Evaluation of LPG (Liquefied Petroleum Gas) Production Economics in Nigeria.

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Abstract- Experiments were carried out to determine corrosion rates of metals using weight loss analytical technique in a gas flare environment. Mathematical model equations for the determination or corrosion rate of metals were developed. Computer programs were written for the developed models for the evaluation of the concentration of iron ion, net anodic current and rate of corrosion of metals. The results showed that the concentration of iron ion increased with an increase in time. The result in addition, revealed that metal polarization increased with subsequent decrease in cathodic current density and increase in anodic current density.

Indexed Terms- LPG, Corrosion, Iron ions

I. INTRODUCTION

Today, there are many worries with respect to environmental pollution problems. Gas flaring has become an increasing concern as a significant source of pollution. This phenomenon arises from inability to effectively utilize the large volume of natural gas produced as crude oil is drilled to the earth's surface. The environment becomes polluted by hydrocarbon gases as some of the intermediate products of petroleum processing plants are flared off upon production in the absence of demand. This has led to the discharge of harmful or toxic pollutants of various kinds into the atmosphere.

These pollutants, which are unlike the natural process, discharged into the atmosphere, do not get re-cycled by any means. The consequences of these harmful emissions are damaging to the plants, animals and materials such as metals. These flared gases and gaseous pollutants contribute to the destruction or deterioration of metallic properties as a result of corrosion. Corrosion according to the National Association of Corrosion Engineers (NACE) is defined as the deterioration of a material, usually a metal by reaction with its environment. Corrosion can affect the metals in a variety of ways, which depends on their nature and the precise environmental conditions prevailing.

The economic and material loss which either directly or indirectly can be attributed to corrosion is very difficult to assess, but reputable authorities suggest that after war and disease, corrosion is responsible for more monetary wastage than any other single factor in the affluent societies of this present industrial age. Those who work in the fields of corrosion frequently try to point out how much it costs, as a percentage of a nation's economy. The approximate annual cost of corrosion in the United States was first estimated in 1949 to be $5 billion, 2.1% of Gross National Product (GNP).

Thus, in recent years, increasingly, more attention has been directed towards preventing corrosion or controlling corrosion. Corrosion control is a process in which humans are very much in control of materials and environments and by correct application of sound principles, can regulate the rate within acceptable, or at least predictable limits for the life of the structure. Research has led to the discovery of many products called inhibitors, which reduce corrosion rates by putting a protective film on metals or steel. However, because of the many different conditions in various areas where materials (metals) are used, no one product or group of products can prevent all corrosion problems.

II. PAST REVIEW

A large percentage of the associated gas produced with the oil was flared, as this was the easiest way of disposing such gas. Hence, Amadi (1989), described flare gas as "surplus gas that is disposed off by combination in the open" despite this limited use of gas, more and more gas accumulation continued to be discovered in Niger Delta Basin, in the search for oil. This associated gas that is burnt has some pollutant effect on the environment concerned. He described the associated gas as a "by product of crude oil production", which is one of the sources of natural gas. He also said that the gas is dissolved in crude oil in subterranean reservoirs or associated with crude oil in overlying gas caps, serving to pressurize the oil to the surface, and again that gas is flared or separately recovered and purified.

According to Adebeyo (1999) gas flare is usually viewed as the effect of light intensity and temperature on the environment. He further stated that "Natural gas flare is thought to cause varying degree of pollution" and also that the magnitude of those effects to the meteorological, biological, chemical parameters, materials (metals) and soil conditions in the environment have not been documented". The value of gas as an essential fuel however appreciated with time, and liquid petroleum became increasingly expensive. It was then realized that if processed and made available to large industries, natural gas could replace a large amount of liquid petroleum fuel whose demand was increasing in the country, instead of flaring which possess some managerial threat because of its pollutant nature on the environment. Hence, Hadley (1998) said that "anybody who knows the economic value of gas and the enormity of it in Nigeria will feel pained about flaring" He also said that "burning of gas is environmentally wrong".

Natural gas is also regarded in Nigeria as a troublesome waste project, which has no alternative use other than flaring it to allow the process of the oil operation, which is the main target and this is done basically in the Niger Delta Basin. In one way, the natural gas is troublesome in that its presence in the oil is not needed and in another way, it is troublesome because it has some pollutant effect on the environment.

Hadley (1998), on this aspect said that "the massive quantity of natural gas usually found in association with oil discoveries was basically regarded as a troublesome waste product". He then added that "it might provide lift pressure to get the crude out of the ground but after wards, it was simply flared off".

The world's proven natural gas reserve estimate is put at 135,000 billion cubic meters (bcm), equivalent to about 56 years of production at the current rate of utilization. These proven gas reserves have been growing at an estimated 5% over the past two decades. Table 1 shows the natural gas reserves of OPEC and non-OPEC countries reported by the international energy agency (lIon, 1990, Adebajo, 1999). Disposal of associated gas has been a major problem for the Nigerian oil and gas industry. Most of this associated gas is flared because of lack of commercial outlets. This is the case of the Escravos Gas Plant that produces about 140 million standard cubic feet per day (mscf/d) of treated associated gas, sends about 100 million standard cubic feet per day (scf/d) of this gas to NOC and flares the remaining 40 million scf/d .

III. MATERIALS AND METHOD

EQUIPMENT USED

The equipment used for the experiment include twenty new pieces of steel, iron, zinc and aluminium metals, emery-paper, distilled water, weighing balance, non-metallic tripod, tape, ruler, digital caliper, ranging pole, meter rule and calendar.

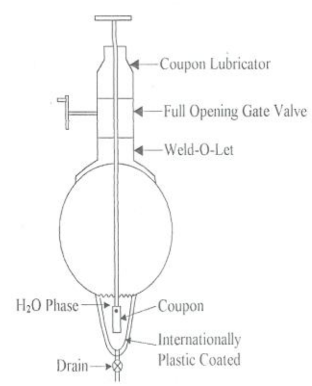


Figure: Flat Coupons Installed in Water Tap Welded in Bottom of a Pipeline.

The sample for this experiment was prepared as follows: The metals used for the experiment were cut to a defined dimension with the help of a saw. The metals cut was thoroughly washed with distilled water and dried. The dried samples were further cleaned with emery-paper to remove every dirt on the metals.

The dimension of the metal was determined with the help of a tape and ruler. The thickness of the sample was determined with the help of a digital caliper while the weight of the sample was determined with the help of a weighing balance. The initial weight of each steel used was l40.20g while its thickness was 1.48mm (0.148cm), iron metal 9sed was 140g while its thickness was 1.46mm (0.146cm). The initial weight of zinc metal used was l7.60g while its thickness was 0.34mm (0.034cm). The initial weight of each aluminium metal was 37.0g while its thickness was 1.24mm (0.124cm). The length and width of each of the metal were 12cm and 8cm respectively.

$$2N + O_2 \rightarrow 2NO \qquad (1)$$

$$2NO + O_2 \rightarrow 2NO_2 \qquad (2)$$

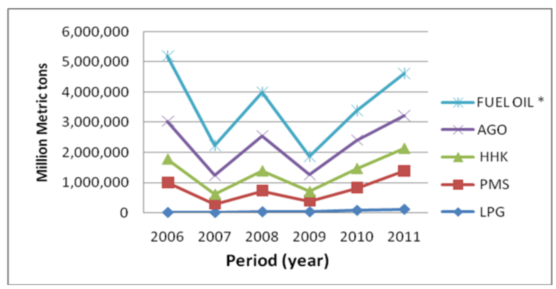
$$4NO_2(g) + O2(g) + 2H_2O(L) \rightarrow 4HNO_3(aq) \qquad (3)$$

Thus, nitrogen as well as sulphur oxide contribute to acid rain. He also stated "in addition to the direct effects therein, NO_2 is the initiator of photochemical smog".

DATA COLLECTION AND ANALYSIS

Table: Finished Products from Domestic Refineries (2006-2011)

	2006	2007	2008	2009	2010	2011
LPG	4,785	1,396	25,868	25,323	72,046	106,603
PMS	992,913	287,238	698,480	363,679	747,776	1,276,871
HHK	786,946	329,888	670,023	319,006	650,518	750,906
AGO	1,259,785	622,714	1,165,961	558,647	945,295	1,094,811
FUEL OIL*	2,158,568	1,001,527	1,445,360	609,610	986,864	1,393,980



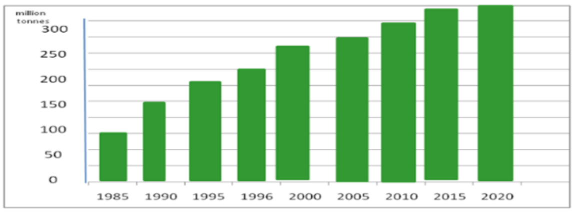
IV. RESULTS

TABLE: LPG CONSUMPTION IN WEST AFRICAN COUNTRIES.

COUNTRY	LPG CONSUMPTION (MT)	RES./COM. CONSUMPTION (%)	RES./COM. CONSUMPTION LPG (MT)	POPULATION (MM PEOPLE)	RES./COM. LPG CONSUMPTION PER CAPITAL
Gabon	17	90	15	1.2	12.8
Senegal	100	98	98	9.5	10.3
Angola	50	90	45	11.7	3.8
Cote D'ivoire	50	85	43	15.7	2.7
Cameroon	28	95	27	14.9	1.8
Ghana	40	85	34	19.2	1.8
Cango rep.	4	90	4	2.7	1.3
Other countries	13	90	12	65.8	0.2

* sub region are	218	92	201	59.3	3.4
West Africa	361	83	301	315.4	1.0
Congo Dem. Rep.	1	90	1	49.6	0.0

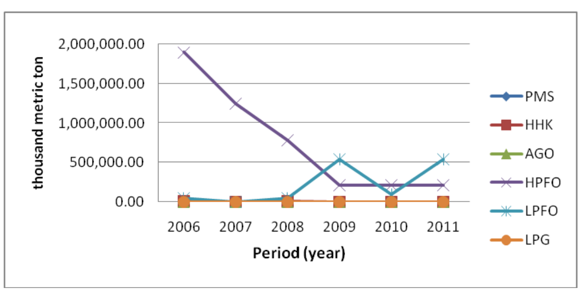
World LPG Demand



Petroleum Products Exports (2006-2011)

	2006	2007	2008	2009	2010	2011
PMS	5,015.89	0	0	0	0	0
HHK	8,298.92	5,858.95	12,134.82	0.00	0.00	0.00
AGO	0	0	0	0	0	0
HPFO	1,898,768.35	1,244,715.97	780,785.09	211,566.69	207,760.87	211,566.69
LPFO	52,615.42	0	52,817.87	543,090.98	99,063.52	543,091
LPG	0.00	0.00	0.00	0.00	0.00	0.00

Graphical Presentation of Petroleum Products Exports (2006-2011)



LPG Product profile in Nigeria Refineries

s/n	Year	Annual Production Metric ton/year	$/Metric ton	Gross Income ($)
1	2005	61,092	620	37,877,040
2	2006	4,785	635	3,038,475
3	2007	1,396	645	900,420
4	2008	25,868	644	16,658,992
5	2009	25,323	645	16,333,335
6	2010	72,046	654	47,118,084
7	2011	106,603	655	69,824,965

Source: NNPC (Business Development Unit).

Installed Capacity of Domestic Refineries

Operators	Location	Installed Capacity
NNPC	Warri	125,000mt
NNPC	Port Harcourt (old)	60,000mt

NNPC	Port Harcourt (New)	150,000mt
NNPC	Kaduna	110,00mt
Total installed domestic capacity		445,000mt

Available records revealed that, Nigeria from its refineries currently produces an average of 39,337 Metric tons of LPG per annum as against an average production of 20,166,666.67MT LNG per annum. It is however not realistic to determine the actual consumption rate of Nigerians due to their attitude towards the use of LPG and LNG for obvious reasons- affordability and availability.

Never the less, "the current LPG consumption in Nigeria is approximately 0.5kg per ton/annum. (Yomi Awobokun, 2010). Going by World Bank Assessment in West Africa subregion, per capital consumption if LPG is 3.5kg. This suggest that, Nigeria with an estimated population of 170,123,740 people (Nigeria Demographics Profile,2012).

Would need: = 595,433.09
This implies that:
The volume need of LPG = 595,433.09metrictons
Shortfall will be = (volume need per annum) – (average production per annum).
= (595,433.09 - 39,337) = 556,096.09

Summary of LPG Production Economies in Nigeria

EVENT	LPG
Total production for 5 years (2006-2011) (metric tons)	236,021
Average production per annum (metric tons)	39,337
Expected yearly production at full capacity (MT)	445,000
Production shortfall per annum at domestic level	45,724.87
Production shortfall at W/A subregional level (MT)	556, 096.09
Percentage production in relation to the expected quantity at full capacity	9%
Production infrastructure in Nigeria	Refineries in PH, Kaduna, Warri
Cost of production infrastructure	$8bn (for full scale refinery) and $0.75bn (for a modular refinery)
Average Cost of product in global market within the period under review.	$158/MT
Expected revenue at full capacity per annum (metric ton)	$70,310,000
Expected total revenue within the period under review (metric ton)	$421,860,000
Actual revenue generated within the period under review	$41,640.100
Ratio of revenue generation in relation to crude oil revenue generation.	1:63

CONCLUSION

From my findings, it is obvious that, the refineries remained the major source of LPG to the country but unfortunately, they are producing for below their installed capacity due to some technical failures; the country therefore embarked on importation in order to sustain the demand though at a very high price. Consequently, LPG production for the period under review had been quite un-economical as production is only 10% of the expected.

It was also observed that the price of LPG in the global market is higher than that of LNG. If train 7 is completed and operational, Nigeria will be better for it. This will increase production to 52 million metric tons per year as against the prevailing 22 millions metric tons per year.

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