings, being dropped when there was little mixing with other components or incinerated in an outside company. By over-reached by the company, the product came to be taken by third party who reserved the waste into sewers or externally own destinies, all of them in the environment. For the new process if directed-two forms of action:

- After all - After generation, are carried out some activities to reuse all waste. Among them, the allocation for the reactor itself as a form of reprocessing. In other words, it would be to use the materials that were thrown out as future sanitizing products. This means a direct reduction in water consumption and increase the company's profitability;
- Prevention at source - As improvement in reducing water consumption, materials were available as alcohol make possible lower the use of liquid to withdraw more precisely the products of other versions to the line setup.

The focus of the work will be done in Tube End technology, with some later statements to reduce consumption by prevention at source.

The quantitative analysis of the new process can be described at the tables below, as well as the new flowchart developed.

5.2. Cleaner production opportunities - Opportunities were identified according to the study and analysis of the flow before the cleaner production (CP).

Company area	Oportunities and/or problems	Action plan, strategy and options	Barriers and needs
1 Production	Risk of contamination among drums	Identification of drums by versions	1.1 Alignment among production areas and Environment 1.2. Training accomplishment with the operation
2 Production	Risk of destination to incinerate	Training of those involved and alignment with areas	1.1. And 1.2.
3 Production	Deposition of drums outside the correct area and contaminate the outside area	Training of those involved and deposition in a right place.	1.1. And 1.2.
4 Production	Noise pollution by centrifugal pump	Exchange centrifugal pump by air (less produced sound)	Company budget
5 Production	Automation missing in reprocessing	Evaluate the benefit cost for the company, focusing on minimizing losses	Company budget
6 Production	Lack of focus of operators on the implementation of service	Make specific training with only one operator	1.1. And 1.2.
7 Quality and environment	Overuse of microbiological slides	Make a specific training with a chemical analyst for collection of two drums in a single analysis	7.1. Alignment among the areas of Environment, Quality and Production
8 Production	Excessive use of Biocide	Analyze with the laboratory and reduce the use of biocide	7.1.
9 Production	Risk great use of water in washing fillers	Application of water meters for effective control of the water used	Company budget
10 PPC	High market demand, with large fluctuations as the versions produced	Make alignment in Production Planning meeting for reduction of setups	Effective Operational Planning
11 Production	Pallet truck used is small, requiring great effort and greater runtime	Make quotation and better provision of pallet truck, in order to meet the designated need	Company budget
12 Production and PPC	Lack of programming for versions to be reprocessed	Study program of d + 1 to direct future reprocesses	12.1 Training with operator 12.2 daily Alignment with the area of PPC

Tab. 1. Cleaner production opportunities

5.3. Inputs and outputs of the new process - after the new process definition, were qualitatively and quantitatively described all inputs and outputs of general products and by-products of the new stream. The main changes are in the treatment that the waste will suffer:

- With the addition of a sanitizing called glutaraldehyde, which have components that "eliminate" the growth of bacteria and fungi, which allows the reprocessing of these residues;
- To carry out the transfer of these liquids, the positive displacement pump via this material would be needed. The most recommended for this activity would be a pneumatic pump with positive displacement;
- Another important shift would be the bottle to where the material would be transferred to the reactor. Used to forklifts powered by gas, which contributed to the issuance of other types of gases that affect the respiratory quality issued by the high carbon content.

ENTRADAS			PROCESSO	SAÍDAS		
Raw materials, supplies and auxiliary	**Water**	**Energy**	**Steps**	**Wastewater**	**Solid Waste**	**Atmospheric Emissions**
Water, hose, empty drum and labour force	15 L	Zero	1.	30L	zero	Zero
Manual pallet truck, labour force	Zero	Apparent zero	3.	Zero	Zero	Apparent zero *
Biocide, funnel	0,8 L	Zero	5.	Residual effluent at the drum (1000 liters added 1L sanitizer)	Disposable canister sanitizer after 1000 liters used – **60Kg**	Zero
Suab, microbiological slides	Zero	Zero	6.	Zero	Suab/ microbiological slides used - **0,09kg**	Zero
Manual pallet truck	Zero	Zero	9.	Zero	Zero	Apparent zero *
Hose, centrifugal pump, drum full of residue	Zero	30 KW	11.	Zero	Empty drum – 60Kg	Zero
Labour force	1 L	Zero	13.	Zero	Zero	Apparent zero
Manual pallet truck, labour force	Zero	Zero	14.	Zero	Zero	Apparent zero
Manual pallet truck, labour force	Zero	Zero	15.	Zero	Zero	Apparent zero
Labour force	Zero	Zero	16.	Zero	Zero	Zero
Labour force	Zero	Zero	17.	Zero	Zero	Zero
Labour force	Zero	Zero	18.	Zero	Identification – 0,001kg	Zero
			TOTAL			

Tab. 2. New process – inputs and outputs

№	Subproducts, wastes, effluents and emissions	Annual quantity *	Cost of raw material	Waste cost associated with raw material	Storage cost	Treatment cost	Transport cost	Sale value	Layout cost	Total cost (R$)	Destination
1.	Sanitizing product, water	14,4 t	0,03	1,15	0,0	2,65	1,34	0,0	0,0	2233,44	Empty drum
3.	Drum with waste to be reprocessed	960 t	0,03	1,15	0,05	2,65	1,34	0,0	0,0	4963,2	Drums Storage Location
5.	Drum Biocide	960,96 t	0,15	1,15	0,05	2,65	1,34	0,0	0,0	4968,16	Drums Storage Location
6.	Suab and slides	0,864	0,01	0,0	0,0	0,0	0,05	0,0	1,9	1960	Outsourcing
9.	Empty drum	0,0	0,0	0,0	0,0	1,34	0,0	0,0	0,0	1286,4	Product case
11.	Reprocessed product	960,96t	0,0	0,0	0,0	0,0	1,84	0,0	0,0	1766,4	Reactors
13.	None	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	192,0	Not applicable
14.	None	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	192,0	Not applicable
15.	None	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	192,0	Not applicable
16.	None	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	192,0	Not applicable
17.	None	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	192,0	Not applicable
18.	Paper	0,096	0,0	0,0	0,0	0,0	0,0	0,0	0,05	4,8	Paper colector

Tab. 3. Main by-products and waste generated quantitatively

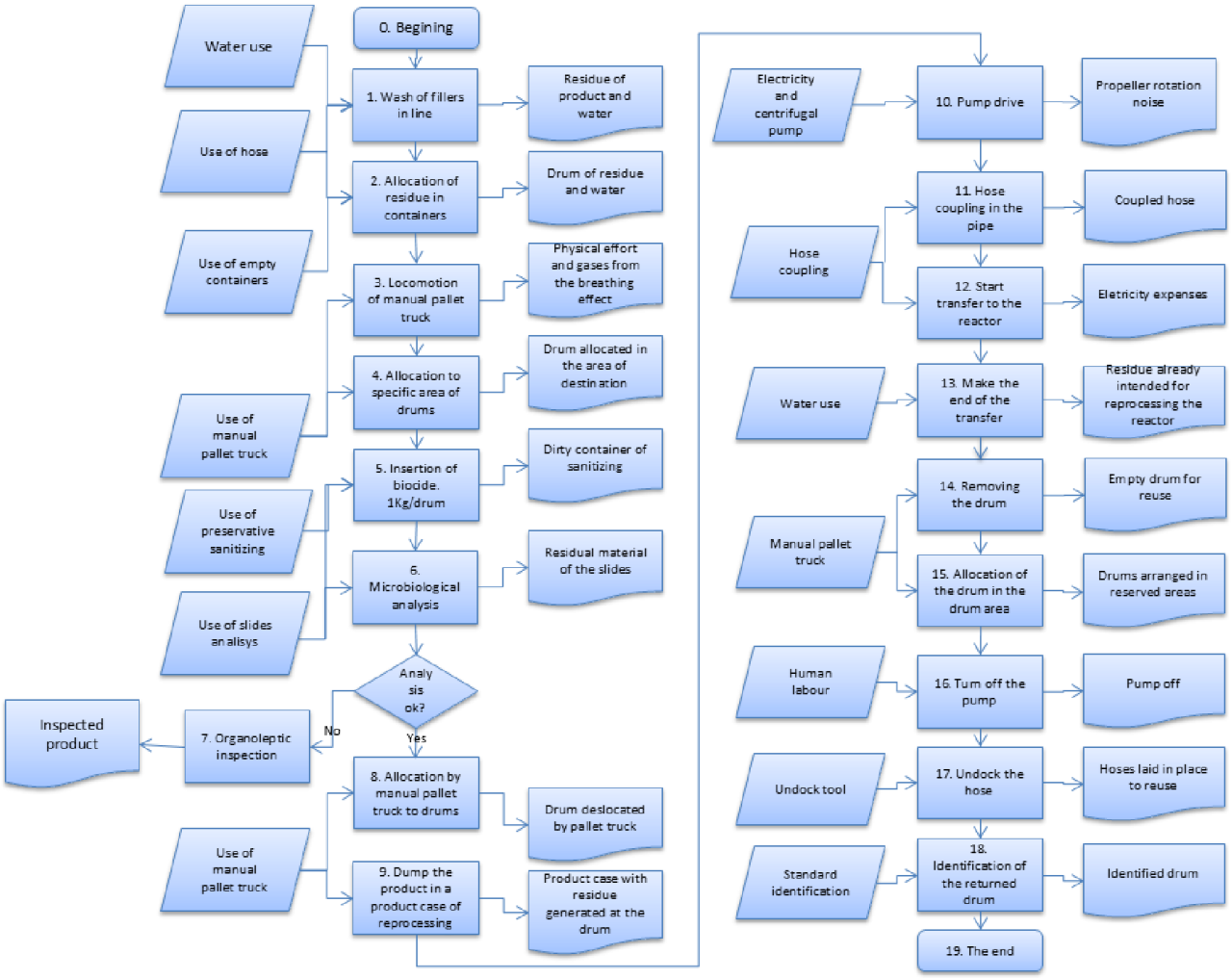

Fig. 2. Flowchart – After the Cleaner Production

5.4. Main consequences of CP in 3 areas of the company

- Production:

Risk - Disposal of bottles outside the correct area, with the result of contamination of the external area.

Detailing - After the allocation of the wash water along with the product withdrawn from fillers on drums, it is the process of withdrawal of production and allocation line in Plastic Tanks area (photo below). To this end, a manual pallet truck is used which enables the transport of waste. After this activity, the bottle must be within the range that is signalled by a containment ditch. The product cannot stay out of this demarcation as in the event of a spill, do not fall into the outdoor area, which can cause contamination in groundwater and consequent environmental occurrence.

Solution - The trench is already one of the measures adopted by the company to contain such risks. However, one should focus on the operator performing this activity, emphasizing the importance of proper disposal and pointing out the main contamination risks in the external area.

- Environment / Utilities:

Risk - Greater use of water in washing fillers.

Detailed - After online production, which are in filler remnants can be removed with a next quantity of 15 litters. This procedure is not reliable, since the operator may use more water than the necessary. This impairs the efficiency of the process using more raw material (in this case, water), adding further costs to the company.

Solution - Installing a water meter to control the water injected into the process. In the installation must be an automated control of the inlet water.

- PPC (Planning and Production Control):

Risk - High market demand, with large fluctuations, generating several setups in shorter production;

Detailing - The market cleaning products suffer fluctuations as market demands. One day ordering is to produce a product type A and type B. Another day this causes in the same production line the existence of many setups in a short period. Thus, it generates more need for washing fillers and consequently more bottles to be allocated for cleaning. This activity brings more reprocessing in the reactors and greater amount of energy involved, besides the work required of hand to be destined for the service.

Solution - Must be an online production study combined with the PPC area for manufactured products that are of the same version, within less impacting setups and consequent lower use of resources already mentioned. This alignment should be done combining market strategies and productivity.

5.5. Viability of Cleaner Production in the company

As the deployment project took place with several modifications in small activities, was directed only two case studies of CP, with the first use of the waste generated in their own reactors and the use of a pallet truck for transportation of bottles.

Feasibility of cleaner production in the company					
Opportunity description	**The problem / Motivator fact**	**Measures adopted**	**Memories of calculation**	**Environmental benefits**	**Social benefits**
Utilization of drums for product production	Drums were neglected, being incinerated or discarded if there was no risk of contamination (more water than product)	a) Elaboration of study to enable the reuse of the material; b) Training all involved to understand the importance of reprocessing; c) Application of the studied process in order to obtain the reprocessing of loads in elaboration.	a. Previous situation Monthly consumption = initial Spent with incineration of about R$ 20,000.00 Annual consumption = about R$ 240,000.00. b. Modification of the investment cost = Approximate cost of R $ 7,340.00 (pump, pallet truck, rail, etc.) Additional operating cost = $ 0.00, Labour force = $ 0.00; c. Economic benefits - Deposition total cost value of incineration for expenses in improvements in the productive sector, enabling better working environment.	There will be no risk of environmental disposition of produced fluids and lower utilization of water to remove the excess; there will not be the need for incineration therefore will not start gases that cause global warming, acid rain or direct pollution to the human body	No contamination of river reservoirs in the region, as well as groundwater and wells
Utilization of manual pallet truck to transport the drums	Emission of polluting gases into the atmosphere from the factory, as well as high demand for gaseous fuel and corrective maintenance (daily)	a) Pallet truck quotation; b) Training	a. Current Situation Monthly consumption = Data not informed Annual consumption = Data not informed b. Modification of Investment Cost = approximately R$ 3,000.00, additional operating cost = R$ 0.00 Labour force R$ 0.00 c. Economic benefits - Reduction of maintenance breaks rate forklift (increased availability of mechanics to work in other direct machines at production)	Reducing emissions of greenhouse gases	Lower emission of greenhouse gases in the environment, with consequent improvement of the internal and external environment of the factory

Tab. 4. Case study of Cleaner Production

6. Conclusion

The main achievement of this process would be to use the proposed flow chart, following your opportunities, focusing on the training of the operation. Ensuring this process, there are a number of ways how to measure continuous improvement in the use of natural resources (water, for example) and the actual waste disposal process. The next step would "leave the Tube End" and go to minimizing the generation of this waste until then, his generation was inevitable.

Through this project management, the proposed new flowchart should minimize product losses and increase the feasibility of production of all versions of manufactured cleaning products. With this, the company can increase the profit and sales, and improve processes due to the lead time be lower (by always having product). Environmental management will be effective with respect to application of the methodology and proper disposal of waste generated.

The first results show that besides being possible, it should increase good manufacturing practices and an exponential minimizing the direct cost of the finished product.

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