Eucalyptus Online Book & Newsletter

ECO-EFFICIENCY AND CLEANER PRODUCTION FOR THE EUCALYPTUS PULP AND PAPER INDUSTRY

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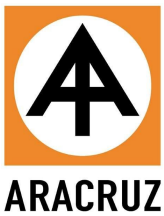

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INTRODUCTION

I do not have, in this chapter of the **Eucalyptus Online Book**, the purpose of offering you an exhaustive treatise on eco-efficiency and cleaner production (CP) for pulp and paper manufacturing. To enable you to read much about these concepts, I made available numerous pieces of literature, most of which can be downloaded to your computer, as they are classics of the virtual literature. They are very good reading references for someone not yet well-acquainted with these entrepreneurial environmental management tools. On the other hand, I will include in the chapter several points of view which make me delighted with the CP and eco-efficiency concepts and practices. I am now working for about ten years on CP program implementation at pulp and paper mills, as well as in the forest area. Even in my other technological consulting works, I always focus on the CP and eco-efficiency fundamentals, which consist in the better use of the resources that Nature offers to the mills and to the human beings running those mills. I always try to apply the old and wise saying "using wisely, you will not run short of". In other words, I always try to look for alternatives for using more efficiently the resources, as well as for minimizing wastes of any kind. And there are a lot of them, is it not so? It seems that we live in a world of plenty, where what gets lost means little. Things of the human beings, a little blind to their impacts on Nature.

As a matter of fact, our forest and industrial sectors working with Eucalyptus as raw materials are rather developed in terms of environmental control and pollution prevention. We have modern companies, certified in accordance with ISO standards for environmental management and quality. Practically all these companies have also their forests certified in accordance with the principles of FSC (Forest Stewardship Council) and CERFLOR (ABNT/INMETRO/BRAZIL), for both forest management and chain-of-custody of their products.

Now, if the present situation involves so much legal adequacy and normative compliance, why am I so enthusiastic about the practice of eco-efficiency and cleaner production at the companies? Precisely because I consider them as a wonderful process of continuous improvement "beyond what the legal or normative compliance demands from us". For me this is

exactly that "beyond compliance", in all its splendor. I am quite sure that our operators and technicians manage to have, with the eco-efficiency, some simple and wonderful tools in their hands, as it will be seen later on. By means of them, they can better understand their economical, environmental and social impacts and they are able to propose feasible alternatives for improvements. They can also develop sensitivity and awareness to things that usually "go unnoticed", because they have not questioned many of the "status quo" in vigor in any place where they may be working or even living. We are very wasteful as society, and this is precisely what we will show along these chapters we will write about eco-efficiency and CP, indicating then fantastic opportunities for improvements for our mills and for the plantation forest area.

Evidently, many of the considerations that we will make will be equally valid for any other kinds of processes, forest species and even for other types of industries and even in our very houses, next to our families.

In the next future chapters we will go on presenting numerous opportunities for eco-efficiency in the forest area, kraft pulp manufacturing, and paper manufacturing. Furthermore, in the mentioned chapters we will not place much emphasis on the opportunities for reduction in energy and steam consumption, we will just mention more evident and even crying opportunities, because there will be in our Eucalyptus Online Book a chapter oriented to the energy optimization and conservation in pulp and paper production. Therein, we will then give a more comprehensive coverage of this subject.

We will now begin the series about our industry and the tool we avail ourselves of to apply these cleaner production concepts. After all, I have approximately a forty-year experience in this sector, having been active in over twenty pulp and paper producing companies, either as employee or as consultant. In other chapters of our **Eucalyptus Online Book**, as well as in mini-articles of the Eucalyptus Newsletter, I have already highlighted the eco-efficient management for several routine and daily situations of our sectorial life. If you have not yet paid attention to that, please access http://www.eucalyptus.com.br/index_eng.html and read what you will be more interested in. I have also listed my more relevant publications about this subject in the section Literature References and Reading Suggestions, at the end of this chapter.

I thank for the attention you will pay to these considerations of mine. I hope that they may be useful or even very useful in your professional and personal life.

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ECO-EFFICIENCY, CLEANER PRODUCTION AND COMPETITIVENESS

Along its history, the entrepreneurial business sector has faced numerous challenges, involving the most different and intricate matters. With the economy globalization, new opportunities and threats appeared for Brazilian companies. Globalization, in a summarized analysis, consists in an immeasurable expansion of the company's market size, but it is followed by a reduction in its market share and in its power of action. A great local producer all of a sudden sees himself as a minute player at international level. Globalization does not mean either to only compete abroad, as a result of opening new markets abroad, but mainly to guarantee the domestic market, so hardly won, against the insatiable appetite of the many international producers. Global competitiveness implies production scale, low costs, compatible quality, delivery logistics and aggregation of intelligence to the production and to the product (design). Then, the great emphasis put by the national producers on the manufacturing costs of their products becomes perfectly understandable, still more in times of weak dollar with regard to other currencies. In the same manner, as there is an accelerated search for competitiveness and generation of positive margins, many undertakers, when analyzing their cost spreadsheets, are astonished, surprised or feel threatened by the so-called "environmental costs". Traditionally understood by, the environmental costs are those costs incurred to analyze, treat, dispose of and control wastewater's, air emissions and solid wastes generated by the industrial activity, in order to fit them into the applicable legislation or the environmental targets of the company. The investments resulting from environmental improvements or new legal requirements are also added to the environmental costs, which ends up generating an increase in manufacturing costs by new depreciation's and financial costs. The natural consequence is a complaint of many undertakers as to "the inopportune environmental requirements", which at last does not result in something practical, constructive and positive. Such complains do not add any better improvement to the environment or to the competitiveness of the organization.

The executives and technicians, when sticking just to this focus on the environmental costs, are considering only a part of these costs and do not manage to see the enormous invisible face of the expenses with environmental wastes, such as losses of raw materials, energy, production and unnecessary value aggregation to something that at last is thrown away as residue and pollution, for examples. To a certain extent, this attitude is historically understandable. As a consolation prize, it is good to know that this is no exclusive privilege of our Brazilian people, since it happens everywhere in the business world.

The recent history of the industrial operations in Brazil (and in many other countries) can be divided, from the environmental perspective, into three periods:

- In the first one, till the end of the ’60s, the natural resources extractivism was the dominant model. Nature was considered as a freely available, free-of-charge and inexhaustible resource. The chimney smoke was a synonym of progress (“it smells of money”, it was said with an insensate prepotency). The way of treating effluents was by diluting the pollution into the rivers and into the atmosphere. The solid wastes, when they did not go into the rivers or into the air, were cast on grounds with no preparation at all, the “famous” sanitary landfills. Many Brazilian natural resources ran out in this way, like the Parana pine, the Brazilwood, the Bahia rosewood (*Dalbergia nigra*), the gold, etc. At the same time, rivers, soils and air were degraded, be it by the industry, be it by the communities insensitive to the environment deterioration. However, it was the reality and the model of that time, based on the existing level of knowledge about the environmental sciences.
- The second historical fact happened recently, between 1970 and 1985. Due to the high environmental impacts and the increasing ecosystem pollution and degradation, the Brazilian legislation began to improve and to become stricter (environmental licenses, evaluation of risks and environmental impacts, public hearings, etc.). During that period, the industry felt under pressure and learned to face these demands as “adding costs” to its products and consequently as reducers of its competitiveness. One of the commonest arguments was to compare the Brazilian legislation to the international ones, in a reactive and complaining way, attempting to cause the local legal restrictions to slacken.
- The great changes in the environmental posture and behavior of the industrial companies occurred at the end of the ’80s and beginning of the ’90s, also by influence of Eco-92 (UNCED – United Nations Conference for Environmental Development / Earth Summit, Rio de Janeiro). The environmental awareness and sensitization began to germinate and to grow in the whole industrial segment and later in the service sector. Voluntary codes and initiatives, letters of principles, environmental management systems, waste recycling technique development, mill closures, life cycle analysis, etc., all of them were mechanisms implemented during the ’90s. In the long run, they showed that the companies could reduce costs and generate economic results via environmental protection.

At present, depending on the place, on the kind of industry and on the company’s awareness/culture, these three conceptual philosophies of the historical phases may be happening even simultaneously. I believe that the magic touch that changed the whole environmental conceptualization and induced the gradual change of the companies’ behavior has been the definition and the attempt to put into practice the sustainable development or the sustainability. The definition implies that the three different aspects – the

social, the environmental and the economical – should be equally considered, and with the same respect. The promotion of this new form of considering growth and development by society allowed two important phenomena to appear:

- The non-governmental organizations (NGO's) changed their romantic attitudes and began to understand that the economic aspect is also important and that the companies must have profits, even to invest more in environmental protection;
- The companies rapidly began to see the environment from the perspective of waste minimization, pollution prevention, eco-efficiency, cleaner production, zero emission, etc.

Another positive point that may be an enormous driving force is the motivational factor. Any person working for a company will feel happy and motivated to work towards sustainability and to help improve the environment, reduce the incidence of garbage, improve quality of life, protect Nature, etc. It is much simpler to motivate the employees to involve themselves in striving for sustainable development than to motivate them to work to add value for the shareholders. The shareholders and the managers must be also convinced that the profits will increase as a result of the efforts made to achieve sustainability, even because the concept of sustainability is anthropocentric. We want the sustainability of mankind, of our businesses, of our company – in short, our own sustainability.

The concepts of cleaner production (CP) and eco-efficiency fit like a glove into this scenario of sustainable entrepreneurial development. In a practical way, to be eco-efficient means "to do more and better with less", or "to use more efficiently the natural resources required in the economical processes". As far as I can see, although different names are concerned, eco-efficiency and cleaner production have practically the same objectives. The names are different just because they have been coined by distinct entities. The World Business Council for Sustainable Development (www.wbcsd.org) and its branches in several countries privilege the term ECO-EFFICIENCY, while UNIDO (United Nations Industrial Development Organization – www.unido.org) and UNEP (United Nations Environment Programme - www.unep.org) promote the concept of "CLEANER PRODUCTION".

In our country Brazil, so abundant in natural resources, we got used to be squanderers and wasteful, dissipating resources. As we always find water, minerals, land, plants, photosynthesis, etc., in large amounts, we "innocently" became squanderers of these resources. Worse than that, we go on doing this, even after having become aware of it. Abundance generates waste. This can be very easily seen in our forest and industrial areas, even with regard to small and little capitalized companies.

Societies or countries short on natural resources, as water (e.g. Israel and South Africa), or land (Japan), or photosynthesis (Sweden and Norway),

have found creative solutions for their deficiencies in terms of scarcity. The problem is that our Brazilian culture also privileges paternalism and the transfer of responsibility. We expect someone to solve the Brazilian Northeastern or Amazon regions economic and social problems; or else either the company or the government to solve our personal problems. Likewise, we want to win gold medals at the Olympic Games without concerning ourselves with constructing and paving the way to achieve this goal. Efforts, a lot of efforts, are required to win those medals. We also forget that we ourselves are the company we work for. We are its blood, its muscles and its brain. Therefore, it is incumbent upon us to make the effort to keep this body in a healthy condition. As a result of this squandering and conforming culture of ours, we tend to make an enormous number of "operational nonsenses", which we come across every day, coming to believe that things are exactly like that, inherent in the squandering process which we are fitted in. For example, the pulp and paper industrial effluents in general are treated at a WWTP (wastewater treatment plant) which is often a highly sophisticated one, while the way of sending them to the station is not sophisticated at all, as clean and dirty waters are mixed with each other, in order to be treated together. In the same effluent to be treated we send good raw materials, either dissolved or in suspension (salts, organic compounds, fibers, etc.). Everything that is being disposed of as effluent or residue was purchased and paid for as raw material or input by the company. To these raw materials we have aggregated costs concerning labor, energy, handling, etc., and afterwards we throw them away as residues and wastes (solid, liquid, air, energy leakage's, etc.). Not yet satisfied with all these wastes, we are forced by the legal parameters to spend more in order to treat them and later to dispose thereof as sludge or another kind of residue, to landfills. For example, any organic matter gets lost from the industrial process goes to the effluent treatment station as COD (Chemical Oxygen Demand). There, it undergoes sophisticated treatments, and goes out as wet sludge, which must be transported, composted, land-filled, handled and sometimes sold. Even when generating income by the sale, the balance is in general economically unfavorable and these losses increase the manufacturing cost. Then, the production cost is increased in three ways: by the loss of this organic raw material as COD; by the treatment we had to give to it, to prevent this lost COD from becoming pollution; and the cost to dispose the resulting solid wastes. A triple penalty to whom is not able to see this.

Well, these simple and routine examples are proofs that there are thousands of opportunities to reduce losses and to generate positive financial results. They are gain/gain type solutions: the company gains, the environment gains and society gains. It is important to stress that most changes due to eco-efficiency - though not all of them - are financially profitable. For this reason, it is important to have available simple tools of basic financial mathematics, in order to evaluate returns on the measures to be implemented for cleaner production and eco-efficiency.

It is frequent for people to be shocked when I state that we can and must earn money with environmental improvement. There is in our souls and minds the romantic belief that the environmental protection should not be valued from the perspective of economical result generation. Thanks to the concept of sustainable development, the economical procedures must and need to be definitively implemented when evaluating environmental impacts. But it should be clear that not always the cleaner production will yield positive financial results. This is the case, for instance, of the treatment of residual toxic substances with no commercial value. In such a case, savings will be only made when these toxic substances will be no longer mixed with other nontoxic ones, so as to avoid increasing the need for corrective treatments for the whole.

Thanks to the power of innovation of the mill workers, as well as to the technological researchers, we will be able to develop future uses, cleaner processes, reduction in waste generation, etc., making the production not only cleaner, but also safer, more economic and more sustainable.

Cleaner production is connected with reduction in pollution in its origin. The first step is to implement a wide program of internal cleaning ("good house-keeping") and to evaluate which residues and effluents are generated by the production process, quantifying them. It should be remembered that garbage/residue mean improper use of a raw material or input.

In other cases, the cleaner production may require technological changes (cleaner technologies), demanding more intensive use of capital. Sometimes, a whole production line may show to be obsolete and the new investments, besides producing more and better, with higher profitability, will do it in an environmentally healthier and friendly way. Cleaner technology can be defined as an industrial manufacturing procedure using less raw materials and less energy, presenting a better yield, resulting a better product with minimum wastes, generating no significant environmental impact. In general, cleaner technologies are oriented to solve chronic environmental problems of odor, water pollution or generation of problematic solid wastes.

Another fact that must be clear is that sometimes, by analyzing the different alternatives, the economically more viable solution may be a "end-of-the-pipe treatment", which should not be discarded as a valid alternative. By end-of-the-pipe treatments should be understood those kind of treatment for pollution control, such as filters, electrostatic precipitators, decanters, flocculators, centrifuges, etc.

Cleaner production / eco-efficiency should be understood as tools on the menu of managerial options to reduce pollution and improve operational efficiency. However, they should be the first aid to be used, before thinking of adopting a treatment for the generated residue. As these techniques practically have not been utilized during the '80s, many companies over ten years of chronological age had their production lines based on the concept of treating the residues, rather than preventing the losses. In such cases, there are great possibilities of finding low-cost eco-efficient solutions with high economic

returns. At many engineering companies planning new industrial units, the traditional concept of "if pollution exists, what should be added to treat it?" still persists, even because it means more engineering services, equipment and constructions. The concept of cleaner production is: "if a waste exists, where was it generated and what should be done to prevent it from occurring in its origin?".

Thus, cleaner production can be understood as a strategy to continuously improve the processes, products and services, the operational efficiency, the quality of life and the environment, reducing environmental impacts, increasing economic results by cost reduction; and finally, allowing to move towards sustainable development. Thus, cleaner production and eco-efficiency will help improve competitiveness of the companies (industrial, public or services), because it will allow increasing the workers' motivation and will make possible wider profit margins. A cleaner production program is a banner that everybody at the company will be willing to carry. The route that we will be following when implementing eco-efficiency is very well understood: mills or companies generating minimum environmental impact, being healthier and happier, making possible higher sustainability and cooperating for the business competitiveness.

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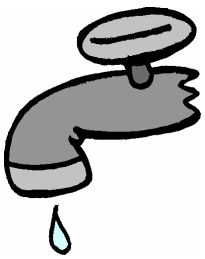
ECO-EFFICIENCY MEANS WASTING LESS NATURAL RESOURCES AND INCREASING FINANCIAL GAINS



During its whole existence, the pulp and paper industry has shown enormous vitality in terms of increasing its production and improving its technologies, in order to meet society's requirements of quantities and qualities of its products. Our pulp and paper industry is highly dependent on natural resources (wood, water, fuels, air, etc.). As a matter of fact, it has established a very intimate marriage with natural resources that were abundant in the past, but now are no longer. This intimacy with the use of

abundant resources led to a technological conception which is not so conservative as to using and consuming these resources. Just consider that at present, even with all hysteria with regard to water conservation, our industry is still dependent on huge amounts of this more and more scarce resource, since our processes are all water-based. We have had and will have several environmental crises more in our history. We have gone through the phase of needing to treat effluents in immense quantities; we have overcome the panic of dioxins and contaminating bleaching sequences; we are trying to close more and more the water consuming cycles at the mills; there are large solid waste recycling plants being established to treat our wastes; there is acute awareness as to produce forests in a sustainable way, following forest certification programs; etc. etc. However, when proceeding and observing carefully our lack of ability to see the losses of natural resources as being significant costs in our products, we are able to feel that there is still much to be done.

The lack of profits and the so-called value destruction phase that the pulp and paper industry went through at world level at the end of the '90s; the low return on the invested capitals; the fear for business sustainability in the future and its uncertainties; the market pressures for cleaner products and processes; the greater business managers awareness and commitments to the environmental aspects; the legislation more and more present, putting pressure on the industry and to the industry directors by the environmental crime law; besides the many emotional aspects connected with environment and our productive activity; all these factors have combined in such a way, that the style of life at the companies gradually began to change for better and better. I believe that the best of all improvements was the very acceptance that we must strive for business sustainability and that this implies economic, environmental and social sustainability concomitantly, according to the example given by the excellent definition of sustainable development.

In very simplified terms, as already seen, to be eco-efficient means to do more and better with less resources consumption, or to use more efficiently the natural resources required for our processes and products. We need very much this concept, as we still waste very much of the natural resources. This waste is malevolent, as it affects our operational performance and our economical results and attacks Nature. Worse than that, as a rule, we do not even know how to value these losses in our complex production cost evaluations. For many years, the natural resources have been abundant and seemed to be inexhaustible. The abundance of something corresponds to a low price of that product. Something existing abundantly and having a low price leads to a wasteful behavior. For example, in our Eucalyptus and Pinus forests, when the wood price was low because there was plenty of it, it was very common that much wood was wasted, in both forest and mills. Unfortunately this still persists in some extent, notwithstanding the greater scarcity and the

price increase of these woods. The amounts of natural resources which are still innocently wasted by the industry and at the forest area are impressive. Despite the great improvement with regard to some decades ago, there is still high consumption of water, energy, labor, oxygen, caustic soda, air, fuels, biomass, etc. At the same time, we got used to generate huge amounts of solid wastes at our mills and to coexist with them (bark, sawdust, ashes, organic sludge from wastewater treatment plants, dregs and grits, lime sludge, carboys and drums, metal scrap, etc.). We go as far as to be proud of establishing fantastic waste recycling plants for these solid wastes, instead of combating them in their origin, where they are generated in the process. The point of view prevailing at many pulp and paper mills is that these residues are inherent in the manufacturing process, that they always existed, and it is even believed that such a situation has much improved. As long as we will go on generating pollution in the water, in the air and in the form of solid wastes, we will have to treat these residues. End-of-the-pipe treatments aggregate costs and do not generate any financial return. The consequences of this short-sighted behavior in terms of eco-efficiency are a great number of processing nonsenses. One of the main among them, for instance, is that even the most modern paper mills still recycle internally approximately 10% broke i.e. their machines go on producing about 10% paper that will return as broke to the pulpers, reducing the production of saleable products in this proportion. Can you believe that there are mills producing even more than twice this value as broke? I wonder whether there is any sustainability at mills rejecting and returning to the re-pulper about 10 to 20% of the finished product, where huge amounts of value were added to, which afterwards are discarded as though they were no significant costs. This broke is generated at web breaks; through unnecessarily removed trims; by exaggeratedly product or process specification limits; as a function of attitudes of operators innocently cutting enormous paper blankets for sampling purposes or to remove defects that will mean a little more trouble for the converting area; by mishandling paper rolls or bales, damaging them; by poor planning at conversion or with regard to the paper roll formats; etc. The internal recycling of this broke is hardly ever seen by the managerial team, it seems to be normal for it to occur. Nevertheless, this recycling generates extremely high costs, reduces machine production and paper quality, increases the specific consumption's, generates enormous reworks, besides impacting on the environment by misuse of the natural resources required to manufacturing. We have written a very long chapter about this subject in our **Eucalyptus Online Book**, you have but to visit it at: http://www.eucalyptus.com.br/capitulos/ENG06.pdf

Whenever a natural resource is misused, an associated pollution is generated as a consequence of it. Let's consider in this case that the mills, as well the pulp as the paper ones, got used to lose about 0.5 to 2% fibers through their effluents. Worse than that, there are cases of operators appreciating fiber losses because they facilitate pressing the sludge generated

at the effluent treatment plants. All sludge thrown away as solid pollution is a natural resource wasted by the production process. To use fibers, the noblest product of the company, as filtration auxiliary, is one more costly innocence and ingenuity which we still put into practice at many mills, believe me!!!

To finalize this small and simplified list of daily examples, I would like to focus on the pulp mill wood yard. Waste is still very high. Most mechanical debarkers are not very efficient to remove the Eucalyptus bark: they partially remove the bark and break many thin diameter logs to short logs which are discarded with the barks and directed to the biomass boiler. As a result of poor debarking, a larger amount of alkali - which is also a natural resource – is consumed to cook the wood due to the presence of bark. We lose pulp wood, which is much more worth than the bark biomass one, and these short logs will have a much more blazing destination than they would as a part of the pulp manufacturing process for paper production.

These few examples among many others of our daily life are just evidences that there are thousands of opportunities waiting for our action. We intend to present many more of them to you in the chapters following on this theme.

When implementing an eco-efficiency program we will be causing behavioral changes for waste reduction and generating financial results for the companies. Furthermore, as the motivation to work for a healthier environment is great among people, to be eco-efficient is associated with greater motivation for generating a healthy working environment in the place where the operators spend most of their time, which is the company itself.

Eco-efficiency is a strategy for continued improvement of products, processes, services, working place, quality of life, as well as to reduce the environmental impacts and production costs. It is a technique oriented towards sustainability. Basically, the purpose is to reduce pollution and the generation of residues and wastes where they are generated, not just to treat them at sophisticated treatment plants, at recycling plants or in fantastic purifying filters. The result is a minimization of environmental impacts, higher operating efficiencies and important cost reductions. If we want to have healthier, more efficient and more competitive mills, one way of doing this is by including eco-efficiency or cleaner production in the quality improvement programs of the company as a whole.

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POLLUTION IS A SYNONYM OF WASTING BEHAVIOR, AS WELL AS OF MONEY THROWN AWAY

My highly esteemed friend and guru for the environmental issues of the planet, our dear Jose Lutzenberger, now absent from among us, once told to me with the naturalness of someone who knows about things: "pollution is something good in a wrong place, because of carelessness, innocence or silliness". Going on, while drinking his traditional beer, he exemplified: "this beer I am now drinking is a divine thing, which I appreciate very much. However, if I let it drop on the house floor carpet, it will turn at once into an undesirable pollution, difficult to remove; it will ferment and cause an unpleasant odor in my carpet for a very long time".

Life is exactly like that; one is always throwing out goods things as garbage or pollution and thus contaminating the planet. We humans waste good things with a frightening naturalness. Anything we are throwing away as pollution has been paid by us, and worse than that, we will pay later to treat and to dispose of in some supposedly safe place. Fibers, minerals, dirty water, papers, packaging, wood sawdust, tree bark, drums, wood logs, little plastic coffee drinking cups, everything in the garbage can has a much higher cost than the simple cost of throwing away, do you agree? They are worth as not used or partially used raw material; they carry a cost aggregated by the process as power, chemicals, labor, etc.; and later they will require additional costs to be treated and dispose of. It is an enormous cost, which most people are not able to see. Sometimes the companies' business men and technicians proudly say that they have fantastic wastewater treatment plants and solid waste recycling and composting units at their mills. Although they have accepted to invest some millions of dollars in those plants, which proves their good environmental intentions, those people are blinded by the logic of the past, i.e. that pollution must be treated or recycled. However, pollution must be combated and destroyed in its origin, where it is generated. If there are

huge garbage recycling plants it is because much garbage is generated and garbage is something good that was thrown away. I consider garbage recycling and effluent treatment to be second rank environmental measures. Recyclers exist because we throw good things into the garbage. If we avoid wasting paper, food, fibers, plastic, wood, etc.; if we adopt internal waste preventing or reusing mechanisms; the end-of-pipe treatment plants and recycling plants will be reduced to minimum size and will have to treat just the really useless wastes without any economic value. It is always possible to reduce wastes and residues generated at the companies and in our homes, as well. When someday the companies recycling our residues will complain that their activity is not yielding profit any longer, due to the lack of good quality residues, we will have reached what we actually expect: the practice of eco-efficiency.

Another seldom perceived truth is that everything we use, everything existing in the garbage can, in our homes, at our companies, everything, absolutely e-v-er-y-t-h-i-n-g, consists in natural resources. When we misuse these natural resources and generate residues and garbage, or contaminate water and air, we are not only dirtying the planet, but also wasting these natural resources and exhausting the reserves of Nature.

From that exposed up to now we can conclude that wastes or residues are natural resources we pay for and do not use, that we throw away and pay much more for doing this, as we will have to control and to treat the generated pollution.

In other cases, we are used to bring things to the mills without remarking we are doing it: for instance, the wires holding the pulp bales; the soil coming along with the wooden logs; the sand mixed with the limestone's; the ashes accompanying the coal, etc., etc., etc. We do not even remark we are paying for all this. They will be in excess in our processes and will turn into wastes without any use. "To gain things free-of-charge", without our use for them, is also a synonym of wasting. Therefore, the traditional Brazilian popular saying that "free-of-charge even an injection of medicine into the forehead is good" as a matter of fact does not apply. I have not yet fully understood the meaning of this popular proverb, but it is certainly one more innocence and ingenuity with environmental impact.

We must be aware that we can change for the better and make efforts to achieve it. Any residue reduction program begins with a good and strong cleaning and organization program. Put as many S's as you wish, call your good housekeeping program as you prefer, but please, keep your mills clean. The cleaner we are, the easier we will see our garbage, as it will begin to appear and to be noticed.

The human being likes changes and to try something new. However, everyone prefers to be the very vector of the change, instead of changing because the others are asking for or stimulating it. Human beings change as a function of awareness, stimulation or punishment. This is so with us, since our childhood. If the kids behave well and are not left back at school, they are given a bicycle; if they fail, they are slapped or they lose the monthly

allowance for some period of time. We have to understand this logic in order to motivate the people we are working with to search for improvements and changes. We have also to feel proud of our companies. A company is not a garbage can: it is not because eventually it may smell a little, due to our always used kraft process, or because it generates solid wastes or effluents in large amounts, that it should be allowed to be dirtied. On the contrary, this should be the reason for much more efforts to clean it and to make it beautiful and healthy. Who does not like to work in a clean, pleasant, healthy place, with green areas, with minimum environmental impact and where everybody has an interaction of respect for Nature? This means advancing towards the real environmental and by extension social responsibilities. The universe is among us just as we are within it. Everything belongs to a large and complex natural system, where protection is demanded and the residue reduction is an essentiality. When we reduce wastes and residue generation, besides protecting Nature and conserving the resources in a more sustainable way, we are improving company's profits, as well money savings also for us, in our homes.

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BASIC CONCEPTS OF CLEANER PRODUCTION AND ECO-EFFICIENCY

In this section I intend to present, in a rather simplified way, some of the basic and conceptual fundamentals for the implementation of a CLEANER PRODUCTION program at a company, whichever its type. We have already mentioned several times that the whole procedure is based on reducing residues, waste and rework. Some of the vital questions to be answered are as follows:

- If a loss exists, what is its quantity?
- Where is it occurring?
- What are the causes of its generation?
- How can it be solved in its origin?

Pulp and paper mills have a significant impact on both natural resources and environment. They do much to minimize and to control these losses called pollution or environmental impacts. However, there is still much room to improve in search of the dreamt sustainability. It is just a question of how to observe the pollution: as a part of our industry, or a process of dissipating resources and throwing money away.

The future will certainly show us pulp and paper mills with much lower uses of water, wood and energy. They will also emit minimum noise, little or no odor at all and pollution in rivers and in the air will be not noticed or perceived by the surrounding communities. My expectations are that within some more time, in the near future, pulp and paper mills will hardly require any landfill areas to dispose of their solid wastes, which will be either recycled indoors or prevented from being generated, or else will be converted into valuable by-products. Also the effluent treatment plants may be much smaller due to the lower water consumption and the more intensive process water recycling. However, hard work and a strong determination are required to reach this so desired future. All possible fronts have to be attacked. I have always believed that "many shorts together makes a long", an old popular proverb to show that the future is built day by day with the introduced improvements: even the very small ones are important. Every morrow is better than the elapsed day. One should be always in search of new levels of performance and waste minimization.

These optimized mills will have:

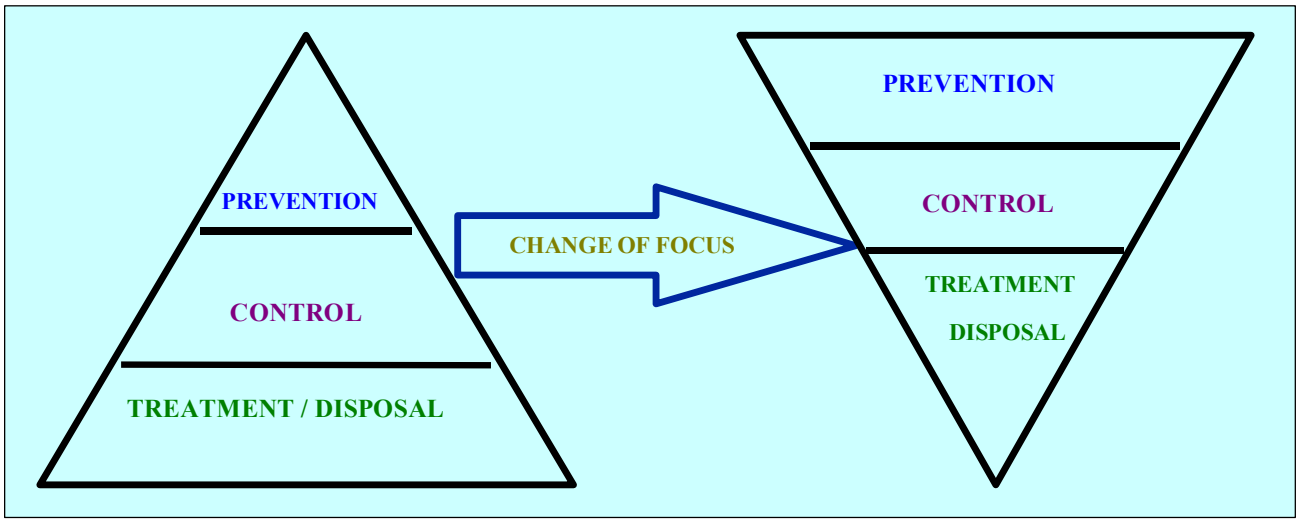
- Improved efficiency and operational performance;
- Enhanced productivity and quality;
- Optimization in using inputs (water, wood, fuels, chemicals, etc.);
- Reduction in harm inputs or outputs;
- Reduction in residue generation, as well as in water, air and solid wasting flows;
- Lower requirements of pollution treatment and disposal areas;
- Improvement in raw material acquisition;
- Reduction or even elimination of conflicts of legal compliance with the governmental control entities;
- Reduction in environmental liabilities;
- Reduction in production costs and increased contribution margins;
- Image valuation with the communities and the markets they are active on;
- People valuation due to their adherence to the efforts made for the socio-environmental improvement of the company.

All this can be eventually achieved without sophisticated technological solutions and without applying a high level of costly engineering. We know that in many cases the change or the new technology will be vital, but success

consists in most cases in numerous small improvements in the process. The sum of these improvements results in fantastic gains for our mills. In many cases, many of these improvements are not even seen by the technicians as environmental problems being solved. However, as every operation consumes natural resources, if we reduce the consumption of these resources we will be improving the environment, do you agree?

It is very easy to exemplify this. Let's consider for instance a pulp washing filter having vacuum problems, so that the consistency of the pulp blanket leaving the filter, which should be 16%, goes down to 12%. As a function of the lower consistency, the pulp stock carries a larger amount of organic substances, since there is more organic matter rich filtrate and less dry pulp per wet ton of stock. In other words, there is much more COD contaminated filtrate per dry ton of pulp leaving that filter. When the wet pulp is sent to bleaching, it consumes more chemicals and generates a higher AOX and COD contamination in the effluent, which in turn requires more treatment and generates more sludge. All this leverage a series of environmental, economical and social losses (which means more work, more pollution, more chlorinated organic compounds in the river, etc.). It is sufficient to correct the vacuum and the consistency, or improve to values even higher than the initial 16%, to have gains in all these aspects. It is really easy to understand, is it not? Later on in this chapter I intend to work out for you a "case study" about this, developing it further and explaining how to value the losses in terms of eco-efficiency and cleaner production.

The success of a CP program consists in a change of emphasis/focus: to abandon the focus on "control and treatment" and to go over to focus on "pollution prevention and solution at its root". Instead of thinking about treating the pollution, the emphasis is on preventing its generation.



Source: Ferreira, 2002

Another eco-efficiency characteristic is the horizon. Instead of being concerned about maximizing the results in the short term, eco-efficiency is rather concerned with business sustainability in the long run. The healthy relations with the markets, communities, control organizations and employees are privileged. The aim is the continuous improvement, so as to make every morrow better than the elapsed day, as already seen above. Everybody in the company should be involved in this striving action, especially the operational workers. After all, nobody knows the mill areas better than each of them in the places where they work. They are the ones perceiving the anomalies. If they cannot yet see them, they need to learn how to notice better the losses and wastes. As they are the ones nearest to the operations, they are fundamental in the process of implementing any improvement program, among them the CP or eco-efficiency one.

In the following list, we are bringing some of the principles for a CP activity, either for a forest operation or a pulp and paper mill:

- To focus on the residue, the loss and the waste where they are being generated;
- To value each residue, loss or waste in environmental, social and economic terms;
- To try to solve each problem in the origin, at the source, at its root;
- To not bring into the mill anything of no interest;
- To prevent and reduce pollution generation (solid, liquid, gaseous);
- To reduce the specific consumption of inputs (water, wood, chemicals, etc.);
- To reduce energy and fuel consumption;
- To reduce wastes treatment and disposal costs;
- To evaluate and reduce the intermediate stocks, as well as the stocks or inventories of manufactured products;
- To reduce reworks and reprocesses;
- To reduce paper broke generation;
- To improve the indexes of operational efficiency;
- To review process and product specifications;
- To quantify always and everything necessary and vital;
- To generate indicators which are vital and useful for the operation;
- To have data and information with credibility/reliability;
- To develop energy and mass balances, in order to favor visualization of losses and residues, which are often "hidden", not visible to the analysis team;
- To recover and create saleable by-products;
- To evaluate indoor recycling, but previously making an evaluation based on material balance;
- To evaluate investment and improvement paybacks;

- To incorporate the cleaner production concepts into the company's quality and productivity programs;
- To minimize the company's environmental impacts;
- To find and solve environmental liabilities;
- To have legal and normative compliance's;
- To put strong emphasis on pollution prevention;
- To put strong emphasis on suggestions made by the company's employees/workers;
- To develop managerial posture and behavior compatible with those required for this conceptual implementation.

To achieve these goals, there is a series of actions that the technicians must learn to perform. Although it is a long list, as a matter of fact all of them are already put into practice by the company. The only difference is that they will begin to be practiced from the perspective of eco-efficiency and cleaner production, valuing the opportunities for improvement. It is in my opinion a new way to do the same things, but more effective, more efficient and more eco-efficient.

In my point-of-view, the whole eco-efficiency success rests on three foundations: "to discover the waste" , "to value this residue" and "to find out how to avoid it".

By valuing it should be understood to discover the value of this loss or residue in economic, environmental and social terms.

When knowing how to do these three things, all the rest is just a consequence.

Then the required actions are those listed in the following:

- Operation analyses;
- Process control procedure analyses;
- Flow analyses;
- Logistics analyses;
- Layout and flowsheet analyses;
- Stock analyses;
- Process loss analyses;
- Leftovers and waste analyses;
- Reworks and reprocesses analyses;
- Analyses of unnecessary works and operations (leading you to nothing or nowhere);
- Intermediate product analyses;
- Analyses of material lost as pollution;
- Energy losses analyses;
- Consumed water and generated effluent analyses;

- Toxicity analyses of the losses;
- Residual packaging analyses;
- Analyses of material leftover in the packagings;
- Product and raw material validity / expiration analyses;
- Analyses of product leftover from unsuitable or unnecessary purchases;
- Analyses of products susceptible to be rejected;
- Analyses of risks and emergencies;
- Previous analyses of environmental accidents;
- Analyses of potential environmental liabilities;
- Analyses of noises;
- Analyses of drainage's, spillage's, sweepings, dust, etc.;
- Ergonomic analyses;
- Occupational health analyses;
- Analyses of impacts to the communities;
- Analyses of the work and the time spent to control, handle, dispose of and treat the pollution;
- Residue handling, treatment, disposal and storage cost analyses;
- Analyses of the costs involved in sanitary and industrial waste landfills;
- Operational cost analyses;
- Investment evaluations (paybacks and rates of return);
- Analyses of production losses and financial result losses for non-production as a function of environmental problems;
- Operation efficiency analyses;
- Company's global environmental, social and economical evaluations, etc.; etc..

Finally, after the careful analyses, the teams involved in proposing alternatives to solve the problems will have some eco-efficiency and cleaner production options.

Following are the groups of options offered as alternatives for solving the losses or residues generations:

- "Good house-keeping" or simply CLEANING;

- Proper equipment maintenance;

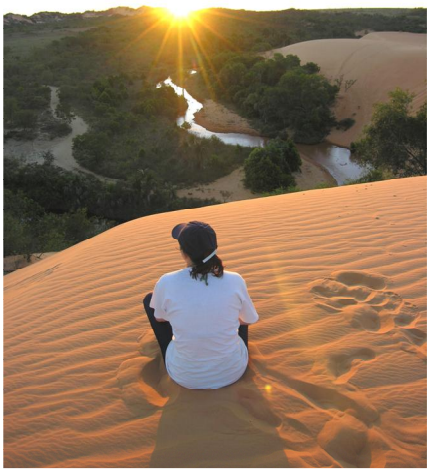
- Equipment rebuilding;

- Equipment modifications;

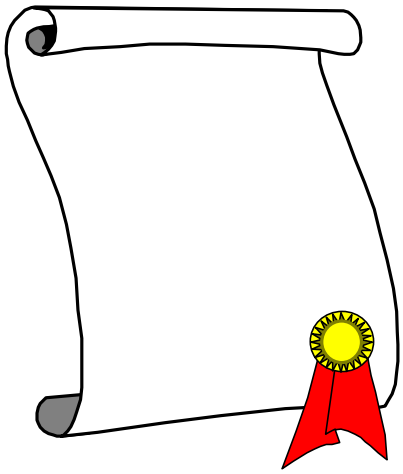
- Better process control;

- Technological change or upgrading;

- Raw material and input changes;
- Process optimization (charges, concentrations, new measurements, etc.);
- Manufacturing process modifications;
- Internal recovery, reuse, recycling;
- Return or development of recycling for packaging material;
- Waste logistics;
- Production of useful by-products for internal use or sale;
- Product or product specification modification;
- Improved information and data;
- Automation;
- Standardization of operations;
- Improved purchases;
- Development of new quantification’s and monitoring plans.
- Etc.; etc.



SUCCESS FACTORS FOR A CLEANER PRODUCTION AND/OR ECO-EFFICIENCY PROGRAM



Any type of program involving people at a company in search of better efficiency and effectiveness requires some solid foundations, without which the program will hardly develop and succeed. In this section I tried to mention those I consider to be the most relevant ones.

They are listed in the following, without an order of value or greater or smaller importance:

- **Sensitization: developing consciousness and awareness**

Sensitization is a magic word that must be energized into people's minds. This is achieved by training, but presents a strong behavioral aspect. We succeed in teaching technology more easily than behavior issues. In general, people are employed by their technical baggage and dismissed by their behavior. Therefore, it is absolutely natural that we should focus on the behavioral aspects in our internal programs, among which are those concerning eco-efficiency and CP. To change behaviors one must be concerned with human relations, with correspondence between discourses and actions, with the organizational climate, with the motivational aspects of people, and put strong emphasis on education. Sensitization is achieved with experiences and examples. It is no use to demand order, good housae-keeping and cleanness, or waste reduction, if the managers do not give the good example, or if the company's policies do not contemplate these factors.

- **Top administration's involvement**

If the company's managers and directors do not involve themselves, if they are not the examples and the real educators and drivers for the program, the chances of success decrease a lot. It is no use just to hire a manager for any kind of entrepreneurial program, whom they insist on calling "champion or leader", in order that he manages to make successful a cause which the other managers do not embrace.

- **People motivation**

Motivated people perform miracles, everybody knows this. Hence the importance of keeping motivation alive. There are good tools to measure internal motivation (motivation scales and motive-meters). The causes for the workers' loss of enthusiasm should be evaluated frequently. In many cases they are associated with the low quality of the dialog among people, either on the same level or between subordinates and bosses.

- **Everybody's commitment**

The companies must search for mechanisms of behavioral gains in their human relations, in order to obtain a greater commitment of the company's people. As the companies are a reflection of the company's people, if they are committed and perform their duties and obligations, doing this enthusiastically, the company will progress, as well as the people working for it. It seems to be a play on words, but it is exactly like that. There is no such magic unit called "company". Also, the company does not have a magic stick to help us. The companies are ourselves, who build them and operate them. They are exactly the result of our actions and our performances. They are also the result of our commitment and of our respect for the machines and products, the people and the philosophies of this collectivity, which we use to call values or policies.

- **Order, organization and cleaning – House-keeping**

We have already seen this point, but it is good to repeat it. There is no way of implementing a CP or eco-efficiency program if the company is not clean or if the machines are not in good maintenance and operating conditions. Clean and well-cared of machines and facilities perform better and are more efficient. The esthetic beauty of the mill and the machines also infuses enthusiasm into people. Everybody feels well in a beautiful environment, with flowers, trees, proper facilities, clean toilets, etc. However, all this must be constructed by everyone, it should not be the exclusive responsibility of an outsourced

company hired to keep the mill clean, or of the maintenance area, is this understood?

- **Quality**

Every company intending to make CP must have an installed quality program, any of them, provided that it is "alive". It may be an integrated management system IS0 9001/14001 or some other kind. The CP program must be integrated into that system and should not compete for people and resources with that quality and management program.

- **Maintenance**

It is fundamental that the maintenance of the mill be suitable and clean. Our machines must be healthy in order that people do not become stressed and in order not to cause pollution. Machines enduring frequent shutdowns and breaks always spoil the environmental quality as a function of losses of fibers, electric power, steam, chemicals, water, etc. Furthermore, they generate rework and reprocesses, which are doubly problematic, as we will be wasting inputs, energy, time, and money and reducing production, turnover, and profit.

- **Prevention at source**

This is undoubtedly the basis of all actions turned towards eco-efficiency i.e. to find where the problem is and to solve it in its origin. If there exist residues, if there exist losses, if there exists pollution, if there exists rework, if there exist inefficiencies, where are all they generated? Thereafter, we need to discover the why(s), the wherefore(s) and the hows, in order to solve each problem exactly there, where it is starting. It is only in an extreme case that it should be thought of an end-of-pipe solution i.e. of establishing a treatment for pollution control. This has already been seen, but it is always advantageous to remind about it.

- **Attention to internal recycling and reuses**

Internal recycling is very dangerous, we have already seen this. If we start transferring our inefficiencies from one side of the mill to the other, we will be going towards mass and energy unbalancing situations, what may be dangerous. For this reason, it should be always tried to solve the problem in its origin and not be thought of transferring it to somebody. This is what happens for instance with many process waters. If the available water exceeds the

needs and copiously exists at some point, so that it is transferred to another place in the mill. Soon, water will begin to superabound at many points and we will not know why. This is very common, as nowadays just a few engineers can read flowsheets, everything is left to be done by the process computers. Furthermore, when an internal transfer is done, we soon forget about it, we stop monitoring and controlling and rapidly the abuses start happening. Something that was just a small transfer may soon turn into a very great and unbalanced one.
But it should be clear that there are many situations where recycling is useful and allows environmental improvements and closures in water flows. The only thing I recommend in all situations involving reutilization of something, be it solid, liquid or gaseous, is to do a deep analysis, taking into consideration which impacts this recycling will bring to the area in question, as well as to the other areas where it may have either direct or indirect effects.

- **To have as working routine everyone observing their residues and wastes, understanding them, "talking to them", in order to avoid generating them**

All of us generate residues due to our personal and operational actions. We must learn how to look at these residues and losses. For this purpose, we must acquire the ability of "talking" to the residues. We should ask them how they were generated, who caused them, by which actions and by which machines. Only like that, by means of a dialog with the losses, we will be able to understand them and to reduce them. If we do not see the losses and residues, if we do not "talk" to them, we are blind and dumb with regard to them - we will be hardly able to reduce them by means of the CP or the eco-efficiency tools.

- **Orientation to economical results via environmental improvements**

This is one more vital point regarding cleaner production i.e. to attribute an economical value to our environmental improvements or to our losses, whichever they are. Even a simple reduction in paper consumption of a copying machine, by using both sheet sides, yields an economic and an environmental result. These results are undoubtedly small, but they can add up to many others and result in a rather significant figure.

- **To calculate the value of each residue or garbage item**

We will see later on how to make this valuation. The most important thing is that everybody should become able to find a value for their wastes. Let's consider a very simple example. When using a chemical product supplied in a drum, there may always remain some residual inside that container, in the same way as some orange juice is left over in the bottle containing it, or some yogurt remains in the little pot, after having been eaten that portion of it that we can reach with the little spoon. All this has a value, as it is worth either as raw material or as product, besides being also worth as the expense to wash the containers, plus the treatment of the pollution generated when washing them. This means that it is necessary to attribute an economic value to all this, to see how much the problem is worth and up to which amount we are able to spend, in order to solve it in an advantageous way.

- **To calculate the payback and the value of each CP improving suggestion**

We have just mentioned this point. If we have an opportunity of obtaining an economic gain by solving the problem represented by a waste, how much the solution will cost and how much the solution will yield us in terms of economic gains? Let's suppose that we will have an expense of $ 1,000.00 to build an inclined support to place the drum containing liquid chemical product so that the whole liquid is used in the process. If we save up $ 500.00 per month, by using in this way the liquid that previously was lost, then the solution has a payback of 2 months. In other words, the implemented improvement would pay by itself in only 2 months. It is simple to understand and easy to explain to everybody at the company.

- **To look at the problem from a developmental, instead of a reductionistic perspective**

One tends often to lose heart when grasping the dimension of the problem. There are almost always many alternatives to solve it, in the whole or in parts. We should always look at these challenges being sure that our creativeness and the union of the team will help to solve it or minimize it.
In case we think already that the solution will be difficult or even impossible, it will be better to entrust another team with the search for the solution.

- **To search for efficiencies and eco-efficiencies**

Efficiency is defined as the way of doing something well. We are inefficient when we are not succeeding in doing so well some operation or work. Efficiency is a synonym of performance. If we have good efficiency we will do well our task, with little waste, little rework and good results and quality. Good operational efficiency results in less environmental impacts and in lower consumption of natural resources: less fibers, less wood, less water, less energy, less work, etc.

Eco-efficiency, as proposed by CEBDES – Brazilian Business Council for the Sustainable Development, is composed of the following elements to be pursued:
- To reduce at manufacturing the consumption of materials, goods and services;
- To reduce at manufacturing the consumption of energy, goods and services;
- To reduce toxic and harmful products utilization;
- To intensify material recycling;
- To maximize the sustainable use of renewable resources;
- To extend product durability;
- To aggregate value to the goods and services.

- **To develop simple and vital indicators**

To know whether we are or are not doing well at our mill, we need measurements. In any industrial activity it is essential to have quantification's, measures and indicators to pursue. But they cannot be in excess, so that we do not even remember the target values. Each area should have its indicators and specifications, always in the process of continuous improvements. We should avoid complicated indicators, which nobody understands the meaning of or the reason for their measurement. Besides the sectorial indicators, all workers should also be committed to the overall indicators the company has.

- **To have real evidences of the environmental gains of each opportunity worked on**

To comply with the organizations of control and legislation and for the development of nice sustainability reports, as well as to motivate us to strive for a better environment.

- **To have real evidences of the process and product improvement (quality, production, efficiency)**

To comply with the technical and commercial managers' needs.

- **To have real evidences of the economic gains**

To live up to the capital owners' expectations and to demonstrate the importance of implementing the cleaner production and the eco-efficiency.

- **To have real evidences of people's motivation**

To comply with the social aspects of the program, since people are the "drivers", the organization engines.

- **To make all possible efforts to obtain the involvement of the opinion-makers and the managers who hold the power at the organization**

To obtain support, not barriers.

- **To not lose heart, but on the contrary, to be always enthusiastic**

There will be always difficulties, but there is nothing better than to face them optimistically and sure that we will be giving the best of us to confront them.

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DO YOU KNOW THESE EXAMPLES ?

In many productive units, whether they are planted forest or pulp and paper production mills, and even at any other kinds of factories, there is always the opportunity to come across situations that are at least constraining, examples of carelessness, lack of maintenance and disrespect to Nature and to the very people working for the companies. The worst is that these same people are responsible for letting these situations come to such an extent of abandonment, negligence and non-commitment.

Just to report some examples, examine in your memory whether you have already come across the examples that I will present, occurred at some visited mill, or else at the very company you are working for! Which was your reaction when seeing this? Did you let it be as it was, because you were not responsible for it? Did you try to interfere, in order to help change the situation? After all, all of us have different reactions, but the most common one is not to care about and to justify it by thinking that these are things we are not responsible for. Sometimes we keep grumbling at the others, as though the "guilt" was always of other people and we had nothing to do with it. If we behave in this way, we will not succeed in creating the better world we are in search for.

Let's now see whether you know some of these few examples presented, which might compose, however, an enormous list of environmental, social and operational "no-compliance's".

Do you know these examples?

All of them are examples of dirtier production:

- Dirty electric installations, entangled wiring, electric boxes used as cabinets, fuses left within the boxes, likewise for tools, etc.
- Scraps, metal pieces, maintenance debris, plastic, timber left all over the area.
- Dirt left by the maintenance team after finishing their work.
- Oil and grease residues, tow and rags, dirtying the environment and the area.
- Generalized disorganization at material and equipment stores, workshops, warehouses, etc.
- Material wastes disposed everywhere in the plant.
- Stacks of badly conserved products and raw materials, left under the rain, full of dust, etc.

- Chemical dust, several types of dirt, paper, short logs of wood, chips, etc., scattered all over the area.

- Garbage collecting truck dirtier than the garbage which it transports.

- Little plastic coffee drinking cups thrown everywhere on the floor.

- Degraded and dirty sanitary installations/toilets, at the sight of which the user hesitates to use them, in spite of being in need of doing so.

- Individual protecting equipment thrown away, even in good conditions of use.

- Completely dirty machine basements, perfect pigsties.

- Disorganized garbage, containing a lot of wasted raw materials. Mixed garbage, good and rich material placed together with wastes.

- Trucks running overloaded and letting residues drop everywhere in the area and on the streets outside the company.

- Steam relief's at every moment by the boiler pressure relief valves.

- Spare parts awaiting close to the main equipment, but all of them dirty, rusty, dusty, etc.

- Paint remains contaminating the area, favoring pitch smearing and marks difficult to remove.

- Loss and spill recovery systems in such a degraded state rather than in a condition to recover anything.

- Improper traffic and flows of vehicles, dirtying the area, damaging piping's, wiring's, pallets, etc.

- Negligence concerning safety (electric's, expired fire-extinguishers, toxic products in improper places, drums with chemical trash flowing out, no respect to occupational health).

- Tools, screws, nuts and spare parts in good condition lost over the area.

- Residue areas and storage rooms without demarcation, without floor, without alert warnings, etc.

- Material leftovers in carboys, drums, sacks, etc.

- Torrent flows of water, oils, effluents or liquors running along the streets.

- Etc., etc., etc., etc.

For these and other reasons, whenever I present a course about CP I use to make some quotations to stimulate people to stir to action against this *status quo* of abandonment and non-commitment with the good, accepting the more or less or the bad as normal.

They are as follows:

- **<u>There can and must be dignity even in poverty and with money shortage</u>**

Managers always excuse themselves for "minus world" situations by saying that the company is cutting back costs, or that the cash is short. My friends, these are excuses that do not justify themselves; money losses are much higher when we do not care about the health of our machines, people, and mills.

- **<u>Examine your garbage every day and look at what you are throwing away</u>**

If we take the trouble of having a look at what we are throwing away, we will be surprised, as there are things that should never be in the garbage, bound to occupy a space in the sanitary landfills. Or else, you may be surprised by finding things that should not even have entered the mill.

- **<u>Give a broom to each company worker as a trophy to be used</u>**

Cleanliness is achieved by working. To sweep and to take care of one's area should not be considered as "shameful" by anyone. I have run companies where we have created the "good house-keeping day", where all at the mill do a general "house-keeping" in offices, floors, machines, virtual garbage, etc. It is an example to everybody to see company directors and managers i.e. top executives together with general employees, everyone involved in sweeping corridors, cleaning machines, putting in order their desks, deleting obsolete virtual garbage from their computers, etc., etc. The ideal situation would be everyone putting this cleaning action into practice every day, which is achieved with awareness, but with exaction as well.

- **Take care with concealed residues or internal recycling**

Whenever we find a recycling for something, we tend to forget about that item, thinking that it is already solved. Recycling is a second-class environmental measure, as it implies the occurrence of a loss or a waste. We have already addressed this point, but it is always good to remind about it. Without losses there is nothing to recycle. In general only valuable things are recycled: paper, steel, aluminum, water, etc. Nobody is interested in recycling garbage which is really garbage. Therefore, much attention should be paid to recycled water, recycled chemicals, recycled pulp broke, etc. All of them are wastes that should be corrected where the problem has its roots. I always say that a clean mill is that having a very small recycling station due to lack of wastes.

- **Pay much attention to the moments everything is excellent in the company's production operation: maybe we will discover the optimum conditions for its operation**

One of the things I am most surprised at is that our technicians are always working out detailed graphs and tables in their computers, in order to "justify" mill operating problems. I call such a behavior "management by justifications". When the mill is operating very well, they are satisfied to be cheerful, making even a holiday of it, in order to make a payment at the bank or to have an appointment with the physician or the dentist. It is amazing: if the mill is operating very well, this is the very moment to look for the causes for its good runnability, in order to try to reproduce this in the future. Would it be a new raw material or a new type of wood? Or else, did some new chemical enter the process? Would it not be related to the calibration of an automation and control equipment by the maintenance personnel? If we come across a situation characterized by one to two weeks of few breaks and shutdowns at the mill, why would this have occurred? This is exactly the moment to look for the truths of the "plus world", not the justifications we look for at the moments of crises.

- **Create the campaign "Adopt a tree" and plant your "Friendship Tree Garden"**

I consider to be wonderful some campaigns conducted by certain companies, by planting trees, as it is the case of the "Friendship Tree Garden" owned by CENIBRA, where friends of the company plant trees in order to forest the mill surroundings. Such a practice might be extended to the employees, who might plant and take care of their trees, by adopting them. I have already put it into practice at many mills and everybody becomes very happy to visit and to follow "their tree", as it is growing up. "Our tree" becomes even a tourist

attraction, which whenever possible we will show to some visitor or to our family, when they will come to visit the mill or our forest. This is a way of humanizing our companies by means of Nature.

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THE FOUNDATIONS TO BUILD A CLEANER PRODUCTION PROGRAM AND ITS IMPLEMENTING STEPS

In a previous section, we had the opportunity to report which are the key factors for a successful implementation of a CP or eco-efficiency program at a company. There exist several similar procedures for loss and waste reduction at the companies. They are called in different ways, but are alike: "zero emission program", "Kaizen", "production without losses", "total quality", 5 S's, etc., etc. All of them have as their basic foundation the clean production, with lower wastes, losses, inefficiencies, reprocesses and rework.

I have worked much with the conceptual and practical fundamentals developed by CNTL – Brazilian National Cleaner Production Center (http://www.senairs.org.br/cntl) -, an entity of SENAI/FIERGS system, in the State of Rio Grande do Sul. It consists in a simple methodology, which is easy to assimilate by everybody and fits in with the systems of environmental management ISO 14001 type, occupational health and security as OHSAS 18001, etc.

The basic foundations for the success of this methodology are:

- Full program adoption by the company's top management;

- Effective participation of managerial levels;
- Creation of voluntary teams of employees, called "eco-teams", which may be either sectorial or multi-sectorial.
- Search for losses wherever they are;
- Valuation for each of the losses or wastes;
- Identification of alternative solutions for "killing" the losses and wastes in the origin of the problem;
- Quantification of economical, environmental and social gains.

The focus is always on the identification of the loss and residue generating causes, involving workers, supervisors and managers. The productive process must be carefully dissected and evaluated with regard to its efficiencies and inefficiencies, environmental impacts and pollution and residue generation. Thereafter, the group identifies and values the technical opportunities to eliminate or to reduce them. A comparison of the BEFORE (with losses and residues) is established with the AFTER (after implementing the chosen alternative). Each alternative is considered from an economical point of view, associated with environmental and social standpoints: what it aggregates as return to the company, to the environment and to the people involved (employees and community).

The following items are valued by the teams:

- Good operational practices;
- Elimination of unnecessary services and activities ("silly services or nonsense procedures");
- Methodology, process or technology modifications;
- Recycling and reuses;
- By-product sales;
- Modifications at the residues life-cycle, quality, etc., etc.

When the eco-team is unable to find any alternatives to solve the problem in its origin, it may accept an end-of-pipe solution as a temporary solution, until new changes will allow solving the problem in a more eco-efficient way. This is due to the fact that the end-of-pipe technology expenses are just and exclusively costs, they do not bring any financial return, sometimes even generating other residues (sludge, ashes, etc.). Nonetheless, in many situations they are the only viable alternatives at the moment.

The unquestionable truth motivating all this effort is that the companies spend much more than they need. If they spend better their available inputs and resources they will be cleaner and more profitable. Even the most developed and well-managed companies may offer opportunities of improvements and environmental, social and economical gains. All of them

always have some kind of inefficiency or generate some type of pollution or waste.

Just to remind once again the main causes of pollution or waste generation:

- Input and raw material waste;
- Poor manufacturing;
- Inadequate input, product and equipment specifications;
- Improper material handling;
- No suitable maintenance;
- No planning for production, purchasing and sales;
- Inadequate logistics;
- Inappropriate technological project engineering;
- Improper use of technologies;
- Insufficient operator training and commitment;
- Internal layout;
- No contingency plans for poor operation, emergencies or accidents;
- Etc., etc.

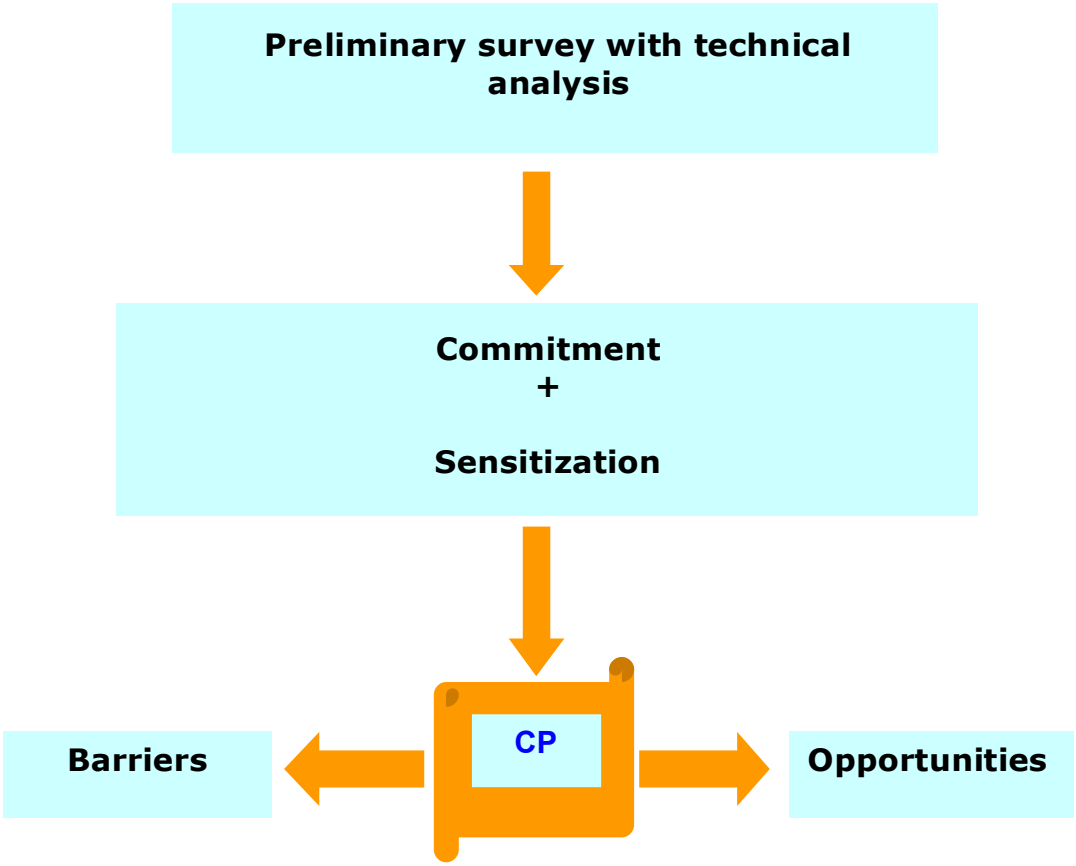
Any CP program deserves to be implemented stage by stage. By the methodology put into practice by us, which we tried to adapt from the basic concepts developed by CNTL, we do this in three stages.

- **Stage 1: CP and eco-efficiency culture promotion through the preliminary identification of simple opportunities**

This is a stage of infusing enthusiasm into the people. As there is much to be done, the ideas appear quickly and in abundance. The gains are easily quantifiable and achieved in short term. In general, many ideas are connected with reduction in water consumption, electricity bill, food waste, etc. Many of these ideas are of extremely easy implementation, as they are a result of "established wasting procedures" or of the "waste culture", etc. All this is very good, as the involved people learn rapidly to begin to notice cases of waste and to value them in economical, environmental and social terms. The recently created teams are motivated and trained. They begin to apply the concepts, identify losses, propose solutions and to value the opportunities.

In spite of the mobilization achieved in this stage, barriers to be evaluated and overcome begin also to appear. These barriers can be behavioral, managerial, financial, technical, legal, etc. They often appear

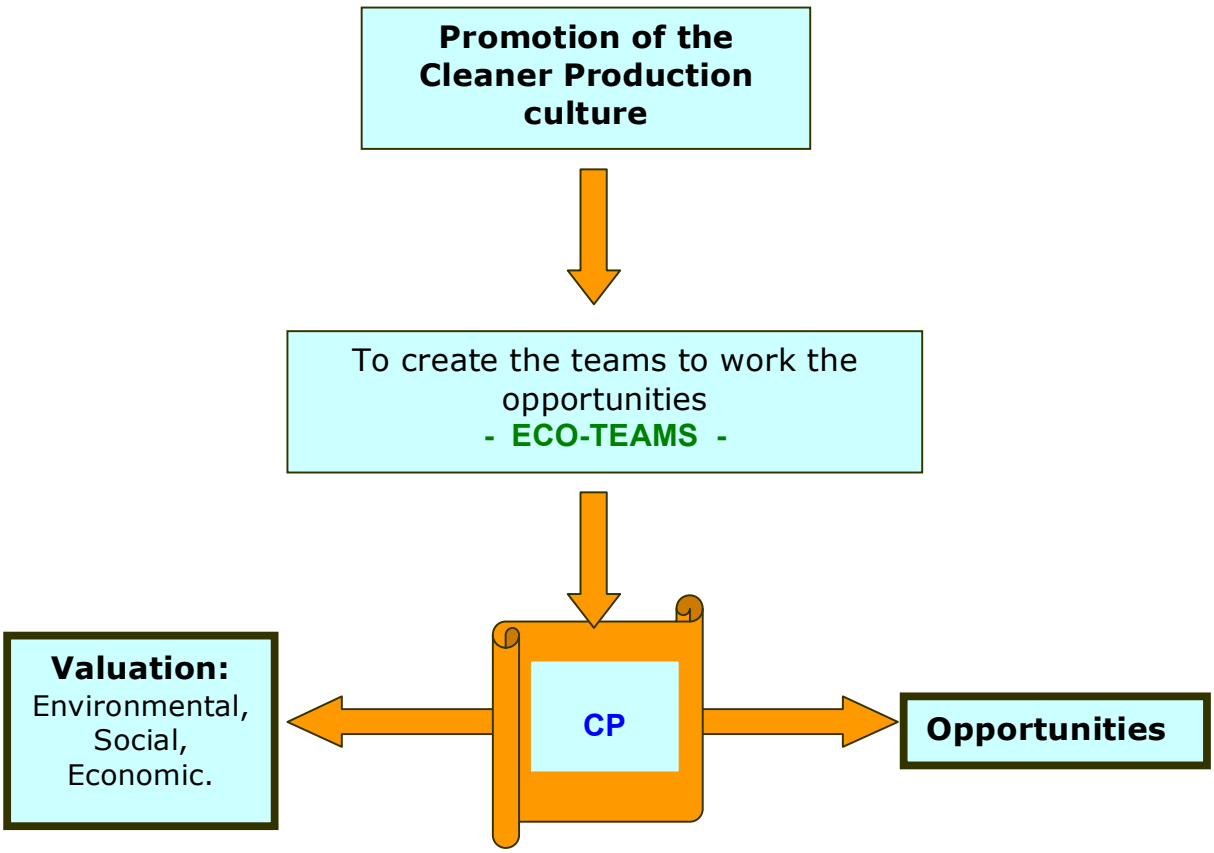
together, to make it a little difficult to implant the program, but all this is quite natural, all this belongs to the game and we must be aware of it.



This is the exact moment at which the people involved in the program learn to recognize and to treat the generated losses and residues. For this purpose, the eco-teams should take the following steps:

- To select the area of study (to define the limits for action);
- To define which projects will be evaluated;
- To form the teams for each project;
- To train, to qualify and to educate the teams about the technologies of the studied area ("to become well-acquainted with the process to be worked on");
- To identify the losses and residues generated (the major losses and the losses associated therewith in that or in other related areas);
- To define the causes for the losses found in the specific area of evaluation;
- To establish quantification and measurement procedures;
- To collect data with credibility and reliability;
- To value the identified losses and residues;
- To identify possible technological solutions;

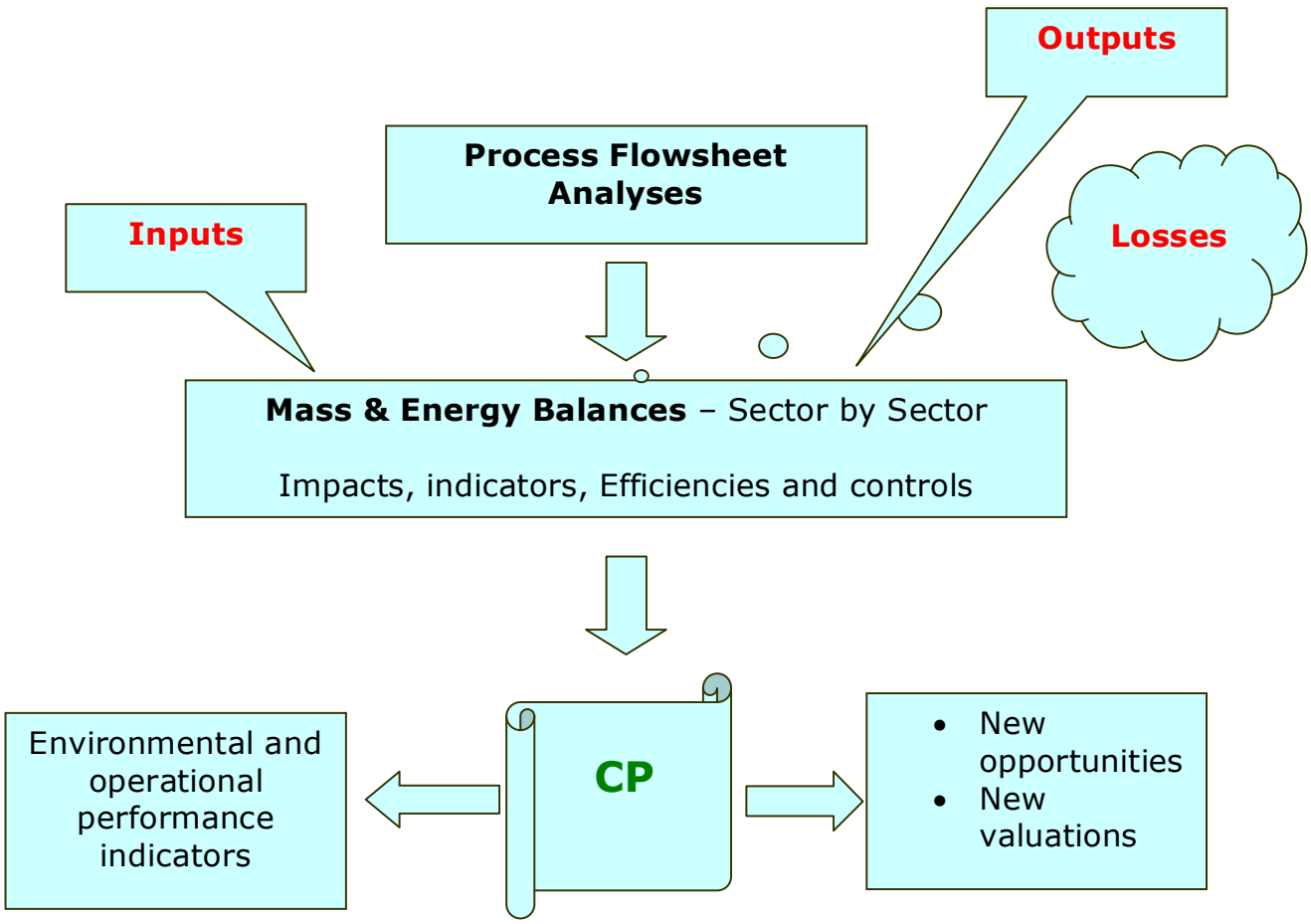
- To identify the barriers to overcome;
- To select the most attractive solutions;
- To engineer the solution, to identify costs, returns, etc.;
- To define priorities;
- To implement the project;
- To reevaluate losses and efficiencies after the project implementation and to compare the "before" to the "after";
- To establish indicators to guarantee the sustainability of the implemented improvement.



- **Stage 2: "Unveiling the process intimacies"**

In this stage 2, more sophisticated process analyses are already looked for, trying to better find the inputs and outputs, the efficiencies, the most vital indicators, their benchmarks, etc. In general, energy and material (mass) balances are required in this stage, besides more difficult measurements of

flows, concentrations, emissions, etc. The waste may be often concealed/hidden, difficult to be visualized by the team. Hence, the need to denude the process, to "talk to the equipment and to the process itself", etc. Every process presents a certain level of inefficiency, there are hardly processes with 100% yield. Hence, the need to unveil its mysteries. At that moment, benchmarking becomes important, as the energy and mass balances will provide us with interesting and vital data for our judgement. By comparing these indicators with those from companies considered to be models/benchmarks, or with the data corresponding to the best technologies available, we will obtain indications of the ways we can select for the best eco-efficiency. Likewise, in this stage 2, the operational performance measurements, the loss and waste valuations, the creation of environmental and operational indicators, etc., go on i.e. the same tools are used, but in a more incisive and deeper way.



- **Stage 3: Cleaner technologies and products**

This is the maturity stage of the program. After the fruitful attacks in both previous stages, the losses, the residues, the pollution and the wastes have a considerable reduction. The following step would be the change of technological level, in both processes and products. The product eco-design and the implementation of cleaner technologies begin to receive evaluations to be implemented. We will speak about cleaner technologies for the pulp and paper sector in another section later on.

The eco-design of the products is a process involving their life cycle evaluation ("from the cradle to the grave"), trying to alter their impacts, minimize their environmental negative effects and guarantee better performances and durability for the consumers. When promoting the eco-design of a product, one is determined to:

- Minimize the consumption of materials for its manufacturing;
- Avoid using dangerous raw materials;
- Use renewable resources, as the case also of fuels;
- Extend the service life time;
- Allow recycling;
- Allow upgrading or modernization's;
- Generate little wastes at manufacturing;
- Let it have a clean death at the end of its use.

With these practices, the company becomes cleaner, more efficient and more attractive for the investors. The products may be even environmentally labelled, the company's image is definitively improved and the share values at the stock exchange markets can be maximized. The legal aspects will be hardly a source of concern and the relations with the interested parties can likewise develop with transparency and maturity.

Hard work is required to reach this comfortable situation. It is not recommended to go through these proposed stages in a hurry and out of order, it is important to overcome first both initial stages. As a matter of fact, the three stages can develop simultaneously, but we cannot want to begin by the third one. If the concepts and good practices are not very well developed during stages 1 and 2, stage 3 would have little chance of success, if it were implemented at once. The simple purchase of cleaner technologies and the changes in the concepts of the ecological design of the products might get easily lost in case the workers' teams are not able to value the eco-efficiency. A clean technology may be easily converted into a dirty technology by poor operation and little attention paid to the environmental indicators. Likewise, a product designed to be environmentally correct may be converted into a product like the remaining ones, with its environmental negative impacts greatly enlarged by the low sensitivity of the company's people manufacturing

it. For these reasons, the ideal procedure is to take safe and not very hasty steps, the speed of which may be controlled by the conquests aimed at in the chronogram. More radical changes are more effectively conquered and sustained when people experience them and get involved with them. And such a process is gradual, as it changes the technology, changes the product, but it must also change the organizational culture and people's behavior.

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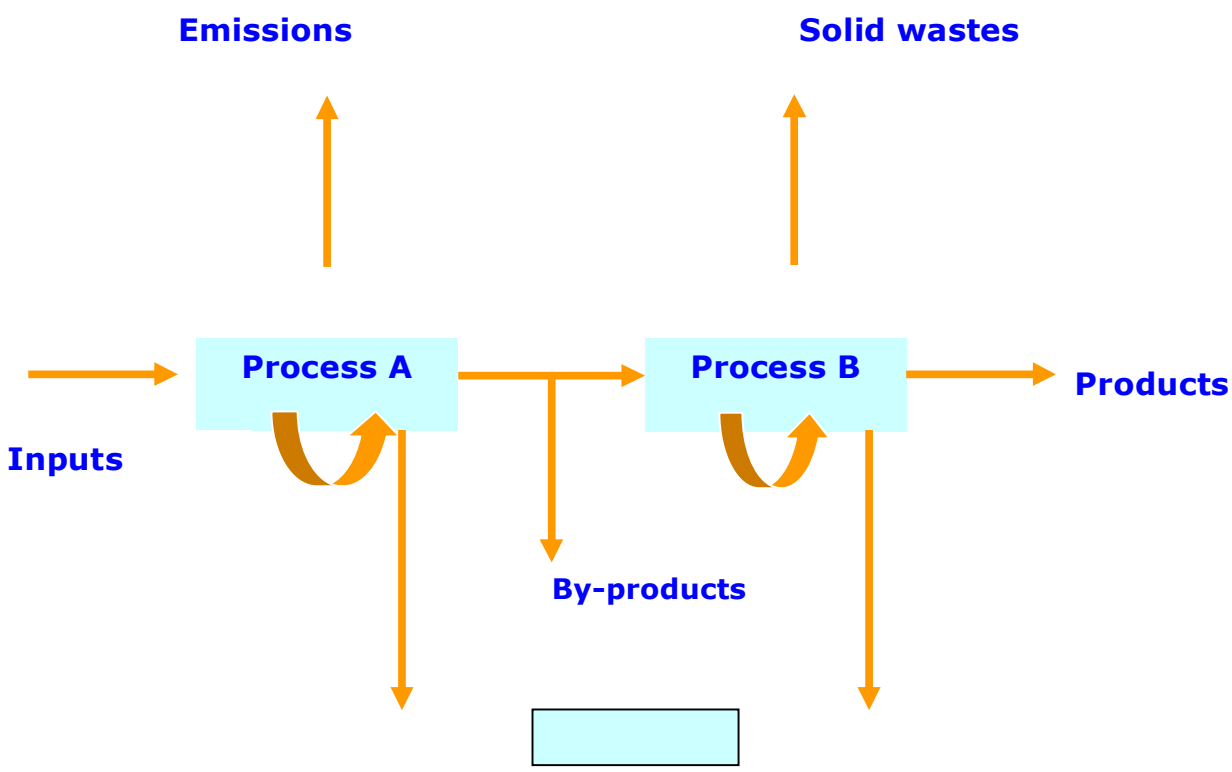
MASS AND ENERGY BALANCES AS CLEANER PRODUCTION TOOLS



Working out mass flow and energy transfer and utilization balances belongs to the strategies to minimize or to eliminate the losses and to find the inefficiencies. A material or mass flow balance consists in fact in following the way the materials (elements, compounds, substances) run along the production process. They may be done either in a wide scope, involving control units or with a scope as wide as the whole mill, or an area of the company.

They may be also applied to a small process, system or even to a simple equipment. A material or mass balance is based on the mass conservation principle, which defends that everything entering a process or a system must leave it in some way, after deducting the fractions that remain stored in it. However, there are situations where there occur chemical reactions with material changes in terms of weights, physical states and/or volumes. They must be also taken into account. Thus, for more complex balances it would be good to have the participation of people with technical qualification to apply them.

The eco-balances or mass and energy balances with environmental purposes are carried out to observe the environmental or ecological effects of the process in evaluation. Since there exist losses or residue generation in this process, which turn into pollution, the balances allow identifying and quantifying them better.

Then the eco-balances have the following purposes:

- To identify the ways followed by the raw materials through the company, as well as their points of accumulation, storage, transformation and losses;
- To identify the points where the residues and the polluting emissions appear in the process;
- To define measuring priorities;
- To quantify the losses and emissions;
- To identify the inefficiencies;
- To value the losses and the wastes;
- To establish manners of minimizing the inefficiencies;
- To identify costs and returns involved;
- To create simple and vital indicators.

The following definitions are required to apply energy and mass balances:

- Which is the process or step one desires to monitor?
- Which are the parameters one desires to evaluate?
- What is the control unit (scope, or what is included in the study and what is not...)?;
- Which are the inlet and outlet flows into and from this control unit?
- Which are the identified intermediate and final storage's?
- Which is the period of evaluation?
- Which are the identified vital stages and key operations?
- Which are the interrelations between the found variables?

Then a basic flowsheet should be drawn, containing the inlet and outlet flows plus the storage's, accumulations and detected chemical transformations. To do all this, the most reliable measurements or data as possible are

required, often unavailable at the company, such as: temperatures, pressures, flows, concentrations, consistencies, storage levels, etc.

If possible, an Excel type or similar spreadsheet should be developed, so as to transform this balance into a process optimization tool for the operators.

As the balance is ready in its several stages, the final stage is the interpretation of the data obtained, by means of which it will be possible to calculate several measures of efficiencies, yields and qualities of operations. These determinations may be associated with costs, which facilitates decision making for the cases where investments are required.

In the following, some suggestions are listed for the improvement teams carrying out their material or energy balances:

- To conduct the flow analyses by steps;
- Estimations are better than not to do anything or to give up;
- Estimations can be gradually improved as progresses are obtained in information and data collections, preliminary tests, simulations, gaugings, etc.;
- To use simple and calibrated measuring instruments;
- To develop indicators of performance and environmental impacts;
- To test the finished mass & energy balance accuracy, checking it with the practical data (how near to the practical data are the data estimated by the balance?)
- When required, ask the equipment suppliers for information;
- To transform the balance data into formats and reports that can be understood by the groups who must be persuaded to take advantage of the data obtained (include currency units, operational performance measurements, control tables and graphs, photos, etc., etc.)

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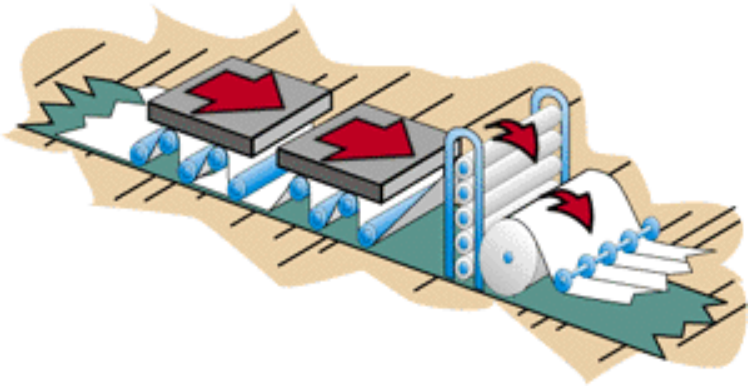
OPERATIONAL PERFORMANCE AND PROCESS CONTROL



We know that there exists a rather true and even fundamental rule for the pulp and paper sector, which reads as follows:

"Production is the great priority, the machines cannot stop"

Then, how to break the paradigms associated with this rule, that may be extremely harmful to the environment and to the process and the product qualities? How to guarantee high productions thanks to the better efficiencies of the machines and the people operating the machines? In this section, we will discourse on the operational performance and on the ways of improving it and consequently also increasing the eco-efficiency. After all, mills operating well and with minimum wastes generate less pollution, less residues, less broke and better results. This is one of the major foundations of eco-efficiency. When the production is better carried out, the environmental impacts decrease.

The good machine runnability and process performance are the dreams of all managers and operators of a *Eucalyptus* pulp or paper mills all over the world. Everybody knows that when producing with a sustained production capacity, the machines will stop less, will generate a larger amount of correctly manufactured products and will waste less steam, less electric power and less fibers and the work will be facilitated and less stressful. Machine shutdowns always involve problems, especially those associated with losses. The latter in turn will be transformed into pollution or give rise to reworks and reprocessing. Furthermore, until the machines will resume their previous rhythm, new amounts of energy and raw materials are consumed, besides the fact that this new production may be off-grade, out of the product specification limits. The rejected products will require reclassifications, reprocessing, higher

consumption's; there will be more losses and further costs. A great waste of natural resources and time!

In short, a large part of our wastes originates from the poor or mediocre operational performance.

To reinforce the concept, let's have a look at what we lose or which problems are generated by a poor operational performance:

- Lost raw materials;
- Machine shutdown time;
- Machines running below their capacities;
- Longer idleness in the process;
- Wasted energy (steam and electricity);
- Lost fibers;
- Lower yields;
- High stored amounts of raw materials ands products, which means higher working capital required;
- Larger amounts of broke, which mean lower proportions of correctly manufactured products, as they should be according to the specifications;
- Higher broke reprocessing required;
- Disorganization on the work, resulting in accumulation and rework;
- Production planning, purchases, sales are not fully fulfilled;
- More machine maintenance requirements;
- Customers receiving off-graded products or not receiving products at all, due to unavailability of products in due conditions to be forwarded to them (customer loss, as consequence);
- Higher water consumption resulting in overflows, drainages, due to flow unbalancing, etc.;
- Loss of workers' motivation.

All this appears in the form of higher costs, more pollution, more residues to treat and to dispose of and much poorer business results. Our inefficiencies will be directed towards higher production costs, lower results for the company and larger amounts of residues/pollution. Absolutely true and unquestionable. Thousands of practical examples confirm what is being said.

Nowadays, there is no way any longer to transfer the inefficiencies to the customers by increasing the sales prices of the products. These prices are driven by the market. If we lose more, if we waste more, our results will be poorer, it is perfectly understandable, do you agree? In other words, the profit of the company is done by ourselves, not just by the financial area. Since it is not worth while to throw money away, let's plunge into this fight with good will and determination. We are our company, remember this. It is incumbent upon us to do our part.

In terms of human resources, we should remind that:

"People can:

- Know or not know;
- Want or not want;
- Do or not do;
- Do well or do badly."

"We need people who know, want, do and do well."

There are often so obvious things to improve, that we are even ashamed of saying how and why we have not yet done them. After all, this is once again a behavior of conformed, not sensitized human beings, totally blind to the opportunities.

The efficiency or operational performance measurement is a way of checking the conformity of our performance with the excellence objectives we may have for our mill or our machines. It is very important that the companies monitor themselves with regard to objectives associated with operational performance indicators. ABTCP – Brazilian Technical Association of Pulp and Paper – has made a great effort to develop indicators that may serve as benchmarking for the companies of that sector in Brazil. This can be confirmed by the various publications the entity has launched about this subject. There are several working groups engaged in this development for the pulp and paper manufacturing and liquor recovery cycle. Reference and benchmarking indices are developed for the mills to compare themselves on both domestic and international level.

Whenever we want to know how competent we have been to operate our mills and our machines, we can look at some performance indicators we are measuring. The most usual ones are as follows:

- Machine availability: it is the proportion of hours, expressed in percentage, that our machine under consideration was available to operate with regard to the total scheduled calendar hours. For example, if we have 99% availability for our pulp production digester, this means that it was in a position to be operated during 99% of the scheduled calendar time.

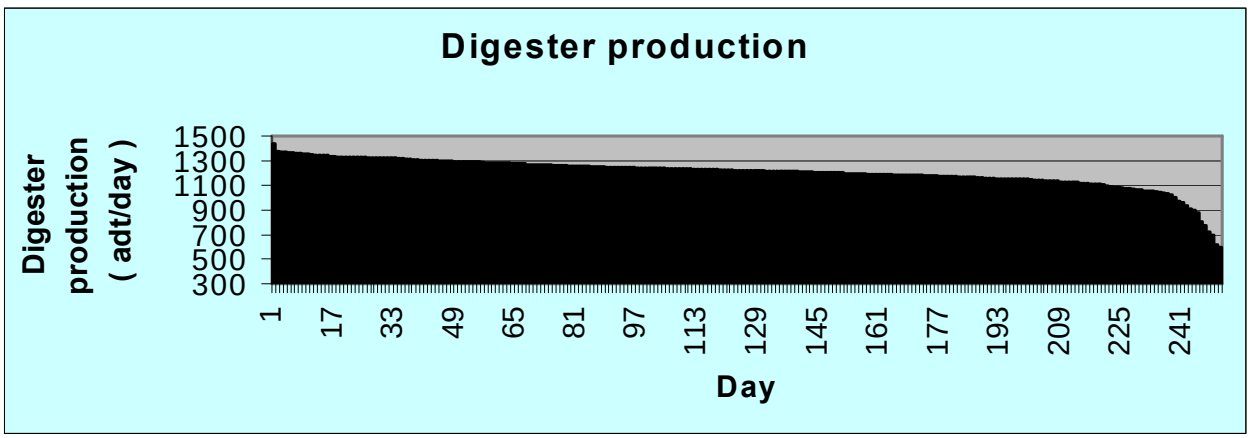
- Use of the time with regard to the availability: it is the proportion of the effectively used time to the time available for operation. In case a digester has taken advantage of only 95% of the time made available for its operation, this is possibly due to other mill areas which prevented it from operating, such as: causticising (lack of white liquor); recovery

boiler (lack of burning capacity); turbo-generator (electric power shortage), power boiler (steam shortage), etc. In such cases, the lost production is irreversible, the heart of the mill stopped operating and the market pulp or finished paper will be correspondly reduced as tonnage's of saleable products.

- Performance with regard to the sustainable production speed or flow: it is the relationship between the effectively practiced production and the production considered to be sustainable for our manufacturing unit. For example, our digester may have a sustained production capacity of 1,250 adt/day, but during the month, during the time it has operated, it produced on average 1,180. Therefore, it is below its capacity and yields lower results to the company. Then its flow or speed efficiency will be:

$$100 \times (1{,}180/1{,}250) = 94.4\%.$$

Each company has a sustainable production capacity. The same equipment may perform better at one company, as compared to other ones. There are several criteria to determine which is the sustainable production capacity. In general, they are related to typical dayly productions, as the untypical days, in which there were stocks accumulations, among other things, are discarded. Ranging the daily productions in decreasing order for a longer period of operation, as for instance, for the last semester or year, it can be considered to be sustainable the production that was achieved in the range of the first 10 to 20% of the ordered operating days. This means that the mill has productive capacity to produce it and if it does not do it continuously, this only occurs due to problems which must be discovered, managed and optimized.



Sustainable digester production: 1,250 adt/day

- Quality yield: it is the percent relationship between the amount of accepted product and the total amount of manufactured product. Let's say that our kraft digester had several production anomalies and as a consequence it produced larger amounts of rejects (not completely cooked chips). Instead of pulp within the predefined kappa number limits, it generated more knots or uncooked rejects. In general, the amounts were 0.5% air dried pulp basis and increased to 2%, which means that the digester knot or reject generation grew for a certain period by 1.5% dried pulp basis. Now let's suppose that this only occurred during 24 hours in a month of 700 operating hours. Based on these data, a loss of 10 tons of pulp in the month can be calculated, which would then result in 0.03% yield loss, or 99.97% accepted quality yield.

- Loss due to the broke that must be reprocessed (when this occurs):

  Reprocessing the broke implies using the machine capacity to rework something that should be already finished and/or even sold. When recycling an exceptionally higher reject to the digester feeding line, we will be reducing its capacity to produce more pulp, since less virgin chips will be fed due to the fact that the reject is being sent back to the digester. The reject occupies room of the useful digester volume, which might be used by virgin chips instead of it. In our example, this corresponds to about 7 tons lost during those 24 poor operation hours. Then the loss would correspond to 0.02% and the yield of that stage to 99.98%.

Global efficiency (GE): it is obtained by multiplying the different partial indices i.e. =

GE = 0.99 x 0.95 x 0.944 x 0.9997 x 0.9998 = 0.8874 (or 88.7%)

We have lost over 10% of our capacity to produce well as a function of miscellaneous problems. Thus, we will be worsening the utilization of valuable natural resources, such as: electric power, water, wood, fibers, steam, caustic soda, etc.

Starting from these data and operational performance, our managers and operators can conduct more detailed analyses, as already mentioned in the item about basic eco-efficiency and cleaner production concepts.

Among these reflections, the following can be highlighted:

- Which are the critical processes of the area in question?
- Which are the key operations, the vital ones, causing enormous inefficiencies if not carefully managed?
- Which are the vital indicators to be measured and which are their optimum levels?
- How reliable are the data being shown on the process control computer screens? And those from evaluations made by the laboratory, maintenance, operation, etc.?
- Which are the sustainable capacities of the machines under our responsibility?
- Which are the major items causing losses in the area under analysis?
- Which are the major cost generating items?
- Which are the costs of our poor (or not so good) operation?
- Which are the causes of inefficiencies or losses, wastes, reworks, broke, wastes, off-grades, residues, etc. in the area?
- What do these losses amount to in physical and economic terms?
- Which are the shutdown and idle times?
- Which are the causes of reduction in machine production?
- Which are the intermediate and product stocks and which are their rotations?
- Which are the opportunities to simplify, rationalize and improve the process?
- Which are the opportunities to reduce wastes and to improve efficiencies?
- Which is the value of each opportunity in economic, environmental and social terms?
- Which is the payback of each evaluated opportunity to optimize performance and efficiencies?

For all these evaluations and analyses to be suitably carried out, operators and managers must be attentive to 12 basic process management rules, as follows:

Rule 01: Focus on the external and internal customer;

Rule 02: To develop leadership and to practice delegation / empowerment;

Rule 03: To involve, sensitize and commit the people;

Rule 04: To understand the process very well;

Rule 05: To like or even to love to work with technical, operational and people's management;

Rule 06: To strive for continuous improvement;

Rule 07: To speed up the decision making process;

Rule 08: To commit oneself to complying with the strategically decided implementations;

Rule 09: To monitor, measure and control the implementation process, in order to guarantee the good quality of the opportunity being implemented, as well as to sustain the achieved improvements;

Rule 10: To have the process aligned with the strategies of the company;

Rule 11: To avoid an excess of bureaucracy, controls, explanations, justifications, documentation's, etc.

Rule 12: To rejoice, celebrate and recognize the gains achieved by the team and the people involved in the process of developing eco-efficiency and cleaner production at the company.

After all, nothing different from any other kind of program, all of them implying that success is achieved by enthusiasm, motivation and dedication of the team, as well as of the leaderships involved.

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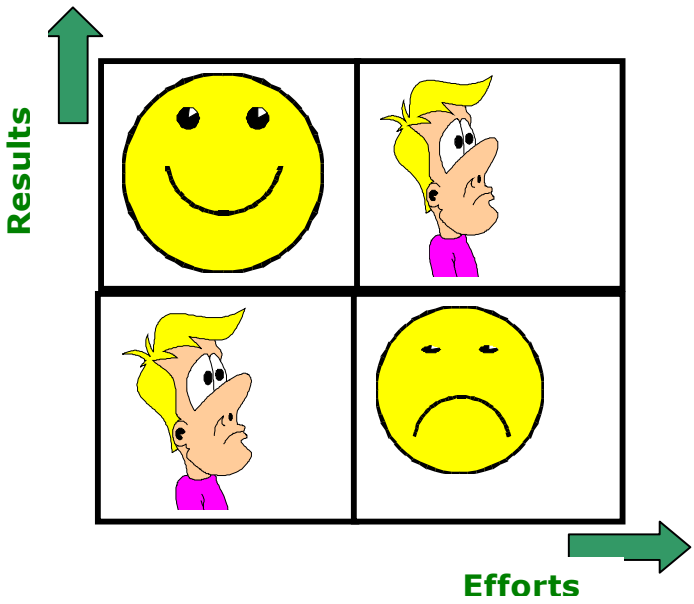
VALUING WASTES, RESIDUES AND INEFFICIENCIES, WITH THE FOCUS ON SUSTAINABILITY



The decisive step for our activity of developing eco-efficient solutions for our *Eucalyptus* pulp and paper manufacturing process is to know how to quantify the wastes we are generating in their economic, environmental and social values. It is only by means of a suitable quantification and valuation that we will be able to know whether the alternatives we have available to solve the problem are efficient, cost-effective and capable of complying with the purposes of sustainability. It should be born in mind that by sustainability it is understood to thoroughly comply with the three pillars of sustainable development: the economical, the social and the environmental one.

To facilitate this evaluation, we have developed a simple procedure, which aims at analyzing the poor operational efficiency problem we are having, which is leading to wastes and inefficiencies. Thus we try to find the real losses and their values in terms of sustainability.

We will try to show this procedure in the form of a case study, with the purpose of exemplifying the ways of unfolding the problem in terms of its quantities and values.

In the chapters to follow about this theme in our Eucalyptus Online Book we will present numerous possibilities, opportunities and alternatives for a cleaner and more eco-efficient production in this business segment, dissecting it in three of its sectors: forest-related, pulp production and paper production. Those new chapters will continue the present one you are reading now, in order to make you better acquainted with the tool we have been using.

Then let's call this exercise, that will be done step by step, as follows:

"**Managing and selecting eco-efficiency and cleaner production opportunities for the pulp and paper industry**".

Each of the 14 steps will be given a denomination and should be taken in its chronological order. Trying to anticipate the action by jumping steps might result in an incomplete evaluation and this in turn might impair our conclusions and decisions.

Case study: Effect of poor pulp washing ("hidden waste" in the form of chemical and organic "carry-over")

- **Step 01: Detailed problem description**

We have chosen as example a problem that is rather common in our industrial pulp manufacturing sector: the pulp washing before pulp is sent to bleaching. When this process is unsuitably carried out, the pulp carries along more dissolved organic matter and alkaline compounds (NaOH, Na_2S, Na_2CO_3) to the first bleaching stage, consuming more chemical reagents and generating more pollution. In that bleaching stage those pulp contaminants will consume more active chlorine, will increase the bleaching costs, will generate additional pollution to be treated and eventually may reduce the mill production.

Let's then describe our problem in detail:

Our mill produces bleached *Eucalyptus* pulp by the kraft process by means of cooking in a continuous digester, followed by oxygen delignification, pulp washing, screening and bleaching in a 4-stage sequence (DoEopDP). The active chlorine consumption in both chlorine dioxide stages amounts to 30 kg active chlorine per bone dry ton (bdt) of pulp at bleaching inlet: 22 kg/bdt are applied in the first ClO2 stage and 8 kg/bdt in the second one.

The mill produces per day the equivalent to 1,900 bdt of unbleached oxygen delignified pulp, which corresponds to a final bleached pulp production of 2,000 air dried tons (adt) per day. However, the mill has enough capacity to increase this production by further 100 adt/day of bleached pulp without any problems, as it has capacity room in kraft cooking, oxygen delignification,

bleaching, drying, causticising and lime kiln, evaporation and recovery boiler areas.

The two present production bottlenecks correspond to brown pulp washing and chlorine dioxide production. The pulp washing plant was poorly engineered and showed to be insufficient to meet this present production. As a consequence, it poorly washes the pulp and delivers it to bleaching at the final washing press outlet at a lower consistency than the project value (project = 30% and present = 25%). Thus, the alkaline loss in kg NaOH/bdt of delignified pulp, which should be 8 kg NaOH/bdt, corresponds to 12. The organic matter carry-over in COD (Chemical Oxygen Demand) is also well above the target value of the project (project = 10 kg COD/bdt; at present = 15 kg COD/bdt). The result of such conditions is disastrous for the active chlorine consumption in the first chlorine dioxide stage, as there is a consumption of 22 kg/bdt, while just 19 kg/bdt might be consumed in case the pulp were washed according to the project specifications.

There is also an important limitation at the chlorine dioxide generating plant. Its maximum daily production capacity is 57 tons of active chlorine or 21.7 tons of chlorine dioxide as such. In case pulp washing section was capable of meeting the values specified in the project, the total active chlorine consumption in both ClO_2 stages would decrease to 27 kg/bdt. Thus, the 57 tons daily produced by the chemical plant would be sufficient to bleach 2,111 bdt/day of unbleached delignified pulp. This means that the mill would have capacity to easily produce the additional 100 tons (adt) per day of bleached pulp, which is the dream of the company's managers and technicians. Without limitations in terms of raw materials, inputs and technologies, poor washing and the chlorine dioxide generating plant are preventing this dream from becoming reality. In the present situation, the company has an excessive chlorine dioxide consumption, a "luxury consumption", due to the excess of contaminated filtrate, which carries along inefficiencies to the first ClO_2 stage.

Step 02: Problem interpretation

Our mill has a "hidden waste" in its process. It is an additional amount of a dirtier filtrate in terms of organic matter and alkaline compounds, which the delignified pulp carries to the bleaching process. This occurs due to a deficiency of the unbleached pulp washing step and this hidden waste will demand a certain chlorine dioxide and acid additional consumption's at bleaching, thus increasing pollution, increasing costs, impairing pulp quality by "overchlorination – chemical overcharging" and reducing the production capacity of the mill, since the chlorine dioxide production is limited. These facts are leading as well to an increase in pollution to be treated and a higher generation of sludge and final pollutants.

Step 03: Preparation of an input and output flowsheet in order to identify the problem and its interference's within the area and with other mill areas

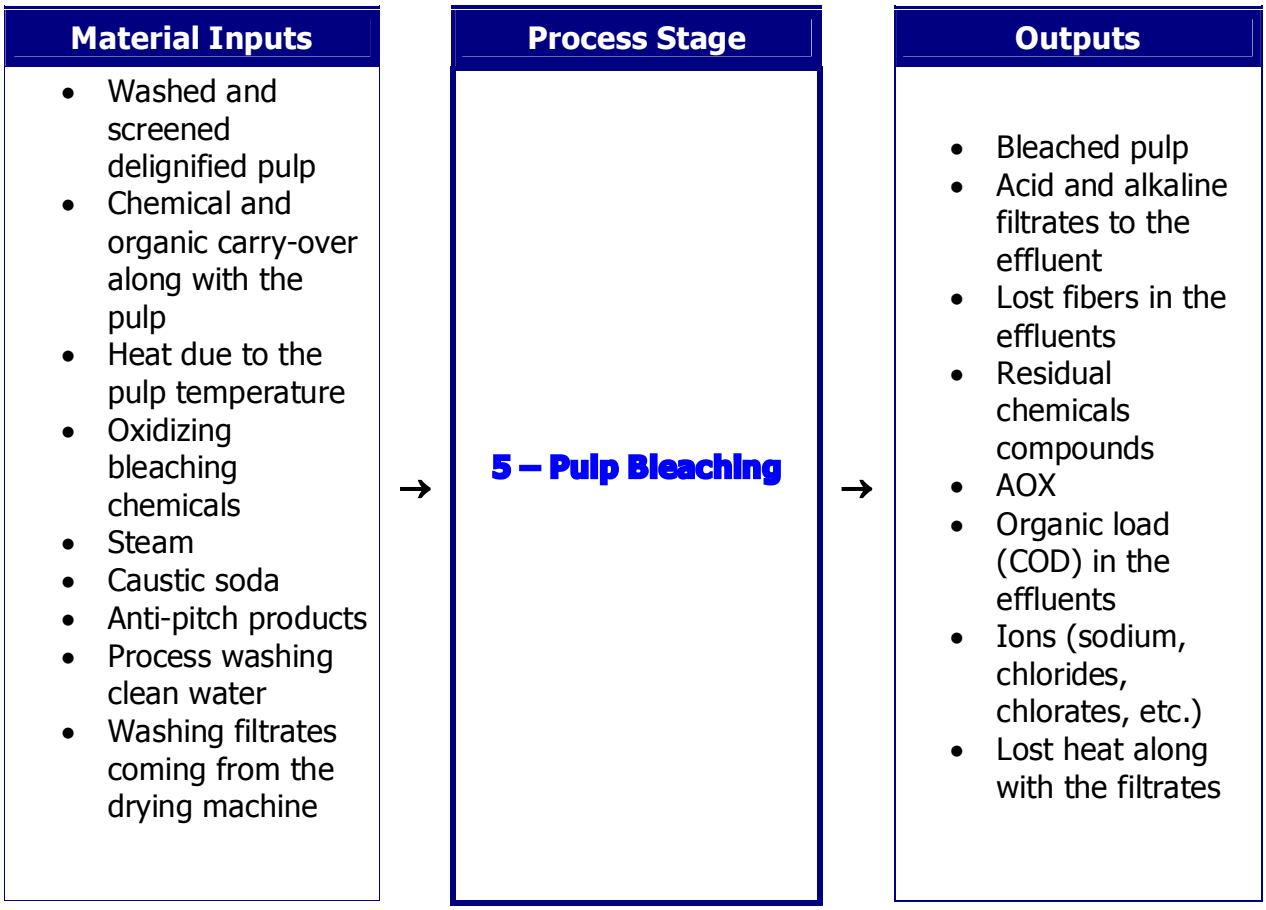
There are several ways of doing this, from which we have opted for a simpler but equally efficient one. Therein, we describe the process from wood and liquor inlet into the digester to the bleaching stage outlet. Thus, we try to identify the inputs and outputs of each control volume. This will make easier to understand how our poor washing interferes with other areas of the process, not only with the oxygen delignified pulp bleaching.

Material Inputs	Process Stage	Outputs
• Wood chips • Water • White liquor • Steam • Recycled black liquor	→ **1 – Kraft digester** →	• Kraft pulp • Cooking rejects • Shives • Residual black liquor • Heat along with the pulp and liquids • Flashed steam

Material Inputs	Process Stage	Outputs
• Dirty pulp • Black liquor • Fibrous contaminants (rejects and shives) • Washing water • Washing condensates • Chemical drainage agents, surfactants, etc. • Anti-pitch chemicals	→ **2 – Unbleached Pulp Washing and Screening** →	• Dirty filtrate to evaporation • Washed unbleached pulp • Rejects • Shives • Lost fibers in the washing filtrates to evaporation • Chemical and organic carry-over with the pulp • Heat with the pulp stock and filtrates

Material Inputs	Process Stage	Outputs
• Washed and screened pulp • Oxygen • Caustic soda • Filtrate with chemical and organic carry-over • Shives • Steam and heat	**3 – Oxygen delignification**	• Delignified pulp • Residual filtrates • Fiber losses • Organic and chemical carry-over along with the pulp, in the filtrate • Heat accompanying the pulp and filtrates • Shives

Material Inputs	Process Stage	Outputs
• Washed unbleached pulp • Dirty filtrate • Fibrous contaminants (shives) • Process water and/or washing liquid / filtrates • COD • NaOH, Na_2S, Na_2CO_3, etc. • Heat accompanying the pulp and the filtrate	**4 – Oxygen Delignified Pulp Washing**	• Dirty filtrate for unbleached pulp washing • Washed oxygen delignified pulp • Shives • Lost fibers in the washing filtrates • Chemical and organic carry-over with the pulp • Heat accompanying the pulp and the filtrate



Let's now evaluate step 4, where a chemical and organic carry-over charge gets in excess to the desired amount along with the washed and screened delignified pulp.

Step 04: Identification of the problems associated with this deficient washing

Deficient washing brings about a series of undesirable production, environmental and economic problems, such as:

1. Washing efficiency fluctuations;
2. Quality fluctuations of the produced bleached pulp;
3. Additional fiber losses at washing and bleaching due to operational overloads due to lower stock consistency;

4. Higher active chlorine consumption at bleaching;
5. Higher consumption of acid used to correct the pH in the first bleaching chlorine dioxide stage;
6. Higher COD load in the acid and alkaline bleaching filtrates;
7. Higher concentration of COD, Na^+, Cl^- and ClO_3^- in the raw and treated mill effluents;
8. Higher generation of secondary sludge at the WWTP - Waste Water Treatment Plant;
9. Higher concentration of AOX and OX (Halogenated Organic Compounds) in the effluent and in the bleached pulp;
10. Increased eco-toxicological sludge and effluent aggressiveness;
11. Significant operational and economic production losses to the mill due to chlorine dioxide scarcity, thus failing to meet the increase on production due to the additional COD and chemical pulp carry-over;
12. Increased heat loss along with the washed delignified pulp filtrate, due to the lower pulp consistency when being forwarded to bleaching;
13. Lower final bleached pulp quality in terms of its viscosity and its intrinsic strengths, due to the higher chemical active chlorine charge applied along the bleaching line;
14. Higher consumption's of other chemicals in the bleaching process, due to the cascade carry-over effect, very common in these poor initial pulp washing situations.

Step 05: Identification of the possible causes and potential damages for the problems reported in step 04

The best way of practicing this step is working out a series of questions with regard to the process. This may involve the operators and the managers. Thus, the eco-team working on the problem can try to find the problem major causes.

The suggested questions are as follows:

1. Are the present equipment operating and maintenance practices in accordance with the best practices for this kind of system? Are the manufacturers' handbook recommendations being complied by the operation at our plant?

2. Is the equipment design and project capacity being complied with? If not, which would be the discrepancies and for which factors (speeds, temperatures, vacua, pressures, rhythms, flows, consistencies, etc.)?

3. Does the present process and automation control state affect the performance of the system, thereby reducing its efficiency?

4. Is the present technology obsolete and has for this reason an impact on the poor performance and on the generation of this carry-over residue and worse pulp consistency after washing?

5. Which would be the benchmark values for this operation and loss levels?

6. Would the pulp type, its raw material, its cooking and delignification levels, its fibrous constitution, the presence of bark fibers, etc., be affecting the pulp washing performance?

7. Might the qualities and quantities of filtrates, condensates and clean process water be influencing pulp washing?

8. Are the operators aware, motivated, trained? Have they indicators to reach in their operations? Is the information level about the process variables suitable for them?

9. Which are the valuable losses occurring as a function of poor washing?

10. What are the environmental impacts possibly resulting from this unsuitable and inefficient procedure?

11. What are the impacts on people and the community, possibly resulting from this poor washing?

12. What are the impacts of this poor washing on other mill areas associated with the washing system of this pulp: chlorine dioxide chemical generating plant, wastewater treatment plant, evaporation, recovery boiler, solid waste handling and disposal, etc. ?

13. Which are the additional contaminants that we will be taking to the physical and biotic environment where the company is located?

14. How are the final specifications of the company's products and by-products (pulp, sludge, treated effluents, aerial emissions, etc.) being affected by the poor washing efficiency?

15. Etc. , etc.

Step 06: Generation of alternative technical solutions for the problem

In the same way as in the previous step, we can develop a series of ideas from some basic questions that should be always made to the process, to the operators and to the managers.

The suggested questions are as follows:

1. How could the operating practices be improved for the washing system?

2. How could maintenance be improved for the washing system?

3. Are equipment and mill area suitably cleaned (shower nozzle, washing filter screens, floors, motors, etc.)?

4. Are there ways of improving operational control by training people, introducing new automation or control equipment, executing new routines of laboratory analyses, creating new indicators, etc.?

5. How could the present process be modified (without high investments) so as to minimize the problem?

6. Would the proposed mill modifications to improve pulp washing have any kind of impact on the other mill areas associated with washing (operational, technical, environmental, social impacts, etc.)?

7. Would there be any gain for the pulp washing area through modifications processed in other areas of the company and directly affecting the washing area: chip selection, fibrous raw material cleaning, digester, evaporation (condensates quality), chemical plant, etc.?

8. Would there exist any type of exaggerated and unnecessary final product specification (e.g.: excess in target degree of brightness, excessive bleached pulp cleanliness, etc.), which has overloaded pulp washing and bleaching, thereby making these operations more deficient?

9. Is there any kind of internal recycling of effluents, condensates, fibers, etc., that might be destabilizing and impairing washing performance?

10. Is there any type of new technology or technological addition that might be effectively implemented in the washing area in terms of costs, performance and qualities?

11. Etc., etc.

It is very important for the eco-teams to carry out these types of brainstorming in the search for solutions and new working proposals. At this stage of the work all ideas are welcome.

The cleaner production options generating stage tries first of all to involve people in the generation of valid options, some of them deserving to be evaluated and quantified by the team.

Step 07: Quantification of the physical and economic losses due to the operating inefficiencies

At this stage, it is essential to quantify all losses occurred due to the "dirtier production" and to the inefficiencies of our process. These losses occur in the pulp washing area, as well as in areas depending from it. This is essential in our valuations. We must not to concentrate our evaluations just in the area where the problem is happening. This would bring a wrong analyses of the problem and consequences.

Furthermore, the problems generating production losses are vital. As a consequence of the lower production, the company loses results and they are very significant. In addition to these losses there are also those related to the higher input consumption's and higher residue and waste generations. The latter include: higher chemical consumption's, higher water and steam consumption, higher generation of effluents and organic effluent load to be treated, higher generation of sludge to dispose of, etc., etc.

All these precious losses must be very well quantified, requiring some measurements, analyses, evaluations, calculations, simulations, mass and energy balances, etc., to be made by the team involved in the project. It is only through the good identification of the real losses that we will know the dimension of the problem and will be able to better evaluate the alternatives for its solution. Each solution alternative has an investment cost and provides a result. These quantification's will enable us to evaluate the paybacks of the proposed solutions in economical terms i.e. how long it will take for us to retrieve the investments made as a function of adopting these CP solutions. This is the great advantage of the eco-efficiency process and of the cleaner production with regard to other total quality programs. The CP methodology has also a business concept, it searches for environmental solutions having an important step of economic valuation. This occurs because every process loss ends up resulting in pollution and in additional costs due to the loss in itself, as well as to treat and dispose of that pollution. We have already seen this, but it is always good to reinforce important points.

It is at this moment that is interesting to mention the subtle difference existing between both concepts, that of eco-efficiency and that of cleaner production. They are practically synonyms, both of them focus on the losses and on the corresponding valuations. The difference is that eco-efficiency (WBCSD) is based on improving the productive process so as to lose less, produce better and consequently pollute and spend less to treat the losses. It is founded on the concept that better processes impact less on the environment. On the other hand, the cleaner production (UNEP) is founded on solving the problems associated with residues, losses and pollution and thus, with the higher environmental efficiency, obtaining economical gains. (http://www.ecoefficiency.com.au/What%20is%20Eco%20Efficiency.htm)

Furthermore, in our example, many of the cleaner production solutions can be implemented by the company without incurring any additional costs for it: to clean better the shower nozzles and the filter screens, to improve vacuum and pressure controls, to lubricate better the presses, to include new consistency measurements by the laboratory, etc. etc.

By way of example, we will identify for our case study the main physical operational impacts of our poor pulp washing and will try to make a reasonable estimation for each type of physical and economic losses associated therewith.

Impact 01: Higher specific bleaching cost due to a higher chlorine dioxide consumption in 3 kg active chlorine per bone dry ton of delignified pulp. Let's admit that the active chlorine cost is 0.45 US$/kg active chlorine.
Then an additional cost of **1.35 US$/bdt of pulp** results therefrom.

Impact 02: Cost of caustic soda lost as higher loss of alkaline compounds with the carry-over. In our case, the additional alkaline loss corresponds to 4 kg NaOH/bdt. Let's admit the cost of make-up caustic soda to be 0.5 US$/kg NaOH.
Then an additional cost of **2.0 US$/bdt of pulp** results therefrom.

Impact 03: Reduction in the organic matter sent to the liquor recovery system as fuel. The additional COD loss corresponds to 5 kg/bdt. Admitting that 1 kg COD corresponds to approximately 1 kg organic matter, there will be an additional loss of 5 kg matter fuel per ton of pulp. Let's admit that the biomass fuel costs 0.05 US$/dry kg.
Then an additional cost of **0.25 US$/bdt of pulp** results therefrom.

Impact 04: Additional cost at the effluent treatment, in order to treat this higher organic COD carry-over loss (it would be 5 kg COD/bdt at washing). Let's admit that at the secondary level treatment, the variable treatment cost of which is 0.15 US$/kg eliminated COD. The COD treatment efficiency would be 80%. The chorine dioxide bleaching stage, as it is oxidative, has partially

reduced the 5 kg/bdt of COD to 3 kg/bdt, a part of it being now more recalcitrant, due to its chlorine content. It should be observed that from those residual 3 kg COD/bdt going to the WWTP (Waste Water Treatment Plant), only 2.4 will be eliminated by the effluent treatment, while the remaining 0.6 kg/bdt will increase the pollution load discarded into the water stream via the treated effluent. This can be very significant to meet the strict specifications provided by the environmental control organ.
Then an additional cost of **0.36 US$/bdt** results therefrom.

Impact 05: Higher sulfuric or hydrochloric acid consumption in the first chlorine dioxide stage, which acid is added to control the pulp pH at the end of the stage.
Then an additional cost of **0.1 US$/bdt** results estimatively therefrom.

Impact 06: Higher secondary sludge generation and handling by the WWTP (Waste Water Treatment Plant). Let's admit a generation of 0.15 kg bone dry secondary sludge per bd kg treated COD. Then the 2.4 dry kg COD/bdt will be converted into 0.36 dry kg secondary sludge. As the latter will come out at 20% consistency, there will be due to poor delignified pulp washing an additional generation of 1.8 kg secondary sludge as such per bd ton of pulp. Let's admit a handling and disposal cost of 15 US$/ton as such of sludge.
Then an additional cost of **0.03 US$/bdt** results estimatively therefrom.

Impact 07: Cost of lost fibers due to washing overload and lower consistency practiced. Let's admit a loss of 150 bone dry grams of fibers per ton of pulp washed in the system, which it would be possible to recover internally. Let's consider the pulp net price at this stage to be US$ 500.00 per air dried ton.
Then an additional cost of **0.085 US$/bdt** results estimatively therefrom.

Impact 08: Heat loss along with the additional filtrate lost (0.67 m^3/bdt). The filtrate temperature would be at 85ºC and the first ClO_2 stage must be executed at 70ºC. This ΔT is lost, as it is not recovered by the liquor system. It corresponds to approximately 10 Mcal/bdt. Estimated value for the biomass fuel (*Eucalyptus* firewood) of 26 US$/2,000 Mcal i.e. 0.013 US$/Mcal.
Then an additional cost of **0.13 US$/bdt** results estimatively therefrom.

Admitting now a daily mill production of 1,900 bdt of delignified pulp (basis of all these impact calculations in our example), we have the following:

Sum of the specific additional costs of impacts 01 to 08

4.30 US$/bdt

Additional daily costs to produce 1,900 bdt of delignified pulp (calculation basis)

1,900 x 4.30 = **8,170 US$/day**

However, this is not the great economical loss resulting from this poor pulp washing for the mill. This daily loss of approximately 8 thousand dollars is just that corresponding to the additional operational costs it has due to this problem. The greatest loss is the impossibility of manufacturing 100 additional tons of bleached pulp per day, as a function of chlorine dioxide supply limitations.

Then, how to calculate the **production loss value** **or the value due to the non-production**?

It is very simple to calculate the economic loss value of a mill as a result of non-production and consequent lower sales. This loss is often referred to as the non-productive hour cost, but the way of calculating it is the same in both cases. It is enough to know three figures: the net specific sales price, the average specific variable cost of the product, and the saleable production that failed to be produced and to be sold.

When being manufactured, any product is composed of two basic costs, which each product unit must pay for:

- Specific fixed costs: the unit or specific costs of all tasks, services, rentals, etc., which the company has to pay, independently of producing or not. In other words, even if the machine is not running, the company incurs these costs. When it fails to produce it incurs them as well. When it produces more than usual, the total fixed costs are the same and the specific fixed costs decrease i.e. when a larger amount is produced, this additional production helps reduce the fixed cost impact on each product unit.

- Specific variable costs: the direct manufacturing costs - those directly paid for manufacturing the products for selling them later. They consist of inputs, energy, everything used for that manufacturing. If we do not produce, these costs no longer exist. The companies must be able to do this cost separation very well, in order to be able to understand how these costs work and thus to optimize their results.

When our example mill will succeed in increasing its production by 100 tons per day, its total fixed costs will be exactly the same. It will not spend more with rentals, salaries of personnel, advertisements, researches, etc.

Nevertheless, it will have an increase in its total variable costs as a function of the additional requirements of inputs, such as wood, caustic soda, fuels, etc. On the other hand, its turnover will also increase, as it will have a larger amount of products to sell.

Then, let's consider in our example that the specific variable costs of the mill correspond to 280 US$/adt and its net unit sales price is 700 US$/adt.

Specific Contribution Margin (SCM) = NUSP - SVC

where: NUSP = net unit sales price
SVC = specific variable cost

Then the result would be:

SCM = 700 – 280 = 420 US$/adt

As the company will not incur any additional fixed costs to manufacture the new 100 adt/day, its margin of total daily contribution and its daily result will increase by: 100 adt/day x 420 US$/adt = 42,000 US$/day.

In the present situation, these 42,000 US$ are net and additional earnings considered as being lost by the today's poor delignified pulp washing.

Lost Net Results = **42,000 US$/day**

This loss is impressive, is it not? It is for this reason that managers are always very attentive to the production losses at their mills.

Then, the total daily loss caused by poor pulp washing would be:

Total economical loss

=

Additional manufacturing costs **+** Lost Net Receipts due to non-production

That is: **8,170 US$/day + 42,000 US$/day = 50,170 US$/day**

Step 08: Election of the CP opportunities to implement

At this moment, the eco-team should have already made its election of alternatives for improvements that it intends to implement. They are of different kinds, as the evaluation was wide-ranging and comprehensive. Some of the alternatives are simple and immediate, they just refer to better organization and cleaning, operational training, establishment of procedure manuals, handbooks, etc. Some other alternatives correspond to investments, sometimes high ones, but we have now available some ways of better quantifying the returns and the paybacks. We also know which will be the impacts that will be minimized in environmental terms by using less natural resources and by the lower pollutants generation.

It becomes easier to work out a table presenting the alternatives to pay attention to, the corresponding investments and the new operational costs that will be incurred. It must be clear that some of the proposed alternatives will add new production costs in terms of electric power, steam, etc. Therefore, the value of savings we have estimated to be 8,170 US$/day will change and it is important to know to how much.

Cleaner production alternatives: preparing and evaluating the selected cleaner production alternatives

Data are given just by way of example

Practices and techniques for improvements in the operational efficiency	Cleaner production alternative to be implemented	Investment requirements US$	Additional operational cost to render the improvement effective US$/day
Cleaning & Organization	• Better shower nozzle cleaning • Better filter screen cleaning • Better pneumatic press equipment adjustment and lubrication	zero	zero
Process control	• To create maintenance indicators for the washing section • To create operational indicators for the pulp washing area • To negotiate new laboratory analyses of alkaline losses, COD carry-over, consistencies, etc., with the laboratory • To install pressure and vacuum gauges online	150,000	200
Present washing area equipment modifications	• To replace the barometric leg with a vacuum pump at one of the washing drums • To replace the pressing system at one of the washing presses	780,000	1,850
Technological change in the washing area	• To install one more complete washing press at the delignified pulp washing end	1,250,000	1,300

Changes in other similar and correlated areas	• To install in the evaporation area a cleaning system for quality improvement of the clean condensate used at pulp washing	1,000,000	850
Recoveries in the washing area	• To send the filtrate with fibers to the fiber recovery filter existing at present in the process	50,000	(-160) Net gain with the recovered fibers
Bleached pulp specification changes	• No changes	zero	zero
Saleable by-product generation	• It does not occur	zero	zero
Total amounts		**3,230,000**	**4,040**

Cleaner production and higher eco-efficiency alternatives

Step 09: Global balance and investment payback calculation

We had calculated that the implemented modifications would allow additional results of 50,170 US$/day. The suggestions made by the eco-team were significant as a function of the potential conjectured gains. The new investments would be evaluated in US$ 3,230,000 and the new additional production costs would amount to US$ 4,040 per day.

The daily net balance in terms of results would be:

50,170 US$/day - 4,040 US$/day = **US$ 46,130 / day**

Investment payback = US$ 3,230,000 / US$ 46,130 = **70 days**

This means that thanks to the substantial increase in production that will be achieved with the high investment of approximately 3.3 million dollars, this investment will be paid within about 70 days of normal operations in the optimized situation. Fantastic, isn't it ?

Step 10: Quantification of the environmental gains of the project after implementation

Besides the substantial economical gains, we will have important environmental gains, such as those estimated in the following:

- Lower water consumption: 1,400 m^3/day
- Lower fiber loss: 160 bd kg/day
- Lower secondary wet sludge generation: 3.4 t/day
- Lower loss of Na^+ through the bleaching filtrate: 4 t/day
- Lower loss of Cl^- through the bleaching filtrate: 3.5 t/day
- Lower loss of COD to the WWTP + higher internal recovery: 9.5 bdt/day
- Lower heat loss through the hot filtrate: 19 Gcal/day
- Lower chlorine dioxide consumption in bleaching as compared to present tonnage: 2.17 t ClO_2/day
- Lower chlorine dioxide consumption in bleaching even when compared to the new 2,100 bleached adt daily pulp production: 1.19 t ClO_2/day
- Lower AOX generation in the effluent: 20 kg/day
- Lower acid consumption in Do stage: 1.5 t/day

Step 11: Quantification of the social gains of the project after implementation

With the better pulp washing plant operation, with no plant overload any longer, it will be easier to operate, which will result in:

- Greater operational safety;
- Lower risks of accidents and emergencies;
- Better cleaning of the area;
- Greater esthetic beauty;
- Easier and less stressing operation;
- Less conflicts between areas.

It is interesting to quantify these improvements with numbers (statistics on accidents in the area, sectorial research on operational climate, life quality, etc.).

Step 12: Working out a detailed report for the administration

After electing the CP options to improve pulp washing eco-efficiency before the bleaching line and after making the due quantification's and valuations, the team must now work out a concise and objective report containing the suggestions and results expected for the proposals they want to present and to implement. There is no such mill manager who is not to be delighted at the prospect of increasing the mill production by about 5% and having an investment payback of just 70 days. After all, 70 days after start-up of the new proposed facilities, the mill will be already yielding additional US$ 46,130/day and the production will reach the 2,100 adt/day dreamt of. Besides these operational and economical gains, significant environmental and social gains are also projected by the cleaner production team. This is exactly what it is expected with the cleaner production and the eco-efficiency: "to do more using less natural resources; to do better with less environmental impacts; to reduce residues and wastes".

You can see by yourselves that this case study contains the conditions delighting the main concerned interested parties and players in our entrepreneurial and business ecosystem:

- The shareholders (better results);
- The production managers (higher productions);
- The state environmental control organization (lower environmental impacts);

- The environment (lower impacts and consumption's of resources);
- The employees (smoother operation, greater safety and lower stress and conflict levels).

Step 13: Generation of documentation and procedures for sustaining the gains

Upon decision approval by shareholders and managers, now it remains to implant the project. However, this does not end with the mere change in machines and procedures. The eco-team must also create the indicators and the rules to monitor whether the expected gains will be reached and maintained in the long term. Also required is an evaluation of the potential barriers that may come to interfere with this project from its conception to its operation at the operational maturity stage. The potential new conflicts and new interrelations among the various mill sectors must be understood, as otherwise what might seem a remarkable gain ends up failing to be accomplished.

Step 14: Rejoicing and commemoration

Every team participating in a project, be it complex as this one or even a much simpler one, is gratified at the gains and at the company's, the managers' and the fellow employees' acknowledgement. A good way of acknowledging this is by training the personnel in courses, events, visits and participation in pulp and paper meetings, exhibits and conferences. It is also interesting to invest part of the gains in indoors technical improvement and educational resources (books, library, free and available Internet for everybody in the mill site, etc.)

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CLEAN TECHNOLOGIES FOR KRAFT PULP MANUFACTURING

In other publications and articles I have already written which are nowadays the best environmentally most advanced technologies to produce bleached *Eucalyptus* kraft pulp in today's most sustainable way. We will call these technologies as clean technologies, or cleaner technologies. As a matter of fact, with the quick technological evolution, many of them will be soon replaced by other more efficient ones, having less impacts on the environment. This is the game, always changing to higher efficiencies and lower consumption's of natural inputs. This is good, for both companies, environment and society.

Anyway, I would like to suggest that you access the following web addresses, in order to read this material. Definitively, there are excellent suggestions, representing some of the best of all existing technologies for this kind of industry. As a rule, the articles are concerned to technologies being used by the most modern pulp mills in operation in this middle of the first decade of the 2000s. There are also suggestions from me to even further environmental and operational performances.

- ECF and TCF Bleaching Sequences for *Eucalyptus* Kraft Pulps

http://www.eucalyptus.com.br/newseng_may06.html#quatorze

- Modern Bleached Kraft *Eucalyptus* Pulp Fiberlines

http://www.eucalyptus.com.br/newseng_jan07.html#quatorze

- Best Available Technologies and Best Environmental Practices to the Production of *Eucalyptus* Bleached Kraft Pulps

http://www.eucalyptus.com.br/newseng_mar07.html#quatorze

- Best Available Techniques to the Manufacture of *Eucalyptus* Pulp (a continuation on this topic)

http://www.eucalyptus.com.br/newseng_july07.html#cinco

- The *Eucalyptus* Bleached Kraft Pulp Manufacturing and the Water Consumption

http://www.eucalyptus.com.br/newseng_may07.html#quatorze

- Closing Water Cycle for Further Reductions on Water Consumption in the Manufacture of *Eucalyptus* Bleached Kraft Pulp

http://www.eucalyptus.com.br/newseng_july07.html#quatorze

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FINAL REMARKS FOR THIS INTRODUCTORY CHAPTER ON CLEANER PRODUCTION AND ECO-EFFICIENCY

We had not in the least the purpose of being exhaustive when writing this chapter about eco-efficiency and cleaner production for the *Eucalyptus* pulp and paper industry. As a matter of fact, this first chapter had rather the mission of introducing the reader to the fundamentals and routines of these tools, as it may have been noticed by you upon reading it. It is very important to be very well-acquainted with the tools and the ways of implementation and application. I hope that the case study example and the opportunities reported herein may have been useful to you. Success will depend on much study, evaluation, quantification, creativeness, implementation, knowledge, participation and determination. Dialogue, conviction, consciousness and commitment are important as well. To sustain the implemented improvements is also essential. In other words, after achieving the highest possible eco-efficiency it should be maintained, which is not as simple as it seems to be. Therefore, the team must keep motivation and an attentive look. It is also necessary to keep alive the flame of searching for solutions to the waste, pollution and residue generation problems, including the new ones to come.

We will come back with many further examples and opportunities in the chapters about cleaner production and eco-efficiency to follow in our Eucalyptus Online Book. Keep attentive, they will be soon coming to you.

I would like to close this chapter with a parable by an unknown author, very easy to be found on the Internet. It is something very appropriate to our daily situations. It even applies to our lives as citizens and at our homes. The parable concerned is titled "The Blue Dress", which maybe many of you are already acquainted with. Anyway, read it and have your hearts touched by it. At the same time, reinvigorate your energies to help change the world and your pulp mill for the better and better.

If you like it and would like to have something on the same level, read also "Flight of Geese", also available on the Internet and with some addresses for access in the section Literature References, which follows the present section.

Parable:

"The Blue Dress"

"A beautiful little girl was living in a very poor district of a distant town. She attended the local primary school. Her mother did not care very much about her, so that the child was almost always dirty. Her clothes were very old and in bad repair. The teacher felt pity for the girl's situation. - "How does it happen that so pretty a girl comes so untidy to school?". He put aside some money from his salary and although with difficulty he decided to buy a new dress for her. She was very pretty in the blue dress! When her mother saw the daughter in that beautiful blue dress, she felt that it was regrettable that her daughter, dressed in that new attire, should go so dirty to school. Therefore, she began to give her a bath every day, to comb her hair, to cut her nails… When the week ended, her father said: -"My wife, do you not think it's a shame that our daughter, beautiful and tidy as she is, should dwell in a place like this one, falling to pieces? What about improving and repairing our house? In my free hours I will paint the walls, repair the fence, grow a garden." Before long, the house distinguished itself in the small village by the beauty of the flowers the garden was filled with, as well as by the care shown in every detail. The neighbors were ashamed of living in ugly huts and they also decided to tidy up their houses, to grow flowers, to make use of painting and creativeness. Within a short time, the whole district was changed. A man who was watching those people's efforts and struggles, thought that they were well worth a help from the authorities. So he went to the town mayor, in order to state his ideas and left with an authorization to form a commission to study the improvements that would be necessary for the district. The street, of clay and mud, was covered with asphalt and pavements of stone. A sewerage was built to collect the sewage previously flowing in the open air and the district gained the aspect of citizenship. Imagine, everything started with a blue dress... It was not that teacher's intention to repair the whole street or to create an organism to rescue the district. He did what he could, he gave his part. He made the first move, which went as far as to cause other people to feel motivated to fight for improvements. I wonder whether each of us is doing the own part in the place they live in. Do we belong by chance to those people who just point to the holes of the street pavement, or to the children running freely without school, and to the traffic violence? It should be born in mind that it is difficult to change the total state of things, that it is difficult to clean the whole street, but that it is easy to sweep one's own sidewalk. It is difficult to reconstruct a planet, but it is possible to make a gift of a blue dress." (Author: Anonymous)

Good luck...

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