CONCEPTUALISATION OF NEW INDUSTRIES AND HEALTH

CASE STUDY: AMNI INT'L PET. DEV. COM. LTD. FIELD, CLIFF LANGLEY PRODUCTION PLATFORM P.H

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CERTIFICATION

This is to certify that this project titled CONCEPTUALISATION OF NEW INDUSTRIES AND HEALTH was carried out by BABALOLA A.R under the supervision of DR J.O. ODIGURE and submitted to the Chemical Engineering Department, Federal University of Technology Minna in partial fulfillment of the requirement for the Award of Bachelor of Engineering (B.ENG) degree in Chemical Engineering.

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DEDICATION

Dedicated to my mother Mrs. R.O. Babalola, my source of inspiration and strength.

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I would like to thank all that contributed in no small way to the completion of this project, you are all appreciated.

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ABSTRACT

This project sought to investigate the Health, Safety and Environmental practices of the oil industry, in particular AMNI INT"L PET. DEV. COM. LTD. Field, P.H. Using the (API-RP45) oil-in-water test, the relationship between wastewater quality measurement and health and environmental problems were investigated. It revealed that the company understudy was to a large extent compliant with the existing standards but needs to improve on some management practices. Factors attributable to these health and environmental problems could be associated with the conceptual design of the water treatment system. This should be considered during conceptualization of new ones. It is recommended that the company should have a health, safety, and environmental policy defined, communicated and implemented from management to employee level. It should also minimize as much as possible wastes from raw material to product level, favoring utilization alternatives, and more stringent measures be adopted by government to enforce compliance monitoring.

INTRODUCTION

CHAPTER 1

Most of the chemicals processing industries in existence today are industries having up to 15years of existence. They consist of old structures, buildings that house old/obsolete equipment. These old structures are liable to structural failure as a result of degradation by agents of the weathering (rain, sunshine, and e.t.c.) and process parameters (pressure, high temperatures). They also consist of equipment, which have outlived their usefulness, as such only constitute hazards of all sorts to operating personnel. What remains of them are maintenance problems; a burst here, a leak there, a breakdown, which are factors that are responsible for fire outbreaks, explosions, leakage of poisonous effluents; gaseous or liquid, which is harmful to both personnel and the environment (including the host community, plants, and animals.), and contacting of high temperatures by personnel.

Catastrophic incidents in chemical and process industries, the 1994 LPG tank explosion in Mexico City, the 1995 Funiwa well-5 blowout in Nigeria, the 1998 Piper Alpha Platform explosion in the European North Sea, and the more recent Idoho field oil spill incident and the Jesse pipeline disaster in Nigeria are an indication that man and the environment will forever be threatened by the consequences of industrial activities. [8]

It would therefore be said that process industries do not only constitute a health hazard to operating personnel, but to the host community in which the industry is sited.

Oil and Gas Exploration and Production (E&P) Industry are sources of revenue and energy. They are also responsible for myriad of health and environmental problems that can result from their activities such as the Mobil Oil spill in January 1998 in Akwa Ibom State of Nigeria where 1,071 households were sampled. Results obtained included system disorders in the people, increased morbidity rate, an outbreak of fever, poor quality of portable water, and general poor health status. [4] The Atlas Cove incident in March 1998, Lagos severed marine life, destroyed fishing boats and nets, and destroyed the peoples' crops and soil. As the people tried to make ends meet, they dipped bodily into pools of petroleum products, which resulted in skin eruptions. [31] One begins to wonder about the benefit of this industry, which by its operations has not been exactly friendly to its immediate environment.

Oilfield activities which entails offshore operations in this case, is characterized by exposure to various hazards such as blowouts, gas leakage, fire, and specific hazards inherent in jobs like materials handled; chemicals e.t.c. These hazards directly affect the workers and the marine environment and indirectly affect the host community when carried by air, water to the people thereby affecting their health as pointed out by the above examples.

As a result, this industry would be examined, operations of existing structures would be scrutinized in comparison with standards of regulatory bodies to determine the extent of compliance or deviation, and seek to find solutions to existing problems.

From analytical and theoretical work on data collected, solutions would be proffered with a view to propose a change viz. Identification of the problem, comparing with regulatory and control legislature, and with these in mind conceptualizing a "new industry" that would reflect a change from old practices, elimination/reduction of existing problems, compliance with set standards and enhanced productivity.

1.1 JUSTIFICATION

The effects of the oil exploration and production operations of the Oil and Gas industry have become synonymous with the degradation of the environment through air and water pollution via flaring and waste/effluent disposal respectively. It has also been known to affect adversely the health of both personnel and people of the host community to the industry.

The conceptual design stage of a development, like an E&P unit requires an Environmental Impact Assessment (EIA) report to examine the potential environmental, social, and health effect of such a development. This is the manner in which Government can regulate the activities of such projects so as to protect the health of the people and the environment.

Through it's regulatory bodies: FEPA, and Department of Petroleum Resources (DPR), Government determines whether or not the activities of a major development is likely to have significant adverse effects and whether or not such effects can be mitigated, and therefore prescribe measures as the case may be to prevent or mitigate such effects.

To proffer solutions at the conceptual design stage of a new industry, that would eliminate/minimize the current problems of the existing industries and as such have a "clean process" the least harmful to the health of personnel and the general community justifies the purpose of this research work.

1.2 AIMS AND OBJECTIVES

This project/research aims at: -

I. Reviewing the current practices in industry as regards health of operating personnel and the general public.

II. Collection of data from crude samples analysis and use of analysis to recommend improvement in compliance program.

III. Conceptualizing an industry, which would have none of the observed problems or seek to control/minimize such problems.

1.3 SCOPE AND LIMITATIONS.

Crude oil production has immense benefits in terms of monetary gains made. This is shown in involvement of various companies in these industries such as Mobil, Shell, Elf, Chevron, Amni, Agip, and e.t.c.

Scope of research was centered on investigating the inter-relationship between health, safety, environment and design of a new industry at the conceptual design stage.

It should be noted that some of the points mentioned in this project work apply in principle to most Oil companies but in particular, limited to the operations of the production department of AMNI INT'L PETROLEUM DEVELOPMENT COMPANY LIMITED. It should also be noted that data was difficult to come by especially in privately owned companies, hence data collected was limited to a period of study equivalent to a six-month industrial training period.

CHAPTER 2
LITERATURE REVIEW

As has been earlier highlighted, in chapter one, the importance of workers and community health as well as the protection from pollution of the environment by the operating industry. We shall scrutinize/address the fundamental causes of these occurrences with a view to develop a concept for pollution prevention and a good, clean health bill for operating personnel and the inhabitants of the host community.

Focus would be upon health, safety, and environmental hazard that workers, the environment, and their inhabitants are exposed to in relationship with oilfield activities (offshore work) in production operations.

As said by P.K.Ghosh [17] "all offshore work is characterized by a number of hazards" Let us examine them!

2.1 Occupational Health and Safety hazards

Occupational health is concerned with health in its relation to work and working environment. Its range was originally limited to occupational diseases and/or injuries attributable to work, to conditions of work, or to working environment. Gradually, the scope was broadened as a result of research which made clear the importance of these elements among the factors causing or contributing to many non-occupational diseases or deviations from health. (S.Forssman)[17]

Forssman also emphasized that occupational health should aim at; the promotion and maintenance of the highest degree of physical, mental, and social well being of workers in all occupations; the prevention among workers in all departures from health caused by their working conditions, in short the adaptation of man to his work.

He further stated that occupational health includes studies on factors relating to work, working methods, conditions of work, and working environment that may cause disease, injuries, or deviations from health including maladjustment to work for instance; chemical and physical hazards such as intoxication from inhaled dusts, fumes, vapour, gases, as the case may be. Skin diseases from irritating substances like chemicals used, lube oils, e.t.c, deafness due to noise, mechanical risks involving machinery, physical and mental strain from heavy, or monotonous work, high speed or long working hours.

To focus sharply on the case study, health of the workers is constantly tried by occupational, safety hazards as a result of the operations of the company. As stated in the above paragraph, the oil field represents all the listed hazards and more. It's operation is capable of causing deviations from health for not only it's operating personnel, but can also contribute to non-occupational diseases and also add degradation of the environment to it's list of evils.

The implication of occupational health and safety hazards is borne in the Mobil Oil Producing incident of May1998 in Akwa Ibom state where a blowout of one of the wells under repairs rendered two of it's four personnel invincible (vaporised) and the others injured seriously and delimbed. It is also shown in the Amni incident where during a boat operation involving hauling of chemicals, one man fell over board and drowned. [30]

In summary the implication of these hazards in a predominantly risky working environment such as the offshore environment of oilfield operation is mostly death or serious injuries to personnel.

As such in developing a concept for hazard prevention, it is necessary to examine the fundamental causes. Therefore occupational health and safety hazards which results in days away from work, days of restricted work activity, job transfer, deviations from health, and injury causants would be treated so as to identify with these hazards and respond accordingly.

2.1.1 Noise

Unwanted sound that constitutes a nuisance, the presence of which produces undesirable effects in the environment in which it exists be it working or in general is noise. It is a sound composed of many frequencies and frequency components of various loudness distributed over an audible frequency range.

One might begin to wonder what sort of hazard noise can cause, it is in fact one of those things we work with that is irritating but borne as just “one of those things”.

The work environment is rife with conversation, equipment/machinery noise in the form of buzzes, vibrations, and wheezes. All are at various frequencies and constitute noise. The especial sources of noise in industries are machines.

Old industries with lives of up to 15years have obsolete equipment that has maintenance problems. Such machines are constantly wheezing, buzzing, vibrating in short making all sorts of noises. Workers in such industries bear this sort of noise intensity with pride as related in stories of “boilermaker ear” as an evidence of a life of good hard work, but people are better educated today and not so proud of such loss of a facility as they once seemed to be. Nevertheless it still occurs that personnel feel that it is somehow less virile to protect their hearing. [11]

However the effect of noise has been described as a subtle pollutant which leaves no visible effect, although can pose a hazard to our health and well being. [13]

As such a noise problem arises, a situation exists when noise interferes with human activities, such as inability to enjoy music, understand a conversation, and distinguish certain consonant. To sum it up, loud noises which are a feature of most working environments may cause:

I. Damage to hearing or health
II. Interfere with work tasks
III. Interfere with speech communication.
IV. Cause annoyance. e.t.c

As such it is necessary to measure noise or know the noise level that would affect the ear. Noise level is measured in decibel (dB). This scale measures the various components of noise according to the response of the human ear. [21] This makes it possible to research the safety limit; noise level that is safe for exposure to the ear.

It was found scientifically that continuos exposure to sound exceeding 70dB can be harmful to hearing, induce temporary stress reactions like increased heart beat, blood pressure, blood cholesterol levels, and have a negative effect on digestive and respiratory systems. Unrelenting exposure could result in chronic stress diseases like ulcers and high blood pressure. [13]

Similar research carried out by a drilling company Sedco Forex, found that in an offshore environment where they operate, 85dB is a safety limit for noise exposure, above which ear protectors have to be worn by personnel. They further indicate noise levels of all the work areas to alert workers in such areas to protect their ears. [18]

Other sources link noise effects to years of exposure. It was found that working population exposed to industrial noise tends to lose their hearing acuity over years of exposure. As the number of years of exposure to noise increases, so does the tendency to lose the faculty of hearing increases.

Age (years) Exposure years (re age 20)	20 0	25 5	30 10	35 15	40 20	45 25	50 30	55 35	60 40	65 45
80dB exposure level total risk due to noise	0.7 -	1.0 -	1.3 -	2.0 -	3.1 -	4.9 -	7.7 -	13.5 -	24 -	40 -
85dB exposure level total risk due to noise	0.7 0.0	2.0 1.0	3.9 2.6	6.0 4.0	8.1 5.0	11.0 6.1	14.2 6.5	21.5 8.0	32.0 8.0	46.5 6.6
90dB exposure level total risk due to noise	0.7 0.0	4.0 3.0	7.9 6.6	12.0 10.0	15.0 11.9	18.3 13.4	23.3 15.6	31.0 17.5	42.0 18.0	54.5 14.5
95dB exposure level total risk due to noise	0.7 0.0	6.7 5.7	13.6 12.3	20.2 18.2	24.5 21.4	29.0 24.1	34.4 26.7	41.8 28.3	52.0 28.0	64 24
100dB exposure level total risk due to noise	0.7 0.0	10.0 9.0	22.0 20.7	32.0 30.0	39.0 35.9	43.0 38.1	48.5 40.8	55.0 41.5	64.0 40.0	75.0 35.0
105dB exposure level total risk due to noise	0.7 0.0	14.2 13.2	33.0 31.7	46.0 44.0	53.0 49.9	59.0 54.1	65.5 57.8	71.0 57.5	78.0 54.0	84.5 44.5
110dB exposure level total risk due to noise	0.7 0.0	20.0 19.0	47.5 46.2	63.0 61.0	71.5 68.4	78.0 73.1	81.5 73.8	85.0 71.5	88.0 64.0	91.5 51.5

115dB exposure level	0.7	27.0	62.5	81.0	87.0	91.0	92.0	93.0	94.0	95.0
total risk due to noise	0.0	26.0	61.2	79.0	83.9	86.1	84.3	89.5	70.0	55.0

Note: It is assumed that the effects of noise and age on peoples' hearing are additive and that there is interaction between the two effects

Table2.1.1: Percentage risk of developing hearing loss in excess of 25dB. [11]

The table above (table 2.1.1) as a result of a detailed study has tracked hearing loss against various levels of industrial noise exposure.

At a sound level of 80dB, there is no percentage increase in hearing loss versus years of exposure that we can attribute to noise, since the entire population tends to lose hearing acuity with age in the absence of such exposure. This age related hearing loss therefore is assumed to be unrelated to noise. For example, if noise exposure were 90dB then after 15years of exposure the total percentage at risk is 12%, and 10% of, which is attributable to noise. Indicating that at higher noise levels the tendency of hearing loss due to noise increases. This is further indicated at a noise level of 100dB and above which is common in most industries where a significant fraction of the population would be at risk within 10-15years of exposure. [11]

How does this noise produce it's effect on the sense of hearing so much so as to cause it's gradual damage and ultimately impair it?

Sound waves enter the auditory canal causing the eardrum to vibrate. The three small bones of the middle ear transmit these vibrations to the inner ear through which they move as fluid pressure waves. The organ of the corti, running the length of the cochlea converts these vibrations to nerve impulses, which are then carried to the brain by the auditory nerve.

Noise through its destructive effects on the delicate hair cells of the organ of the corti within the cochlea of the inner ear causes hearing loss. These cells convert vibrations in the inner ear to nerve impulses, which are carried by the auditory nerve to the brain resulting in a sensation of sound.

Progressive destruction of the hair cells and a correlated reduction in the number of associated nerve fibres can be caused by noise exposure or by aging. Though these cells are in their thousands if a significant amount is damaged, then hearing is impaired.

To calculate the level of noise exposure, level of exposure to noise is given by the relationship:

$$Fe = T_1/L_1 + T_2/L_2 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Tn/Ln$$

Where:

Fe : equivalent noise exposure factor

T : period of noise exposure

L : permissible exposure duration.

It should be noted that; using the relationship above, Fe, must not be greater than 1, if so, exposure is out of permissible limit. [13]

2.1.2 Handling Chemicals.

Production chemicals as the name indicates are chemicals used during field operations in an oil field. They are important because of the many problems of crude from the reservoir. They are therefore injected into the process flow by means of an injection pump to improve the quality of the crude.

Some of the problems of crude for which production chemicals are utilized are emulsion, corrosion, scale formation. They are also used to clarify produced water, depress pour point, and also as a biocide.

The production chemicals of use in the industry are:

I. Water clarifier
II. Pour point depressant
III. Scale inhibitor
IV. Corrosion inhibitor
V. Demulsifier
VI. Biocide.

The water clarifier is used to treat produced water to effectively remove oil and solids. The pourpoint depressant is used to improve flow of crude through the pipes at a low temperature, also known as the "cold flow improver". The scale inhibitor, which is water-soluble, is used for the prevention of alkaline earth metals scale deposits. It is therefore effective in preventing calcium carbonates, strontium sulfates, which leads to scale formation. Corrosion inhibitor is used to prevent corrosion in pipeline. Demulsifier, which is a liquid phase production chemical is used for the demulsification/breaking of crude emulsions. The biocide, which is a water soluble liquid, functions as a controller to both aerobic and anaerobic types of bacteria, fungi, and algae useful in the control of iron oxidizing bacteria, and effective in the control of anaerobic sulfate reducing bacteria which are responsible for hydrogen sulfide production and corrosion of steel pipelines and equipment.

Despite their usefulness during production operations, they are also responsible for the ill health of the handlers. By their constituents they are a hazard to the handler.

As reported by P.K.Ghosh in his research "A number of hazards are a characteristic of all offshore work as these are specific hazards inherent on jobs, like materials handled such as chemicals"[17]

Similarly, oilfield workers that have retired, that worked with chemicals, usually have skin disorders as well as other deviations from health due to over-exposure to these chemicals.

Their effect on the health of personnel due to exposure/handling include:

I. Repeated contact with the skin can cause moderate to severe irritation, burns and dermatitis.

II. Contact with the eyes can cause irritation (severe), burns, and if not immediately removed from the eyes may lead to permanent eye damage.

III. Inhalation of mist aerosols or very high vapor concentrations will produce intense nose and respiratory irritation and may result in lung damage. Prolonged exposure may result in chemical pneumonitis and in extreme cases pulmonary oedema.

IV. Ingestion of chemicals is harmful when swallowed. It could be severe gastrointestinal disturbances, dizziness, nausea, vomiting, collapse, coma, and possible death. It may also result in irritation of the mouth and digestive tract.[16]

It further has effects attached to its properties like flammability, flashpoint, and e.t.c.

Most of the reactions some of these chemicals engage in are hazardous and mixing with strong oxidizing agents could cause hazardous decomposition to occur and produce ammonia and oxides of nitrogen, which are hazardous to personnel.

Reuse of emptied containers, which is common amongst the public, could also expose the users to hazardous residues. This was exhibited in the Koko Port in the then Bendel State incident where cans reused caused the death of many families and ill health of others.

In occupational health and safety administration, every incident represents a potentially hostile situation, chemicals represent combustion, corrosion, explosion, and toxicity. [13]

2.1.2.1 Laboratory hazard

Potential causes of accidents	**Potential**	
	incident	***Loss***
Reagent bottle uncovered after use	Inhaling toxic gases e.g $CHCl$, HCl e.t.c	Damage to body organ, chronic ill health.
Not rinsing wares after use	Possible unwanted reactions	Bodily harm, equipment and material loss
Not using safety wear in handling corrosive chemicals	Chemical burns	Injury, property damage
Not labeling chemical containers	Confusion of chemicals.	Injury, property damage, and waste

Potential causes of accidents	**Potential**	
Assuming any colorless liquid is water	Poisoning, fire	Injury, Ill-health
Not slackening of bottles with gas generation before opening	Explosion	Injury, property damage
Chewing gum, kolanut while pipetting	Swallowing poison, choking	Injury,Ill-health
Exposure of eyes to dangerous radiation	Eye damage, other damages	Loss of eye sight, sterility
Lab without toxic fume/vapor detectors	Poisoning, explosion	Injury, ill health
Poor safety policy, unplanned/no training for lab personnel	Increased accidents, and low productivity .	Frequent injury and property damage

Table 2.1.2.1: Laboratory accident causation analysis. [3]

Laboratory work arises as an aspect of oilfield operations when quality control or effluent monitoring is needed. It involves testing, and analysis of samples collected from the offshore location.

Laboratory accidents also occur, hence laboratory work can be potentially hazardous to personnel that work there. Some laboratory incidents, their causes, and losses as a result of their occurrence are as follows in the table above (Table 2.1.2.1) as it affects operating personnel.

2.1.3 Stress

Stress is a condition of being under pressure/tension. It is a condition causing hardship, disquiet. It is a subtle condition, which contributes largely to conditions of ill health, be it physical, mental, or emotional.
The effects of stress in an enabling environment such as the working environment are immense. The rigors of a daily routine, the demand for maximum efficiency and productivity, the desire for increased pay, responsibilities and other factors. These factors induce workers to stretch beyond their capabilities (normal), work long hours in hopes of being paid overtime bonuses, in short cause themselves stress and from which deviations from health results.

This issue is not theoretical, it is manifest in our daily lives and a source of concern to the well being of our health.

Offshore oil operations involving production engages it's personnel in continuos operations work according to the system of the 12-hour shifts which requires the presence of two complete teams on the installation. The general practice on all offshore petroleum installations is to alternate seven or fourteen days of work with seven or fourteen days of leave. [17]

The above situation is the case in many oil installations where production operations take place. For example, on the platform operated by my case study (Cliff Langley), each team is in pairs and arrives on crew change days in batches. Batch one operates from 6a.m - 6p.m, while batch two operates from 6p.m - 6a.m. All batches are assumed to be rested by the end of each alternate batch.

This sounds like a good working programme but it is a source of stress.

Mental stress of personnel on the platform is recognized as a factor contributing to illness, accidents, and low output. It's causes are long hours, fast pace of work, lack of proper rest, various environmental factors such as noise, vibrations, rocking, cold, heat, poor lighting, domestic worries, and constant fear of hazards, injury and disease.

The personnel are carried to an environment that is strange and different to the one they are used to. They are transported over water to a marine environment, they miss their families, the fear of falling overboard, being seasick, the hope that two weeks would soon come to an end, overexertion during working hours doing strenuous work are the every day, every week, every year problems of a production personnel.

The effects are cumulative. The signs of stress are; unusual irritability, claustrophobia, and frequent insomnia (2%) requiring tranquilizers, psychosis and depressive psychosis.

Stress may lead to excessive smoking, alcoholism, and even drug addiction, which inadvertently contribute to the further breakdown of health.

2.1.4 Process hazards.

Most chemical industries are involved in processes of converting matter/materials into finished products and as such are involved with facilities and equipment necessary for such conversion. The use of equipment and the presence of a process flowline of such equipment performing their specific functions is not unknown, so also is the familiarity of health and safety hazards that could ensue as a result of being in contact with this process line.

Toxic and corrosive chemicals and fume leakage, fires, explosions, plant personnel falling accidentally, and mechanical equipment incidences are major health and safety hazards encountered in the operation of plants in the process industries. [23]

An unwanted reaction could occur in a plant, in particular of the kind, which by their own might become self-accelerating. [17] Build up of pressure could occur that would cause a blowout, explosion, domestic or process parameters (e.g ignition temperature) could cause fire, usage of wrong tools, or of damaged tool on the job could create an unsafe condition, over-exertion due to overstretching e.t.c are various forms of which these process hazards are encountered by personnel.

The production operations of the oil industry requires mainly separation; which involves gravity settling, dehydrating; involving heat and electrical treating, stabilization, water treatment, gas compression and disposal.

Crude oil mixture from the wells enters the process manifold and through the headers flow is channeled into A, B, and test trains for onward separation (gravimetric) into gas which is flared, water which is treated and disposed of, and oil which is further treated to remove residual gas and water. [18]

Short and uncomplicated as the process is, it is the cause of many health and safety problems. It is responsible for; leaks that cause pollution, waste, fire outbreaks, explosions, blowouts e.t.c.

The 1998 Piper Alpha platform fire in the European North Sea, the 1984 LPG tank explosion in Mexico City, the 1995 Funiwa well-5 blowout in Nigeria,[8] are incidences to testify to the effects of this industry.

The typical problem areas in the process are where flanges, valves, and fittings are because they are the sources of leakage, which could causes fire (gas leakage), or ill health by inhaling fumes.

2.1.4.1 Fire

From an operating point of view, the most hazardous aspect of working with petroleum is fire. Most hydrocarbons will readily ignite from a spark or if they are heated to their ignition temperature by contacting a hot object like a heater treater.

For a fire to occur, the following must be present;

I. A combustible substance - hydrocarbon in this case.
II. Oxygen or air
III. Enough heat to ignite the fuel air mixture (an energy source to provide ignition).

Liquid hydrocarbons will not burn unless in vapor state and mixed with the proper quantity of air. This does not make it safe even in the liquid state. Hydrocarbons will evaporate just as water does and the space above the liquid phase may contain sufficient vapor which could be ignited from a spark. Once ignition has occurred, the heat from the fire will cause continuous combustion due to additional vaporization of the liquid. This is the temperature at which sufficient vapors present from evaporation cause ignition known as flash point.

Not only must hydrocarbons be in a vapor state in order to burn, they must also be present a certain mixture with air for ignition to occur i.e. the concentration of hydrocarbons in air must be within the flammability limits in order for natural gas to burn. For example, in order to burn natural gas in air, the concentration must be at least 5% and not more than 15% in the order of 5% to 95% of air. This means that if the mixture has less than 5% natural gas, then it is too lean to burn, and if it is more than 15%, it is too rich to burn.

A combustion mixture will not burn unless it is heated to its ignition temperature and sufficient heat is generated to maintain the temperature above the ignition point. The ignition temperature varies for different hydrocarbons and is higher for more volatile hydrocarbons, such as methane or propane than for heavier liquids such as crude oil.

It is not necessary that a spark be present for a hydrocarbon vapor to ignite. If the vapor is mixed with air within it's flammability limits, it will ignite when it's temperature reaches ignition point.

Usually when a hydrocarbon burns it actually undergoes a chemical reaction in which the hydrogen and the carbon atoms are combining with the oxygen in the air to form water and carbon dioxide. The chemical reaction will occur when the temperature of the mixture reaches ignition point. The fire you see is actually the result of heat that is liberated when this reaction occurs.

$$CH_4 + 2O_2 \text{ ====== } CO_2 + 2H_2O.$$

The above reaction is the burning process of natural gas and will stop if the temperature at the point of combustion falls below the ignition temperature, i.e.

the fire will continue until the feed source is depleted, or the fire is extinguished. [22]

The possible causes of fire outbreaks on a production facility are as follows;

I. Failure to obey the "No Smoking", "No Naked Flame" warnings.

II. Improper disposal of oily wastes such as oil and grease removed during machine servicing as well as used oily rags.

III. Unauthorized hot work such as welding, grinding, reveling and wire brushing (which produce sparks).

IV. Improper earthing of machines/electrical equipment such as welding sets

V. Overloading of electrical equipment.

VI. Use of internal combustion engines without fitted spark arrestors.

VII. Removal of lagging from hot surfaces such as machines exhaust and boilers.

VIII. Use of internal combustion engine in confined areas or dangerous areas containing flammable gases.

IX. Improper storage of and use of flammable materials such as cooking gas, petrol, diesel, paints, thinners, oxygen/acetylene gas e.t.c

The classes of fire are;

I. Fire involving solid combustibles e.g paper

II. Fire involving liquid combustibles e.g petrol

III. Fire involving gaseous combustibles e.g natural gas

IV. Metallic combustibles e.g Zinc, Magnesium. [24]

Fire is a great hazard which when occurs is capable reducing a whole investment to rubble as such a source of a great, huge loss.

2.1.4.2 Blowout

Blowouts are a hazardous occurrence in oilfield operations that result in serious fatalities. These fatalities range from serious injuries to death.

Blowouts occur as a result of loss of well controls hence the escape of significant amount of oil and/or gas (in most case gas).

Usually, wells exist that produce water and gas along with crude oil, but are in greater percentage than the accompanying crude oil, such wells are known as water or gas producing wells as their case may be.

The pressure at which production fluid comes out of formation is usually very high due to the existence of production fluid in a vacuum underwater. A slight pricking of the surface would cause production fluid to climb up with it's own pressure without pumping.

Such high pressures like 500psi characterize gas head pressure. Imagine the pressure of a shotgun which is 2.5psi; it would fling the recipient of it's shot, talk less of the pressure of a well that has blown out, the damage can only be imagined.

Occurrences of this hazard include the 1995 Funiwa well-5 blowout in Nigeria, the 1998 Mobil oil Eket blowout incident that claimed lives and property.

2.2 Environmental Concerns.

It has become cause for concern, the state of the environment today. The constant breaking news has been that of environmental degradation; the intensity of the sun; global warming; hole in ozone layer (ozone depletion), greenhouse effect, e.t.c.

Man's activities are a major contributing factor to the above named effects. The waste generation, burning of fuels, usage of halons, indiscriminate effluent disposal are ways we contribute domestically and industrially to environmental degradation.

The general populace (especially people living within the same area as an industry) feels the health effect of environmental pollution. The burning of fuel be it coal, associated gases, e.t.c, release acidic/alkaline gases, hydrocarbon into the atmosphere, which cause global warming, and a number of deviations from health like choking, fainting, lung cancer, and even death.

Exploitation and exploration of crude oil has led to massive pollution of the oil producing areas (Niger Delta, Nigeria). The implication of such a development on the health of the people in the oil producing areas is far reaching. Most analysis indicates economic losses, but a more dangerous hazard in the area has to do with health of the citizenry. This quest for industrialization has resulted in environmental degradation and destruction, which have attendant health effects.

Human welfare is reduced by ill health and premature mortality caused by degradation of air and water quality as well as other environmental risks. Pollutants can cause health problems through direct exposure or indirectly through changes in the physical environment, the effect of which ranges from increased solar radiation, to lower nutrition. [27]

With water and air pollution in mind, effluent disposal; and gas flaring would be treated to discover how they affect the environment (how they constitute a hazard) and indeed people.

2.2.1 Effluent Disposal

The water body, which is where most wastes are disposed of, is an indication that environmental problems are inter-related to our health. This is so because whatever pollutes water (portable) would automatically affect human beings i.e. our health because we are dependent on water for life.

Pollution due to waste will always eventually involve the system of the earth, especially because the pollutants emitted into the air, and those present in the soil are washed by precipitation into the water body. It is possible to subdivide pollutants according to the effect they exert on the water system and to the degree of harm they do to the environment.

Apart from the direct damage due to contact with and ingestion of water polluted by toxic pathogens and other substances, incalculable damage is done to marine life, one of the main sources of sustenance. Surfactants and oils limit the capacity of water to dissolve in atmospheric oxygen, and the admixture. Hot water reduces it's solubility, toxic substances such as metals (lead, mercury, e.t.c), phenol, are absorbed and concentrated in tissues of fish, thus entering into the human food chain.

Crude oil production process is characterized by waste, one of which is produced water. It is the end product derived from extracting oil from fluids emanating from a well, which may contain 1000ppm of oil and grease. In addition produced water may be high in dissolved solids, heavy metals, and other toxic compounds (notably phenolics). [3]

The produced water treating section consists of separators, hydrocyclones, a degasser, and skimmed oil pump. They all work together to remove oil from water so that after treatment, the oil and grease content in water would be fit for disposal. [18]

Existing technologies for the removal of oil and grease from produced water include gas floatation, gravity separation, and addition of chemicals to assist in separation. [3]

The effect on human health/welfare and economic growth of water pollution pose a most serious problem to oil producing areas. Children and the poor who are inflicted feel the direct impact of water borne disease. The frequency of being inflicted by diseases leaves the affected ones vulnerable to illness and death from other causes. The cost of water pollution includes damage to aquatic life, stalling of the livelihood of rural dwellers.

The health effect of these is as reported in cases of serious outbreak of Hepatitis A in Shongai due to the consumption of contaminated seafood. Also the spread of cholera in Peru could not go unnoticed. [27]

2.2.2 Gas Flaring

Flaring involves the burning of pretreated "clean gas" as a means of disposal in production operations. The flare shall be luminous and bright (i.e. show complete, smokeless combustion) at operating gas flow rate.

As it has been indicated, flaring is a part of production operations, which has to do with the disposal of gas by burning. It is however a harmful ventures as well as wasteful option to industries that operate this system.

Flaring of natural gas has been an integral part of the operations of the operations associated with the exploration of crude oil and natural gas resources in Nigeria since inception. Currently, more than 75% of associated gas produced is flared. An amount totaling to more than 2billion square feet per day which is estimated to be a quarter of the gas the world vents and flares. It has been estimated that Government loses about N17 billion to gas flaring annually. Flaring has become unacceptable both in terms of resource management and in view of the environmental concerns over the effect of emission into the atmosphere.

Most of Nigeria's oil facilities were built in the 60's and 70's. In those days, gas was not a popular energy source as it was more difficult to produce, and transport than crude oil on which many of the worlds' economies are based. There were also few marketers at the time in Nigeria and there was little awareness of the consequences of gas flaring. [25]

From gas flaring operations, there are releases/emissions into the atmosphere of oxides of carbon, nitrogen, and sulfur. Also gaseous particulate and heat radiation.

The effects of these releases into the atmosphere are the major causes of environmental problems, most especially as regards the air. The effects include; global warming, heat radiation, which in general affect adversely human, animal, and plant life as well as degrade the non-living environment.

2.2.2.1 Acid Rain Formation.

Gas flaring gives rise to the formation of acidic oxides of carbon (CO_x), sulfur (SO_2) and nitrogen (NO_x). The phenomenon of acid rain arises due to the dissolution of these acid gases in the atmospheric water in the sky to a degree that it becomes acidic leading to the formation of the acid rain with a pH of below 5. [26] It is given by the following reactions:

<u>SO_2</u>

$$SO_2 + OH ===== HOSO_2$$

$$HOSO_2 + O_2 === HO_2 + SO_3$$

$$SO_3 + H_2O ==== H_2SO_4$$

<u>NO_X</u>

$$NO_2 ====== NO + O$$

$$NO + O_3 === NO_2 + O_2$$

$$NO + OH + m ==== HNO_2$$

$$NO_2 + OH + m === HNO_3$$

Where m is a third body that absorbs energy like N_2 or O_2.

It is however important to note that there is no evidence of acidification causing any damage which is due largely to the fact that Nigerian natural gas has low, if not negligible sulfur content.

2.2.2.2 Global Warming

One of the most dangerous, serious threats to life is the possibility of a rapid warming of the earth due to the accumulation of heat retaining gases in the atmosphere. This phenomenon is the result of what is known as the greenhouse effect. This is the allowance of the passage of light rays generated when sunlight is absorbed by the earth's surface, but the retention of the heat generated as a result. An increase in greenhouse gases from flaring operations (CO_2, CH_4, and NO) in the biosphere causes increase in the earth's temperature. An eventual warming of between 1.5 and 5.0°C has been predicted (Illori, 1996). This will lead to gradual melting of polar ice caps: resulting in global increase in sea level and flooding in coastal areas.

In 1989, Nigeria flared 617mmscf of associated gas in the process 30 million tons of CO_2 was released into the atmosphere, in 1994 35million tons of CO_2 was released along with 12million tons of CH_4 in the Niger Delta. Considering these gases are greenhouse gases there is however an alarm of a much higher global warming potential as a result of the release of CH_4 into the atmosphere as it's effect is sixty-four times that of CO_2. As such the significant effect of gas flaring is even more serious. (Illori, 1996)[26]

2.2.2.3 Heat Radiation.

The combustion of gaseous hydrocarbons contained in natural gas is an exothermic reaction, which results in the evolution of heat to the atmosphere. This endangers both animal and plant life around the vicinity of a flare. Typical gas flares in the Nigerian oilfields are located at ground level and in some cases (offshore locations), at a distance from the platform/rig. Thick vegetation, farmlands, marine environment, beach settlements surround these flare locations and village huts about 20m - 30m from the flare.

The heat radiation from the flares is a function of the flame temperature (which is about 1300°C - 1400°C), gas flow rate (in millions square feet per day), and geometric design of flare stack.

In some cases, the surrounding soil is scorched, the villagers complain of "internal heat" due to the cumulative effect of long term exposure to radiant heat(Illori, 1996; Nanewotor, 1998). There is but 100% loss of yield at 200m from the flare, 45% from 600m, and 10% from 1000m. Therefore the farther away from the flame source of radiant heat the better.

The effect of these environmental concerns are directly felt by the environment but it's effect on the health of all is a long term effect i.e. the effect of an impoverished, degraded environment with poor quality of portable water, contaminated marine life (thereby affecting our source of protein or causing food poisoning), poor air quality (leading to increase in respiratory ailments), increased morbidity rate, and the list goes on.

The inter-relationship between problems of safety and the environment with health of the public and operating personnel in existing structures has been established from the discourse undergone in this chapter.

The hazard that operating industries constitute to the health and safety of personnel and the public, and the environmental are identified as follows;

I. Noise

II. Chemical handling hazards

III. Stress

IV. Process hazards including fire, blowouts e.t.c

V. Effluent disposal

VI. Flaring.

Findings on the above mentioned problems should be on a priority list to be singled out for treatment to prevent losses. They should therefore form the basis during conceptualization of new industries, to eliminate avoidable problems in future, ensure high productivity and quality, and compliance with environmental standards.

CHAPTER 3

EXPERIMENT/RESEARCH METHODOLOGY

Oily wastewater from production process is channeled into a chamber where oil and water are separated by gravimetric methods. The water from this process (which is of primary concern) is discharged into the sea.

Grease content in certain industrial wastes is an important consideration in handling and treatment for ultimate disposal. It (grease) is singled out for it's poor solubility in water and tendency to separate from the aqueous phase. [6]

For the above reason therefore, wastewater must be treated for the recovery of oil and grease before it can be discharged into receiving waters. This would require examination and measurement of wastewater and oil and grease respectively.

The aims of such measurement include:

I. Detrimental effect of waste effluent on the quality of the receiving waters
II. Studies to determine possible treatment methods
III. Studies to determine possible alterations in production process aimed at reducing the amount of pollutants discharged.

IV. Identification of valuable bye-products that could be recovered from the effluent.[36]

Water quality monitoring or oil and grease determinations is essential for:

I. Compliance monitoring in environmental engineering practice.
II. Enforcement program (from information gathered) needed to maintain water quality standards and permit future assessment of impact of resource exploitation and of possible management alternatives.
III. Control of spills of hazardous materials into watercourses. These may take the form of discharge of toxic matter resulting from malfunction of equipment, fire, human error, e.t.c

3.1 Methodology

Measurement of oil-in-water or oil and grease level in water ready for disposal is important to producing companies. It is how Amni (case study) establishes the extent to which it is complying with environmental regulations and discharge limits.

The oil and grease content of water test is one of the tests carried out in the oilfield the American Petroleum Institute (API) method. It is dubbed the API-

RP45 test. It is done to determine the effectiveness of the treating process. It determines the extent of compliance of the company in question with set standards.

Oil and grease data generated for the analysis was taken from samples. The water samples used were taken from sample withdrawal point located upstream of the chemical injection point at the degasser.

Sample containers were used to collect the water samples for the test. To take the sample at sample withdrawal point, the valve at the point was opened and allowed to run into a basin for some time until there is homogeneity. The samples are then taken in pre-washed containers (washed with sample water), the valve was closed, and the samples were corked properly to prevent the entrance of foreign bodies.

Samples were taken for onward analysis at the rig laboratory. The samples used were taken from the Amni field (platform: Cliff Langley). Twenty-five samples were taken during the period of study and analyzed.

3.2 Equipment/reagents

I. Smart calorimeter

II. 1,1,1 trichloroethane: To have a proper reading. This was used as a reagent to capture oil from dirty water.

III. Calibration curve: Because meter has no internal calibration for oil and grease, the results have to be correlated with a calibration curve to get the reading in PPM.

IV. 250ml separator funnel

V. Water sample.

VI. Retort stand.

Procedure

150ml of the water sample were taken at the degasser in a 250ml-separator funnel and 15ml of 1,1,1 trichloroethane was added to it. The funnel was corked tightly and shaken vigorously for a minute in an inverted and periodically re-inverted position. The funnel was then clamped to a retort stand before which built up pressure was relieved by slowly opening the cork. Suspended water and particles were removed from the funnel by inserting a small cotton plug into the delivery tube of the funnel. The water and the 1,1,1 trichloroethane were allowed to separate for ten minutes. The 1,1,1 trichloroethane exhibited a yellow/brown color due to the presence of oil. After ten minutes, 10ml of the lower 1,1,1-trichloroethane layer was drained into a sample cell. A blank was scanned, after which the sample was scanned to give percentage absorbance. This reading was correlated on the calibration curve) to give ppm of oil-in-water (or oil and grease).

The methodology of the analysis of the data involved the data being fed into the computer and analyzed for deviations (standard deviation) as presented in table and figure 4.1.

O&G(mg/l) /MONTH	WK1	WK2	WK3	WK4	WK5	STDEV
OCTOBER '98	15.7	18.5	20.6	22.0		
NOVEMBER '98	23.0	30.0	28.0	25.0		4.75
DECEMBER '98	29.0	28.0	36.0	32.0	26.0	3.87
JANUARY '99	30.0	28.0	29.0	30.0		2.86
MARCH '99	36.0	33.0	30.0	28.0		2.72
APRIL '99	28.0	29.0	30.0	31.0		2.72

Table 4.1: Oil and Grease Analysis

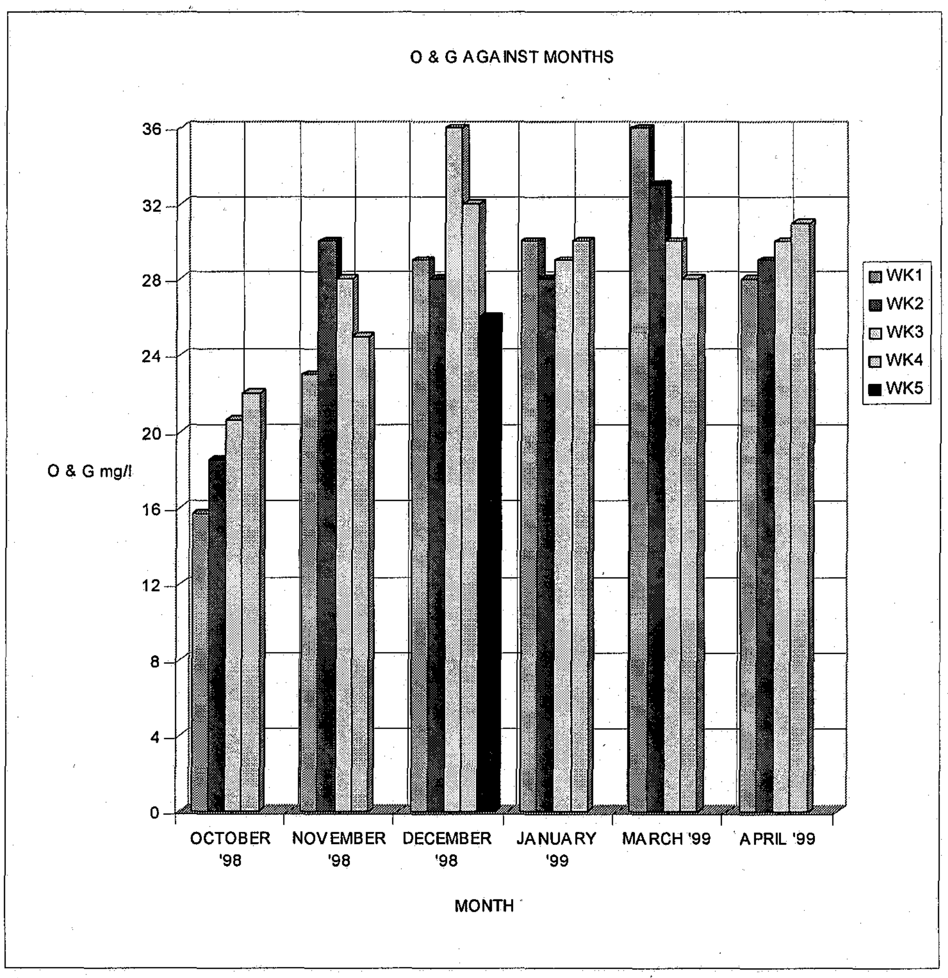

Fig 4.1: Oil and Grease Analysis for Period of Study (6 mon

CHAPTER FOUR

RESULTS AND DISCUSSION.

The oil and grease data generated for this analysis was gotten from samples taken at Cliff Langley production platform at the degasser, observing all safety procedures.

Once the data have been collected, the process of analysis begins, but almost invariably the data must first be translated into a form appropriate for analysis. [33]

From the analysis carried out (Table and Figure 4.1), it was observed that there were deviations which can be accounted for by production faults and management decisions.

There are obviously many ways in which to characterize a yield data. Almost always, the most efficient quantity for characterizing (the most reliable estimate) variability is standard deviation. [7]

From the table (table 4.1) it was observed that among the data there were variations, which were large at first, then gradually decreasing until it converged.

Due to errors in analysis, the yield from sample to sample even though the batch product is homogenous varies. The estimated standard deviation between analytically determined yield will approach a fixed value denoted by sigma (σ) which is mathematically explained as approaching a sort of convergence. [7]

As shown in table 4.1, the standard deviation between the months of October and November was 4.75, it further decreases between the months of December and January to a value of 2.86. It finally converges between the months of January and April with a value of 2.7(i.e. January/March, March/April).

Estimated standard deviation values generally differ from the true value, but the difference will tend to decrease as **n** is increased. The accuracy of standard deviation(s) therefore improves with increasing value of **n**. [36] It has also been pointed out that if sample data contained chanced errors then it would approach convergence. [7]

Error could arise during sampling as a result of the following:

1. Spill of reagents
2. Dirty glassware
3. Presence of suspended particles e.t.c

In general, deviations as shown in Fig 4.1, can be attributed to production problems. They include:

1. Faulty equipment
2. Rate of chemical injection.

The process of oil/water separation involves the use of separators, hydrocyclones, and chemicals e.t.c. At any point in time any of these vessels/process lines could be deficient and/or the chemicals e.g. water clarifier, could be inefficient due to the loss of the ability to carry out it's normal functions.

The rate of chemical injection into the process flow can affect the water treating process. The chemical in question is the water clarifier, which is used to treat produced water to effectively remove oil and solids. It also resolves oil-in-water emulsion, coalesces oil particles and suspended solids. The presence of a high cationic charge in this chemical when in solution helps it in separating emulsions.[16] This is due to the fact that colloids possess electric charges, therefore depending on the charge on the colloid, separation is carried out.

However an increase in the rate of injection could adversely affect the effective separation of the oil-in-water emulsion. When chemical applied to an emulsion becomes too much, it develops into phenomena called "unbreakable emulsion" or the burning of emulsion. This means that the emulsion would not separate hence high oil and grease level. An equally low rate of injection gives too little or no separation (in-effective separation), resulting in high oil and grease level as well. If any of the components of the equipment in the produced water treating section were faulty, then there would also be ineffective separation.

The hydrocyclone used in the operation had problems; one had dirty cones, and the other was broken down. The one that was handling the bulk of the produced water was faulty (i.e. the one with the dirty cones). [34] This brought about increased chemical injection rate, which lead to inefficient separation.

Also to be faulted are the management decisions made to contribute to the deviations.

Management apathy defined by administrators that are not often technically oriented, have difficulty realizing the potential benefits of a programme like effluent monitoring and sing the classic song of a production supervisor and/or plant operator "I am meeting deadlines and making money, so don't rock the boat". [13]

An unqualified administrator would be profit driven when a case like faulty equipment needing immediate repairs requires urgent treatment. This administrator would prefer to work with the faulty hydrocyclones than to repair or replace, as long as operations are not interrupted. Preference would also be paid to fines for violation as it is little compared to profits made. In short an unqualified administrator is not sensitive to factors that affect the plant equipment, his interest lies with profits.

Bureaucratic resistance to change defined by reluctance to adapt to changing circumstances is commonplace in the industry. [13]

It is no more news that indigenous companies employ the use of expatriates. Their advice is hung unto as gospel and indigenous engineers suffer rejection when they offer advice. Most expatriates are of the replacement school of thought when a machine breaks down. Therefore a production problem involving broken down/faulty equipment, which would otherwise have been repaired by indigenous engineers (believe in repairs) would remain so for a long time. This is so because an order for replacement takes a long time to arrive.

It is however important to note that the Department of Petroleum Resources (DPR) limit of 48mg/l and the self imposed limit of the case study of 40mg/l were not exceeded, dubbing the system operated, a doubly compliant system.

The deviations can however be reduced with a good maintenance system (including repairs for replacement), well-trained administrators (preferably engineers by profession because only an engineer can be sensitive to operational problems), team work, and the use of experienced indigenous engineers.

This would enhance:

1. compliance monitoring
2. productivity
3. cost effectiveness (reduced costs)
4. Reduction of harmful substances contained in wastewater inadvertely protecting the quality of receiving waters and hence preventing ill health of host.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.0 Conclusion

From the investigation carried out, the following conclusions can be drawn:

The fundamental factors responsible for health, safety, and environmental problems can be attributed to: effluent disposal, heats radiation and global warming from gas flaring, and process hazards.

Experiments carried out revealed that though the operating company was compliant with set standards, it should seek to reduce deviations encountered.

The factors responsible for these health/safety and environmental problems should be singled out at the conceptual design stage for improvement.

5.1 Recommendation

The following recommendations are being suggested for the improvement of this project finding:

I. A health, safety, and environmental policy should be defined, communicated, and implemented from management to employee level.

II. Adequate training should be given to operating personnel so as to protect themselves from hazards.

III. Work related hazards should be nipped in the bud i.e. by eliminating hazards inherent in equipment, process line and even at the raw material stage.

IV. More stringent measures by Government in enforcement of compliance standards.

V. Work incentives should be given to workers for complying with health, safety and environmental policies to encourage better practices.

VI. Preventive and predictive instead of suppressive measures should be adopted in all cases to protect the huge investment.

VII. Wastes from raw material to product stage should be minimized as much as possible. Utilization alternatives should be favored.

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