South American Development Society Journal

Vol.: 08, | Nº.: 22 | **Ano:** 2022 | **ISSN:** 2446-5763 | **DOI:** 10.24325/issn.2446-5763.v8i22p395-407
Data de Submissão: 10/03/2022 | **Data de Publicação:** 07/05/2022

REVERSE LOGISTICS OF INDUSTRIAL SOLID WASTE: A CASE STUDY

Carlos dos Santos Cabral – Universidade Santa Cecília (UNISANTA), Santos-SP, Brasil
cabralcarlos@terra.com.br

Aldo Ramos Santos

Abstract

The main objective of this study was to develop a proposal for integrated environmental management of waste from the inputs used in industrial processes in plants / chemical process units that use industrial filtration to separate liquids and / or solids, proposing solutions aimed at transportation storage, handling, use, separation and management plan, as well as a system that represents the state of the art of Reverse Logistics in Brazil, initially applied to filtering inputs and extended to the entire industrial filtration segment; The application and elaboration of a PELR - Strategic Reverse Logistics Plan based on the Environmental Management System is a fundamental point for the success of this strategy aimed at the return to the origin manufacturer of the inputs where the participants have extended responsibility in all stages up to the final consumer. The efficiency of the costs involved is paramount in the application of a Reverse Logistics strategy, where this study makes possible the ways of its absorption and fulfillment of socio-environmental responsibilities.

Keywords: Incineration. Extended Producer responsibity. Reprocessing. PERS - State Solid Waste Policy. PNRS - National Solid Waste Policy.

Introduction

Several solid residues from industrial processes are inserted into the environment, if the correct strategies of use, reuse and disposal are not observed, they become in many cases pollutants.

For industrial solid waste, in addition to those that result from industrial processing, it is worth considering the by-products / inputs used for the industrial activity to take place, where parts and equipment used during the process can be highlighted, as well as filter elements used for the separation of the raw material to be collected through industrial filtration that takes place in food industries, beverages, plants, refineries, among others.

The disposal of filter elements in Brazil still needs a huge advance, and the main factor to consider for the sector in which it was used is that, according to the legislation, the disposal must be carried out by the waste generator, who is also responsible for any damage that improper disposal may cause to the environment. In a practical way, it indicates that it is up to the company that acquires and uses the filter element to dispose of it in accordance with current legislation, which is not always done in an ecologically correct way during the period in which the filter elements characterize or represent an environmental risk.

According to law 9.509/1997, the main objective described in its Article 2 is to guarantee the population and future generations the right to an ecologically balanced environment, where in the VI principle the control and inspection of production, storage, transport, commercialization, use and final destination of substances, is ensured, and thus applying the XVII principle, highlights impositions on the polluter (also included on the user), of penalties and responsibilities attributed to the causes of pollution and environmental degradation; In Section II, where the objectives of the State Environmental Policy are addressed in principle V, the imposition on the polluter of the obligation to recover and/or indemnify the damage caused (SÃO PAULO, 1997).

Examining Table 1 - Amount of solid waste, household and/or public, collected and/or received (t/day), it is possible to verify the form of disposal and places of solid waste in tons/day in 2008, portraying a reality .

Table 1 - Daily amount of solid waste 2008

Daily amount of solid waste, household and/or public, collected and/or received (t/day)									
		Final destination unit for solid waste collected and/or received							
Total calculated at the Brazilian level	Total	leak I give to clear sky (dumping ground)	leak in wing areas or floodable	landfill controlled	landfill Restro-om	Unit in compost from waste organic	Unit in screening of recyclable waste	Unit of treatment by incineration	Other
Total	259 547	45 710	46	40 695	167 636	1 635	3 122	67	636
% intended	100%	17,61%	0,02%	15,68%	64,59%	0,63%	1,20%	0,03%	0,25%

Where

(green) represents the % destined for disposal in ecologically correct locations.

(red) represents the % destined for disposal in ecologically incorrect locations.

Source: adapted from Cabral (2019).

Table 1 Daily amount of solid waste shows in 2008 a percentage of disposal in ecologically incorrect locations in the total of 33.56%, being discarded incorrectly: 17.61% in dumps, 0.02% in flooded or floodable areas, 15.68% in controlled landfills and 0.25% in other areas.

For the disposal of the filter element, that is, without representing an environmental risk, it must occur through the application of a full and skillful Logistics strategy for this operation, which in this case is called Reverse Logistics.

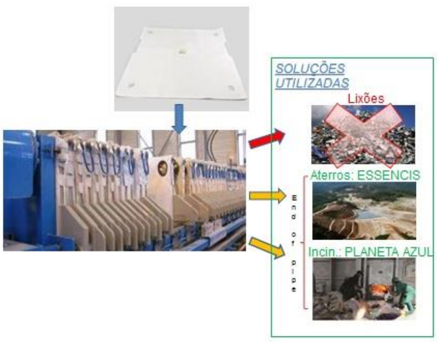

Figure 1 - Types of Descartes.

Source: prepared by the author himself.

As an example applicable to this study, in Mining Companies, Refineries and Power Plants, filter elements are used during the industrial process, which in many cases are discarded by supplier companies or client companies “in an environmentally inappropriate manner”, causing environmental impact from the disposal of these synthetic materials. ; in this case, the return of supplied products that will be used in the industrial process by the Client Company is called Post-Consumption Reverse Logistics, that is, at the end of the useful life of these used products.

Figure 1 exemplifies the types of disposal used in dumps, sanitary landfills and incinerations, which are still applied in an inappropriate way, since the landfill or incineration strategies (RL - Reverse Logistics) represent a cost considered inadequate by the administrators of companies that end up disposing of waste without proper environmental analysis and causes of disposal in the environment.

Figure 1 shows that the solutions used by companies start from dumps (totally incorrect), sanitary landfill, which in most cases eliminates the possibility of reuse of waste ends up becoming impossible since all waste when mixed with several become garbage; Incineration where the "end of pipe" strategy (also applied to sanitary landfill) exemplified in Figure 5 - Incineration and Disposal where Operation LR for hazardous, toxic, ferrous and other products thus starts the Incineration process with application of the end technique of pipe (filtering equipment for the treatment and separation of gas emissions into the atmosphere), disposal for landfill via RSI feeder – incinerated solid waste, separation of ferrous materials that will be reused in steel mills and hazardous waste landfilled.

The PNRS – National Solid Waste Policy provides for the Reverse Logistics of products that are being marketed and/or industrialized, in use and disposal, as seen in Figure 2.

Figure 2 LR - PNRS applications.

Source: adapted from PNRS (BRASÍL, Law 12.305, 08/12/2010).

Analyzing Figure 2, Logistics is applied in a CS following a straight flow that indicates the possession of the product and / or input, starting with the inbound (supply) of the production of inputs and raw materials and later through the outbound process selectively distributes or exclusively for commercialization and thus transferred to the company or final consumer for consumption, where after the end of its useful life it is destined for disposal; according to the PNRS, pre-consumption Reverse Logistics is applied in marketing, where the products to be marketed are inadequate and/or have defects that are harmful to their consumption and/or use.

Post-sales Reverse Logistics is one in which the product supplied when used has defects and returns to the original supplier for replacement or technical assistance, whereas Post-Consumption Reverse Logistics must constitute strategies and operations for ecologically correct disposal of products that end of their useful life, make it possible to return to the point of industrial origin for insertion in a new (ideal) production process or ecologically correct disposal.

The main reference for the existence of this practice is that when a Mining, Refinery and Plant acquires inputs from a supplier of filter elements without contractually applying to this supplier the obligation to assume Reverse Logistics, and thus disregards what it determines and states the PNRS through the EPR - Extended Producer responsibility, defined by the OECD - Organization for economic co-operation and development as an approach to environmental policy in which responsibility, physical the producer's financial or financial value for his product is extended to the post-consumption stage of its life cycle (BRASIL, Law 12.305, 2010).

NOTE: A broader benefits approach to this practice will be highlighted in the case study.

Waste Management is the extended responsibility of the producer, regardless of being in possession of the product, who in partnership with the other members of the CS must constitute a strategic plan for Waste Management as highlighted in the PNRS Article 3, items VII, VIII and IX when of its destination, disposal, generation of solid waste and the mandatory management in item X is defined as a set of actions carried out, directly or indirectly, in the stages of collection, transport, transshipment, treatment and environmentally appropriate final destination of solid waste and disposal environmentally appropriate final disposal of the tailings, in accordance with the municipal plan for the integrated management of solid waste or the solid waste management plan, required under this Law (BRAZIL, Law 12.305, 2010).

Objective

General: Observing the application issues of Reverse Logistics, the study aims to develop a proposal for integrated environmental management of solid waste from inputs used in industrialized processes that make use of filtration to separate liquids and/or solids, proposing solutions aimed at transport, storage, handling, use, separation and handling plan, as well as a system that represents the state of the art of Reverse Logistics in Brazil, initially applied to filtering inputs and extended to the entire industrial filtration segment.

Specifics: From the case study of an industrial input used as a filtering element of an industrialized product.

a. Presentation of post-consumer industrial waste from the industrial filtering tarpaulin input (Figure 3),

b. Analysis of the classification of post-consumer industrial waste in which the input waste is inserted,

c. Quantification / update of the respective class,

d. Methods in which the post consumption Reverse Logistics steps must occur for reuse or recycling, as well as processes that allow the analysis and mitigation of the impacts caused,

e. Presentation of a proposal for Environmental Management of waste from inputs used in industrial processes.

Material and methods

The type of research used is exploratory, where the fields of application currently practiced in the management of industrial waste (inputs of filtering elements) highlighted in the specific objectives were identified.

For industrial filtration, the active companies use inputs made of synthetic fabric for rotary filters, belt filters, press filters, among others; the solid residue applied as a reference for this research is found after consumption of the industrial filtering canvas used in filter presses, as shown in Figure 3.

Figure 3 - Double Canvas Filter Press.

Source: prepared by the author himself.

The double canvas input (industrial filtering element) shown in Figure 3, which results in the post-consumer industrial waste, is made of polypropylene purchased by the Plant, Refinery, Mining and/or industrialized processes, normally aimed at meeting the greater need and productivity of the company, where many In these cases, it is sought to separate the water from the clay (Mineradoras), where the clay cake produced between the plates during the pressing process will be discarded, and the water reused in the industrial process.

The post-consumer industrial solid waste object of this study results from the disposal of the filter element (Figure 3) made of PP - Polypropylene yarn, which has dimensions of 1660x1660mm, and approximate weight of 3.1kg; PP - Polypropylene yarn is a synthetic thermoplastic polymer obtained through polymerization reactions of simple molecules called monomers; synthetic fibers are manufactured in laboratories synthesized from petroleum, mineral coal, among others.

This industrial raw material is made of PP - Polypropylene monofilament yarn (single yarn), due to its main characteristics of high resistance to acids, because even in the face of a filtering work where the pH is zero, it does not undergo any physical chemical change and its resistance to acid is considered excellent, but on the other hand, its resistance to temperature is not very high, being indicated to work in environments with a maximum temperature of 60ºC, where above this temperature the PP begins to harden and due to rigidity it loses its usability. and filtering.

Another important detail of this industrial input made of PP is that it cannot work exposed to the sun because the ultra violet rays quickly rot the fiber, resulting in it falling apart; an alternative for resistance to temperature and/or sun would be to use a filter element made of PA yarn – Polyamide that resists working in temperatures up to 120ºC, but this fiber has the fragility not being able to work in acidic environments, being indicated for environments of work that have a neutral or alkaline pH (LOKENSGARD, 2013).

The filter element is installed in a membrane-type filtering plate (flexible central part) also made of PP – Polypropylene and used in a filter press.

It is important to note that the PNRS in its art. 31 provides, through the EPR - Extended Producer Responsibility, justifying the responsibility of industries in the control of their solid waste, which includes the inputs used for their industrial process; Thus, a close relationship is established between industries and the polluter pays principle, which should bear directly the costs attributed to the impact related to the use of the natural resource highlighted in the topic Transfer of responsibility from the municipality to the private sector.

Table 2 shows the Generation of industrial solid waste in Brazil (ABRELPE 2003), in the main Brazilian states.

Table 2 - Generation of Industrial Solid Waste in Brazil

ESTADO	CLASSE I	CLASSE II	CLASSE III	TOTAL
São Paulo [1]	535.615	25.038.167	1.045.895	26.619.677
Rio de Janeiro [2]	293.953	5.768.552*		6.062.515
R.Grande do Sul [3]	205.326	1.404.732	25.632	1.835.890
Paraná [4]	634.543	15.106.393*		15.740.936
Pernambuco [5]	12.622	1.325.791	4.071	1.342.483
Goiás [6]	4.405	1.488.989*		1.491.374
TOTAL	**1.686.464**	**50.130.614**	**1.075.598**	**52.892.675**

[1] CETESB. Inventário de Resíduos Estaduais. 1995 Universo da amostra 1.432 indústrias.
[2] FEEMA. Relatório de Atividades do Projeto de Controle Ambiental. Setembro 2000. Dados Originais referentes à geração mensal de resíduos no período de 1996-2000. Geração de resíduos: 505.209,66 t/mês: Geração de resíduos classe I: 24.496,11 t/mês
[3] FEPAM. Relatório sobre a geração de resíduos sólidos industriais na Região Hidrográfica do Guaqiba. Agosto 2002. Os dados são do ano 2000 e referentes a 9.341 industrias da região.
4 IAP. Inventário Estadual dos Resíduos Sólidos Industriais - Diagnóstico, dezembro 2002. Universo da Amostra. 683 industrias
5 CPRH-GTZ. Inventário de Resíduos Sólidos Industriais 2001. Universo da amostra: 100 industrias.
6 Agência Ambiental. In: Resol - Notícias, 18 de janeiro de 2003 (www.resol.com.br). Os dados apresentados são parciais e cobrem um universo de 75 indústrias.
* Resíduos classes II e III

Source: adapted from Abrelpe (2003).

Through Table 2, it was observed that the State of São Paulo, according to data collected by Cetesb in this Table compiled by Abrelpe (2003), through the Waste Inventory and with a universe of 1432 industries, has a total of 26,619,677 ton/year, corresponding to 50.33% of the compiled total of 52,892,675 ton/year, thus becomes the object of a comparative and progressive analysis for this study.

For the characterization of this article, a study and sampling of the industrial residue was used, coming from the input, which is a filter cloth made for a filter press in PP - Polypropylene wire, intended for liquid filtration and previously detached.

The production process of this fiber, because it is complex, brings some environmental concerns; some producers use crude oil to isolate the polymers, which can lead to a depletion of fossil fuels and/or cause environmental pollution by the runoff of this fuel.

The chemical production of adipic acid used in the industrialization of this synthetic fiber also frequently creates nitrous oxide, classified by NBR 10004/2004 in Annex C - Substances that make waste hazardous with the identification code P078 and CAS - Chemical Abstract Substance with the code of identification 10102-44-0, a greenhouse gas, which has the potential to erode the ozone layer and promote smog; nitrous oxide is also classified in Annex D – Acutely toxic substances (ABNT-NBR10004/2004, 2004).

The Resin Identification Code System, SPI – Plastic Container Coding System, which served as the basis for the ABNT NBR ISO13.230/2014 standard that deals with the “Symbology indicative of recyclability and identification of plastic materials” where the six materials identified by each symbol is the plastics that predominate in the market; in the specific case, PP – Polypropylene receives the symbol (ABNT – NBR ISO13230/2014, 2014). NOTE: The presence of the resin identification symbol facilitates separation and recycling, thus allowing it not to compromise the quality of other recycling chains.

As highlighted by NBR 10004/2004, this input is considered a solid industrial waste, where in chapter 3, item 3.1 solid waste, as it results from activities of industrial origin and cannot be discarded without observing the technical and economic solutions that are viable and with the best technology possible.

In item 3.2 letter b, it is noted that this input can cause risk to the environment if proper management is not carried out.

In item 3.3 referring to toxicity in line with item 3.2 letter b, if adequate management is not carried out and as this input is made of PP, it cannot be exposed to the sun because the ultra violet rays quickly rot the fiber resulting in it falling apart and when burnt, presents toxicity and the greenhouse gas, nitrous oxide, classified by NBR 10004/2004 in Annex C - Substances that make waste hazardous with identification code P078 and CAS - Chemical Abstract Substance with identification code 10102-44 -0, are hazardous (ABNT – NBR ISO10004/2004).

In item 3.4 toxic agent, this input, if it does not have a process of cleaning the weather and or filtered products, may, together with its degradation, if incorrectly deposited in the environment, add the toxicity of nitrous gas to the product, for example, if the filter element is used to filter precipitated silica that occurs in chemical plants, to precipitate together during its degradation the precipitated silica in the environment.

Precipitated silica, a synthetic product basically obtained through the process of the reaction between sodium silicate and sulfuric acid, obtaining a product with high purity and finesse, white in color, very fine, low apparent density, high surface area and with great ability to adsorb liquids (LOKENSGARD, 2013).

Precipitated silica has its main applications in agribusiness, the food industry, rubber manufacturing, ceramic manufacturing, in household cleaning products, which are substances or preparations intended for cleaning, disinfection or disinfestation at home and in water treatment, subdivided into four groups: cleaning products (detergents, dishwashers, coconut soap...), those with antimicrobial action (such as disinfectants, sterilants, deodorants used in different environments), disinfestants (raticides or insecticides, for example) and products household biologicals (such as those used to remove organic matter from grease traps).

It also includes those employed in hospitals or clinics, both for surfaces (cleaning the floor, walls...) and for medical and dental instruments and articles, in the pharmaceutical industry, chemical industry, paint manufacturers, among others (LOKENSGARD, 2013).

In the process, the precipitated silica is composed of sodium silicate and sulfuric acid.

a. Sodium silicate is a white solid soluble in water, thus producing an alkaline solution, it is stable in neutral and alkaline solutions, it has the molecular formula Na_2SiO_3 (GAUTO and ROSA, 2011).
b. Sulfuric acid is an aqueous solution of hydrogen sulfate, whose formula is H_2SO_4 ; like all acidic substances it has its solubility in water and forms hydrogen, H^+, or more correctly the hydronium cation as the only cation,

   Sulfuric acid has a very high degree of ionization ($\alpha = 61\%$), thus indicating that it is a strong and corrosive acid; Due to its very strong oxidizing and dehydrating power, it is able to carbonize organic compounds, such as carbohydrates (or carbohydrates).

   Sulfuric acid has a corrosive action on the tissues of living organisms and can cause severe burns when in contact with the skin; sulfuric acid is a colorless liquid, has a density equal to 1.84 g/cm3 and is viscous, in addition to being a fixed acid, since its boiling point is equal to 340ºC, which means that, under ambient conditions, it goes from very slowly to the vapor state. Important: inhalation of sulfuric acid vapors can cause loss of consciousness and serious lung problems (GAUTO and ROSA, 2011).

Regarding the composition of the filter element characterized in this study, the NBR ISO10004/2004 in Annex C Substances that offer hazardous waste indicates that the Propene used in the manufacture of the yarn for making the filter element has an Identification Code U243, CAS - Chemical Abstract Substance 1888-71-7, and in Annex E for toxic substances it is related to the same coding, thus justifying the necessary attention to the Waste Management Strategy described in this item to control this input and in particular to Post Consumption Reverse Logistics (ABNT – NBR ISO10004/2004, 2004).

In chapter 4 of NBR ISO10004/2004, which portrays the Waste Classification Process, indicates that the waste must be characterized and classified from the identification of its constitution, which is established from the raw material used in its manufacture, inputs applied, origin process and/or subsequently added to its application in the new production process in which the input is inserted.

Item 4.1 portrays the classification report where it can be based exclusively on the production process with the use of annexes A and B, including the classification report, origin of the waste, description of the segregation process and description of the criteria adopted in the classification.

According to NBR ISO10004/2004, the classification of solid waste must occur observing the following flowchart characterized in Figure 4 Flowchart - Characterization and classification of waste.

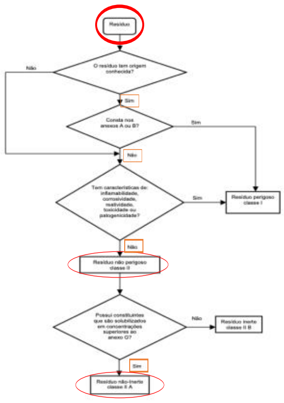

Figure 4 - Flowchart Figure - Characterization and classification of waste

Source adapted from NBR 10004/2004 (2004).

In this way, when analyzing the filter element after its useful life, and complying with the classification flowchart of this solid waste when discarded, it presents due to propylene with the identification code U243, CAS - Chemical Abstract Substance 1888-71-7 used in the wire of PP, basis of the textile manufacturing process, hazardous aspects due to flammability and hazardousness through the toxicity of the greenhouse gas resulting from nitrous oxide, when exposed to temperatures above 165ºC or improperly burned when discarded, with identification code P078 and CAS - Chemical Abstract Substance with identification code 10102-44-0, listed in NBR ISO10004/2004, where due to the biodegradability and combustibility characteristics related to the raw material used in its industrialization, it is classified as a Class II non-hazardous waste A – non-inert, confirmation made through evidence as provided for in NBR 10004/2004 (2004, p. 5).

- 4.2 Waste classification: b) Class II A waste - non-inert,
- 4.2.2. Class II waste - non-hazardous,
- 4.2.2.1. Class II A waste - Non-inert,

Those that do not fit into the classifications of class I waste - Hazardous or class II waste B - Inert. Class II A waste – Non-inert may have properties such as biodegradability, combustibility or water solubility.

NOTE: It is important to emphasize that even the composition of this waste is Class II A - non-inert, this classification would be directly changed if filtered by-products were impregnated during the filtering operation that are included in the provisions of topics 4.2.1 - Class I hazardous waste that as defined in topic 3.2 of said standard or even described in 4.2.1.1 to 4.2.1.5.

After classifying the industrial waste class II, it is comparatively verified through tab. 4 that class II waste corresponds to a total of 50m t/month, and the State of São Paulo is responsible for 25m t/month, fully justifying the management strategy of this solid waste, since it alone corresponds to 94.06% of the total amount of waste produced by the State of São Paulo, in addition to being the highest when compared individually with all other classes (I and III).

Reverse Logistics Steps

The process of industrial filtration of precipitated Silica using the double canvas shown in Figure 3 in the dimensions of 1660x1660mm with an approximate weight of 3.1kg, takes place in an equipment called a Filter press containing 144 membrane plates.

The saturation durability of the filter element in this work environment can vary from 30 to 90 days (detected mainly by the passage of solid material together with water), depending on the number of daily production cycles, where the filter element must be replaced.

Thus, at each replacement of the set of filter elements (Figure 3) in a filter press with 144 plates, considering the weight of 3.1 kg of each filter element installed on each plate, we will have a total solid waste of 446.4 kg of solid waste to be discarded.

In a normal process of filtering in a Plant, these filtering elements after disposal by time of use are sent to a yard destined to the storage of this solid residue that will be removed by a third company that carries out the disposal according to the specific contract for this activity.

Questionable points indicators for the disposal of solid waste using PELR - LR Strategic Plan

a. Does the discarded solid waste contain leftovers from the filtered raw material?
b. Can these leftovers of filtered raw material, when transported, contaminate the environment?
c. What is the purpose of hiring a third-party company to dispose of this solid waste
    i. Just vacate the scrap yard?
    ii. Simple disposal in dumps?
    iii. Environmentally correct disposal as determined by the PNRS - National Solid Waste Policy? If yes
        a. Does the contracted company need to have certifications and/or documentation that identify the correctly ecological disposal and destination for this solid waste?

NOTE: If in any of these initial points highlighted above the answer obtained is yes, a Strategic Plan of LR - Reverse Logistics, applied to Disposal and Ecologically correct destination and Environmental Management must be applied.

Proposal for integrated environmental management of solid waste

Regarding solid waste management and Integrated Solid Waste Management, Pereira apud Günther (2018), indicates that it is necessary to differentiate the concepts presented to

a. solid waste management, which identifies a sequence of operational steps starting with the generation of solid waste until its final disposal and which involves its packaging, collection, transport, transfer or transshipment, processing and final disposal (environmentally ecological disposal in the soil) ,

b. integrated management of solid waste, which deals with a new paradigm conception for the approach of solid waste, having by definition an interrelation of normative actions, operational actions, financial actions, planning, administrative actions, social and educational actions, monitoring, supervision and evaluation for the effective management of solid waste, aiming to respond to the needs of each location (region), in order to obtain socio-environmental benefits, optimized economic conditions and conditions of social acceptance.

The objective of Environmental Management, as presented in NBR ISO14001/2015 item 0.2, is to provide the organizations integrated in it with a structure that aims to protect the environment, making it possible to respond to changes related to environmental conditions and the socioeconomic needs that arise, providing organizations to achieve the defined and intended results for their Environmental Management system, being able to provide the information that provides the achievement of long-term success and that creates alternative conditions for their sustainable development, through

a. protection of the environment through prevention or mitigation of various environmental impacts, mitigation of potential adverse effects of environmental conditions in the organization,
b. assist the organization in meeting legal and/or miscellaneous requirements, increase the organization's performance, control and/or influence the way in which an organization designs, manufactures, distributes, consumes and disposes of its products, based on the life cycle of them in order to prevent their unintended impacts,
c. enable the organization to achieve the financial and operational benefits resulting from the implementation of environmental alternatives justifying its position in the market,
d. communicate environmental information to stakeholders (interested parties).

The Environmental Management System, through NBR ISO14001/2015 in item 5.2, determines that the Senior Management establish, implement and maintain an Environmental Management Policy within the scope defined for its Environmental Management System, established at least by the participating participants with the commitments and goals in the following way

a. “The Usina... provides products and solutions for diversified markets, including automotive, electronics, flavors and fragrances, health, personal and home care, consumer goods and industry, through its GBU's (Global Business Units), with awareness of the need to reduce

- the generation of hazardous waste,
- to reduce its effluents.
- Have in their business plans the reduction of the Consumption of Natural Resources, so that future generations can enjoy them in the same way as we do today.

a. The company is committed to Continuous Improvement and Pollution Prevention,
b. It is also committed to complying with applicable environmental requirements, both from environmental legislation and those to which our company subscribes.
c. It establishes Environmental Objectives and Goals with goals with the objective of contributing to the improvement of the Environment, to which our business partners must be fully and demonstrably certified”.

The Environmental Management System determines in item 3.4.5 continuous improvement and is based on the methodology concept of the PDCA cycle - Plan, Do, Check and Act - Plan, Do, Check, Action, thus providing an iterative process of Kaizen - improvement to be continued

PDCA vs Environmental Management Cycle determines the topics to be considered in the PDCA Cycle within the Organization's Context, examining internal and external issues as well as the Needs and expectations of stakeholders (stakeholders), ascertaining and analyzing the intended results in the Environmental Management system (NBR ISO14001/2015 (2015); The PDCA Measurement - Rotation Cycle identifies that at each standard established by the PDCA and after its execution, the plan must be measured (rotate the PDCA) and apply specific methods for the continuous improvement of the system creating a new standard for PDCA.

The application in Environmental Management of the specific PDCA that will integrate the Environmental Management system will have the following methodological application in its systemic approach.

a. *Plan*

- • PELR - Strategic Plan for LR-Reverse Logistics, which highlights the goal and method applicable by the Members: Plant, Input Supplier, Company Responsible for Ecologically Correct Destination.

b. *Do*

- Execution of the steps described in the PELR by the Members: Plant, Input Supplier, Company Responsible for Ecologically Correct Destination.

c. *Check*

- monitoring and measurement of processes in relation to the applied environmental policy.

d. *Action*

- take actions for continuous improvement.

Within this context, the PELR - LR Strategic Plan applied to the Ecologically Correct Disposal through the Integrated Environmental Management of Waste presented in the PDCA PELR cycle, will imply the integrated action of the Plant, Filtering Element Input Supplier, Company Responsible for ecologically correct disposal and destination and other members of this reverse flow, where each of the participating Companies must include in its Environmental Management System as normative actions interrelated with the Integrated Management of Solid Waste, which will start from the supply of the input filter element until the final destination for reinsertion into another production process or ecologically correct disposal and disposal.

PELR - LR Strategic Plan, Stages

The LR Strategic Plan (PELR) must be carried out based on the following steps: Contracting a supplier, Supply Scheduling, Service Schedule/Schedule, Equipment to be made available, Hiring an outsourced company, Transport, Acquisition of the Filter Element

LR Operation - Reverse Logistics - Post Consumption

Reverse Logistics - Post Consumption: Operation of separation, sending for recycling of solid waste, recycling and ecological disposal:

A. Opening of Bags and removal of solid waste destined for post consumption LR.

B. Separation of post-consumer solid waste.

See Table 3 with individual statement of recyclable and/or disposal inputs.

Table 3 - Recyclable Inputs and For Incineration

▪Inputs: PP fiber – Polypropylene > destination Extrusion for Recycling...2,800 kg
▪Binding Sleeves: PP fiber – Polypropylene > destination Extrusion for Recycling.........................0,120 kg
▪Labels: nonwoven > incineration and disposal destination………..0,005kg
▪Velcro: PA – Polyamide>incineration and disposal destination..0,010kg
▪Line: PP – Multifilament Polypropylene > destination Extrusion for Recycling...............................0,100kg
▪Buttons: PP – Polypropylene, non-thermosetting > incineration and disposal destination.............0,065kg

Source: prepared by the author himself.

Figure 5 - Incineration and Disposal complements the approach initially presented for Incineration, it represents the operation that must be carried out by the Supplier of the input, responsible for the solid waste or by an Outsourced company contracted in the post consumption LR Operation, thus starting the Incineration process with application of the end of pipe technique (filtering equipment for the treatment and separation of gas emissions into the atmosphere), destination for landfill via conveyor type feeder of the RSI – Industrial Solid Waste, separation of ferrous materials that will be reused in steel mills and hazardous waste landfilled.

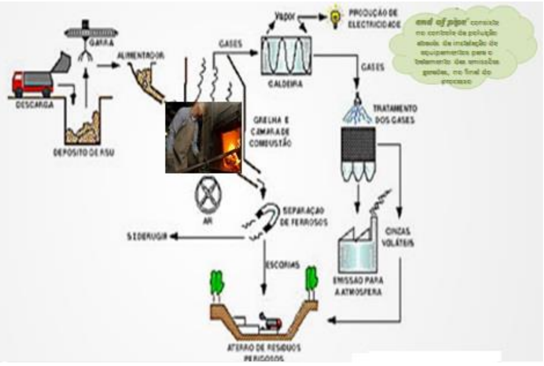

Figure 5 - Incineration and Disposal

Source: prepared by the author himself.

Figure 6 demonstrates the Post-Consumption Reverse Logistics Operation Flowchart in a didactic, visual and practical way for the activities intended for the PELR.

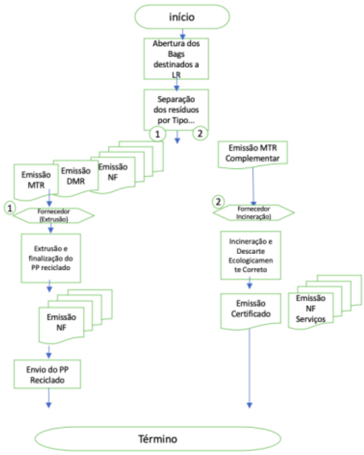

Figure 6 - Figure of the Reverse Logistics Operation Flowchart

Source: prepared by the author himself.

Results

Based on the data shown in Table 2, the State of São Paulo through the Waste Inventory and with a universe of 1432 industries has a total of 26,619,677 ton/year, corresponding to 50.33% of the compiled total of 52,892,675 ton/year , thus becomes the object of comparative and progressive analysis for this study.

Thus, the classification of the input (filtering element) listed and analyzed as class II residue and comparatively analyzed with the corresponding data in Table 2 that class II residues correspond to a total of 50m t/month, with the State of São Paulo responsible for 25 million t/month, fully justifying the management strategy of this solid waste, where alone it corresponds to 94.06% of the total waste produced by the State of São Paulo, in addition to being the highest when compared individually with all other classes (I and III).

The LR Operation - Post Consumption Reverse Logistics of inputs (filtering element) through the data presented in item b and duly portrayed in Table 3 quantifying the Recyclable Inputs and for incineration clearly demonstrate that the failure to carry out this Environmental Management may cause an environmental impact by the contaminants described in the input analysis.

When analyzing the isolated condition in this single manufacturing plant, as it has two press filters in this same configuration, we will have an amount of 869.76 kg of inputs returned to the environment and 0.160 kg of ecologically correct incinerated and discarded/landed materials every 90 days.

Also using the data shown in Table 3, each input (filtering element) with the application of the proposed PELR will constitute the following amounts of solid waste

a. 3,020 kg destined for extrusion – recycling.

b. 0.080kg destined for incineration and ecological disposal/landfill.

Table 4 below makes a progressive projection with the above data in relation to the PELR per Solid Residue in input unit (filtering element).

Table 4 - Solid Waste Input from the Filter Element

insumo (elemento filtrante)					
LR: extrusion and recycling for second process (kg)	disposal/incineration (kg)	quantity tarpaulins per filter press	quantity Filters in this manufacturing plant	**Total LR: recycling every 90 days (kg)**	**total disposal/incineration/landfill every 90 days (kg)**
3,02	0,08	150,00	2,00	**453,00**	**12,00**

Source: prepared by the author himself.

It is observed that in each stage of the PELR (90 days) the total recycling for the second processing will be 453kg and the total disposal/incineration/landfill will be 12kg.

Table 5 provides a comparative analysis of Solid Waste input (filtering element) with Class II SP waste.

Table 5 - Projection according to Table 3 Solid Waste Generation in Brazil

projection according to Table 3 Generation of Industrial Solid Waste in Brazil								
amount Industries Table 2	amount of Canvas on average per filter press in SP	average of filters per industry in SP	**Total LR: recycling (kg)**	**total disposal/ incineration/ landfill (kg)**	**Class II SP waste (t/month)**	**% achieved with PELR recycling SP**	**% achieved with PELR disposal/incineration/landfill SP**	**Total %**
1.432,00	100,00	2,00	**864.928,00**	**22.912,00**	**25.038.167,00**	**0,001151%**	**0,00003%**	**0,001182%**

Source: prepared by the author himself.

Projecting in this Table 5 the amounts calculated through the PELR (Table 4) with the data from Table 2 that records in the state of São Paulo the Class II solid waste discarded by 1432 industries, we will have a total of 864.92t, 0.001151% of a total of 25,038,167t/month in solid waste totally reintegrated to the second production process and 22.9t, 0.00003% in solid waste that could not be reintegrated in another production stage and that had an ecologically correct disposal/incineration/landfill.

Table 6 below makes a comparison and projection with the solid waste collected publicly in the Brazilian territory.

Table 6 – Projection according to Table 1 publicly collected solid waste in Brazil

incorrect disposal in t/day						**projection according to Table 1 solid waste collected publicly in Brazil**				
Open pit (dump)	Spillway in flooded areas	controlled landfill	others	**total day**	**total in 90 days**	**Total LR: recycling (kg)**	**total disposal/incineration/landfill (kg)**	**% achieved with PELR base recycling only in SP**	**% achieved with PELR disposal/incineration/ base landfill in SP only**	**Total %**
45.710	46	40.695	636	**87.087**	**7.837.830**	**864.928**	**22.912**	**0,00368%**	**0,000883%**	**0,00456%**

Where:

represents the % destined for disposal in ecologically incorrect locations

Source: prepared by the author himself.

Table 6 highlights the quantities researched in Table 1, which depicts household and public solid waste collected and/or received daily in Brazilian municipalities.

The purpose of this comparison and projection of values is precisely due to the amount of incorrect discards presented through Table 1, where it is relevant since there is no implementation of an Environmental Management System with the PELR strategy addressed in this study, so almost directly the companies involved in the capture of this waste because they do not find possibilities that do not represent high disposal costs, such as those of "incineration" end up disposing of this waste incorrectly in informal companies known as "junk iron" that do not find application for sale. in the recycling market, they eventually dispose of these residues in the areas highlighted in red.

Discussion

Projecting in this Table 6 the amounts calculated through the PELR (Table 4) with the data from Table 1 that records publicly collected solid waste in the Brazilian territory, we will have a total of 7,837,830t/trim in publicly collected solid waste, which will be applied proportionally to the total Total LR recycling calculated through Table 5 will represent a percentage of 0.00368% in Class II solid waste and a percentage of 0.000083% in solid waste that will be destined for disposal/incineration/landfill with ecologically correct destination, will total a percentage of 0.00456% of the total incorrectly discarded in 90 days.

A comparative analysis between the total percentage of solid waste discarded by industries in São Paulo versus the total percentage of solid waste publicly collected in the Brazilian territory reveals that the percentage gain by the application of the PELR strategy will reach a result of 385.7868%, through the calculation of the following Equation: 0.00456 / 0.001182% (total%tab7 / total%tab6).

The results obtained through the analysis of the data shown in Tables 5, 6 and 7 demonstrate and corroborate the determinant in the PNRS and PERS attributed through the EPR - Extended Producer Responsibility and Shared Responsibility that waste industrial solids coming not only from industrial leftovers must have strategic treatment for their ecological disposal, but also the inputs used in industrial processes must be treated equally responsibly; the total values of 25,038,167t/month in class II industrial solid waste only in the state of São Paulo and the 87,087t/day of incorrect disposal collected publicly reiterate this urgent need for a strategic approach to be implemented.

In this study, the input filter element highlighted in Figure 3 - Double Canvas Filter Press was used, and from the analysis, verification, verification and quantitative calculation through this productive input, a fragility was demonstrated in what involves the disposal of said productive input.

The calculation of the percentages shown in Tables 6 and 7 justify the need for the PELR composed of several stages that was fully highlighted in the development of this work, where its non-application indicates an incorrect disposal in the order of 1.86t/year (465kg inputs 8 x 4 quarters) only of the input highlighted in Figure 3 in a single Industrial Park - Plant and which, having its scenario expanded to 1432 industries in the state of SP alone, represent a total of 3,459.712t/year of discarded waste, (1432 industries x 3 .02kg x 100 double plies on average x 2 filters x 4 quarters), justify the implemented PELR.

The detailed study of the PNRS and the PERS determine shared obligations by the participants of the productive and commercial chain of diverse products, mainly with regard to inputs used in industrialization, which, despite being pioneers in Brazil and in the State of São Paulo, reveal the non-compliance with the application of strategic approaches.

The relevance of the Strategies listed in this study through the PELR jointly deals with the paradox between the garbage that we find daily in houses, streets, deposits and places destined with the approaches used in these Strategies so that solid waste from inputs that are incorrectly discarded does not become tomorrow the garbage we will find.

In this way, instead of the endless activity of collecting the garbage discarded by the frenetic and daily consumption, we act directly at one of the starting points of this chain of garbage generation and consumption of our increasingly scarce natural resources destined for human survival.

The industrial input and respective industrial waste dissected in this study represents a small proportion of as many other inputs that, if approached technically, will bring the correct adjustment initiated by the PPP - Polluter pays principle, reversing the values that only represent an authorization to pay to pollute for a quality of a better life for all, where those responsible for environmental degradation related to the need for consumption can responsibly treat our resources.

Conclusions

It is concluded that the solid waste presented in this case study resulting from the inputs of filter elements used in industrial processes needs greater attention regarding mandatory compliance with the provisions of the PNRS and PERS through the EPR - responsibility extended to all participants in the various stages that involve acquisition, transformation, commercialization and correct destination at the beginning of a new industrial process and/or ecological disposal.

It presents, in addition to the evident conditions of environmental pollution in dumps and other inappropriate places, the inconsequential wear of natural resources because the solid waste studied here can and should be inserted into a new production cycle, saving resources and minimizing the environmental impacts of waste disposal. toxic products that often accompany industrial inputs, polluting and contaminating natural water sources and due to toxicity proliferating diseases that are often irreversible for humans.

The PELR listed in this study through its Stages that involve the Hiring of a supplier of industrial input filter element, Supply and assembly schedule, Schedule for removal and assembly of new filter elements in accordance with a strict supply schedule, which also stands out the Post-Consumption Reverse Logistics Operation, aiming instead of an improper disposal for the input, the reintegration of this raw material in a second production process occurs, thus providing the saving of fossil resources from the raw material used in the manufacture of the polymers used in this intended input industrial filtration.

Recycled PP material from industrial inputs designed through PELR are used for the following manufactures

a. in the manufacture of ecological blocks for the manufacture of popular houses in the proportion from 10 to 70% of the mass; other variations can also be used in the mixture used in masonry floors.

b. plastic composites used in the manufacture of railway sleepers, planks, beams and columns for the manufacture of ecological furniture and support structures for roofs that require high resistance.
c. in the manufacture of plastic boxes for the manufacture of composters.
d. manufacture of injectable toys for playgrounds and public leisure areas.
e. manufacture of various rigid packaging for the transport of non-toxic products.
f. injection of model parts in the manufacture of molds and/or mechanical parts intended for casting.
g. among others.

Referências bibliográficas

1. ABNT – Associação Brasileira de Normas Técnicas. **NBR9001 - Sistemas de gestão da qualidade — Requisitos.** Rio de Janeiro, RJ, p. 1-32, 2015.
2. ABNT – Associação Brasileira de Normas Técnicas. **NBR10004 - Resíduos sólidos – Classificação**. Rio de Janeiro, RJ, p.1- 71, 2004.
3. ABNT – Associação Brasileira de Normas Técnicas. **NBR14001 - Sistemas de gestão ambiental — Requisitos com orientações para uso.** Rio de Janeiro, RJ, p. 1-41, 2015.
4. ABNT – Associação Brasileira de Normas Técnicas. **NBR26000 - Diretrizes sobre responsabilidade social.** Rio de Janeiro, RJ, p. 1-110, 2010.
5. ABRELPE – Associação Brasileira de Empresas de Limpeza Pública e Resíduos Industriais. **Estimativas dos custos para viabilizar a universalização da destinação adequada de resíduos sólidos no Brasil.** São Paulo, SP, p 1-94, Junho 2015. Disponível em: www.abrelpe.org.br. Acessado em agosto de 2019.
6. ABRELPE - ASSOCIAÇÃO BRASILEIRA DE RESÍDUOS ESPECIAIS E LIMPEZA. **Panorama dos Resíduos Sólidos no Brasil**. São Paulo, SP, pg 1-65, 2003. Disponível em: www.abrelpe.org.br. Acessado em agosto de 2019.
7. BRASIL. PORTARIA Nº 280, 29 de Junho de 2020. **MTR Manifesto de Transporte de Resíduos.** Diário Oficial da União de 30/06/2020, Edição 123, Seção 1, p 95, 2020.
8. BRASIL. Ministério do Meio Ambiente, Conselho Nacional do Meio ambiente. **Resolução Conama nº 452, de 02 de julho de 2012**. p 6, 2012.
9. BRASIL. LEI 12.305, 12 de agosto de 2010. **Política Nacional de Resíduos Sólidos**, altera a Lei no. 9.605, de 12 de fevereiro de 1998 e dá outras providên-

cias. Disponível em http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm acesso em 01/01/2021.

10. BUHRER, Nilton E. **Química e Tecnologia dos Plásticos.** 2. Edição Curitiba, Paraná. Universidade Federal do Paraná. 1966. (Monografia Didática n.º 5) p.1 a 128.
11. CABRAL, Carlos dos Santos. **Aterros Sanitários, controlados e lixões, uma análise da realidade brasileira, retrospecto e evolução a partir da Lei 12.305/10**. (Artigo Acadêmico, VII ENPG - Encontro Nacional de Pós Graduação 08, 09 de novembro de 2019). Universidade Santa Cecília, Santos, SP. 2019.
12. CABRAL, Carlos dos Santos. **Gestão da Cadeia de Suprimentos**. (Caderno didático: Unidade Logística e o Sistema Produtivo). MBA Supply Chain e Logística Integrada - EAD - Universidade Cruzeiro do Sul, Cruzeiro do Sul Educacional - São Paulo, SP, 2019.
13. CABRAL, Carlos dos Santos. **Gestão da Cadeia de Suprimentos**. (Caderno didático: Unidade Criando Valor ao Cliente através da Supply Chain Management). MBA Supply Chain e Logística Integrada - EAD - Universidade Cruzeiro do Sul, Cruzeiro do Sul Educacional - São Paulo, SP, 2019.
14. CABRAL, Carlos dos Santos. **Integração Logística Na Cadeia De Suprimentos**. Sociedade Educacional das Artes - SP. 1. ed. , 2013, 241 p. ISBN 978-85-67379-14-2.
15. CABRAL, Carlos dos Santos. **Logística reversa de resíduos sólidos industriais: estudo de caso**. **(**Dissertação de Mestrado da Unisanta, Universidade Santa Cecília. Santos, SP, 2021).
16. CONSELHO REGIONAL DE QUIMICA IV REGIÃO SP – **Propriedades do Polipropileno**. disponível em: https://www.crq4.org.br/. Acesso em 24 nov.2019.
17. FRACAROLLI e BALZAN. **Filtro-Prensa De Viga Lateral/Automático/Para Tratamento De Lodo - Fb Series**. Disponível em: https://www.directindustry.com/pt/prod/fraccaroli-balzan-spa-62900.html#product-item_449865. Acesso do vídeo em 25/02/2020 12:00h.
18. GAUTO, Marcelo Antunes; ROSA, Ricardo Gilber. **Processos e Operações Unitárias na Indústria Química. Rio de Janeiro:** Editora Ciência Moderna, 2011. ISBN: 978-85-399-0016-9.
19. IBGE. **Manejo de Resíduos Sólidos**. Tabela 93, Disponível em: https://www.ibge.gov.br/estatisticas/multidominio/meio-ambiente/9073-pesquisa-

nacional-de-saneamento-basico.html?=et=resultados. Acesso em 28/09/2019 21h.

20. LOKENSGARD, Erik. **Plásticos Industriais, teoria e Aplicações. São Paulo: Cengage Lerning,** 2013. ISBN: 978-85-221-1187-9.
21. PEREIRA, Raissa Silva de Carvalho. **Logística reversa de resíduos de equipamentos elétricos e eletrônicos: proposta de indicadores de monitoramento para órgãos ambientais.** (Dissertação de Mestrado em Ciências da USP Universidade de São Paulo). São Paulo, SP. 2018.
22. SAI – Social Accountability International. **Responsabilidade Social 8000, Norma Internacional: SA8000**. New York, USA. 2014.
23. SANTOS, Carmenlucia. **Prevenção à poluição industrial: identificação de oportunidades, análise dos benefícios e barreiras. (**Tese de Doutorado da Escola de Engenharia de São Carlos) - Universidade de São Paulo. São Carlos, SP, 2005.
24. SÃO PAULO. LEI 12.300, 16 de março de 2006. Lei nº 9.509, de 20 de março de 1997. Institui **Política Estadual do Meio Ambiente**. Diário Oficial de 21-3-97 Seção IV, Artigo 13. PL 53/92. São Paulo: Palácio dos Bandeirantes, 1997.