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EVALUATION OF SAFETY IN CEMENT INDUSTRY: A CASE STUDY OF A CEMENT COMPANY IN LAGOS.

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ABSTRACT

The safety of a cement industry is of great concern to the general public. In this research, the Consequence analysis techniques was used as a decision making tool to evaluate the safety of a southern Nigerian cement industry. The top events investigated include the prevailing atmospheric dust content, airflow and emission rate, accidents, its rate of occurrence and types, and kiln shell temperature. Results revealed that considerable time and money is lost due to downtime and in compensation payment to the employees. Analysis of available data revealed that emissions of cement dust and limestone far exceed the daily threshold limit allowed into the atmosphere, an action that constitutes great nuisance to the society. The consequences of these actions, if not properly handled could lead to various hazards such as the respiratory track and skin diseases. Due to the possible consequences of the observed top events, the management of safety in the industry should not be left alone to the employers, but the employees must be properly educated on the short and long term effect of poor process organization and management.

INTRODUCTION

Cement is a hydraulic bonding agent used in the building and civil engineering constructions (Agunbiade, 2000). It is a fine powder obtained by grinding the clinker and gypsum (sintered from clay and limestone mixture). When water is added to cement, it becomes slurry that gradually hardens to a stone-like structure. It can be mixed with water, sand and gravel (coarse aggregates) to form initially mortars and then concretes.

Nigeria has about nine cement plants capable of producing six millions tons per year. However, less than 3 are in continuous operational condition at any given time. The main hazard of these industries is the high dust content of the flue gas in all the technological units. The following dust levels were recommended by International Labor Organization in 1983 for the individual processes (Parmeggiani, 1983): Shale / Clay extraction: 41.4 mg / m^3, Raw materials crushing and milling: 79.8 mg / m^3, Shivering: 384 mg / m^3, Clinker grinding: 140 mg / m^3, Cement packing: 256.6-mg/ m^3, Loading: 197.0 mg / m^3.

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The level of dust from the individual processes far exceed the Federal Environmental Protection Agent set limit of 250μg/m^3. Particulate emission into the atmosphere is said to have killed hundreds of palm trees in Ogun state of Nigeria in 1986, and Bendel Cement and Ewekoro Cement Companies were cited as the highest emitters of particulate (Agunbiade, 2000). In modern factories, utilizing wet process technology about 15 – 20 mg/m^3 of particles is released continuously during production (Permeggiani, 1983). Air pollution of the neighborhood is usually about 5 – 10 % more compared with the initial environmental level. Small quantities of hydrocarbons, aldehydes, and ketones often accompanied dust pollutant from the rotary kiln and cement mill section (Murray et – al, 1978). These gases are emitted from the various physio-chemical reactions that occur in the rotary kiln. Modern industrial societies, which include the cement industries, create far more carbon (iv) oxide (CO_2) than what the planet vegetation can consume (Gwendolyn et - al, 1993). As the excess CO_2 rises into the atmosphere, it acts as absorptive body, which trap heat reflected from the earth surface. Many scientists accept that the green house effect from increased level of CO_2 and other heat trapping gases will eventually cause an increase in global temperature (SPMAN Report, 1999).

Noise is one of the major problems faced by millions of employees currently working in factories all over the world. Uncoordinated sound waves from various machines at elevated temperature results in the generation of noise in the cement industries. The noise is a local problem in the immediate surrounding of the factories (Abdulkareem, 2000). Industrial noise at level of about 90 – 110 dB is sufficient to caused immediate hearing loss (Gavriel, 1991). Other adverse health effects sometimes attributable to noise are increased incidence of heart attacks, miscarriage and headaches. Workers at the Milling and Kiln platforms are continuously exposed to risk from noise generation.

The pathological conditions encountered by workers in the loading and packing sections of cement industries cannot be emphasized. The dust particles stick to the workers skin thereby blocking the skin pores that allow the flow of air (oxygen) in and out of the skin for a healthy skin growth (Agunbiade, 2000). These in turn cause various skin diseases such as eczema for the employees. Also, the inhalation of dust particles has enormous side effects on the lungs of the individuals. It could cause respiratory tracks diseases and digestive disorders. High ambient temperature is noticed near the furnace doors and platforms. This heat is transferred by radiation to the surrounding, which, raise its temperature by some degree Celsius. This makes the vicinity to be hot and cases of burns have been reported (Lowe and Solomon, 1983).

SAFETY AND HEALTH MEASURES

Safety can be defined as the state of being safe " That is when the working environment can not cause any physical, mental, psychological, etc. harm on man and nature (Odigure, 1998). According to Howard (1983), safety of process must be accomplished in the final analysis. There are two associated categories of process accident prevention measures: i.e. hardware, which relates to equipment and layout and software, which pertains to standards guides and procedures to be used. Every system has an inbuilt mechanism of self-regulation and destruction. The removal or introduction of matter or information to a system will lead to disequilibrium (Odigure, 1998). However, the self-regulatory mechanism will force the system back to a new state of equilibrium. The change between the initial and final states of equilibria is a measure of expected hazard in the system. Hazard therefore, is the resultant of " abnormal " operation. It can be expressed in naira, downtime (hours, days and years), death, cost of litigation, period of sick leave etc (Odigure, 1998). Various techniques are used in safety study. These include the failure mode and effect analysis, cause consequence analysis, hazard operability study, fault trees and event trees. Knowledge of composition, free silica content of all materials and condition of machine used in cement industries are basic requirements in the prevention of hazards in the sector.

Dust, which constitutes one of the problematic environmental issues, can be reduced to minimum via utilization of appropriate technologies. In quarries, excavators should be equipped with air-conditioned closed cabins to ensure good air supply and ventilation. All dusty processes premises in cement works (grinding, sieving and transfer by conveyor belts) should be equipped with adequate air upply/ventilation system. Noise, which is an un –wanted sound (Gavriel, 1991) can be controlled from conceptual design stage or before installation. The kiln section of cement industries radiates huge amount of heat. Therefore, the kiln should be equipped with cold air shower and adequate screening from the work environment should be provided. The major objectives of this research include investigating the safety in the cement industry, in particular in Lagos, South Western, Nigeria to determine the current state of management efforts and to identify future challenges.

METHODOLOGY

All the data used in this research were obtained from a Lagos Cement Company's logbook. The available data collected could be categorized into the following:

(a) Total number of accidents and hours lost in the various departments of the company.
(b) The break down of the type and occurrence of these accidents.
(c) Emission rate and air flow rate of the dust particle.
(d) The kiln shell temperature.

RESULTS AND DISCUSSION

The results obtained from historical data collected from the company are presented in tables 1 – 4 and figure 1. Equipment dependability has always been a priority in human development. The dependability of equipment is a function of its reliability, availability, maintainability and safety (Odigure, 1999). Every notified accident results, not only in the official compensation of the victim, but also leads to an inquiry to find the underlying precauser with the sole purpose of preventing future occurrences.

Table 1: The type of accident and their occurrence

Accident Occurrence / Year.	Bruise Abrasions	Laceration	Sprain	Simple Fracture	Compound Fracture	Crush/ Head Injury	Burns	Trauma	Death
1995	313	143	24	3	1	-	29	-	1
1996	325	132	14	-	5	2	23	-	1
1997	235	117	35	1	2	8	24	-	-
1998	179	113	29	2	-	3	38	31	3
1999	116	69	35	2	1	7	26	11	1
Total	1168	574	117	8	8	20	140	42	6

Table 2: Air – Flow and Emission Measurement.

Date	Time (Days)	Venue	Air flow rate (Nm^3 / hr)	Dust Emission Measurement(Kg/ hr)
15th Oct.1999	1	Kiln 1	577, 064.4	333.38
27th Oct. 1999	13	Cement Mill 1	17,277	2.55
28th Oct. 1999	14	Cement Mill 2	16,453.2	2.41
		Kiln 2	744, 762.6	43.58
9th Nov.1999	21	Cement Mill 1	29, 151	54.01
		Cement Mill 2	20,619.6	12.20
20th Nov.1999	44	Kiln 2	714,768	51.66
		Kiln 1	666,339	278.36
27th Nov.1999	51	Kiln 1	625,983.6	329.58
20th Dec.1999	74	Kiln 1	705,804	254.46
23rd Dec.1999	77	Kiln 2	754,903.2	68.75
13th Apr. 2000	189	Kiln 2	586,867.2	1.529
19th Apr.2000	195	Cement Mill 1	24,154.2	50.93
		Cement Mill 2	18,219	16.90

Dust emission presented in table 2 can be expressed in mass per volume as in Table 3. The kiln shell temperature average for a period of two years over the full length of the kiln at its various zone are presented in Figure 1.

It could be observed from table 1 that the rate of accidents decreased considerably over the periods (1995 – 1999). About 46% of the total accidents are from production department (Table 4). Burns and scalds, which is a thermal injury account for about 6.65% of the total accidents (table 1).

Table 3: Dust content released between October 1999 and April 2000

Time (Days)	Venue of measurement	Dust content (g/m^3)
1	Kiln 1	0.58
13	Cement Mill 1	0.15
14	Cement Mill 2	0.15
	Kiln 1	0.059
21	Cement Mill 1	1.853
	Cement Mill 2	1.592
44	Kiln 2	0.072
	Kiln 1	0.418
51	Kiln 1	0.526
74	Kiln 1	0.361
77	Kiln 2	0.009
189	Kiln 2	0.003
195	Cement Mill 1	2.11
	Cement Mill 2	0.928

Table 4: Total number of accidents / Injuries with Hour lost in the various departments.

Year	Dept.	Quary	Technical	Mechanical	Electrical	Unit control	Mobile plant	Admin-istration	Transport	Store	Produ-ction	Total
1995	No of accidents/	19	105	28	6	25	41	23	30	30	283	590
	Hours Lost	8	184	252	104	8	64	248	56	56	384	1364
1996	No of accidents/	22	104	19	-	22	15	49	31	31	255	548
	Hours Lost	264	344	-	-	56	-	-	-	-	1016	1680
1997	No of accidents/	14	79	22	4	25	58	57	5	5	198	497
	Hours Lost	-	104	152		176	224	256	25	24	1209	2170
1998	No of accidents/	16	102	22	11	17	25	15	23	23	177	431
	Hours Lost	-	364	-	-	32	8	112	-	-	590	1106
1999	No of accidents/	1	14	-	5	3	9	3	2	2	24	63
	Hours Lost	-	4	-	-	128	-	-	-	-	24	192

These are caused when a portion of the body surface is exposed to either dry or moist heat carrier of sufficiently high temperature. It occurs mainly in the production and electrical unit of the company, due to increased probability of exposure to the hot kiln shell (fig. 1) and shock from electrical appliances. Trauma, which is caused mainly by the consequences of injuries, is sensory in nature (Osundosumu, 1999). It may also be due to vibration or acts, which may result in persistent pains, faulty reception of sensations, disturbances in the nutrition of the parts supplied by the nerve affected and weakness or paralysis of muscles with corresponding impairment of functions.

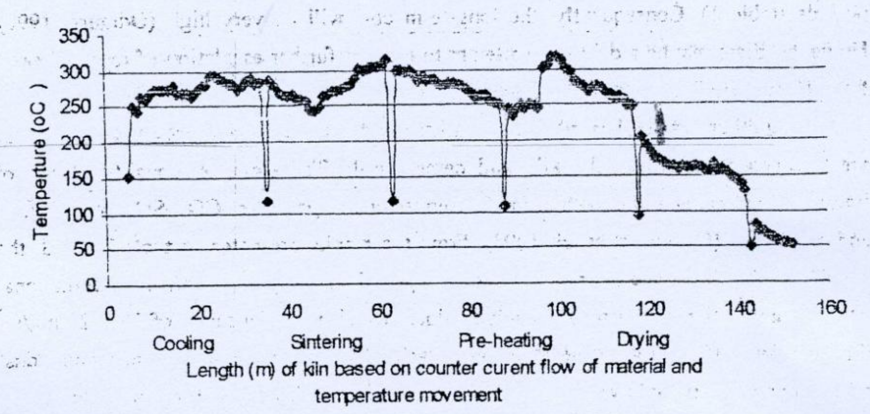

Fig. 1 Overall kiln length temperature

Trauma from shock, bleeding, fractures and dislocation account for about 8.26% of the total accidents (Table 1). However the reported cases of various trauma was considerably increased in 1998. The observed drop in 1999 may be for new cases as most trauma are not easily treated medically. Alternatively they may represent the worst cases as no record of employee movement for the period 1998/1999 was provided. Laceration is caused by falling loads, stones and accidental contact with machines such as milling cultures, toothed wheels and rollers. Reported lacerations incidents were drastically reduced by 1999, perhaps due to better safety education of the employee and installation of more safety gadget.

No matter their type, accidents always lead to production time – loss that has direct effect on the profit and production target of the company. From table 4, it could be seen that the greatest lost hours was recorded in 1997 with total lost hours of 2,170 hours.

Production department has the greatest lost hours of 1,209 in 1997. These lost hours can be reduced if the main precursors of accidents are properly identified and their sources eliminated. For instance, bone fracture; dislocation and sprains are occasionally followed by nutritional disturbance of the entire section of the limb. Their delayed consequences include stiffening of joints, withering of muscles and heightened sensitivity to cold. Deafness and balancing equilibrium may occur after a fracture of the base of the skull, if extended to the temporal bone that harbors the middle ear, the inner ear and the organ of balance in man. The frequency of these incidents remains relatively high for the periods (table 1). Consequently, the long-term cost will be very high (Odigure, 1998). However, there maybe a deliberate attempt to prevent further escalation of reported cases from 1998 – 1999.

Another noticed hazard of the industry under study is the dust emissions. These are released mainly from the kiln and cement mill. The emission consists mainly of limestone and cement dust with secondary emissions of gases i.e. CO_x, SO_x, NO_x, ketone and aldehydes (Gwedolyn et. al, 1993). From the results presented in table 2 and 3, the weight of the dust released per volume is high when compared with the international labour organization (ILO) recommended values, which is in the range of 15 – 20 mg/m^3 (Parmeggiani, 1983) for a wet processing technology. The company's minimum dust released value by the kiln was 3mg/m^3, while that of the mill was 2110 mg/m^3 (The reason for this enormous discharge at the cement mill may be due to faulty dust collecting system i.e. the electrostatic precipitator (ESP)). The consequence of high dust emission on the factory workers and its environs are numerous. This could result to increased lung diseases e.g. bronchitis, silicosis from sand blasting (Osundosumu, 1999) and skin diseases such as eczema (Parmeggiani, 1983). Results presented in Table 2 clearly showed that the kilns operate under unstable regime with excessively high concentration of dust in the flue gases. This could be associated with poor/unstable de – dusting units or technological condition in the kiln. The incident of dust in flue gases have been reported for poorly managed raw mix slurry with high moisture content (Odigure, 1998). The same is also observed for the de- dusting system of the mills.

Thermal pollution is one of the greatest problems facing the world today (SPMAN, 1999). It could be observed from Figure 1 that a relatively cool environment is noticed at the drying zone while the highest shell temperature is witnessed at the calcining/sintering zone. Due to the kiln shell temperature, the ambient temperature of the surrounding is raised by a few degrees, sometimes by about 10°C at about 5m away from the kiln surface (Agunbiade, 2000). The high increase in the ambient temperature was particularly noticed in the calcining/sintering zone.

CONCLUSION

The operation of a cement company in Lagos is associated with lots of short and long term's hazards. Current safety practices do not go far enough to guarantee good quality of life for the immediate environment and man. Investigations revealed that large emission of cements dust and limestone are daily plunged into the atmosphere along with secondary emissions, an action that constitute great nuisance to the society. This is clearly connected with poor control of technological parameters in the various operation units. Proper planning, organization and controlled replacement of outdated proper units may move the organization closer to the realization of a better safety working environment.

RECOMMENDATION

(1) Training of employees to achieve high standard of environmental performance by providing necessary awareness and given specific training on the cement production.

(2) Carrying out regular environmental audits to monitor progress.

(3) Carrying out regular overhauling of the plant as at when due.

(4) Regular medical check-up to be carried out on the employees especially those at the dense dust related areas e.g. the packing unit.

(5) The use of automated control devices such as alarms, to inform the people nea the plants to stay off when there is going to be a start up or shut down of machinery.

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