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Saftey and Control of Natural Gas (LPG) Utilization in Residential Areas in Nigeria

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ABSTRACT

Natural gas is a vital component of the world's supply of energy. It is one of the cleanest, safest and most useful of all energy sources. Nigeria is endowed with large reserves of natural gas. The estimated reserve stand at about 187 trillion cubic feet. Nigeria has the largest gas reserve in African and is ranked 7th in terms of global gas reserves.

Natural gas as raw material is produced in large quantities in oil and gas wells in Nigeria. although produces in large quantities the lack of effective transmission and distribution system result in a greater percentage of this energy sources to be flared off, thereby resulting in wastage of valuable and scare foreign exchange for the country.

This work reviews the methods used in safety and control of natural gas (LPG) utilization in residential areas.

I. INTRODUCTION

Natural gas is a natural occurring mixture of hydrocarbon and non-hydrocarbon gases found in underground rock reserves. It is formed primarily of methane; it can also include ethane, propane, butane, pentane and heavier hydrocarbons. Other gases like carbon dioxide, Helium, Nitrogen occurred in trace as impurities. The composition of natural gas varies widely, but below is a table outlining the typical makeup of natural gas.

TYPICLA COMPOSITION OF NATURAL GAS

Methane	CH_4	70-90%
Ethane	C_2H_6	
Propane	C_3H_6	0-20%
Butane	C_4H_{10}	
Carbon dioxide	CO_2	0-8%
Oxygen	O_2	0-0.2%
Nitrogen	N_2	0-5%
Hydrogen Sulphide	H_2S	0.5%
Rare gases	He, Ne	Trace

Natural gas is colourless, shapeless and odorless in its pure form.

Natural gas is clean burning and emits lower levels of potentially harmful by-products into air. (Ikoku 1984).

VOLUMETRIC COMPOSITION OF NATURAL GAS IN NIGERIA GAS WELLS

GAS WELLS	VOLUMETRIC COMPOSITION										
	C_1	C_2	C_3	i-C_4	n-C_4	n-C_5,i-C_5	+C_6	N_2	H_E	H_2S	CO_2
AFAM	81.0	6.5	5.9	1.3	2.0	1.4	-	0.2	-	-	1.7
BOUN	89.8	3.4	0.7	0.7	0.2	1.9	-	-	-	-	3.8
IMO RIVER	86.5	5.6	1.0	1.0	1.0	1.3	-	-	-	-	1.5
KOROKORO	82.7	6.2	1.2	1.2	1.8	0.1	-	-	-	-	1.7
APARA	84.9	8.5	0.6	0.6	0.8	-	-	0.3	-	-	1.3

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UMUECHEM	79.6	7.6	1.1	1.1	1.6	3.3	-	0.5	-	-	1.1
OBIGBO	97.0	1.5	-	-	-	0.3	-	-	-	-	1.1
UGHELLI	88.1	6.3	0.3	0.3	1.1	-	-	-	-	-	2.1
EBUBU	81.5	9.9	0.9	0.9	1.2	0.8	-	-	-	-	1.0
AVERAGE	85.7	6.2	3.9	0.9	1.2	1.1	-	0.3	-	-	1.7

(Source: SPDC June, 2001)

Natural gas sold for heating purposes at homes usually contains 85-95% of methane, with varying proportions of higher paraffin homologues and a maximum of about 15% of non-methane component; it has a specific gravity depending upon its composition.

The complete combustion of such natural gas produces only carbon dioxide and water vapour as end products hence, it is entirely non-polluting.

CALORIFIC VALUES OF FUEL GASES

	Average CV in Btu/cf
Natural gas (used in home)	1020-1050
Methane	1012
Ethane	18000
Propane	25000
Butane	3106
Water gas	295-500
Producer gas	132-136
Hydrogen	120

(Source: True 1991)

ENERGY CONTENT OF VARIOUS RESOURCES

RESOURCES	**QUANTITY**	**ENERGY CONTENT KILOWATT-HOUR**	**BARREL Of OIL EQUIVALENT (BOE)**
Oil	**1 barrel**	**1700**	**1**
Natural gas	**1 scf**	**0.3**	**1.76×10^{-4}**
Coal	**1 kg**	**7.8**	**4.6×10^{-3}**
Uranium	**1 kg**	**2.1×10^{7}**	**1.2×10^{-4}**
Wood	**1 kg**	**2.9**	**1.7×10^{-3}**

(Source: True 1991)

Nigeria's long term energy policy should be aimed at provision of competitive and stable energy to the economy. This will increase the level of economic and productive capacities of the country; and the living standard of the people. Nigeria could do very well on natural gas provided this is properly harnessed and utilized.

Natural Gas Distribution

Distribution is the final step in delivering natural gas to end users. While some large industrial, commercial, and electric generation customers receive natural gas directly, from high capacity interstate and intrastate pipelines (usually constructed through natural gas marketing companies) most other users receive natural gas from a local distribution company (LDC).

Natural gas distribution requires an extensive network of small diameter distribution pipe. It has been estimated that there exist over one million miles of distribution pipe in the United State. Because of the transportation infrastructure required to move natural gas to many diverse customers across a reasonably wide geographic area, distribution cost typically make up the majority of natural gas costs for small volume and end users. (Imperial venture 2002).

Delivery of Natural Gas

The delivery of natural gas to its point of end use by a distribution utility is much like the

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transportation of natural gas. Distribution involves moving smaller volumes of gas at much lower pressures over shorter distance to a great number of individual users.

The natural gas is periodically compressed to ensure pipeline flow, although local compressor stations are typically much smaller than those used for interstate transportation. Because of the smaller volumes of natural gas to be moved, as well as the small-diameter pipe that is used, the pressures required to move natural gas through the distribution network is much slower than that found in the transmission pipeline. Natural gas travelling through the distribution network requires as little as 3psi of pressurization. Traditionally, rigid steel pipe was used to construct distribution networks. However, new technology is allowing the use of flexible plastic and corrugated stainless steel tubing in place of rigid steel pipe. These new types of tubing allow cost reduction and installation flexibility for both distribution companies and natural gas consumers. (Kartz et.al 1959).

The availability of natural gas for commercial production and well-planned towns, village or estate area is of great importance to economic distribution of natural gas. A well planned estate, town or village is required to facilitate easy laying of pipeline; not where buildings are erected haphazardly.

Gas Projects in Nigeria

In Nigeria, in pursuance of the government objective in the natural gas sub-sector, efforts have been geared towards the development of the gas industry to reduce gas flaring and to increase utilization of natural gas both domestically and for export. A number of major gas projects include:

1. **Liquefied Natural Gas (LNG) Project:** The largest and most significant of these projects is LNG project. With a development budget of approximately $4 billion, it is a joint venture with 4 shareholders; NNPC (49%), Shell Gas (25.6%), ELF (15%), and Agip (10.4%). The project consists of various trains' liquefaction plant, gas treatment system, transmission pipelines loading terminal and storage tanks. The project processes about 750 million cubic feet of gas daily.
2. **Escravos gas-gathering Project:** Developed by Chevron to recover associated gas from its offshore fields. The plant processes over 300 million cubic feet of associated gas daily.
3. **NGL (Natural Gas Liquids) Project:** This is a joint venture project between Mobil and NNPC. The reserve estimated for the NGL is around 350 million barrels.
4. **Trans West African Gas Pipeline:** The objective of this project is to supply gas to some ECOWAS countries. The gas is intended to be used to generate electricity in these countries. It would require the construction of about 600 kilometres of pipeline.
5. **Forcados Yokri Integrated Project:** Developed by SPDC. It will collect some 80 million standard cubic of associated gas from four flow stations. The gas will be combined with associated gas from Odidi and taken by offshore gas gathering system (OGGS) to the NLNG plant at Bonny.
6. **Greater Ughelli:** This is a gathering scheme involving the greater Ughelli oil fields of Afiesere, Kokori, Uzere, Utorogu, Egini, Evwreni, Eriemu, Oweh and Olomoro.

Other project includes Brass LNG and OKLNG. (NNPC Journals 1997-1999)

Natural Gas Processing

Primarily after exploration, discovery, drilling and completion of gas, productions follow. This means the gathering of gas from well heads, gas plant separators, flare point and boosting of its pressure by using compressors when the need arises. The gas comes specifically from three forms of reservoirs.

1. Associated gas- oil reservoir (gas produced with oil). Gas will continue to be produced as long as oil is being produced.
2. Non-associated gas reservoirs (dry gas) produced in the absence of significant quantity of oil
3. Condensate reservoirs: Some high pressure reservoirs in which the gas and oil are at a pressure above the critical point of the gas phase of the hydrocarbon present.

Before associated or non- associated natural gas is piped from the field to industries and homes, it must undergo various treatment processes.

Natural gas when produced from a well comes with various amounts of impurities which must be removed and treated before it can be used as fuel in homes or industries. Natural gas plant must carry out this purification to comply with the regulations of the consumers and to meet the specification for purity, pressure, temperature of the quality controls imposed by sales contracts

Natural gas containing acid gases from the reservoirs is piped to the natural gas plant where the sour/acid gases are removed. Acid gas must be removed to make it marketable. (Enyi 2007).

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The main functions of gas plants may be summarized as follows:

1. To receive the sour natural gas withdrawn from underground geological reservoirs and to remove all impurities.
2. The above process results in gas pressure reduction and the plan must be capable of re-pressurizing it for transmission purpose.
3. The separation and removal of by products such as propane, butane, condensate and elemental sulphur also occurs when applicable.
4. The conservation of hydrocarbon.

Design of LPG Delivery System

The design of any LPG delivery system has four basic components: a storage tank, a pump unit, a metering unit and the piping (including valves and other control elements) that connect these components and leads from the metering unit to be discharge nozzle.

The system is closed and must permit no leakage of liquid or vapour.

It must also be designed and constructed to withstand high pressure.

Specifications regarding operating pressures that these systems must be capable of withstanding have been developed by the American society of Mechanical Engineers (ASME: "Pressure Vessel Code." Section 8) and have been adopted as part of most state fire and safety codes.

Safety and Control of Natural Gas Utilization in Homes

Safety and control is of great importance in the design, construction operations and maintenance of pipes and distribution of natural gas to home.

The hazards associated with any particular fuel are detected by its composition, physical properties as well as the chemical reactivity of the predominant constituents. Evaluation of the degree of hazards associated with the utilization of natural gas is best analyzed relative to the hazards of other common fuel. The Nigeria natural gas being predominantly methane (85-95%); it properties and combustion characteristics will be similar to those of methane.

Natural gas due to its lighter relative weight to air readily forms layers near the roof or ceiling confined spaces and this give rise to destructive explosion. This phenomenon is responsible for most explosions in coal mines and also occurs in homes that are not well ventilated.

Most gas accidents are due to human error from poor housekeeping, carelessness, negligence, insufficient training and lack of safety knowledge, unsatisfactory working and communication system. These sources can be minimized by improving the working and communication systems and by continuous and adequate safety training and enlightenment campaigns by the government organization and non-government organization (NGOs).

In homes, couplings, regulating valves, pipes and other connections are the common gas leak point.

II. CONCLUSION

Natural gas distribution in Nigeria can be improved by well planned dynamic marketing programmes directed at the distribution of natural has to homes so as to get people to embrace natural gas as their primary and preferred source of energy for heating and cooking in place of less- efficient fuels like woods and kerosene.

Indigenous gas culture should be encouraged among the majority of the populace who believe that gas is dangerous and handle domestically or that gas cooking is an expensive and luxurious one or that wood or kerosene is cheaper and better fuel for cooking.

Also concerted effort should be geared towards encouraging domestic consumption of gas allowing government to invest in the distribution of infrastructure before attracting private sectors.

Provision of enabling policies to encourage the exploration, production and utilization of natural gas in Nigeria. The government should ensure that gas flares are stopped completely by producing companies.

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