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Case Study

PERFORMANCE EVALUATION OF THE NIGERIAN PETROCHEMICAL INDUSTRY: RELIABILITY OF THE BAG FILTER IN CARBON BLACK PRODUCTION

***[1]Mamudu O.A., [2]Igwe G.J. and [2]Okonkwo E.**

[1]World Bank African Centre of Excellence, Institute of Petroleum Studies, University of Port Harcourt, Rivers State, Nigeria
[2]Centre for Gas, Refining and Petrochemical, Institute of Petroleum Studies, University of Port Harcourt, River State, Nigeria

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**Corresponding Author's Email:*
a.mamudu.11@aberdeen.ac.uk

ABSTRACT

Nigeria established three petrochemical plants in Warri, Kaduna, and Eleme respectively, between 1988 and1995, designed to produce the feed stocks for the country's plastics, rubber and detergent industries. Poor performance of the three state-owned plants and the unsuccessful outcomes of other proposed petrochemical plans discouraged government from establishing new ones. This situation has led to both loss in revenue and low capacity utilization. The Eleme petrochemical complex was later divested to Indorama, a private concern, which surprisingly turned around the fortunes of the plant within three years. One of the largest contributors to the sub-optimal performance of the Nigerian petrochemical plants is equipment failure and for the carbon black production process unit, equipment failure is as high as 56 percent of the total failures. This paper examines the impact of the failures due to the use of the bag filter equipment. The study was subjected to the root cause analysis while steps towards mitigating the failure rate was attempted using the reliability centered maintenance process. Results of the analysis and indices can be used by public to design its future investment in the sector.

Keywords: Petrochemicals, Nigeria, Carbon Black, Bag Filter.

INTRODUCTION

A petrochemical industry can be defined as any commercial enterprise that deals directly or indirectly with the production of chemicals and polymers from petroleum and natural gas. Although oil and gas still serves as its major source, since they are readily available and can be easily processed, its feed can also be gotten from other renewable source such as coal, oil shale, corn, sugar cane and tar sands (Matar and Hatch, 2001). These alternatives tend to serve as future sources since not much has been done to access their potentials. The industry can be traced back to the World War One era when the British extracted benzene and toluene from petroleum (Ophardt, 2003), since then its relevance has been greatly felt as shown in Figure 1. They basically serve as the building blocks for pesticides, rubber, plastics, detergents, soaps, furniture appliances, cosmetics, solvents, paints, drugs, fertilizer, explosives, synthetic fibers, rubbers, flooring and insulating materials.

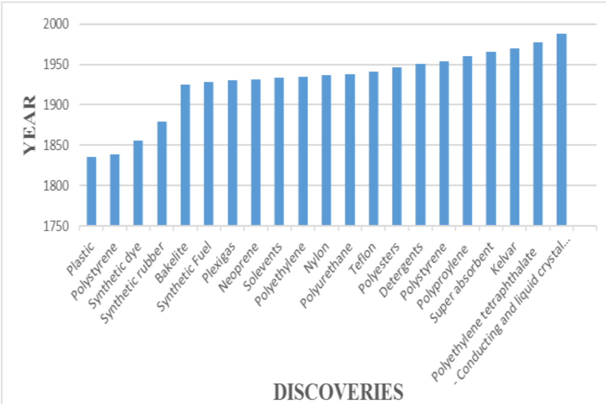

Figure 1: Petrochemical Discovery Timeline. [Petro-Chemicals Europe]

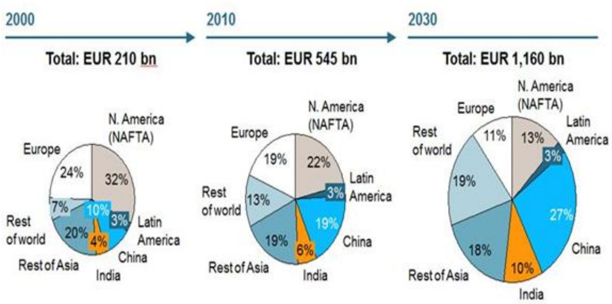

Figure 2: Demand for Petrochemicals by Region (Berger, 2013)

Global View

The United States (US), Western Europe and Japan dominated the industry before the year 1980, accounting for 80 percent of the world primary petrochemical production. Notwithstanding countries like Saudi Arabia and Canada that have lots of crude oil and natural gas reserves built petrochemical plants both for their small domestic demand and export market (IHS, 2011).

Singapore, Korea, Taiwan, Thailand, Malaysia, Indonesia and China has also contributed their own quota in their capacity limiting the over dependence on the United states, Western Europe and Japan as they currently account for only 37% of the world primary petrochemicals production. Figure 2 shows the demand of petrochemicals by region for the year 2000, 2010 and a forecasting 2030 (IHS, 2011).

The Nigerian Petrochemical Industry

In 1968, the need for the production of petrochemicals in Nigeria came into limelight which led to feasibility studies carried out by international companies such as Foster Wheeler International Corporation, Amoco Corporation and Beicip, all for the establishment of a petrochemical complex. The federal government and the citizens of Nigeria believed that the country should harness and maximize the vast quantities of associated Natural gas which was totally being flared and the by-product of crude oil refining (Efoechuku, 2006).

The petrochemical industry in Nigeria finally surfaced in 1978, since then the nation has been trying all possible means to ensure that its petrochemical plants operate at maximum capacity. Efforts were also made to increase the number of the plants, all to no avail. In trying to find a lasting solution to this saddening state, certain factors have surfaced: low refining capability, structural problems, political Instability, unfavourable investment environment, poor management, sabotage, infrastructure decay, outdated technology and most of all corruption where operational and development cost are inflated just to get extra money in the pockets of some individuals (Ogedegbe, 2009).

Presently the petrochemical industries in Nigeria is majorly run by the Federal government through the Nigerian National Petroleum Corporation (NNPC) and the much praised Indorama Eleme Petrochemicals Company Limited (IEPL) formerly known as the Eleme Petrochemicals Company Limited (EPCL) which was acquired from NNPC in 2006. Although NNPC has four refineries, only two of these refineries have petrochemical complexes attached (DPR, Nigeria). This includes Warri Refinery & Petrochemical Company (WRPC) and Kaduna Refinery & Petrochemical Company (KRPC).

The petrochemical plant of WRPC was commissioned in 1988 to produce 35,000 MT/Yr (Metric Tons per Year) of polypropylene and 18,000 MT/Yr of carbon black while KRPC which was also commissioned in 1988 was designed to produce 30,000 MT/Yr (DPR, Nigeria)of Linear Alkyl Benzene (LAB). Albeit the carbon black plant seems to be 20 percent operational, the same cannot be said for the rest. During the third quarter of 2013, much effort was being put to re-start the polypropylene plant which had earlier recorded fifteen years of permanent shut down. This led to the coming up of the propylene purification section only, while some maintenance work seems to be on -going on the other areas (NNPC Bulletin, 2013). The linear alkyl benzene plant which is supposed to be first of its kind in West Africa is also not functioning optimally.

The only full pledge Nigeria Petrochemical Company – Eleme Petrochemical Company Limited which was designed to produce products such as 440, 360 and 120 Kilo-tonnes per Annum (KTA) of olefins, polyethylene and polypropylene respectively was privatized and sold to the Indorama Group in August 2006 when much output was not recorded due to technology breakdown, lack of availability of spare parts and political issues. Indorama Eleme Petrochemicals Company Limited came into the picture, did a major turn- around maintenance, a process believed to be distinctly important to the healthiness of the plant, thus ensuring the smooth and stable running of the plant (Ogedegbe, 2009).

IEPL is currently known to be one of the leading suppliers of poly- olefins not just in Africa, but also US, Europe and Asia as well. They presently meet the needs of more than 200 plastic processing companies in Nigeria, also selling to other countries. No wonder it was awarded the prestigious Presidential Award for Exports by the Nigerian Export Promotion Council (NEPC) for the year 2011. The company paid 16.87 billion naira as taxes, 52.62 billion naira as dividends to Federal, State and also 880 million naira per annum to Host Communities for development. The organisation also helped in providing jobs to over 1200 Nigerians thereby contributing immensely to the unemployed generations (IEPL, 2015).

Proposed Petrochemical Projects

Albeit the federal government had earlier encouraged foreign investors into the industry to jointly position Nigeria as a regional hub for gas based industries of fertilizers, petrochemicals and methanol, nothing is presently being heard about them. These earlier proposed projects include: five fertilizers blending factories, a collaboration between Nagarjuna Fertilizers and Chemicals Limited (NFCL) and Chevron (Uche, 2011), Viva Methanol to Olefins project (UOP, 2008), the Xenel petrochemical plant and the Central Gas Processing Facility which was to be collaboration between Oando Nigeria Plc and Nigerian Agip Oil Company (Uche, 2011).

Carbon Black Production

The name carbon black originated in the year 1913 from the Latin word “carbo” which means charcoal. Albeit different definitions has been accredited to it, it is traditionally known to be a black pigment produced from burning organic compounds such as wood and currently known to be a remarkably fine powder that consists of elemental carbon, with various amounts of volatile matter and ash (ICBA, 2015).

Its relevance in the rubber industries cannot be underestimated as 94% of its product is being used as a reinforcing agent for rubber while only 6 % serves as a crucial integral in hundreds of diverse applications, such as printing inks, paints, paper and plastic. No doubt that it is presently the most refined and best controlled commodity available in the rubber industry (ICBA, 2015). Since inception different methods of production has been established, but on a commercial basis the following processes are adopted in order of usefulness: Oil furnace (presently adopted by WRPC), Gas furnace, Thermal and Channel process (WRPC Process Manual).

Description of the Oil furnace Method used in WRPC

This method is based on a partial combustion process as shown in Figure 3. It involves the production of black from the feed stock, separation of black from the gas stream and the final conversion of the black to a marketable product.

Preheated decant oil, preheated air and fuel gas moves into the reactors to produce smoke. The reaction flame is maintained by fuel gas and preheated oil, while a portion of the feedstock (decanted oil) reacts with the excess air to give the required temperature (1500-1600 °C). Pre-quenching with water helps to stop the reaction by reducing the temperature below what is needed for reaction. The smoke moves to the air and oil pre-heaters to further cool the temperature to a range of 150-250 °C. The secondary quench vessel acts as both a temperature regulator and dirt’s collector through the use of inner baffle before sending the feed to the bag filters which helps to separate the carbon black from other gaseous products, the off gas being sent to a dryer combustion heater while the excess off gas moves to an incinerator. Through screw conveyors the carbon black is transported into two micro pulverisers which ensures that lump of carbon blacks are broken down.

Collection cyclone separates the powder from the gas, the output being moved to a loose black surge tank that provides a steady rate of input into the wet mixer. Pelletizing additives are added to increase density. The mixture is then sent to a dryer that helps to evaporate the volatile matter and also form carbon black pellets. Bucket elevators lifts the product pellets to the drum magnet which separates any form of rust or iron particles and then to the product storage tanks. A portable bagging machine works by packaging four 25kg bags per minutes. The bags are collected in form of pellets in a portable platform for transportation and storage more easily (WRPC Process Manual).

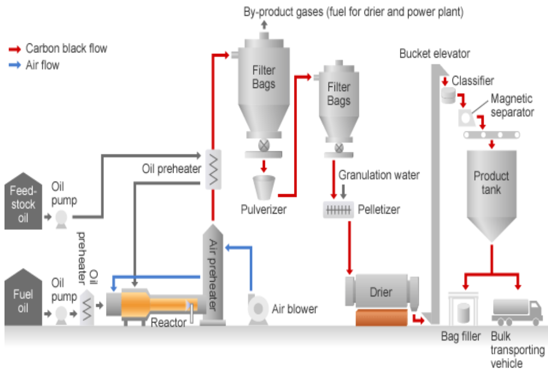

Figure 3: Oil Furnace Method Currently Used In WRPC [Asahi Carbon Limited]

Bag Filter

Generally the equipment's commonly used for the effective and efficient separation of carbon black from the gas stream include the use of electrostatic precipitators, cyclone separators, scrubbers, and bag filters. Currently bag filters have terminated the need of the other means as it seems to be more flexible in operation and has higher collection efficiency when compared to the rest (Drogin, 1968)

Filtration is carried out during the production stage in three different areas: the main bag filter that separates the carbon black particles from the gas stream leaving the reactor, the purge filter that receives the off-gas from the pelletizing dryer and other areas that might that include the transportation of the black within the plant (Dubey *et al*., 2005). Two basic factors are considered in selecting the separation methods; it includes the bag collector style and the filtration method

Bag Collector Style

Although this comes in the form of mechanical shaker, reverse-air style and pulse-jet style design, the last two are prominent.

Reverse Air Style Approach

This process as shown in Figure 4 employs the use of woven fibre glass bags in which the dust gas stream enters the bag from the inside while the clean gas comes out through the bag wall. The woven bag does not necessarily take part in the filtration process as it serves as a mechanical structure just for the collection of the dust layer or cake. Cleaning is done by injecting low pressure reverse air into the bags in an opposite direction to the flow of the incoming gas. This inflates the filter bag column and removes excess dust (Raymond *et al*., 1998).

Strength:

- It operates best in a high temperature environments
- It experience low pressure drop across its filtration process.

Weakness:

- During the cleaning process it requires the shutting down of a portion of the bag house which means one extra compartment has to always be provided for continuous running
- Regular cleaning is required
- No efficient way to totally eradicate the dust cake as the cake is required for the filtration process.
- The air used for cleaning must always be filtered
- It operates both on a low grain loading as well as a very low air to cloth ratios
- Operators are exposed to toxic dust as they are required to change the bags by entering the bag house (Raymond et al,1998)

Pulse-jet style collector

This approach makes of use Woven bags with membrane fibers where the bag itself takes part in the filtration process. Metal cages helps to provide a form of support to the bags while the dust-laden gas enters from the outside, with clean gas exiting from the inside. For the cleaning process as shown in Figure 5 a combination of compressed air and induced gas is injected into the inside of the bag which mechanically shakes the dust from the outside of the bag. In addition, the flow of air is reversed through the bag, removing fine particles trapped between fibers, and providing thorough cleaning (Swaim and Associates, 2015).

Strength:

- It functions at a higher air to cloth ratio and grain loading when compared to the reverse type
- It provides constant and high-volume production throughout the life of the bags
- Compact as they require less space making retrofitting into exiting reverse air installation very easy.
- Minimal accumulation of dust due to the aggressive cleaning action
- The bags have longer life span and can be cleaned continuously (Swaim and Associates, 2015).

Weakness:

- It always requires the use of compresses air to carry out its cleaning operation
- Cannot be used in a high temperature environment except with the use of special fabrics
- Cannot be used if the gas has a high moisture and humidity content. (Swaim and Associates, 2015).

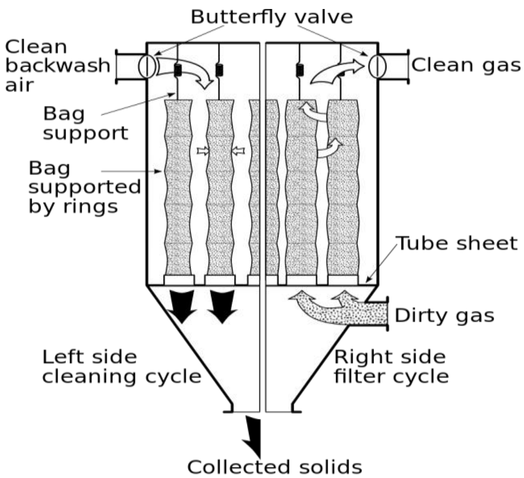

Figure 4: Reverse Air Style

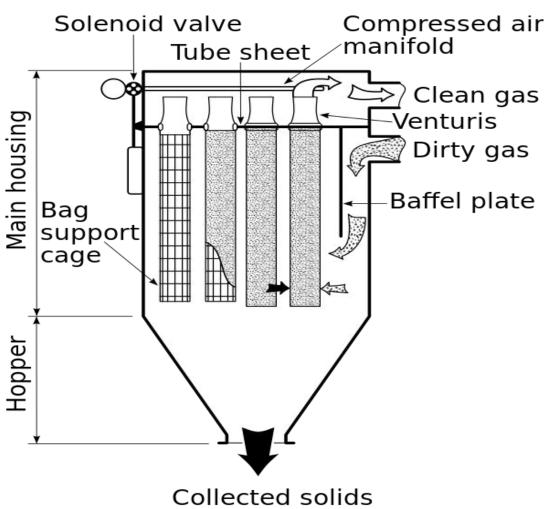

Figure 5: Pulse Jet Style

Filtration Method

Conventional Filtration

These processes involve two basic steps as buttressed in Figure 6. The first step which is known as seasoning is simply the formation of the primary cake: then the building up of dust between the openings of the fabrics (secondary cake). Although the secondary dust cake increases the effectiveness of the filtration process, it also leads to a decrease in both airflow and pressure drop which eventually leads to the replacement of the filter (Dubey *et al*., 2001).

Membrane filtration

It utilizes the use of a thin membrane to perform its function as shown in Figure 7. The membrane comes in different forms as shown in Table 1it has the property of being durable and having a high filtration rate. The fiber chosen actually depends on the thermal, mechanical, and chemical requirements of the application. The membrane serves as the primary filtration layer removing the need for the seasoning process while the fabric serves as a support layer. (Dubey *et al.,* 2001).

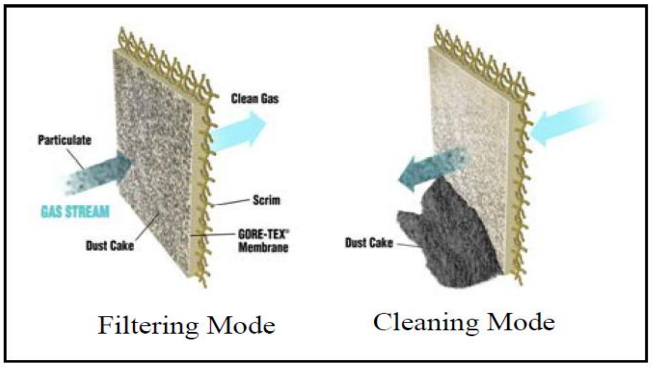

Figure 6: Convectional Filtration

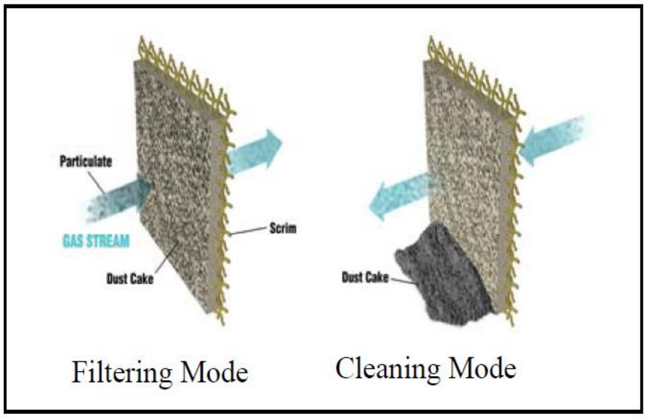

Figure 7: Membrane Filtration

Table 1: Filter Media Selection Chart. [Services. 2009]

Fiber Type	Temperature Limit F/C	Resistance To Acids	Resistance To Alkalis	Resistance To Hydrolysis	Resistance To Oxidation
Cotton	$180^{o}/85^{o}$	Poor	Good	Good	Good
PVC	$150^{o}/65^{o}$	Excellent	Excellent	Excellent	Excellent
Polypropylene	$190^{o}/90^{o}$	Excellent	Excellent	Excellent	Poor
Nylon	$230^{o}/110^{o}$	Poor	Excellent	Good	Good
Homopolymer Acrylic	$257^{o}/125^{o}$	Good	Good	Good	Fair
Polyester	$300^{o}/150^{o}$	Good	Poor	Poor	Good
PPS	$375^{o}/190^{o}$	Excellent	Excellent	Excellent	Fair
Aramid	$400/^{o}205^{o}$	Poor	Excellent	Poor	Fair
Polyimide	$450^{o}/235^{o}$	Fair	Fair	Good	Good
PTFE	$500^{o}/260^{o}$	Excellent	Excellent	Excellent	Excellent
Fiberglass	$550^{o}/285^{o}$	Good	Fair	Excellent	Excellent

F: Fahrenheit, C: Celsius, PVC: Poly vinyl chloride, PTFE: Poly-tetra fluoro ethylene, PPS: P-phenylene sulfide

Bag House Currently Used In WRPC

This is a large structure with nine compartments, each housing 492 bags with a total of 4428 bags. Although it uses special treated cylindrical glass fibre coated bags as a filter medium to separate 100% of the carbon black from the off gas that comes out from the reactor, its cleaning method is fully the reverse air process. Through the hopper, the dust laden gas enters into the various compartments, flows through the gas from the inside while the dust is collected on the inside of the bag. The dust layers which gather in large quantities on the glass fibre coated bags stops when air resistance through the bag surfaces. (WRPC Process Manual)

Cleaning is carried out on the particular compartment that seems full, by injecting air in a reverse direction. This action partially collapses the bag by pressurizing it causing cracking of the dust to take place. The hopper also helps to collate the dust cake. The cleaning process is stopped and the compartment returns back into the filtration process. Rigid rings which are attached to the bags further help to maintain the shape of the bag during the cleaning process.
Problems encountered include;

- Short life span of the bag
- Operators exposed to toxic dust during cleaning process
- Cleaning system not efficient which lead to maximum accumulation of dust cake
- Low air to cloth ratio, bridging and blinding

Statement of theory and definitions

Root Cause Analysis

The fishbone in Figure 8 below highlights different ways the reverse air, fiber glass fabric membrane technology currently being used in WRPC can become in – effective.

Reliability Centered Maintenance

It is observed from Figure 8 that faulty major components and lack of both proactive and reactive maintenance are the major reasons why the bag filter fails. Table 2 shows the reliability centered maintenance sheet emphasizing on the different ways this issue can be tackled.

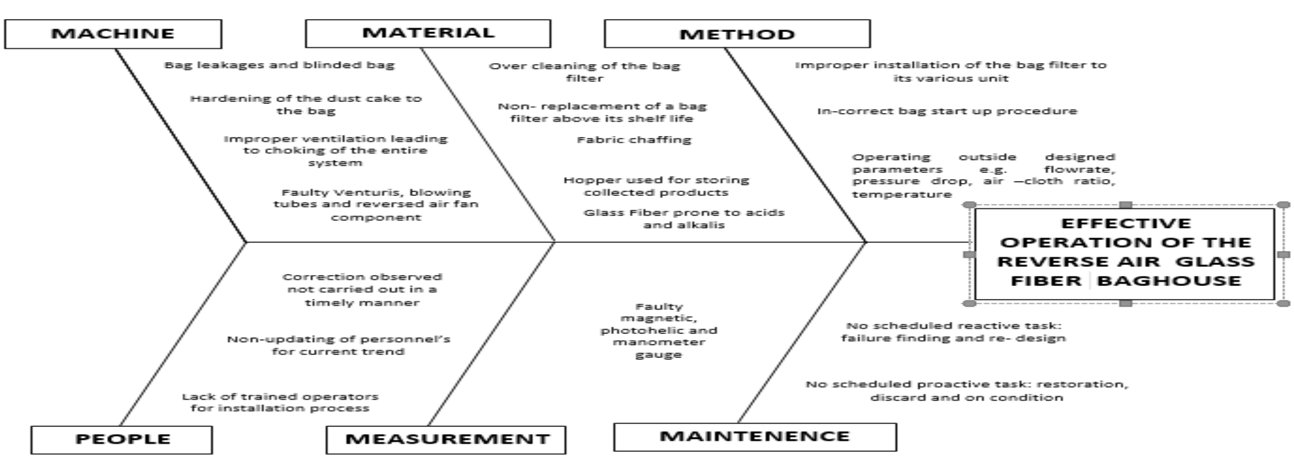

Figure 8: Fishbone of a Reverse Air Glass Fiber Baghouse

Table 2: Reliability centered maintenance of a reverse air glass fibre membrane bag house

S/N	FUNCTION	FUNCTIONAL FAILURE	FAILURE MODE	FAILURE EFFECT	CONSEQUENCES	RECOMMENDATIONS
SUPPORT: METALLIC CAGES, CELL PLATES, ADJUSTABLE HANGER, ANTICOLLAPSE RINGS AND MIRROR PLATE						
1	• To provide rigid support for the filter bag during the filtration and cleaning process	• Support not provided	• Anti-collapse rings not properly sewed to the bag	• Total collapse of the bag during the cleaning process • Fabric Chafing	• Down time, loss in both content and the bag , revenue loss and operators exposed to dust particles	• Training of concerned staffs for installation procedure. Periodic checks, scheduled maintenance and total replacement of faulty components.
			• Bag not properly attached to cell plate and hanger	• Vibration of the bag		
FITRATION PROCESS : BAG FILTER, HOPPER AND FILTER MEDIA						
1	• To provide 99.9 percent separation of the carbon black from the off gas	• Total filtration process not achieved	• Exceeding the life span of the bag	• Bag failure	• Down time, increased operational cost, revenue loss , loss in morale of the plant operators , and respiratory irritations when exposed over a long time	• Total replacement of the bag once it exceeds its shelf life, operating within its designed parameter, usage of suitable membrane and periodic checks.
			• Operating outside designed parameters	• Bursting of the bag		
			• Improper installation of bags	• Mechanical Leaks		• Training of staffs for proper installation method, operating manual should be handy and regular checking of the bag for signs of leakages , wear or tear
			• Bag failure	• Bag leakages		
			• Incorrect new bag start - up procedure	• Premature blinded bags		
		• less than 99.9 percent separation	• In accurate air to cloth ratio	• Blinded bags		• Recommended air to cloth ratio and pressure drop should strictly be followed. Reliable measuring instrument should be used
			• High pressure drop			
2	• Accumulation and support of dust cake	• Dust Cake not gathered	• Over or under cleaning of the bag	• Bags over or under impregnated with dust	• Complaints by customer and bad reputation	• Cleaning energy sufficient to remove dust without over cleaning. Hoppers should be used for its right purpose, regular inspection during shut down and bag changes.
			• Hoppers used for storing of the collected product	• Bridging of the dust		
CLEANING PROCESS: VENTURIS, COMPRESSED AIR RESERVOIR, FILTER MEDIA, BLOWING TUBES AND REVERSED AIR FAN						
1	• Dislodge accumulated dust cake from the filter media	• System not functioning properly at all times	• Water in the compressed air supply	• Hardening of the dust cake to the bag	• Downtime	• Periodic monitoring, and correction made in timely manner
			• Building up of dust	• Choking of the entire system		

Definition of terms

- **Air –to-Cloth Ratio:** The ratio of the amount of gas that flows into the bag filter to the square feet of the filter area available
- **Bridging:** Gathering of dust between two or more filter bags or the forming of cavity over the discharge or opening of a hopper
- **Blinding:** The reduction of the gas flow and an increase in the pressure drop as a result of accumulated dust that cannot be discharged by the cleaning mechanism**.**

MATERIALS AND METHODS

Although different reasons have been speculated to be the reasons behind the low performance of the different petrochemical plants, for this study, the carbon black plant in WRPC was critically analyzed.

The data used for this research was collected via past records, operating manuals, review of previous work done on the subject matter, personal working experience, observation and one on one interviews with both production and maintenance staffs of carbon black staffs of WRPC.

RESULTS AND DISCUSSION

This section highlights the specific reasons why downtime was encountered. For analysis sake, years from inception of the plant are taken at intervals as shown below.

Year 1989-1995

Table 3: Downtime Analysis (1989-1995)

REASONS	DOWNTIME(DAYS)
REF.F	58.2
EQ.FAIL	1186.71
P.F	4.25
TAM	95.25
INST.N.B	31
UT.C	86.44
UN.PM	15.08
BF.FAIL	46.5
GT.FAIL	211
UL.C	44.61
SCH.MT	39.38
SCH.S/D	31
L.FG	240.64
BL.COV	7.21
FE.C	31

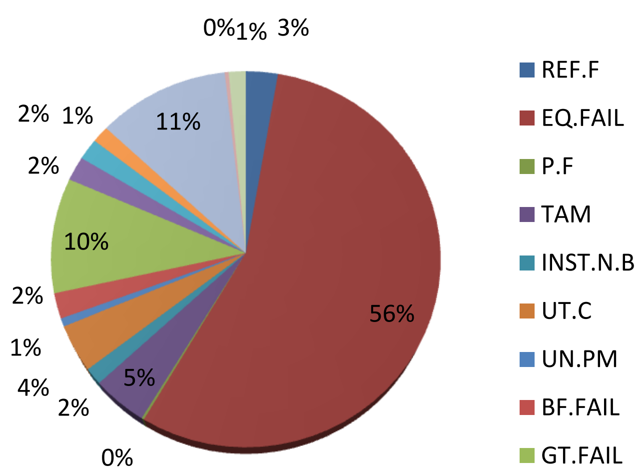

Figure 9: Downtime Analysis in Percentage (1989-1995)

From Figure 9 above, it is clearly seen that larger percentage of factors that hindered production goes to equipment failure (EQ.FAIL), lack of fuel gas (L.FG) and gas turbine failure (GT.FAIL) with Figures 56%, 11% and 10% respectively. For clarity sake equipment failure is the failure of the pulverisers, pelletizers, bag filters, reactors or the combinations of any of them. The Installation of new bags (INST. N.B), bag filter failure (BF.FAIL) and un-availability of power mixer (UN. PM) and the gas turbine failure can be grouped under equipment failure. REF.F: Refractory Failure, P.F: Power Failure, TAM: Turn Around Maintenance. UT.C: Utilities Constraint, UL.C: Ullage Constraint.

Year 1996-2001

Table 4: Downtime Analysis (1996-2001)

REASONS	DOWNTIME (DAYS)
REF.F	303
LAY.REF	123
CUR.REF	61
EQ.FAIL	1372.12
P.F	21
I.A	15.5
PL	6.51
L.S	9.5

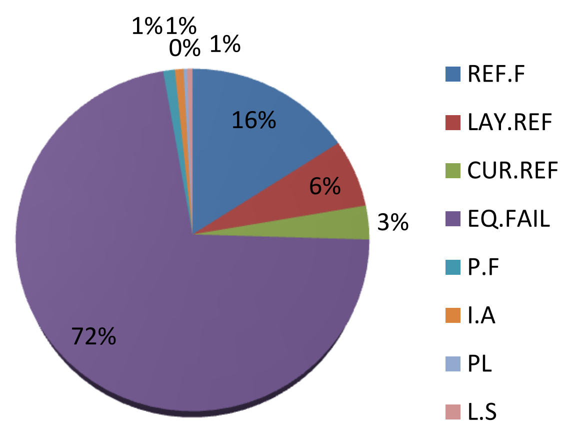

Figure 10: Downtime Analysis in Percentage (1996-2001)

Equipment failure (EQ.FAIL) and refractory (REF.F) failure accounts for the larger portion with 72% and 16% respectively (Figure 10). Curing of refractory (CUR. REF), power failure (P.F), Instrument Revamp, Planned shutdown and lack of steam (L.S) seems insignificant. Although the refractory lining of a carbon black reactors generally have a life span between 6 months to 2 years, it is observed that relining is done on the reactors longer than that. This results to visible hot spots on the reactors, reactor back pressure, voltex leakage and refractory grits in the reactors.

Year 2002-2008

Table 5: Downtime Analysis (2002-2008)

REASONS	DOWNTIME (DAYS)
EQ.FAIL	696.57
TAM	973
R/F	61
S/R-	214
INS. RV	547

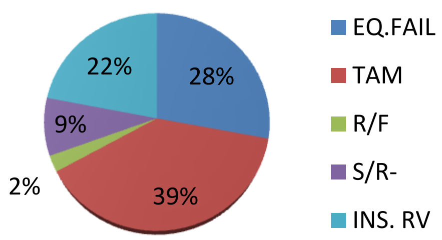

Figure 11: Downtime Analysis in Percentage (2002-2008)

Within this year, turn around maintenance (TAM) seems to have a large role to play as it accounts for 39%. Equipment failure (EQ.FAIL), Repair on the screw conveyor (R/F), Substation Rehabilitation (S/R) and Instrument revamp (INS.RV) accounts for 28%, 2%, 9% and 22%, respectively (Figure 11).

Although turn around maintenance is important for the effective running of any plant, it should be carried out within the stipulated time frame so as not to disturb revenue generation. Refurbishing or overhauling of instruments in the plant is understandable since this happens one in a while.

Year 2009-2014

Table 6: Downtime Analysis (2009-2014)

2009-2014	
REASONS	**DOWNTIME (DAYS)**
REF.F	154
EQ.FAIL	679.2
P.F	10
I.A	14.5
INST.N.B	118.5
UL.C	182
BL.COV	353.25
N.P	23
D.1	111
S.M	281

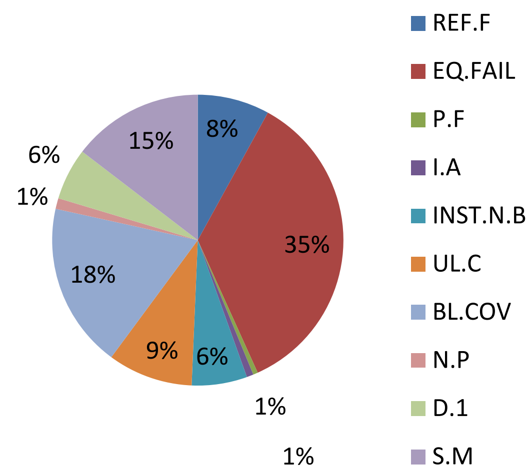

Figure 12: Downtime Analysis in Percentage (2009-2014)

Within the period of 2009- 2014, equipment failure, blockage conveyor and specific maintenance carried out on smaller units of the plant seems to contribute a larger role in the shutting down of the plant (Figure 12). Smaller units include valves, pumps, compressors, drum magnets and the bucket elevators.

From the above findings, it is clearly seen that the sub optimal performance of the carbon black plant is largely as a result of the failure of major equipment. Although the bag filter is designed to be 99.9% efficient, this structure can fail due to different factors below as listed in the root cause analysis.

- Improper assembly of different parts of the filter during installation which leads to excessive leakages from the body of the vessel.
- Operating outside its gas temperature, pressure drop, air to cloth ratio and gas volumetric flow rate. Blinded bag is as a result of high pressure drop.
- Incorrect operational procedure.
- Over cleaning of the bag filter and fabric chaffing.
- Non-replacement of the bag above its shelf life.
- Exposure of the glass fibre membrane to acidic environment/acids.
- Faulty instrumentation and lack of trained personnel.
- Lack of both proactive and reactive maintenance schedule.
- Ageing of the overall system.
- Usage of components for non-designed purpose. Hoppers used for the storing of collected products leads to bridging of the dust.

The current use of the reverse air style as its bag collector is also not the best as this method is associated with low air to cloth ratio, inability to totally eradicate dust cake formed and the exposure of the operators to toxic dust during cleaning. This particular problem can be totally eradicated by the usage of pulse jet approach which is known for its larger air to cloth ratio, longer bag life span, minimal dust cake accumulation due to its aggressive cleaning system and its compactness.

The bag filter also uses glass fiber membrane as its filtration method, although this approach has its own strength within the industry, the use of poly vinyl chloride and poly-tetra fluoro ethylene fiber has excellent qualities in terms of resistance to acids, alkalis, oxidation and hydrolysis.

CONCLUSION

This case-study through its various sections has shown that although there are many factors that has contributed to the suboptimal performance of the petrochemical industry in Nigeria, major equipment failure seems to play a vital role.

Presently the "reverse air glass fibre bag filter" used during the production of carbon black experiences shorter life span of its bag, low air to cloth ratio, low resistance to acid, bridging of dust, blinded bags and the maximum accumulation of dust cake. All these issues are attributed to the following factors: faulty installation, operating outside design range, non-adherence to operational procedure, in-effective cleaning system, usage of bag above shelf life, exposure to acidic environment, faulty instrumentation, lack of trained personnel, ageing of the overall system and finally the lack of a good maintenance schedule.

These factors have not been properly addressed, which has led to safety/environmental concerns (exposure of operators to toxic dust), and operational/non-operational consequences (downtime, increased running cost, reduced revenue and loss of job).

RECOMMENDATION

An effective maintenance schedule which incorporates both proactive and reactive task will go a long way in rectifying issues listed above. This includes scheduled restoration tasks on components that require regular preventive measure to prevent any form of crashing. Schedule discard tasks on components that need to be thrown away once it exceeds its shelf life and no schedule task on components that are allowed to crash before being replaced.

The use of pulse jet as a bag collector and poly vinyl chloride or poly-tetra fluoro ethylene as its fiber membrane will help to reduce cost This approach has a combined advantage of larger air to cloth ratio, longer bag life span, minimal dust cake accumulation, compactness, excellent qualities in terms of resistance to acids, alkalis, oxidation and hydrolysis.

CONFLICT OF INTEREST

None declared

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