EXERGOECONOMIC ANALYSIS OF IHOVBOR GAS POWER PLANT

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ABSTRACT

Exergoeconomic parameters of Ihovbor Gas Power plant were determined in this study. To achieve this, the exergy of each stream, the economic cost of the plant components, the exergetic costs of each stream and the exergoeconomic evaluation of each component were determined. The average exergy efficiency of GTs ONE, TWO, THREE and FOUR were found to be 59.32%, 60.83%, 59.80% and 60.38% respectively and it decreased with increase in ambient temperature. The exergy destruction cost was greatest in the combustor (average of 1596.175$/hr), the relative cost difference was greatest in the air compressor with an average ratio of 0.36585, the exergoeconmic factor of the gas turbine was greatest (91.84%) and the average cost of power generation was found to be $0.0162/kWhr. Exergoeconomic parameters can be used as tools for energy audit and determining the running costs of power plants and power generation.

Key words: Gas Turbine, Exergy, Exergy Destroyed, Efficiency, Cost, Annualized Cost, Exergoeconomic

1 INTRODUCTION

Gas Power Plants are thermal plants that generate either mechanical or electrical power using energized gas. Ihovbor Gas power plant is a 4 x 112.5MW (International Organization for Standardization (ISO) 126.1MW) thermal power plant situated in Ihovbor a suburb of Benin City, Edo State, Nigeria and operated by the Niger Delta Power Holding Company (NDPHC) and fueled using natural gas. In managing any energy conversion system, the energy conversion process requires assessment in order to minimize waste of resources and achieve optimal utilization of resources. With the dwindling deposit of fossil fuel and its increasing demand, it becomes necessary to understand the mechanisms which degrade the quality of energy (ability to do work) and energy resources and to develop a systematic approach to improving the systems [1].

One of the tools for assessing power system is efficiency. Researchers today in studying the efficiencies of a system are concerned with the destruction originating in the energy conversion system as a result of change in entropy which the First Law of Thermodynamics cannot determine. Exergy analysis is based on the first and second laws of thermodynamics and makes it possible to characterize the optimal analysis technique on energy systems. It identifies energy levels and adverse thermodynamic processes, and also play an important role in strategic development and provision of instruction set for existing power plants [2-3]. Exergy analysis predicts performances and efficiency of an energy system and its component by quantifying the entropy generation of the system's components [4]. The application of exergy analysis in power plant will help the plant engineer make decisions and possibly optimize plant performance and minimize fuel consumption and reveal inefficient thermodynamic processes [5-7]

In exergy analysis, the ambient conditions are the reference point and exergy is possible if the system properties are brought into equilibrium with the ambient properties through reversible processes [8]. According to Dincer and Ratlamwala [9] the reference environment is in stable equilibrium, with all parts at rest relative to one another and no chemical reactions occurring between the environmental components.

The reference environment acts as an infinite system, and is a sink and source for heat and materials. These characteristics of the reference environment must be specified completely and this is commonly done by specifying the temperature, pressure and chemical composition of the reference environment. The results of exergy analyses, are relative to the specified reference environment, which in most applications is

modelled after the actual local environment and it is a primary tool in best addressing the impact of energy resource utilization on the environment [10].

The following are the importance of exergy and its utilization

1. It is an effective method using the conservation of mass and conservation of energy principles together with the second law of thermodynamics for the design and analysis of energy systems [11].
2. It is a suitable technique for furthering the goal of more efficient energy-resource use, for it enables the locations, types, and true magnitudes of wastes and losses to be determined [11-12].
3. It is an efficient technique revealing whether or not and by how much it is possible to design more efficient energy systems by reducing the inefficiencies in existing systems (Dincer and [11-12].
4. It is a key component in obtaining sustainable development [11-12].

Exergy has been a prime tool and its use has been extended to economy by including cost accounting to exergy analysis and exergy streams [9, 13]. The combination of exergetic analysis with its economic implication is known as exergoeconomic analysis. The goal of conducting exergoeconomic analysis of systems is to minimize the cost of exergy [2]. According to [14] exergoeconomic analysis combines the exergy analysis with economic principles and incorporates the associated cost of the thermodynamic inefficiencies in the total product cost of the energy system. Exergoeconomic analysis has become a powerful tool for assessing the performance of energy conversion system for improving overall system efficiency and lowering life cycle costs of a thermodynamic system [15-16]. Exergoeconomics applied to design optimization provide the designer of an energy-conversion plant with information not available through conventional energy, or cost analyses, but critical to the design of a cost-effective plant [17]. More also exergoeconomic analysis has been efficiently used as a design tool for the realization of a gas turbine power plant principle [18]. Exergoeconomic analysis estimates the unit cost of products such as electricity and quantifies monetary losses due to irreversibility [4].

For engineering purposes, the results from exergoeconmic analysis are used for improvement of the system, as it is often more cost effective and less time consuming than optimization of the system due to the large uncertainties associated with cost

information and normal operational fluctuations of thermodynamic parameters of complex thermal systems [19].

Exergoeconomic analysis as an important tool is used by engineers for:

1. Rational prices assessment/feasibility assessment of plant products based on physical criteria [20-21].
2. Optimization of specific process unit variables through improved design concept to minimize the final product cost, i.e. global and local optimization [20-21].
3. Detection of inefficiencies and calculation of their economic effects in operating plants, i.e. plant operation exergoeconomic diagnosis [20].
4. Evaluation and improvement of various design alternatives or operation decisions of the system components and profitability maximization [20-21]
5. Energy audits [20].

Researches on the exergy and exergoeconomic analysis have been carried out.

Kwon et al. [22] in their exergoeconomic analysis of a cogeneration plant found that the cost of products are crucially dependent on the change in the annualized cost of the component whose primary product is the same as the system's product.

Oyedepo et al. [14] in their study of selected gas turbines in Nigeria (Egbim Thermal Power Plant, Ughelli Power PLC, Afam Power Station and AES Barge Gas Turbine Power Plant), discovered that the efficiency of the plants is within the range of 18.22-32.84%. Decrease in ambient temperature results in increase in the plant efficiency. From their exergoeconomic analysis, the low exergoeconomic factor associated with the combustion chamber shows that the cost rate of exergy destruction is the dominant factor influencing the component.

Ogbe et al. [15] carried out a probabilistic exergoecominc analysis of four modeled industrial gas turbine units, two each of 100MW GE Engine and 25MW Hitachi Engine at Transcorp Power Plant in Ughelli, Delta State, Nigeria. From his results, the irreversibility of the gas turbines decreased with an increase in inlet temperature and is consistent with the report by Chand et al. [7] in their analysis of 112.4MW single shaft in Genting Lanco, Vijayawad at ISO condition.

Mousafarash et al. and Eke et al. [2, 23] from their observation of the exergy efficiencies of thermal plants showed that increase in inlet temperature has negative effect on the exergy efficiency of the cycle and that the heat addition process (combustion chamber/boiler)

has the maximum rate of exergy destruction due to the chemical reaction, mixture and high temperature. [24] Studied unit 14 of South Tripoli Gas Turbine Power Plant at varying operating load. Their result showed that the average cost per unit exergy net power is equal to 7.1$/GJ at 40% design loads, and equal to 5.5$/GJ at 60% design load, and equal to 4$/GJ at full operating load. The exergetic efficiency of the gas turbine increased with increase in operating load.

This research work conducted the exergetic analysis of Ihovbor Gas Power Plant and determined the various cost associated with the components and the exergy streams, and the exergy destroyed using available data from 2014-2017.
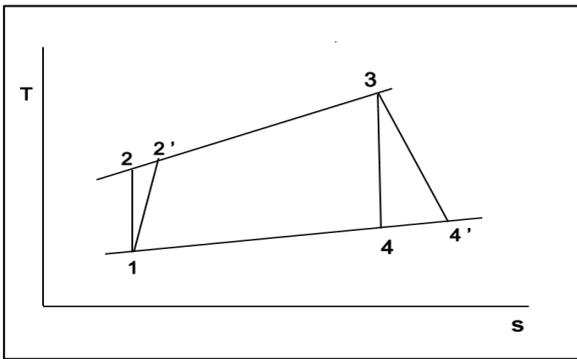

Figure 1: The T-s diagram of a Gas Power Plant

1.1 Cycle Description

A gas turbine has typically low efficiency in the range of 20-30% and operates on Brayton or Joule cycle but it is preferred because of its low capital cost, high flexibility, high reliability without complexity, short delivery time, and fast starting and loading [25-26]. It consists of the air compressor, combustion chamber and the gas turbine and the T-s is illustrated in Figure 1. The air compressor compresses the air isentropically from state 1 to state 2, but due to irreversibility in the air compressor, the air is delivered at state 2' thus generating entropy. The compressed air is heated from state 2/2' at constant pressure to state 3 and the high temperature accompanying heat addition also generates entropy. The energy in the flue gas is extracted by expanding the flue gas isentropically from state 3 to state 4 in the gas turbine but due to irreversibility in the gas turbine it is expanded to state 4' and this also generates entropy. This entropy generation can be reduced by minimizing the irreversibilities such as friction, turbulence, and non-quasi-equilibrium processes [27].

2 METHODOLOGY

The four procedure proposed by [28] will be followed in this study. These steps are:

A. Exergy Analysis
B. Economic Analysis of each of the plant component,
C. Estimation of exergetic costs associated with each flow and
D. Exergoeconomic evaluation of each system component.

2.1 Exergy Analysis

The exergy stream of any thermo-mechanical system has thermal, pressure and chemical components and entropy is generated due to irreversibilities.

The thermal exergy of the plant at any point k is given as

$$E^T = mC_P \left[(T_k - T_{ref}) - T_{ref} \ln \frac{T_k}{T_{ref}} \right] \quad (1)$$

where E^T is thermal exergy in MW, m is the mass flow rate of the working fluid in kg/s, C_p is the specific heat capacity of the fluid in kJ/kgK T_{ref} is the ambient temperature and T_k is the temperature at point k. From figure 1, point k are points 1,2,3,4 respectively. Temperature is measured in Kelvin K
where

$$C_{Pa} = 1.04841 - \left(\frac{3.8371T}{10^4} \right) + \left(\frac{9.4537T^2}{10^7} \right)$$
$$- \left(\frac{5.49031T^3}{10^{10}} \right) + \left(\frac{7.9298T^4}{10^4} \right) \quad (2)$$

where T is the temperature measured in Kelvin K
The Pressure exergy of the plant at any point is given as

$$E^P = mRT_{ref} \ln \frac{P_k}{P_{ref}} \quad (3)$$

where E^p is pressure exergy in MW, R is the gas constant in kJ/kgK, P_{ref} is the ambient pressure and P_k is the pressure at point k. Pressure is measured in bar.

For fossil fuel with chemical formula C_aH_b; the chemical exergy is given as

$$E^{CHE} = m_f \times \left(1.033 + 0.0169 \frac{b}{a} - \frac{0.0698}{a} \right) \quad (4)$$

where m_f is mass flow rate of the fuel
The entropy, S of the plant at any point k is given as

$$S_k = m \left[C_p \ln \frac{T_k}{T_{ref}} - R \ln \frac{P_k}{P_{ref}} \right] \quad (5)$$

For any component of the system the total exergy is given as :

$$E^{CHE} + \sum (E_o^T - E_i^T) + \sum (E_o^P - E_i^P) + T_{ref} \sum (S_o - S_i)$$
$$+ Q_{CC} + W = 0 \quad (6)$$

where subscript o and i are the sum values at entry and exit of the component respectively.

And the exergy destroyed, E_D the component due to change in entropy of the process is given by equation (7)

$$E_D = T_{ref} \sum (S_o - S_i) \quad (7)$$

The efficiencies of the components and the plant are given by equations (8) - (11)

Compressor:

$$\eta_{AC} = 1 - \frac{E_{D,AC}}{E^{W,AC}} \qquad (8)$$

Combustion chamber:

$$\eta_{CC} = 1 - \frac{E_{D,CC}}{E^{CHE}} \qquad (9)$$

Gas turbine:

$$\eta_{GT} = 1 - \frac{E_{D,GT}}{E^{W,GT}} \qquad (10)$$

where $E_{D,\,AC},\,E_{D,\,CC},\,E_{D,\,GT}$ are the exergy destroyed in the air compressor, combustion chamber and gas turbine respectively while $E^{W,\,AC}$ and $E^{W,GT}$ are the work done on the air compressor and the gross work done by the gas turbine.

Overall plant:

$$\eta_{PLANT} = 1 - \frac{\sum E_D}{E^{CHE}} \qquad (11)$$

Exergy destruction rate, is given by equation (12)

$$\varepsilon_d = \frac{\sum E_D}{E^{CHE}} \qquad (12)$$

where, $\sum E_D = E_{D,AC} + E_{D,CC} + E_{D,GT}$

2.2 Economic Analysis of the Plant

The economic analysis of the plant shows the investment, operation and maintenance cost of the plant and are necessary for analyzing the exergy cost of the streams in the system.

Annualization cost method proposed by Moran [29] was used in carrying out the analysis. Annualization cost of the equipment ($\dot{C}$) \$/yr is determined in accordance with [30-31]

$$\dot{C} = PW \times CRF \qquad (13)$$

where PW is the Present Worth and CRF the cost recovery factor.

The PW of the plant's component is proportional to Cost of the equipment known as Purchase Equipment Cost (PEC), the Salvage cost SV and the Present Worth Factor PWF

$$PW = PEC \times (-SV)PWF \qquad (14)$$

PEC of the different component as stated by [32]. For air compressor:

$$PEC = \left[\frac{71.1m_a}{0.9 - \eta_{AC}}\right]\left[\frac{P_2}{P_1}\right]Ln\left[\frac{P_2}{P_1}\right] \qquad (15)$$

Efficiency of air compressor η_{AC} is taken as 89.4%

For the combustion chamber:

$$PEC = \left[\frac{46.08m_a}{0.995 - P_3/P_2}\right][1 \\ + \exp(0.018T_3 - 26.4)] \qquad (16)$$

For gas turbine:

$$PEC = \left[\frac{479.34m_g}{0.92 - \eta_{GT}}\right]Ln\left[\frac{P_3}{P_4}\right][1 \\ + \exp(0.036T_3 - 54.4)] \qquad (17)$$

Efficiency of gas turbine η_{GT} taken as 87.8%

From figure 1, P_1, P_2, P_3, P_4 are the pressures at point 1,2,3,4 respectively, T_3 is the temperature at point 3 while m_a and m_g are the mass flow rates of air and flue gas respectively.

$$CRF = \frac{i}{1 - (1 + i)^{-N}} \qquad (18)$$

$$PWF = (1 + i)^{-N} \qquad (19)$$

Capital cost Z in \$/sec for each component is given as

$$Z = \frac{\emptyset_K \times \dot{C}}{3600 \times n} \qquad (20)$$

For the Analysis of the plant, the following assumptions/values were used

Salvage cost SV= 10% of PEC

Interest (i) = 17%

Years of plant (N) = 4yrs (2014-2017)

Maintenance factor $\emptyset_k$ = 1.06

Operating hour per year (n) = 8472

2.3 The Exergy Cost of Each Stream

Exergy costing is based on a principle that exergy is the only rational basis for assigning monetary values to the interactions an energy system experiences with its surroundings and to the thermodynamic inefficiencies within the system as the exclusive use of mass, energy or entropy results in misleading conclusions [17].
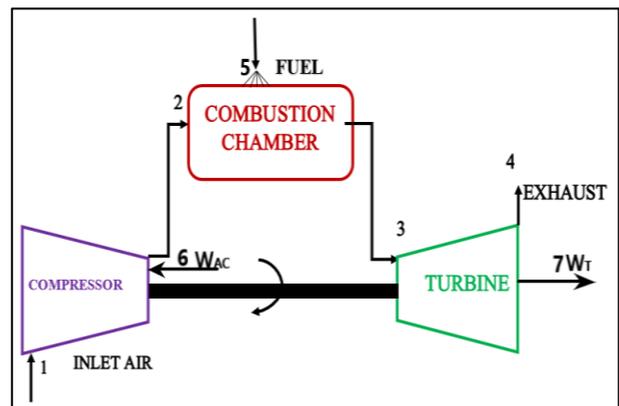

Figure 2: Gas Turbine with Encoding for Exergy Cost Analysis

In analyzing the exergy cost of the simple gas power plant having air compressor, combustion chamber and gas turbine the code/numberings in figure 2 is used. The Specific-Cost Exergy Costing (SPECO) method proposed by Lazzaretto and Tsatsaronis [33] was used for all the components of the system to construct a set of nonlinear algebraic equations.

The formulations of the equations are shown in equations (22) – (24) for air compressor, combustion chamber and gas turbine respectively.

$$C_2 = C_1 + C_6 + Z_{AC} \qquad (21)$$
$$C_3 = C + C_5 + Z_{CC} \qquad (22)$$
$$C_4 + C_6 + C_7 = C_3 + Z_{GT} \qquad (23)$$

Auxiliary equations (25) and (26) were also used

$$\frac{C_3}{E_3} = \frac{C_4}{E_4} \qquad (24)$$

$$\frac{C_6}{W_{AC}} = \frac{C_7}{W_{net}} \qquad (25)$$

where $E^{W, NET}$ is the work-net of the plant.

The cost of fuel $\dot{C}_5$ for power is taken as $3.16 per GJ ($3.34 per MMBTU)

$$C_5 = \dot{C}_5 \times E^{CHE} \qquad (26)$$

where C is the specific annualized cost in $/sec

2.4 Exergoeconomic Cost

Average cost per unit fuel of exergy C_{FE} for each component

$$c_{FE} = \frac{C_F}{E_F} \qquad (27)$$

Average cost per unit product of exergy C_{PE} for each component

$$c_{PE} = \frac{C_P}{E_P} \qquad (28)$$

Cost of exergy destruction C_D

$$C_D = C_{FE} \times E_D \qquad (29)$$

where E_F and E_P are the exergy fuel and exergy product for each component while C_F and C_P is the cost of the fuel and product respectively.

The inlets to each component are the fuel for the component while outlets from the components are the products for the component.

2.4.1 Relative Cost Difference r_k

Relative cost difference r_k shows the rate of increase of the cost of exergy in each component. This cost increase between cost of fuel C_{FE} and cost of product C_{PE} is caused by the cost of exergy destruction and the investment related cost (Capital cost Z) as the relative cost difference r_k shows [17].

$$rk = \frac{C_P - C_F}{C_F} \qquad (30)$$

2.4.2 Exergeconomic Factor f_k

The exergeconomic factor f_K compares the two cost sources contributing to the cost increase between C_F and C_P and shows the contribution of the investment-related cost to the sum of cost of exergy destruction and investment-related cost [17].

$$f_k = \frac{Z}{Z + C_D} \qquad (31)$$

3 RESULTS AND DISSCUSSION
3.1 Exergy Analysis

The data for the exergy analysis which is the average performance data of the plant based on inlet air temperature was gotten using Microsoft Excel sheet. The data represents the calculated performance of the plant installed at Ihovbor which is a General Electric 9E Frame Gas Turbine (PP.9171E) while the data for the economic, exergy cost and exergoeconomic cost is the average performance data of the plant from January 2014 to May 2017.

The results of the exergy analysis shown in Figs 3, 4, 5 and 6 showed that the component with the lowest efficiency is the combustion chamber as its average efficiency is 64.03%, 64.81%, 64.37% and 64.67% for GT ONE, GT TWO, GT THREE and GT FOUR respectively and this is caused by the high irreversibility accompanying combustion and mixing and this gives room for improvement of combustors for resources utilization. [2,23,35]. The plant has an average efficiency of over 98% in the gas turbine which is the highest of all the components while the air compressor has efficiencies of 89.85%, 91.37%, 89.83% and 90.522% for GT ONE, GT TWO, GT THREE and GT FOUR respectively.

Generally, the average efficiencies of Ihovor Gas Power Plant are 59.32%, 60.83%, 59.80% and 60.38% for GT ONE, GT TWO, GT THREE and GT FOUR respectively. From the plant linear trend line the efficiency of the plant generally decreased with increase in temperature as increase in inlet air temperature leads to increase in irreversibility thus increasing exergy destruction rate [2, 14, 15, 34, 35].

3.2 Economic, Exergy Cost and Exergoeconomic Analysis of the Plant

From the economic analysis of the plant as shown in Table 1, the air compressor PEC is greatest with above $21M and this depends on the mass of air compressed. The combustion chamber PEC is lowest ($0.32M) and it depends on the mass of air and the pressure loss during combustion. The PEC of the Gas Turbine is $13M and this depends on the mass of the flue gas.

Table 2 shows the exergy cost of each of the streams at the price of $3.16 per GJ ($3.34 per MMBTU the exergy with greatest cost is at point 3 and this is due to high thermal exergy accompanying heat addition.
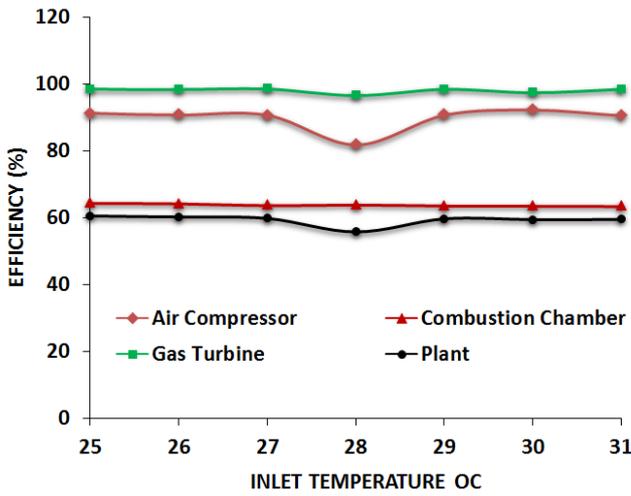
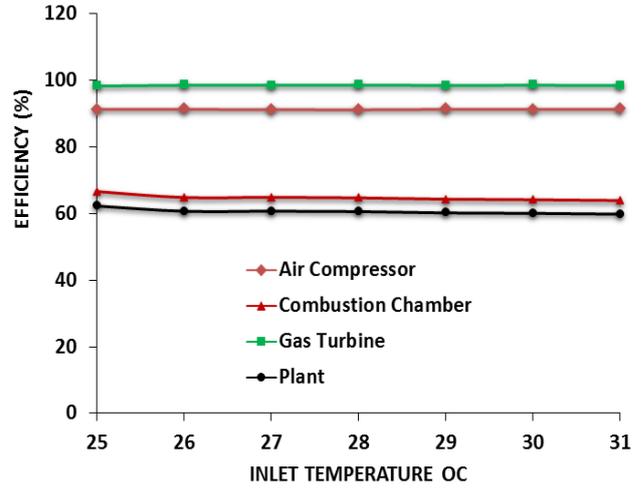Figure 3: Exergy Efficiencies of Gas Turbine 1

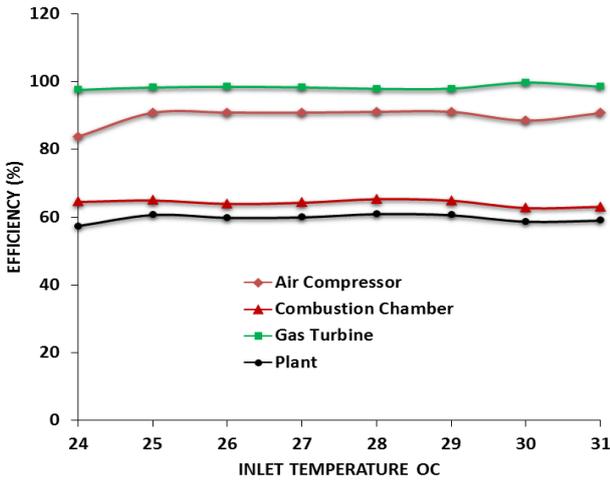Figure 4: Exergy Efficiencies of Gas Turbine 2

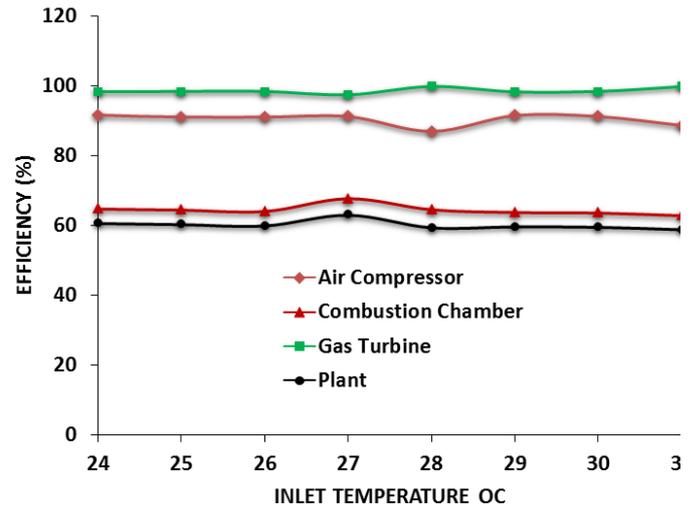Figure 5: Exergy Efficiencies of Gas Turbine 3

Figure 6: Exergy Efficiencies of Gas Turbine 4

The exergy cost of the streams were found to be dependent on the annualized cost of the plant components (Kwon et al., 2001). From the result of the exergy cost, the price of electricity (product) is $0.016, $0.0162 and $0.0163 and $0.0164 per kWhr and is an average of $0.0162 per kWhr ($4.60 per GJ) generated by the power plant which is almost equivalent to the price of final exergy of [24] at 100% design load.

From the results in Table 3, the cost of exergy destruction is greatest in the combustion chamber with an average of $1596.186 per hour followed by the air compressor and the least is the gas turbine with

average values of $164.333 per hour and $44.576 per hour respectively. From the relative cost difference, the air compressor is the most affected by the sum of cost of exergy destruction and investment related cost while the least is the combustion chamber. The cost of investment played the most significant role in increasing cost of exergy in the gas turbine while the cost of exergy destruction plays the most significant role in the increase of cost of exergy in the combustion chamber. Thus, increase in capital investment especially in gas turbine inlet temperature will improve its efficiency [14].

Table 1: Economic Analysis of the Plant

GT	PURCHASE EQUIPMENT COST ($)			ANNUALIZATION COST ($/YR)			CAPITAL COST Z($/sec)		
	$AC*10^6$	$CC*10^6$	$GT*10^6$	$AC*10^6$	$CC*10^6$	$GT*10^6$	AC	CC	GT
1	21.517	0.3275	13.007	6.419	0.098	3.88	0.223	0.0034	0.1349
2	22.997	0.3327	13.211	6.86	0.099	3.941	0.238	0.00345	0.137
3	21.836	0.3203	13.237	6.514	0.096	3.949	0.226	0.00332	0.1372
4	24.756	0.3633	13.888	7.385	0.108	4.143	0.257	0.00377	0.144

Table 2A: Exergy Cost of each Stream

	GT ONE			GT TWO		
POINT	C ($/HR)	C ($/GJ)	C ($/KWHR)	C ($/HR)	C ($/GJ)	C ($/KWHR)
1	0	0	0	0	0	0
2	2403.36	6.115	0.022	2460.05	6.312	0.0227
3	5966.12	3.94	0.0142	5986.52	3.983	0.0143
4	2946.27	3.94	0.0142	2934.71	3.983	0.0143
5	3552.7	3.16	0.0114	3516.31	3.16	0.0114
6	1741.99	4.432	0.016	1757.55	4.509	0.0162
7	1655.42	4.432	0.016	1697.83	4.509	0.0162

Table 2B: Exergy Cost of each Stream

	GT THREE			GT FOUR		
POINT	C ($/HR)	C ($/GJ)	C ($/KWHR)	C ($/HR)	C ($/GJ)	C ($/KWHR)
1	0	0	0	0	0	0
2	2322.52	5.808	0.0209	2608.61	6.372	0.0229
3	6137.88	3.995	0.0144	6262.59	4.023	0.0145
4	3083.03	3.995	0.0144	3067.83	4.023	0.0145
5	3647.51	3.16	0.0114	3643.04	3.16	0.0114
6	1809.74	4.526	0.0163	1862.72	4.55	0.0164
7	1651.74	4.527	0.0163	1750.48	4.55	0.0164

Table 3A: Exergoeconomic Cost

	GT ONE			GT TWO		
EXOGERMIC PARAMETER	AC	CC	GT	AC	CC	GT
C_{IE} ($/GJ)	4.432	3.9254	3.9399	4.5095	3.9776	3.9828
C_{pE} ($/GJ)	6.115	3.9399	4.104	6.312	3.9828	4.1609
E_D (MW)	10.81	110.88	2.0873	9.345	108.8	2.9441
C_D ($/h)	172.5	1566.9	29.606	151.71	1558	42.213
Z ($/h)	803.1	12.223	485.47	858.32	12.417	493.07
C_D + Z ($/h)	975.6	1579.1	515.08	1010	1570.4	535.28
F_K (%)	82.32	0.774	94.252	84.98	0.7907	92.114
R_K	0.38	0.0037	0.0417	0.3997	0.0013	0.0447

Table 3B: Exergoeconomic Cost

	GT THREE			GT FOUR		
EXOGERMIC PARAMETER	AC	CC	GT	AC	CC	GT
C_{IE} ($/GJ)	4.5257	3.8413	3.9949	4.5501	4.0022	4.0232
C_{pE} ($/GJ)	5.808	3.9949	4.1659	6.3721	4.0232	4.1998
E_D (MW)	10.797	117.31	3.4112	9.6	113.66	3.965
C_D ($/h)	175.91	1622.2	49.059	157.25	1637.6	57.427
Z ($/h)	815.01	11.954	494.06	924	13.558	518.36
C_D + Z ($/h)	990.92	1634.2	543.11	1081.2	1651.2	575.79
F_K (%)	82.248	0.7315	90.967	85.457	0.8211	90.026
R_K	0.2833	0.04	0.0428	0.4004	0.0052	0.0439

4 CONCLUSIONS

The exergy analysis of Ihovbor gas power plant was done in this study and the cost implication of the result of the exergy analysis was determined.

The result of the exergy analysis showed that the gas turbine has the highest exergy efficiency while the combustion chamber has the lowest exergy efficiency. The low exergy efficiency of the combustion chamber was caused by the large thermal exergy lost during combustion reaction. The result also showed that increase in temperature leads to decrease in plant exergy efficiency. The plant average efficiencies were found to be 59.32%, 60.83%, 59.80% and 60.38% for GT ONE, GT TWO, GT THREE and GT FOUR respectively.

The economic cost of the plant showed that the air compressor PEC was greatest at above $21M, the gas turbine above $13M, while that of the combustion chamber was least with $0.32M. The exergy cost analysis showed that the cost of power generation was at an average of $0.0162 per kWhr/ $4.5045 per GJ generated by the power plant. The exergoeconomic analysis of the plant showed that the sum cost of investment and exergy destroyed influenced the increase in cost of exergy of the air compressor the most and the combustion chamber the least.

The low exergoeconomic factor of the combustion chamber showed that the cost of exergy was the defining factor in its increase of exergy while investment cost is the significant factor increasing the cost of exergy in the air compressor and the gas turbine.

Exergoeconmic parameters can be used as a tool for carrying out energy audit, managing the cost of power generation and determining the running cost of power plants.

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