ABSTRACT: This paper provides a critical analysis of the ISO 14001 Environmental Management System (EMS) deployed at Tecnosol Comércio e Serviços Ltda., partner of Holdercim Brasil S.A, a cement group. The main activity of Tecnosol is co-processing industrial waste in the synthesis kiln at the Alvorada cement plant, in the municipality of Cantagalo, Rio de Janeiro, Brazil. The purpose of co-processing industrial waste in cement plants is to use the waste as fuel in synthesis kilns and mix it with the clinker in the cement production. This paper describes the EMS installation and discusses the difficulties found during the deployment of the system, the opinion of the employees regarding the company’s environmental agreements, the practical results of the installed system and an assessment of the occupational health and security issues in the Environmental Management System.

Key Words: By-processing activity; Environmental Management System; Industrial waste

1. Introduction

This paper discusses industrial waste and its elimination using a special procedure. Hanna (1996) commented that, in Greater São Paulo, 75% of the industries produce about 3.25 million ton. of industrial waste per year, which includes 376,000 ton. of toxic waste. 20% of this toxic waste incinerated, 31% is disposed of in landfill and 21% stored in other forms. The remaining 28% should be investigated in further detail. Due to the lack of disposal areas and the limited opportunities of secure controlled incineration, society began researching alternative solutions for waste disposal. One economic alternative is the incineration of residual waste in cement kilns. This alternative, called by-processing or co-processing of residues is beneficial to both sides, and represents savings for the cement companies. Normal fuels are substituted through rest of high calorific value and represents, for the producing companies, a secure option for the final disposal of the waste. Although this is common practice in other countries, by-processing is seldom used in Brazil and the state control companies are concerned about adopting this type of activity, considering the environmental impact and health hazards to the workers. Incorrect industrial waste disposal may contaminate the air, soil, water and, consequently, the inhabitants in neighbouring areas. The Brazilian sanitary authorities do not often efficiently apply the existing laws to industrial waste disposal. Moreover, in general, they have no political strategies to control it. Consequently, the problems arising from the inappropriate disposal of waste are not solved. Thus, future societies are at risk and may be faced with multiple problems, which will require large sums of money and expertise to solve. It also represents for the
companies that generate the residue a secure option for the final disposal of their waste. By-processing is very common in developed countries but not in Brazil. The state companies for environmental control have many restrictions related to this procedure, which consider the environmental impacts and the health hazards to the workers, especially when used without the correct control conditions.

Holdercim do Brasil S.A. is a cement producing company that signed a contract with Tecnosol Comércio e Serviços Ltda, a company that offers services in the environmental area, in order to develop by-processing activities in their facilities in Cantagalo, Rio de Janeiro, Brazil. Tecnosol Com. & Serv. Ltda. decided to implement an Environmental Management System in accordance with the ISO 14001 standards.

2. GENERAL CONSIDERATIONS

Many Brazilian companies are endeavouring to identify elements that offer the opportunity to improve performance and competitive levels. One of the visible changes is that the companies were very concerned about their image of their products and/or services conveyed to customers and the community. Consequently, a greater degree of awareness and control of the impacts and damages that their activities could cause to the environment has developed and subsequent endeavours have been made to enhance the environmental quality on a global scale. The ISO 14001 series provides tools and sets a standard for implementation of this management system, looking for an improvement of the productive system and correction of the detected errors. Many Brazilian companies that are often unconcerned about the certification are introducing environmental administration to the management of the project. Brazil is far behind Japan, which was the first country in the world to be awarded the ISO 14001 certificates. By the end of 1999, Brazil had been awarded only 172 certificates, 1.2 % of all certificates issued throughout the world.

3. Objectives

This paper describes the steps to implement an Environmental Management System and the difficulties encountered in this process. At the same time, a survey was carried out of the main problems caused by the activity of the by-processing to the environment. The company employees were interviewed and the questionnaires answered. The main objectives are as follows:

1. To describe the steps taken by Tecnosol Comércio e Serviços Ltda. to implement an Environmental Management System (EMS) in the cement company of Cantagalo, Rio de Janeiro, to achieve the certificate, considering the criteria of ISO 14001;
2. To analyse the difficulties encountered when implementing the EMS;
3. To describe the environmental concern with this type of activity;
4. To evaluate the integration between the health and security workers in the EMS;
5. To analyse, from the workers’ viewpoint, the improvements after implementing the EMS;
6. To critically analyse the progress obtained by implementing the system;
7. To propose strategies for support and maintenance of the EMS.

4. Methodology

To undertake this research several visits (monthly) were made to the plant, where all the steps of the implementation of the EMS were taken. This permitted an assessment of the
steps taken, since the first meeting, to inform and train the staff in Cantagalo, Rio de Janeiro State, held in January 1998, until the award of the certificate in December 1999.

Information was collected from newspapers, bulletins, journals and the Internet. Reports from Holdercim and Tecnosol were also examined and environmental auditors contracted from independent companies. There was a visible improvement in the environmental behaviour of the process.

The “survey” investigation method was used to collect the data in the field. This method is a procedure in which the information is systematically collected from a local population with regard to the company, through direct enquiry, using personal interviews, questionnaires, etc (McClosky, 1967).

Informal interviews were used throughout the implementation of the EMS. After the certification was complete, two structured interviews were carried out, one with the medical department and the other with the management of Tecnosol. After the certification, the workers were asked to answer a questionnaire to obtain information about changes in the work relationship.

5. BY-PROCESSING OR CO-PROCESSING ACTIVITY

By processing of industrial waste in cement kilns is a special case of incineration. The high temperature of the kiln, over 1400ºC, and the long time in which the gases stay in the burning area, ensures complete incineration of the waste. The operating licence given by the state environmental agency permits Tecnosol to undertake the industrial waste by-processing activity. The waste may be solid, liquid or a paste, of all classes, pursuant to the Brazilian standards. The main problems for state environmental agencies concern gas emissions and the guidelines for reuse of energy to substitute fuel. By-processing is not a solution for all waste because some substances may cause technical and operating problems in the kiln. This process may be used with two groups of materials:

- Waste as a raw material substitute: has similar characteristics to the raw material used in cement production and after the process may be included in the product.
- Waste as a fuel substitute: waste with high calorific power and which substitutes the traditional fuels used to operate the kiln.

The waste processed in the factory can be divided in four groups:

1. Solid waste that can be pounded,
2. Solid waste that can not be pounded
3. Liquid waste and
4. Paste waste

6. ENVIRONMENTAL IMPLICATIONS

Cement production is an industrial process with aspects of environmental aggression mainly concentrated on the question of emission of acid gases and the large quantity of particulate material, coal and soot in different steps for the productive process.

- An important and current discussion, in the scientific community, involves the world
concern for the contamination of the environment with organic pollutants, mainly because a large amount of these contaminants are composed of organochlorines which cause a high persistence of bio-accumulation. They are called persistent organic pollutants (POP’s).

This group contains the polychlorinated dibenzo-p-dioxins (PCDD) and the polychlorinated dibenzofurans (PCDF) that are the most toxic produced by man. The two main sources causing these substances are the chemical industry and thermal processes. The PCDD/Fs produced in the thermal processes spread over the environment through the air and are mainly absorbed in particulate in suspension.

- In the early nineties, the detection of pcdd/Fs in the cement dust and the exhaust gas suggested that cement factories which incinerate hazardous waste may be significant generators of PCDD/Fs.”
- Considering the risks of generation of dioxins, typical in any process of incineration, and in the attempt to avoid the release of these extremely toxic substances, incineration conditions similar to the incinerators of hazardous waste are required: very high temperatures of over 1200ºC with a minimum residence time of 2 seconds, oxidant atmosphere and turbulent flow in the incinerating region. Guarantees are required for complete combustion, fixation of residue in the clinker and no change in the properties or quality of the cement (see, Inspection Report, 1998)
- An assessment of pollution by metals dioxins and furans was made. Topsoil was chosen as the environmental indicator. Samples were collected and measurements taken at points near one of the plants and the result was considered normal. The report concluded that the cement factory could not be established as a source of dioxins and furans, but that samples from the chimney filter should be collected for a deeper analysis.
- Drivers of waste haulage companies made frequent visits to the dispensary complaining of headaches, nausea, vomiting, etc.
- Residents in communities near the cement factories complained about breathing problems and the disagreeable odour that was caused by toxic waste.

7. DIFFICULTIES ENCOUNTERED IN DEPLOYING THE EMS

The main difficulties encountered by Tecnosol in deploying the EMS, according to ISO 14001 standards, are described below:
- The constraints involved in the deployment of EMS by Tecnosol, because of an interface with the work of Holdercim, which is not adopting an EMS. However, Holdercim is investing in and making some commitments to the environment;
- Tecnosol relationship with the transport companies;
- The metal barrel, which is the only packaging involved in the process, must be controlled because the packaging is either incinerated or returned to the customer;
- The poor educational level of the workers at the plant: they found difficulty in assimilating new information and attending the training process;
- Legal aspects were difficult to understand as the company is small and does not have a specialised legal department;
- Survey of legal technical standards. The company standards were merely voluntary;
- Communication with neighbouring communities;
- The operational control was a problem. The rotation oven control is automated and its operation is the responsibility of Holdercim;
- It was difficult to establish the determining factor of authority and liability;
• The proposed EMS did not control the metal-contamination level of the cement. Holdercim has a quality control procedure for the product and a laboratory used for this purpose. It periodically analyses clinker and cement samples.

8. RESULTS OF INTERVIEWS

The measurements taken in the workplace showed that activities related to exposure to chemical agents are not healthy. The medical department commented that, after the deployment of EMS, the monitoring of the workers for exposure to chemical agents was more effective and the number of registered accidents could be controlled. For assessment of the installation of EMS in Tecnosol, two basic points must be considered:

• Involvement of the workers;
• Training processes.

A questionnaire was distributed in order to assess the influence of the EMAS on the work relationship after their deployment. A description of the questionnaire and first application will be presented in a separate paper. The questionnaire was answered anonymously by seventy-five percent of the workforce. The results are summarised below:

• 90% of the workforce believe in the company project and also that their personal attitudes have changed, both inside and outside the workplace, since the deployment of EMAS;
• 57% who answered the questionnaire considered that their work is hazardous to their health;
• 19% think that they will contract some kind of occupational disease if they continue to work for the company for a prolonged period of time;
• 75% of the workforce thinks that they are well informed about the risks that they are exposed to;
• 95% of the workforce use the EPI equipment for protection and believe that they have had no health problems as a consequence of their work activity;
• 85% of the interviewees feel appreciated by the company and believe that their job description is clear. They also have an increased sense of safety because they know exactly how to proceed in event of accidents and/or danger;
• 90% of the interviewees think that the certification process has brought better conditions within the company, such as: increased occupational safety, knowledge of procedures and work patterns, an awareness of the risk factors and the need for self-involvement in order to avoid spills and contamination.

9. CRITICAL ANALYSES OF THE DEVELOPMENT

One of the major benefits from installing the EMS in the company has been the environmental impact assessment and risk mapping. This has permitted a review of the operations and assessment of the situation pursuant to the legal requirements. It also helped give the company access to information regarding the effectiveness of the company policies regarding both its strengths and weaknesses. Consequently, they could directly focus on the areas that, potentially, should be modified. The top executives of Tecnosol feel more confident about the requirements of the state control agencies. It was not possible to compare other companies, but certainly Tecnosol felt more prepared to meet
environmental legal requirements. This fact opened up a new market and created an enhanced streamlined image while increasing customer satisfaction. An indicator of total quantity of the annual by-processed waste production in the kiln is that, by August 1999, 13,482.06 tons of waste were processed and the forecast for December 2000 was approximately 20,000 tons. (see Figure 1).

![Graph of by-processed industrial waste (Tecnosol)](image)

Figure 1: Graph of by-processed industrial waste (Tecnosol) (* August 2000)

It can be seen that there was a production increase of 17.9% between 1998 and 1999 and, considering the forecast for the year 2000, the production will increase 16% between 1999 and 2000. As mentioned earlier, the certification process brought financial profits to Tecnosol. Publicity about the certificate was focused predominantly on customers and this was a major factor in the increase in the competitiveness of Tecnosol. A number of clients chose to by process their industrial waste after Tecnosol was awarded the certificate.

Another progressive factor, related to the deployment of EMS, was the introduction of improvements in the production process. This occurred due to the fact that they were concerned with spills, during the discharge, moisture, and transportation process of waste to the kiln. The targets and goals anticipate investments by Holdercim of approximately 1.5 million dollars to improve the infrastructure, build their own laboratories, purchase automated equipment, increase the paste residue facility in order to increase the processing capacity, etc. Many of these changes occurred as a result of the installation of the EMS in Tecnosol, as each improvement was an incentive for the other. Initially, investments were made to increase the automation of the process in order to reduce the amount of contact with waste by the workforce. Subsequently, the higher expectation in relation to the maintenance and improvement of the EMS led to the addition of new buildings and expansion of the existing facilities. With regard to the measured environmental variables monitored in the EMS, a considerable decrease in water consumption and a smaller drop in electricity consumption can be found, mainly due to the installation of new equipment.

This lower consumption did not cause major monetary changes since the consumption of water and electricity was considered low. A major concern for Tecnosol were the emissions from the chimney in the kiln containing the clinker, and a vast improvement was made by reducing the emission of all solid particles in suspension. Some Environmental Impact Assessments (EIA), carried out previously, reported the need to correct this problem because the regularly taken readings exceeded the limits set by the state environmental control agency FEEMA (Rio de Janeiro State Foundation for the
Environment). The EMS increased the number of corrective actions and changing the electrostatic filter for the sleeve filter was the solution adopted for the problem. Previously, the reading for this variable was approximately 300mg/Nm³. In 1999, with the installation of the sleeve filter, this figure dropped to approximately 16mg/Nm³. The acceptable limit is 70 mg/Nm³.

Another important variable in the system is the measurement of the exposure level of the employees to chemical agents and noise. Before the EMS, this monitoring was inadequate and, after its installation, a measuring and examining routine was adopted. These assessments showed that there no longer exist activities or hazardous operations that lead to exposure to chemical agents. In relation to the noise, many changes were made in favour of the workforce.

10. CONCLUSIONS

The main difficulty seemed to be in the transition from the installation to the implementation. First, it is apparent that a survey was required with regard to meeting legal requirements and to mitigate the weaknesses of the company. However, after this step, it was necessary to adapt everything to the day-to-day working life of the company. Some difficulties were encountered at this stage, which led the team to perform ongoing critical analyses. Questions were raised and asked, such as: Did the methodology selected clearly evaluate the more important environmental impacts? This detail caused a more mature attitude in the staff involved in implementing the EMS and the situation was as follows: the current status of the company should be accurate and the significance of the values to be considered was essential in the decision-making process. However, within the criterion “Concerns of the interested parties”, the values considered were too subjective and contact between the company and the neighbouring communities was inefficient. The company was apprehensive that the desire to implement and certify the system would be open to misinterpretation and/or distortion. The interested parties should be consulted, mainly when the selected methodology considers values that require their opinions. Advisory companies, in general, do not run this type of survey because they claim that the resulting assessment is very subjective. During implementation, the quality of the work routine improved substantially. It was found that the participation of the environmental co-ordinator is basic to, and a prerequisite for, the delivery of an effective and efficient EMS. A co-ordinator who has limited or no awareness of the environmental issues will only administer the bureaucratic requirements of the law.

Although not acknowledged by the company, a crucial factor found in the system was the need for comprehensive communication. Internal communication was managed effectively but the company did not do its best to inform and clarify its position to the neighbouring communities concerning its commitment to the environment. Nor did they say that the company had been awarded the ISO 14001 certificate. This was disseminated only to customers and the local and sanitary authorities. There were no publications, no organised local events and no visits to the neighbouring community with a view to informing the community of the new practices adopted by the company.

The main environmental impacts, raised by the EMS, were the handling of dangerous waste, risk of air, soil and water contamination, ergonomics and explosion and fire hazards. The staff considered all the critical points of the system. Most of the subjects established before being awarded the certificate were addressed and most of the proposed goals had been achieved.
Tecnosol organised the EMS in such a way that it did not guarantee environmental protection because no filters were available to prevent gas emission. The problem of the gas emission should be controlled and prevented by the Holdercim cement plant. The auditors certified the company Tecnosol, but the environmental performance of by-processing was not certified. Dioxins and furans are still produced and it would be necessary to measure and control these in order to certify the by-processing environmental performance. The company directors did not do monitoring because Brazilian legislation does not require them to do so. Unfortunately, many companies that deploy EMS are awarded the certificate and assume the persona of a public environmental commitment, yet do not take a pro-active stance in relation to environmental issues.

The following observations, described below, show the positive points of the process:

- Most top Tecnosol executives were in favour of the implementation. They were very confident about the certification and participated actively in the process;
- Financial resources were always available and Tecnosol’s point of view included targets and goals resulting in major improvements to the company. Investments in facilities and equipment were added to the targets and are being achieved along with increased billing.
- The dissemination of the environmental questions addressed by Tecnosol influenced other companies (customers, transport companies, etc) to implement the EMS, to meet requirement 4.3.1. of the ISO 14001 standard. Tecnosol did not penalise or break contractual agreements with customers and suppliers, but systematically collected in terms of the problems of work interfacing, and this produced very good effects;
- The work interface with Holdercim also brought very good results. Even when considering the difficulties encountered, Holdercim responded to the many demands made by the Tecnosol EMS. Holdercim was thus influenced and pressured to change its environmental behaviour, although it decided not to formally adopt an EMS;
- The organisational climate, which was good before deploying the EMS, improved. As it is a company with a small number of employees, Tecnosol gained the support and motivation of its personnel, facilitating the installation of EMS, mostly during the stage of preparing the procedures and instructions. The participation of everyone was essential and this factor united the groups and initiated the motivation to be awarded the certificate.

An interesting fact is that more than 50% of the employees think that their working environment is hazardous to health, but few of them (10%) would choose to leave the company for alternative employment. This indicates loyalty that can be based on the fact that 90% of the employees who answered the questionnaire believe in the position that Tecnosol has adopted, and have noticed continuous environmental and personal improvement. The employees feel more appreciated because of the active role they have played in the introduction and administration of this system.

The certificate process involved all Tecnosol employees and, consequently, an ethos of teamwork has evolved, coupled with an increase in the motivation of the workforce.

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12. BIBLIOGRAPHY


2- INSPECTION REPORT. Cement industries that carry through co-processing of industrial trashes, Centre of Studies of Health of the Worker and Ecology Human being CESTEH, Foundation Oswaldo Cruz, Rio de Janeiro, 1999. (in Portuguese).