ANALYSIS OF THE ENVIRONMENTAL MANAGEMENT OF SOLID WASTE FROM BREWERY PLANTS IN CAMEROON : THE CASE OF PLANTS IN THE CITY OF DOUALA

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ABSTRACT

In order to comply with Cameroonian environmental legislation and regulations, to ensure and organize the prevention of pollution through preventive and curative actions, to integrate the environment in the training of personnel, the brewery factories of the city of Douala are committed to a logic of sustainable development and decided to have their environmental management system certified according to the ISO 14001 standard. With this in mind, we focused our study on the analysis of the environmental management of solid waste management in breweries in Cameroon. To achieve the set objective, a survey was carried out in all the workshops of the factory through a questionnaire given to the operators and workshop managers to have an idea on the activities and waste produced in each workshop. Then, the analysis of the compliance with Cameroonian regulations in terms of waste management has shown that the company is at more than half of its achievements with a percentage of compliance of 66%, the non-achievements are noted at a rate of 14% and the actions not fully compliant are estimated at 20%. After establishing the flow chart of each activity, the environmental aspects and impacts associated with solid waste management were identified, evaluated and prioritized. The method for evaluating and prioritizing environmental aspects was specified by Société Anonyme des Brasseries du Cameroun. The significant environmental aspects (SEA) are mostly related to the discharge of drums and barrels; used metal parts, which are linked to the lack of traceability. In addition, the mixing of plastics, cardboard and plastic bottles with household waste or the mixing of soiled rags with household waste is mainly due to insufficient staff awareness, insufficient number of garbage cans and/or poorly identified garbage cans. The brewery, beer and soft drink packaging in glass containers have a higher number of ESAs with a percentage of 50% each.

Keywords : *Environmental analysis, waste management, AES, DAOM, ISO 14001.*

I. INTRODUCTION

According to the ISO 14001 standard, in its chapter 2.1, the Environmental Management System (EMS) is "the component of the overall management system that includes the organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy". It is with this in mind and aware of the growing importance of the environment in their development strategy that the breweries of Cameroon and particularly that of the city of Douala (Société Anonyme des Brasseries du Cameroun, Guiness Cameroon, Union Camerounaises de Brasseries...) are integrating one of their main managerial components. This consideration is the manifestation of their will to put the environment at the heart of their policy. Thus, environmental management is gradually developing, the pivot of the sustainable development approach (MULLER C et al. 2013). The establishment of an EMS is a means of internal management to the company, based on the principle of continuous improvement and based on the ISO 14001 standard whose purpose is to develop a policy and objectives taking into account the legal requirements and other requirements to which organizations have subscribed without forgetting information on significant environmental impacts (ISO 14001, 2004).

As a reminder, after a voluntary commitment and the real involvement of the various departments, the implementation of the EMS provides for the analysis of the nuisances of the company's activities at several levels: water, air, soil, waste produced within the framework of the various activities and finally the nuisances including noise and odors (ISO 14001, 2004). The stakes are to :

- Save the environment: raw material savings, avoid soil, air and water pollution, safeguard ecosystems, health...

- To make waste treatment costs profitable: by reducing the quantity of waste and its toxicity through preventive measures, sorting or recycling;

- Improve the image of the company: By avoiding any inconvenience due to waste (traffic, odors, toxicity, soil contamination ...) the company shows common sense, attention, dynamism and modernity;

- Facilitate the process for obtaining environmental certifications: waste management in companies is a first step towards obtaining an international environmental management certification such as ISO 14001 (Mekahlia, 2010).

It is in this perspective that we question the effectiveness of the implementation of an EMS as a means of internal management of brewery companies through an environmental analysis in the city of Douala. The main objective of this study is to conduct an environmental analysis of solid waste management in breweries. More specifically, it is our responsibility to identify, in an exhaustive manner, all the environmental aspects related to solid waste management, the evaluation and identification of the environmental aspects as well as the significant environmental impacts following the method established in their procedure of identification and evaluation of environmental aspects.

II. MATERIAL AND METHODS

II.1. MATERIAL

II.1.1. Study area

The environmental analysis of the solid waste management of the plant in our study area, concerns all the solid waste produced on the site, which covers a total land area of 37589 m2. The different workshops encountered at the plant are 20 in number: MPC, brewing, fermentation, filtration, hot and cold syruping, packaging of BG in PET, packaging of BG and beer in glass bottles, MLU, Boilermaking, Electricity, Mechanics, General Service, CMMS, Garage, Beer and Soft Drink Laboratory, the administrative block, Sick bay.

II.1.2. Texts and legal documents

The documents used in this work are those concerning: the regulatory watch on waste in Cameroon, including

- Law N°96/12 of August 5, 1996 relating to the management of the environment;
- Decree N°2809/2012/PM of September 26, 2012 laying down the conditions of sorting, collection, storage, transport, recovery, recycling, treatment and final disposal of waste;

- Order N°002 MINEPDED of October 15, 2012 fixing the specific conditions of management of industrial waste (toxic and/or dangerous) ;
- Order N°003/MINEPDED of October 15, 2012 setting specific conditions for the management of medical and pharmaceutical waste;
- Joint Order N°005/MINEPDED/MINCOMMERCE of October 24, 2012 setting specific conditions for the management of electrical and electronic equipment as well as the elimination of waste from such equipment.
- Joint Order N°004/MINEPDED/MINCOMMERCE of 24 October 2012 regulating the manufacture, import and marketing of non-biodegradable packaging. Transit slips, waste traceability manifests which specify in particular the origin, nature, characteristics, quantities, destination of industrial waste (toxic and/or hazardous) and the methods of transport, storage and final disposal of said waste as well as the companies involved in these operations; Follow-up registers in which the company records the types, natures, quantities, hazard characteristics and origin of the hazardous waste it has produced, collected, stored, transported and disposed of.

II.2. METHODOLOGY

The methodology adopted to carry out this work followed the following outline:

II.2.1. Inventory of the existing situation

The inventory allowed us to make an inventory of all the activities carried out on the site. During this phase, we learned about the different wastes generated in each workshop of the factory and the existing good practices, through interviews with the company's staff (managers of the different departments, team leaders and operators). We used a questionnaire (13 questions, 9 of which were open-ended and 4 closed-ended) to conduct these interviews. Then, we consulted the various existing traceability supports linked to the management of solid waste, including: waste monitoring notebooks, passage slips of the company in charge of removing industrial waste, traceability manifests, etc.

As solid waste is the subject of our study, we have first identified the texts that may be applicable to solid waste management in Cameroon. We analysed the requirements contained in the applicable texts according to the means of control observed during the inventory, with the aim of identifying or pinpointing the regulatory non-conformities of the company. We assessed what the company complies with completely (compliant), what it does not comply with for all the areas concerned (non-compliant) and what it complies with only partially or only for certain wastes (not completely compliant).

II.2.2 Identification of the environmental aspects of solid waste management

After the realization of the different processes of each activity, we realized the inventory of all the environmental aspects and impacts associated to the site, related to the activities, products and services of the company with regard to the solid waste. After observing and recording the different stages of the process of the activities of each workshop, we identified in a chronological order the environmental aspects related to the management of solid waste and their associated impacts. During this identification, we took into account all the solid waste generated, its storage conditions, the storage location, the storage environment, the containers and the disposal of the waste; without

forgetting the accidental spills of solid products and the emissions due to the handling of these products.

II.2.3. Assessment of environmental aspects and impacts

In this phase we have identified, from the environmental analysis and the evaluation scale established by the procedure of identification and evaluation of environmental aspects (EA), those that, among all the identified environmental aspects, can be qualified as "significant". Since it is not possible to work on all the environmental aspects, we have the aspects related to the solid waste on the site in order to be able to prioritize and estimate those that are significant, that is, those that are considered to be priorities according to the method used. The method of evaluation of the environmental aspects chosen consists of rating the aspects in relation to evaluation criteria. The criteria taken into account for the analysis and evaluation of the environmental aspects are, among others

- Occurrence/Frequency (F) : Frequency refers in normal operation to the probability of occurrence of the environmental impact and in case of an accident to the probability of occurrence of the hazardous phenomenon.
- Severity (G): In environment, the severity takes into account both the intrinsic dangerousness of the aspect (e.g. hazardous waste has a higher severity than non-hazardous waste) and the quantity or volume of the aspect (the greater the quantity or volume consumed or discharged, the higher the severity). It may also take into account the sensitivity of the environment that is impacted, which can be treated separately.
- Sensitivity of the environment (S): This criterion aims at defining the characteristics of the surrounding environment likely to be affected by the aspect (example: water resource which can be polluted by a discharge of drums...). The more "fragile" (sensitive) this environment is with regard to an aspect, the more important the impact will be.
- Control (M): Finally, control is defined by the prevention measures aimed at limiting the probability of the impact or damage occurring and the protection/intervention measures aimed at limiting the seriousness of the impact or damage.
- Regulations and legislation Compliance with legal and regulatory requirements must be taken into account in the analysis and evaluation of environmental aspects.

Table 1 represents the environmental rating criteria:

Table 1: Environmental Impact Assessment Scale

Symbol	Wording		0	1	2	3	4
F	Frequency or Occurrence	In case of accident		**Negligible** Never during the life of the plant	**Low Probability** Happened once during the life of the plant	**Probable** Has happened more than once during the life of the plant	
		Normal operation		**Exceptional** Once or twice per year	**Rare** Once per month	**Occasional** Once per week	**Frequent** Daily
G	Gravity			**Minor** Minimal consequences without noticeable degradation and can be erased	**Notable** Important consequence, limited to the neighborhood	**Critical** Consequence that can be significant over time	**Major** Serious, costly and difficult to control consequences
S	Sensitivity		Receiving environment is not sensitive	Sensitive receptor environment			
M	Mastery			**Total** Detectable situation, with regular control and verification	**Average** Detectable situation, with control but without regular verification	**Limited** Detectable situation, but without control (adapted equipment or instructions)	**None** Undetectable situation
R	Regulations			No regulatory or compliance requirements	There is a regulatory requirement but the company is not fully compliant	There is a regulatory requirement but the company is not in compliance	
C	Criticality		**F×(G+S)×M×R**				

III. RESULTS AND DISCUSSION

III.1. Inventory of the existing situation

Depending on the type of storage, there are intermediate storage facilities, internal final storage facilities and external final storage facilities at the plant. Not all the company's waste is tracked. The quantities of waste generated, estimated from the manifests of traceability, the notebooks of follow-up, the slips of passage of removal of waste allow us to estimate the average quantities produced per month and the number of providers. It is clear that spent grain and yeast are the largest average quantities per month, and that the service providers pass through each day when there is production, as shown in Table 2.

Table 2: Summary of the waste monitored and its average quantity per month

Wastes monitored	Average quantity per month	Number of times providers have visited
Crib + Levee	1878 tonnes	Every day (when produced)
Medical waste	17.13 Kg	Once per week
Used batteries	3 Pièces	Once per week
Oil and air filter	4514 Kg	Once per week
Special laboratory waste	58 Kg	Once per week
Soiled rags and sawdust	24,5 Kg	Once per week
Plastics	4845 Kg	Two to three times per month
Groisil	134,7 tonnes	Once per week
DAOM	81 m3	Four times per week
Kieselguhr	189 m3	Two to three times per day

The Cameroonian regulatory watch in terms of waste management allowed us to highlight the regulatory non-compliances of the company as presented in figure 1.

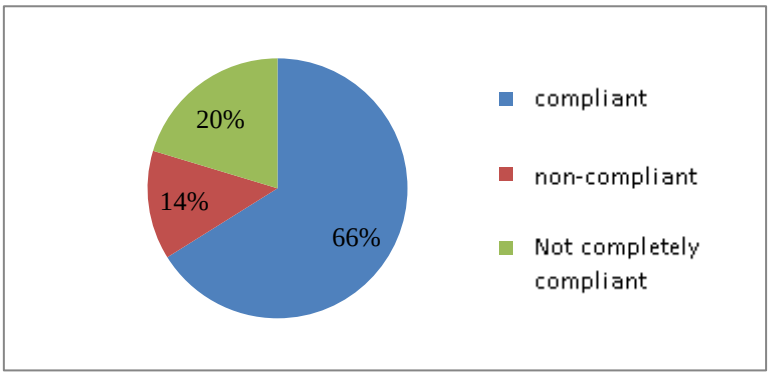

Figure 1 : Summary of regulatory analysis results

Figure 1 above presents a summary of the results of the regulatory analysis on this sector graph. It appears from this analysis that the company has a compliance percentage of 66% which is explained with support of different measures put in place to eliminate its waste: the submission of some waste to approved service providers, the installation of waste garbage cans despite the absence of selective sorting and also the wastewater treatment plant to overcome problems of accidental discharge. However, it has a percentage of non-compliance of 14% due to the smallest details of the standard are not implemented. The actions that are not fully compliant are at a percentage of 20%. The not total conformity is due to the fact that all the waste generated in the company is not managed by the environmental department and consequently, there is not a traceability of all this waste demonstrating the absence of selective sorting of waste at the source. However the company will be able to be in conformity with 100 % firstly by having a total traceability of these waste, by integrating in its activities of the programs allowing to ensure a better knowledge of the environment as recommended in the article 6 paragraph 2 of the law n°96/12 of August 05, 1996 carrying framework law relating to the management of the environment, this will facilitate the action of selective sorting.

III.2. Identification of environmental aspects related to solid waste management

Among the solid wastes, we have among others:

- The rejection of packaging, labels, films and plastic bags, used crates of plastic cans and drums of additives and cleaning products. These, if badly managed, could pollute the soil because they are slowly degradable, they are resistant and constitute a worse enemy for our environment. These plastics can invade the oceans. The bad management of plastics will contribute to the depletion of one of the natural resources that is crude oil (ACV Bio Intelligence Service - 2008);
- The rejection of office papers, filter papers, cardboards, bad pallets. The non-rational consumption of the latter will contribute to deforestation because it takes 2 to 3 tons of wood to manufacture one ton of conventional paper;
- The rejection of damaged raw materials can attract pests (bugs, rodents ...);
- The rejection of metal parts, scrap metal;
- The rejection of oil soiled rags, ink cartridges, ink cans, oil and air filters;
- The wrecks of machines exposed to the weather;
- Medical waste has an impact on humans through infectious risks and exposure to diseases. The waste from contaminated health care institutions, when dumped in the natural environment or at public dumps, causes bacteriological or toxic contamination of the soil and groundwater (Hafiane et al., 2011).
- The rejection of waste electrical and electronic equipment (WEEE); In case of mismanagement, they pollute the natural environment, alter the health of man; because they contain heavy metals (lead, mercury, cadmium, chromium) which have consequences at the level of the nervous system, and is extremely carcinogenic. But also other metals such as barium which causes brain tumor, muscle weakness, heart damage, and finally plastic which has effects on fertility.

  The discharge of batteries and used batteries are toxic and polluting.
- The rejection of broken glass whose bad management contributes to the depletion of one of the natural resources that is the sand...

Regarding the conditions of storage, the place of storage, the environment of storage, the containers and the elimination of the waste, the factory presents as environmental aspect:

- The mixture of waste particularly the mixture of the groisil to the labels and cap, the mixture of plastics, cardboards and broken bottles to the waste assimilated to the domestic waste which has as repercussions, the increase of the volume of waste sent to the elimination and the difficulty of management of these waste.

The overflow of cardboard in the storage bin which poses a problem on the visual management

- Leakage of waste leachates, the ground although being paved, the leachates are drained in the gutters and consequently, will infiltrate in the ground, then in the water table because the ground of the city of Douala is sandy: we note the pollution of surface and underground water.
- The storage of cardboard boxes in bad weather increases the volume of waste sent for disposal because it will no longer be incinerated.
- The odors following a prolonged storage will have as effect the olfactory nuisances.

Speaking of accidental spills of solid products, we note:

- Spillage of chemical products on the ground which will be drained in the water and will participate in the pollution of these.
- Spillage of Kieselguhr on the ground which increases the polluting load of the waters and will delay the activity of the sludge of the purification plant.

Spilling of sugar on the ground which may lead to an increase in the organic pollutant load.

- The discharge of malt or corn into rainwater drains, which can increase the organic load of pollutants, which are mineralized in the receiving water bodies and the nutrients resulting from this mineralization stimulate plant production, causing eutrophication.

As for the emissions due to the handling of solid products we mention :

- The emanation of kieselguhr dusts (CBR3, CBL, Charcoal, Clarcel) which has the effect of possible transient irritation of the eyes and respiratory tract.
- The emanation of malt dust.

Nevertheless, we present the environmental aspects by workshop that we summarize as follows:

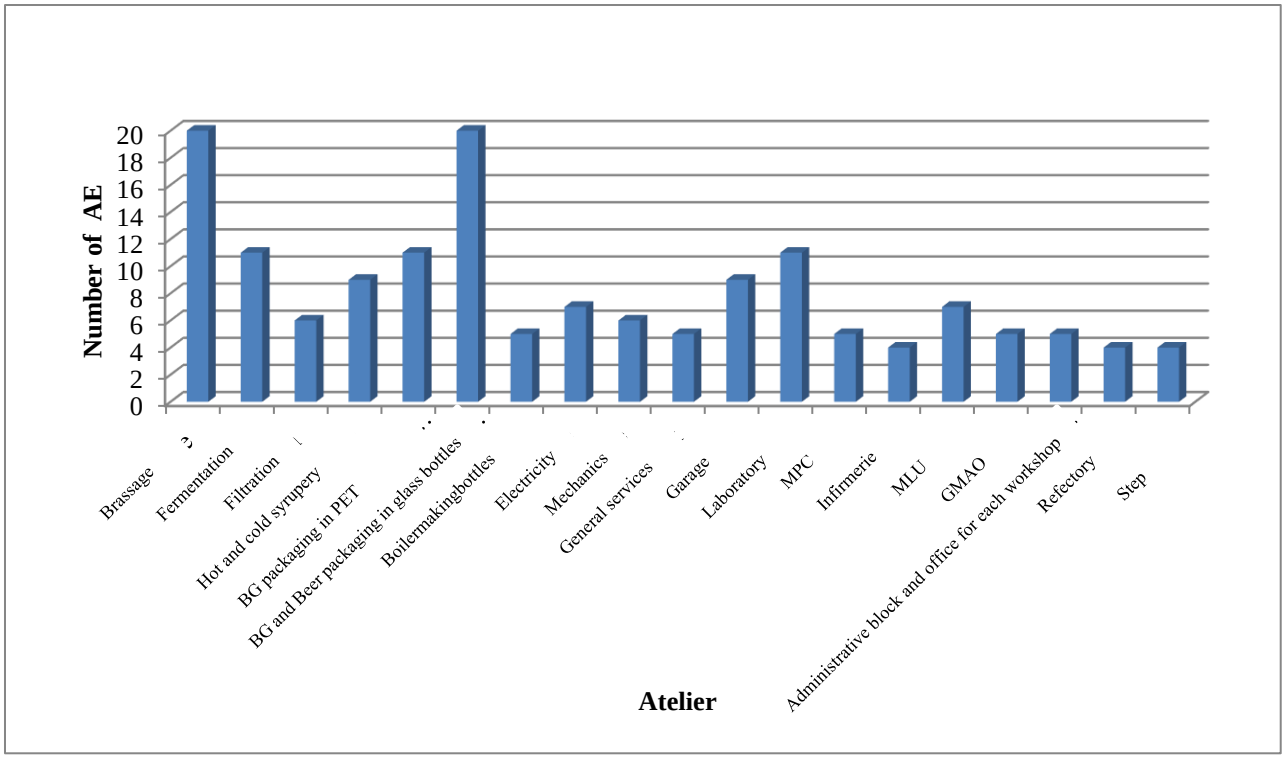

Figure 2 : Summary of the number of environmental aspects per workshop

Figure 2 shows the number of environmental aspects per workshop. From this histogram it can be seen that all the workshops of the plant have at least one environmental aspect related to solid waste management. This can be explained by the fact that in all the workshops there are solid inputs and consequently solid outputs. Nevertheless, the Brewing and Packaging BG and Beer in Glass Bottles workshops have a higher percentage (13%), i.e. 20 AE in each of these workshops. While the Sick bay, Canteen and STEP workshops have the lowest number of AE (4) or a percentage of 2%.

III.3. Significant environmental aspects and impacts

After having identified all the activities of the company as well as the environmental aspects and the associated impacts in normal operation and in case of malfunction, it is necessary to determine the significant impacts and therefore the SEAs. The determination of the AES allows the definition of the objectives, the targets and the programs.

The scale of assessment of the impacts can be found in the procedure of identification and prioritization of environmental aspects used in most of the breweries in the city. Given that we are in a continuous improvement process, as a threshold, the impact is considered significant when the associated aspect does not comply with the regulations (R = 3) and when the criticality (C) is greater than or equal to 24.

Table 3 : Summary of AES frequencies by workshop

ATELIER	Number of EA	Number of AES	Frequency (%)
Brassage	20	10	50
BG and Beer packaging in glass bottles	20	10	50
Filtration	6	5	83,3
Electricity	7	5	71,4
Hot and cold syrupery	9	4	44,4
General services	5	3	60
MLU	7	3	42,8
Administrative block and office for each workshop	5	2	40
MPC	5	2	40
Boilermaking	5	2	40
Mechanics	6	2	33,3
BG packaging in PET	11	2	18,2
Refectory	4	1	25
Garage	9	1	11,1
Fermentation	11	1	9,1
Beer and soft drink laboratory	11	1	9,1
Infirmerie	4	0	0
STEP	4	0	0
GMAO	5	0	0

Table 3 summarizes the frequency of significant environmental aspects (SEA) by workshop. From this table, it is clear that the most recorded SEA are in the Brewing and Packaging BG (glass) and Beer workshops, followed by the Filtration and Electricity workshops. It is clear from this analysis that the environmental aspects mainly concern the discharge of cans, plastic and metal drums, and the discharge of used metal parts. Decree No. 2012/2809 /PM of September 26, 2012 setting the conditions for sorting, collection, storage, transport, recovery, recycling, treatment and final disposal of waste recommends that: industrial waste (toxic and / or hazardous) can only be collected, transported or stored for final disposal by any natural or legal person approved by the administration in charge of the environment (Article 8, paragraph 1). In the same decree, in Article 11, any generator, collector, transporter or destroyer of industrial wastes (toxic and/or hazardous) shall keep a register in which he shall record the types, natures, quantities as well as the hazard characteristics and origin of the hazardous wastes he generates, collects, stores, transports, recovers or disposes of.

These SEA are then classified in descending order of importance in Table 4.

Table 4 : Classification of SEA in descending order of importance

N° AES	Environmental aspect	Criticality
1	Disposal of waste electrical and electronic equipment	54
2	Mixing of waste	54
3	Spent grain dumping on the ground	48
4	Emanation of kieselguhr dust	48
5	Dispose of soiled rags in the household waste bin	48
6	Leakage of waste leachate	36
7	Dumping of diatomaceous earth on the ground	36
8	Disposal of used mechanical parts	36
9	Dumping of labels and broken bottles on the ground	32
10	Dumping of labels, broken bottles and caps in the gutters	32
11	Emanation of malt dust	24
12	Malt dust discharge	24
13	Rejection of metal cans of hops	24
14	Overflow of cartons in the storage bin	24
15	Rejection of plastic packaging bags from Stabifix	24
16	Rejection of non-compliant labels	24
17	Storage of cartons under the weather	24
18	Disposal of kieselguhr packaging paper	12
20	Disposal of Plastic Cans	3
21	Rejection of sugar fiber bags	3
22	Rejection of pallets in poor condition	3
23	Rejection of raw material damage	3

Table 4 shows that the priority action to be implemented at this plant is the management of WEEE, as the discharge of waste electrical and electronic equipment has the highest criticality, followed by actions to mitigate the mixing of waste and the discharge of spent grain to the ground.

IV. Conclusion

In summary, the objective of this study was to conduct an environmental analysis of solid waste management in breweries. Our methodological approach consisted in the realization of an inventory of the factory and the analysis of the conformity of the company as regards waste management. To evaluate the identified environmental aspects, we referred to the environmental rating criteria. This study was able to show that the company has a compliance percentage of 66%, followed by 14% of non-compliance and 20% of actions not fully compliant. After evaluation, the significant environmental aspects are the most noted in the brewing and beer and soft drink packaging workshops, i.e. approximately 50% (10 EAs) of the EAs identified in each of these workshops. Based on these results, this work could be used by brewery companies to implement an environmental management plan and thus advance in their efforts to obtain ISO 14001:2004 certification.

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