International Conference of Science, Engineering & Environmental Technology (ICONSEET), 2(4): 23-28, 2017
ISSN 0794-9650

www.repcomseet.com

Performance Equation Modeling for A 2 KVA Locally Designed and Constructed Inverter Systems

Jimoh A. A[a], Lawal O.A[b], Kabiru. L[c].
Kwara State Polytechnic, Ilorin, Nigeria
E-mail: *adehameed79@gmail.com*

Abstract - The level of dependency on alternative source of electrical power supply cannot be overestimated. This is due to the critical roles that reliable electrical power supply play in our immediate endeavor and survival. In this regard, the research work finds it very worthy to investigate the performance index and modeling of performance equation for a 2 kVA locally designed and constructed electrical power inverter. The research work employed an independent approach in the performance analysis of the 2 kVA inverter. The approach forbears the conventional fashion of comparing a foreign and locally made inverter. Rather some metric parameters were measured and recorded when the inverter was set on, using a predetermined load in kVA. 23rd Edition of IBM statistical package for social science software was used to simulate the data set. The simulator helps to generate the equation constant and the offset values. In the final touch, some technical assessments were employed to gauge the performance index using the independent values of the modeled equation. If the performance values obtain from the modeled equation is equal to zero (0) or less than five (5), it was gauge a very okay performance, 5 – 20 performance values were rated fairly okay and 20 above was rated performance not okay.

Keywords: Equation Modeling, Inverter, Performance index, Simulation Data, Statistical package and Technical Assessment.

1. Introduction

The Nigeria national grid relies fully on the hydro and gas generation power plants for mains input on the grid. However, in recent times series of factors has led to supply shortage ranging from poor maintenance culture, inadequate skilled personnel, poor planning etc all reduce the mains supply reliability and availability [1]. In this twenty first century, the frontiers of knowledge in the telecommunication industries, sophisticated medical life savings equipment, accurate data and processing machines among other electronic machines are all electrical power dependency, capable of malfunctioning on slight input voltage variations, talk-less of total mains outage or unavailability [2].

Voltage variation is an embedded problem in power system, this may result from series of irregularities right from the generation, transmission and distribution grid, although an automatic voltage regulator may be used to cater for these voltage irregularities in the distribution end at extra cost. Apart from the aforementioned of voltage variation effect, there are environmental pollution effects liable from gas generation power plant. The health hazard caused by the emission of greenhouse gases from the power plants and individual household generator cannot be over – emphasized. This pollution is greatly pronounced on the health of all living things habited on earth; hence researchers' effort was geared on alternative electrical power supply which has a stable output voltage and it is environmental friendly [3]. A worthy alternative power supply system commonly found is the solar inverter system. The performance indices of locally made inverters are not numerically ascertained despite its demand as alternative to mains power supply system. In this regard, this research presents a modeled equation for the performance index of a 2 kVA locally designed and constructed power inverter system [4].

2. Research Problem

The problem is to analyze and model an equation for the performance analysis of a 2 kVA locally designed and constructed inverter system. The locally made inverters are products of electrical & electronic components that are readily available in the local market and the serve as the most readily available alternative source of power supply to the mains. Hence, the need to determine their performance is worth researching.

3. Performances and Inverter Overview

Ideally, performance validation of most research work relied on comparison between existing system and new system. In which the performance of the existing system will be used to bench mark the performance test of the new system [5]. In reality the performance of the existing system has not in any time been quantified. In the case of electronic gadgets, the standard organization of Nigeria (SON) was saddled with the responsibility of performance evaluation [6]. But in recent times, the reliability of most electronic gadgets despite SON approval is more than questionable. This among other reasons, demands for the need to independently determine the performance index of a locally designed and constructed inverter without comparing it with any other foreign inverter [7].

The early inverters from the late nineteenth century through the middle of the twentieth century were accomplished using rotary converter or motor generator sets. In the early twentieth century, vacuum tube and gas filled tubes began to be used as switches in inverter circuits. The origins of electromechanical inverters explain the source of the term inverter. Early AC- to- DC converter used an induction or synchronous ac motor direct - connection to a generator (dynamo) so that the generators commutator reversed its connections at exactly the right moments to produce D.C. A later development is the synchronous converter in which the motor and generators windings are combined into one armature, with slip rings at one end and a commutator at the other with only one field frame. However, in a motor generator set, the D.C can be considered to be separately generated from the AC; with a synchronous converter, in a certain sense it can be considered to be “mechanically rectified AC “. Given the right auxiliary and control equipment, motor generator set or rotary converter can be “run backwards”, converting DC to AC. Hence an inverter is an inverted converter [8].

4. Research Methodology

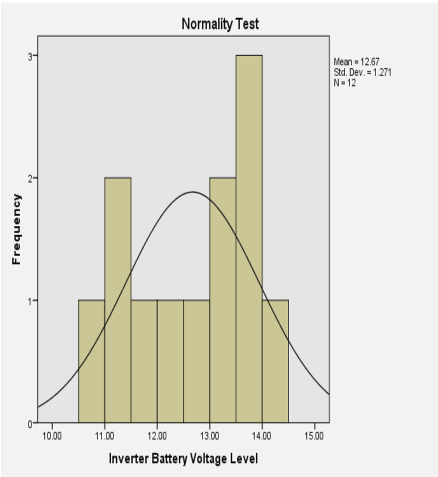
Metric campaigns were conducted on the 2kVA inverter as presented in Table 1.0 at a predetermined load in kVA.

Table 1.0: Metric Campaign for the 2 kVA Locally Designed Inverter

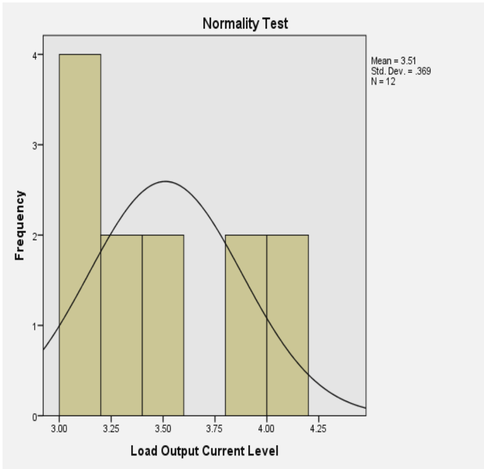
S/N	TIME (mins)	BATTERY VOLTAGE (Volts)	OUTPUT VOLTAGE (Volts)	BATTERY CURRENT (Amps)	LOAD CURRENT (Amps)
1	20	14	260	12.60	3.15
2	40	13.97	257	12.63	3.15
3	60	13.95	253	12.65	3.16
4	80	13.94	250	12.66	3.16
5	100	13.40	243	13.16	3.29
6	120	13.00	245	13.57	3.39
7	140	12.95	242	13.62	3.40
8	160	12.40	240	14.23	3.55
9	180	11.54	220	15.29	3.82
10	200	11.35	200	15.54	3.88
11	220	11.00	190	16.04	4.01
12	240	10.56	185	16.71	4.17

The over drain level of the battery was set at 10.50 Volts and measurements were recorded for every 20 minutes interval with a 1.9KVA load. The data set were keyed into the (SPSS – 23) for performance analysis. The assessment employed for gauging the performance of the inverter at any given time *(t)*, was bedrock on the ability of the inverter to maintain a near constant output voltage at full load. Since in the case of a small machine; the output voltage regulation may be found by direct loading. This assertion was taken from the fact that if the output voltage of an inverter drops considerably on full load as compared to the no load output voltage; the performance of the inverter will be poor due to high voltage regulation ratio. In this regards, technical assessment was employed to put the metric of performance of the inverter on the following independent parameters of: the duration of time spent on full load support (t), the load output voltage (V_{OL}) and load output current (I_{OL}).

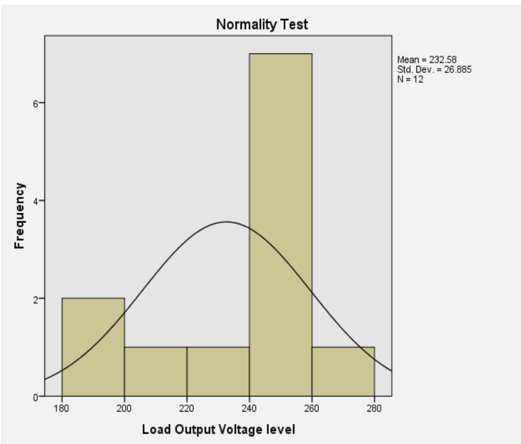
5. Results and Discussions



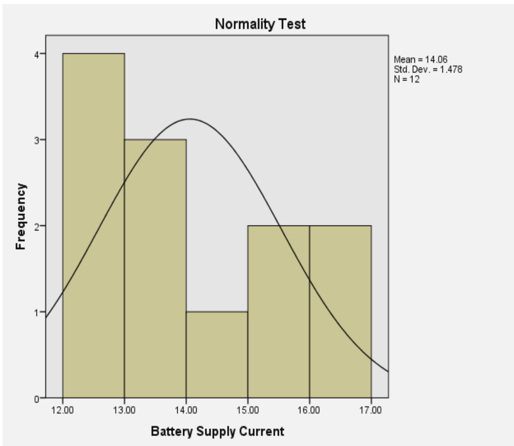
(a)



(b)



(c)



(d)

Figure 1: Normality Test for the Measured Values of 2 kVA Locally Designed and Constructed Inverter (a) Inverter Battery Voltage Level (b) Load Output Current Level (c) Load Output Voltage Level and (d) Battery Supply Current.

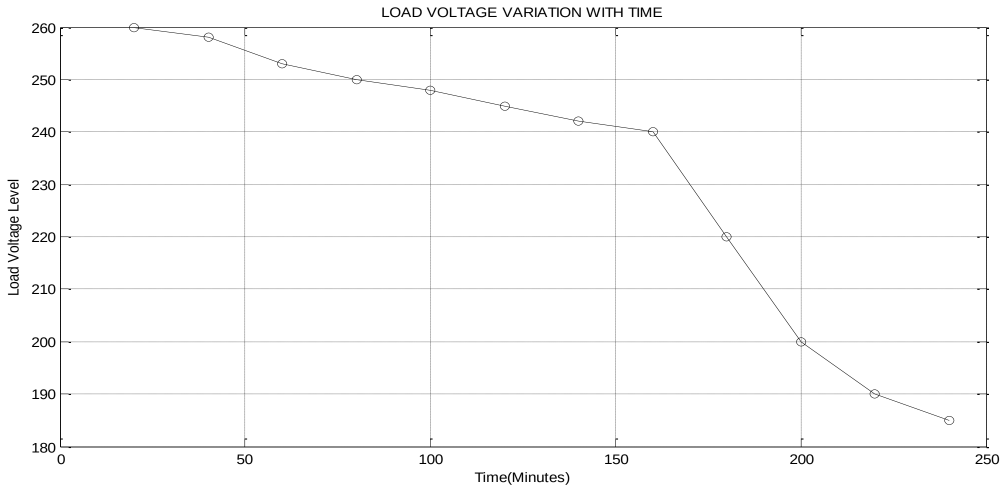


Figure 2. Load Voltage variation with Time

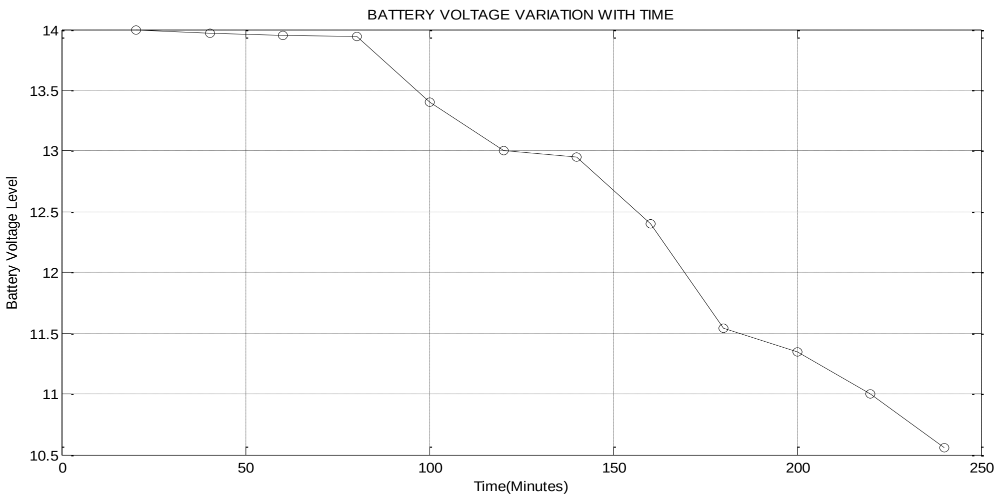


Figure 3: Battery Voltage variation with Time

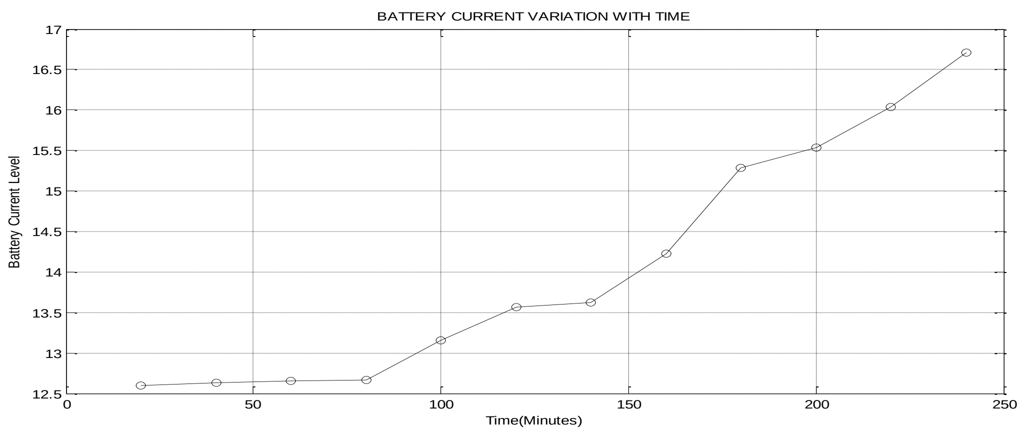


Figure 4: Battery Current variation with Time

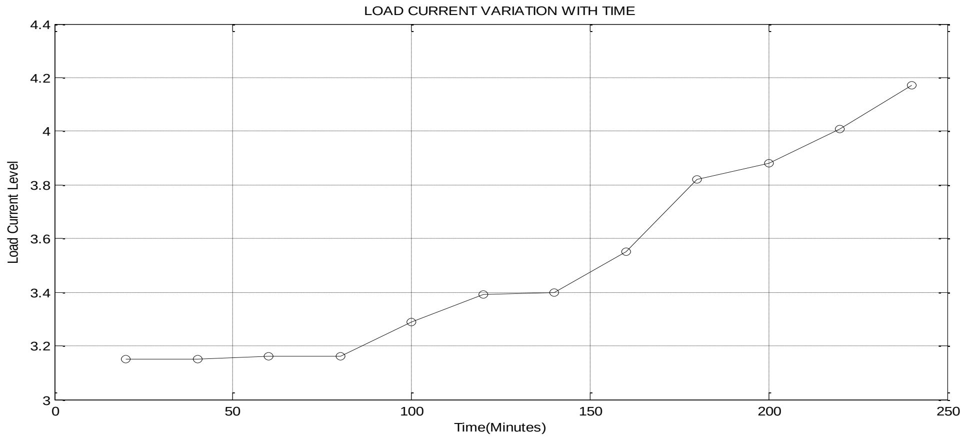


Figure 5: Battery Currrent variation with Time

Generally, measurements are known to be liable to outliers, sometimes called error. Errors arise due to imperfection on the part of human and machines that are used to obtain the numeric data. In this research work, a normality test was run on SPSS-23 software simulator to check for the normality test of the measured data in Table 1.0 as presented in Figure 1.0. The Figures show that the metric data are normal and they are completely devoid of outliers, hence they possess some level of credence when used in the investigation of the 2 kVA performance and equation modeling analysis. Figure 2, 3, 4 and 5 show the depiction of the metric parameters variation with time. In Figure 2, the graph depiction shows that the inverter provides support when maximally loaded for about four (4) hours, however, the inverter output voltage only drops by 20 volts in nearly two (2) hours. This indicates a very good performance by the inverter, although, afterward the output drops drastically with a compensation for the load sustainability through the corresponding increase in the battery current level as shown in Figure 4.

Table 2. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.965[a]	.930	.904	.22852

a. Predictors (Constant), Load Output Current Level, Measurement Time, Load Output Voltage Level

Table 2 on the other hand comprises the model summary and it shows the Adjusted R square value, which indicate that the metric parameters that were keyed in to the SPSS-23 software were 90.4% capable of determining the success of the inverter performance and it was therefore adjudged okay.

Table 3.0: Modeling Coefficients

Model	Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	18.472	5.851		3.157	.013
	Measurement Time	.012	.003	1.184	3.582	.007
	Load Output Voltage level	-.034	.011	-1.216	-2.974	.018
	Load Output Current Level	-2.906	1.062	-1.453	-2.737	.026

Table 3.0 shows the modeling coefficients for the metric parameter that was keyed in to SPSS software. At this stage, it is worth mentioning that, all the components used as well as the metric parameters obtained are all ohmic in nature (i.e they obey ohm's law, having a voltage – current linear

relationship), with this credence, a linear regression equation was adopted for the equation modeling formulation.

Fundamentally, the equation modeling therefore takes a form of general regression equation of the form:

$$P(invt) = K + K_1(t) + K_2(V_{OL}) + K_3(I_{OL}) \quad 1$$

where *P(invt)* is the inverter performance, *K* is the constant value in the modeling coefficient table, K_1 is the constant of measurement time at time *t*, K_2 is the constant of the load output voltage and K_3 is the constant of load output current. In this regard, the performance equation for the 2KVA inverter is equal to

$$P(invt) = 18.472 + 0.012\,(t) - 0.034\,(V_{OL}) - 2.906\,(I_{OL}) \quad 2$$

With the equation modeling derived, the performance of a 2 kVA locally designed and constructed inverter can be determined at any time t of operation of the inverter with the load output voltage measured (V_{OL}) at time *t* and the load output current (I_{OL}) at time *t*, with this assertion the instant where the inverter voltage regulation ration is equal to zero (0) or less than five (5) was rated okay performance, between five (5) to twenty (20) was rated fairly okay and above twenty (20) was rated poor performance.

6. Conclusions

The performance equation modeling for assessing and gauging of the performance index of the 2 kVA locally designed and constructed inverter has been investigated and formulated. Although, the simulation results of Table 2.0 shows that the modeled performance equation is 90.4% capable of determining the performance of the locally made 2kVA inverter. This shows the independent performance analysis that forbear the usual known comparison method of foreign and locally made inverter is a welcome idea. The recent unreliability of most foreign gadgets calls for concern when they are used to bedrock the performance evaluation of a locally made inverter.

REFRENCES

[1] Theraja AK, and Theraja BL, A Textbook of Electrical Technology, First Multicolour Edition. S. Chand and Company Limited, Ram Nagar, New Delhi – 2005, p. 1684-1688.

[2] Bogart Jr, Electronics devices and circuit Merrill publishing, Co. First Edition, 1990, p. 237 – 307.

[3] Syed N, Electrical Power System, Schw Outline Series, Fifth Edition, 2016, p. 166 – 168.

[4] Larry P, and Lewis WF, Solar Cells and their Applications Second Edition, ISBN 978-0-470-44633-1, 2010, Section10.2.

[5] Chebil J, Lawas AK, and Islam MD, Comparison between Measured and Predicted Path Loss for Mobile Communication in Malaysia, World Applied Sciences Journal, 2013, p. 123–128.

[6] SON import regulation (Accessed on 27th July, 2017 by 10:23Am). Available: http//www.son.gov.ng/google.

[7] Dietert JS, Karger S, and Rembold B, Statistical channel modeling based on ray-tracing simulations, COST 259, TD 004. 2000, p. 10 – 12.

[8] Theraja AK, Development of Electrical Power System, Twenty-Two Edition, S. Chand and Company Limited, Ram Nagar New delhi-110053, 2010, p. 212 – 214.