



Performance index analysis of various 3.5KVa/48V power inverters

Godspower Onyekachukwu Ekwueme¹✉, Ifeyinwa Faith Ogbodo²

(^{1, 2}) Department of Industrial & Production Engineering, Nnamdi Azikiwe University, Awka Anambra State, Nigeria

✉ Corresponding author:
if.ogbodo@unizik.edu.ng

Abstract

The initial cost of the power inverter system is significantly higher compared to the conventional source of power. As a result, there is needed for the performance evaluation of various power inverters in order to determine the cost efficiency of the power inverter as an alternative source of power. The aim of the present study is to investigate the performance index of 3.5kva/48v inverters for a domestic source of electric power supply. Four types of inverters (mercury and safer power, sinergy and su-kam) commonly available in the market were considered. And three performance indices (resistive load test, inductive load test and output waveform) were used to determine the cost effectiveness of one inverter over the other. Results showed that the sinergy power inverter has the best performance. In terms of the battery discharge current, sinergy is 35% (for the resistive) and 61% (for inductive test) more efficient compared to mercury at an output load of 1 kw.

Keywords: Power Inverter PI, Motor Generator MG, Uninterrupted Power Supply UPS, Sealed Maintenance Free SMF, Constant Current Constant voltage CCCV, fuzzy logic control FLC

INTRODUCTION

Electric power interruptions are common, especially after storms, prompting the search for reliable and economical backup power sources. This study, titled *Investigation of the Performance Index of 3.5KVA/48V Inverter*, aims to address these interruptions by evaluating the efficiency and reliability of various inverters. An inverter is a device that converts direct current (DC) to alternating current (AC), powering household appliances when the grid is down. It is crucial for areas with unstable power supply, such as Nigeria, where the lack of constant electricity can hinder business operations (Theraja, 1997; Ekwueme et al., 2025).

The evolution of inverters has shifted from early mechanical systems like motor generators to modern solid-state inverters that offer lower harmonic distortion and more efficient switching. Historically, inverters have been essential in applications like uninterruptible power supplies (UPS), where they provide AC power during outages (Theraja, 1997; Emegha et al., 2025). The study also explores various types of batteries used in conjunction with inverters, including maintenance-free and tubular batteries, each offering different advantages in terms of efficiency and lifespan (Bogart, 1986).

This investigation examines four inverters – Su-Kam, Safer Power, Mercury, and Sinergy – chosen for their high demand and availability. The methodology involved testing these inverters under specific load conditions (1000VA), using a range of materials, tools, and equipment to ensure accurate analysis of performance (Idigo, 2024). Results from these tests aim to identify the most efficient and reliable inverter, which is critical for businesses and households facing frequent power interruptions.

METHOD

The setup for the experiment included using a set of 200W incandescent light bulbs as resistive loads to simulate real-world power consumption. Each inverter was connected to a battery system that provided the DC power necessary for the inverter to convert to AC. The testing was divided into two main parts: resistive load tests and inductive load tests. For the resistive

load test, the incandescent light bulbs were used to draw a constant load from each inverter, with power levels ranging from 200W to 1000W. The primary parameters recorded during these tests were the battery voltage (VBAT), battery current (IBAT), output voltage (VAC), load current (IL), and the corresponding power in watts. The goal was to observe how the inverter's output changed as the load increased. For each load level, data was collected, and the inverter's response in terms of current and voltage was measured.

Inductive load testing involved appliances such as a ceiling fan (70W) and a refrigerator (130W), which were connected to the inverter. Inductive loads present a different challenge because they cause a phase shift between the voltage and current, which can affect inverter performance. Similar parameters—battery voltage, output voltage, battery current, and load current were recorded for inductive loads as well. The results were analyzed by comparing how each inverter responded to the changes in load.

Table 1: Load, Power and Inverter quantity

LOAD	POWER	QUANTITY
Bulbs	200wat	4
Bulbs	100wat	2
Laptop	65wat	2
Standing fan	70wat	2
Ceiling fan	70wat	1
Deep freezer	140wat	1
Refrigerator	140wat	1

RESULTS AND DISCUSSION

Hasil Inverter resistive load test result from table 4.2 show Su-kam inverter result. a set of 200watt incandescent light bulb were used for the resistance load test for the four inverters.

Table 2: Result from Su-kam Inverter

Battery Voltage		Battery Current (Amp)	Output Voltage		Output Current (Amp)	Load
(VOLT)	BATTERY LOAD	(VOLT)	LOAD			
54.5	54.1	3.9 AMP	219.5	219.3	0.98	200watt
54.3	53.5	5.4 AMP	219.5	219.1	1.8	400watt
54.0	52.1	8.6 AMP	219.5	218.5	2.7	600watt
54.5	49.5	11.4 AMP	219.5	217	3.7	800watt
54.2	48.1	13.7 AMP	219.5	214	4.6	1000watt
VBAT	V _{L(DC)}	IBAT	V _{AC}	V _{L(AC)}	I _{L(AMP)}	LAOD WATT



Figure 1: Su-kam Battery Setup

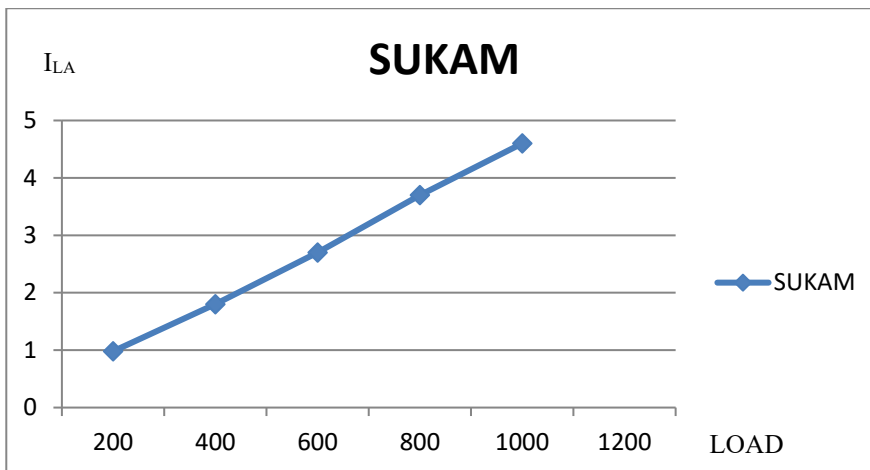


Figure 2: Inverter versus Load

From **Figure 2**, it is seen that the load characteristics is linear. That is an increase in the load current is directly proportional to increase in load (watt).

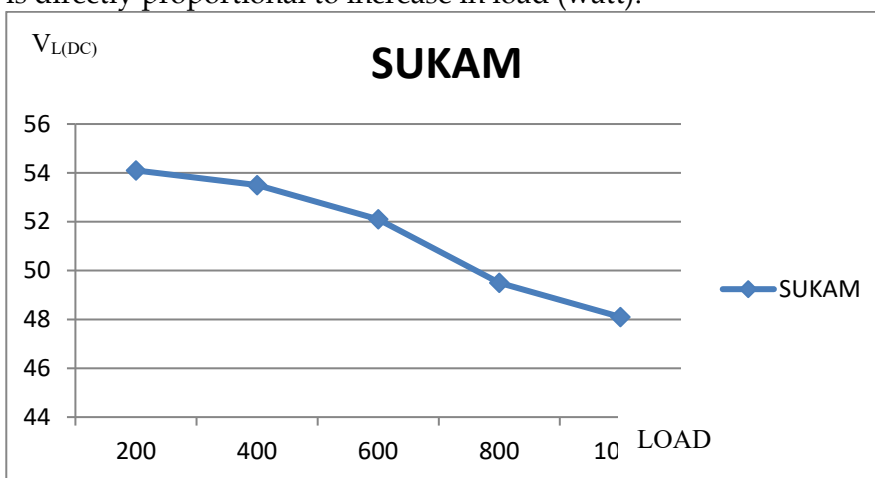


Figure 3: Power versus Load

It is observed from **figure 3**, the increase in load (WATT) result to a decrease in load voltage and the drop or decrease become obvious from 600 WATT-1000 WATT.

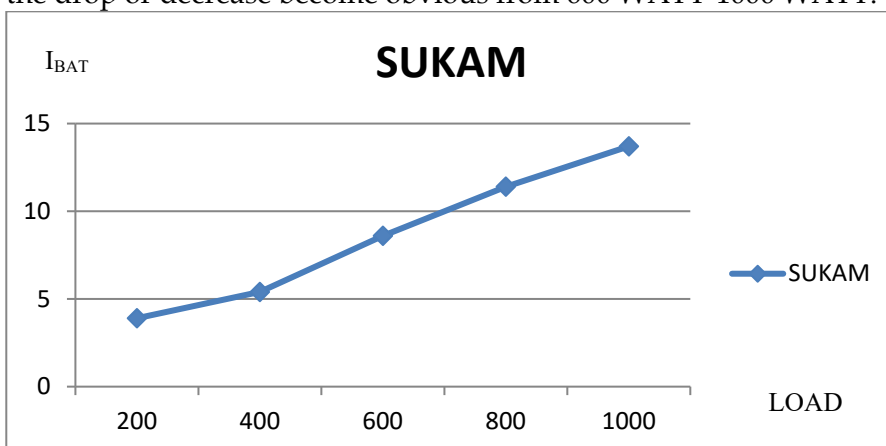


Figure 4: Increase in load result

In **figure 4**, it was observe that the increase in load result to an increase in battery discharging current in SU-KAM inverter. The inductive load used for this test is 2ORL Ceiling fan70WATT 1 refrigerator (130WATT), 50h_e rating each. The test result shown in **table 3** and it was used for all (four) inverter.

Table 3: Variables

VBAT	VL (DC)	IBAT	VAC	VL (AC)	IL (AMP)	LOAD (WATT)
55.2	49.9	4.4	219.5	219.1	1.0	200 watt

55.2	48.4	7.6	219.5	218.2	1.4	300 watt
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Table 4, It was observed that Su-kam inverter increase in inductive load result to an average increase in batter, discharging current. 300 watt (load) was used base in the availability of load.

4.2 Sinergy Inverter Load Test

Resistive Load Test

Table 4: Variables

VBAT	VL DC	I.BAT	V _(AC)	V _{L(AC)}	IL (A)	LOAD
54.3	54.02	2.5	222	221.5	0.98	200watt
53.0	51.8	4.8	222	221.0	1.8	400watt
52.1	50.0	7.4	222	210	2.7	600watt
54.5	49.0	10.0	222	218	3.5	800watt
54.0	48.5	12.2	222	218	4.6	1000

It was observed from the table 5 above, that sinergy inverter has low battery discharging current than SUKAN

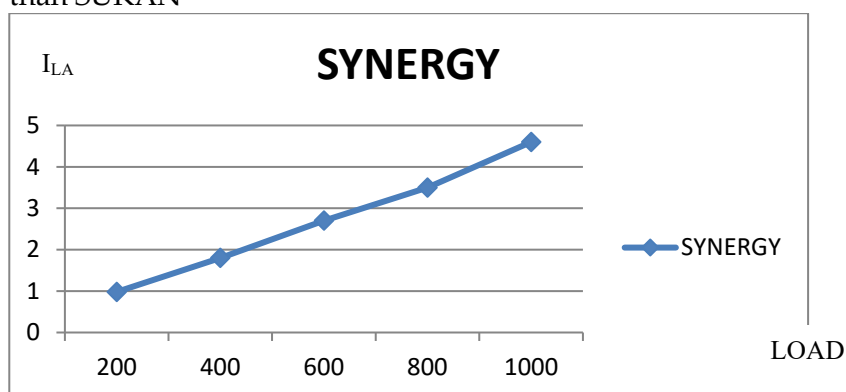


Figure 5: Load characteristic

Figure 5, the load characteristic is linear. That is increase in load current is directly proportional to increase in load (watt). The confirm that the (SINERGY inverter) load purely resistance.

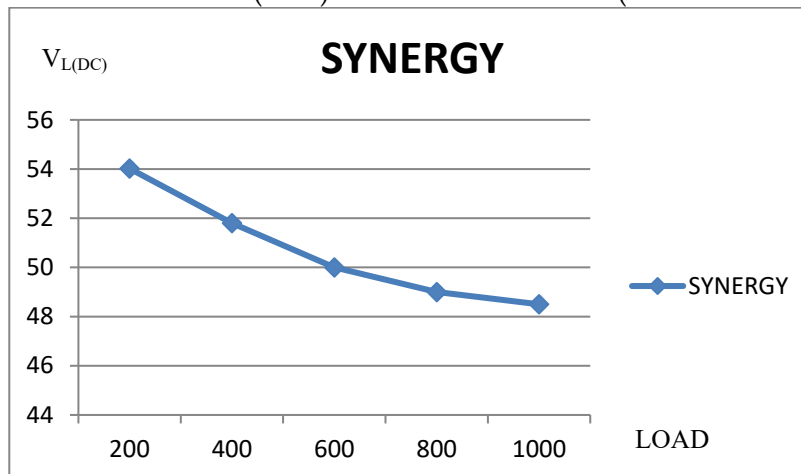


Figure 6: Inverter versus Load

Figure 6, It was observed that increase in load lead to decrease in battery VOLT and it was obvious between 200WATT and 400WATT

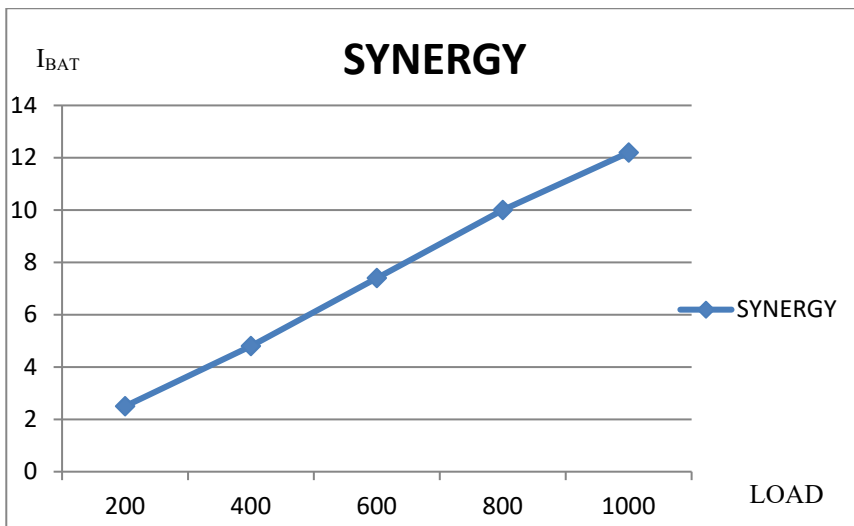


Fig 7: Synergy

Fig 5, it was observe that, increase in load result to linear increase in discharging current.

Table 5: Inductive Load

VBAT	V _{L(DC)}	V _(AC)	V _{L(AC)}	I _{L(AMP)}	LOAD	I _{L(DC)}
54.3	54.1	222	2221.5	1.2	200	2.5
52.8	51.5	222	220	1.2	300	3.3

In table5, It was observed, that sinergy inverter have little effect on inductive load because the voltage drop was little and AC voltage was also very small and SINERGY out wave form.

Table 6: Safer-Power Resistive Load Test

VBAT	V _{L(DC)}	I	V _(AC)	V _{L(AC)}	I _{L(A)}	LOAD
55.2	55.1	2.5	218.5	218.0	0.98	200
54.8	54.7	5.1	218.0	217.5	1.7	400
55.4	53.1	7.6	217.3	216.6	2.9	600
55.2	51.3	10.2	216.0	215.4	3.6	800
55.2	49.9	12.6	214	214.9	4.8	1000

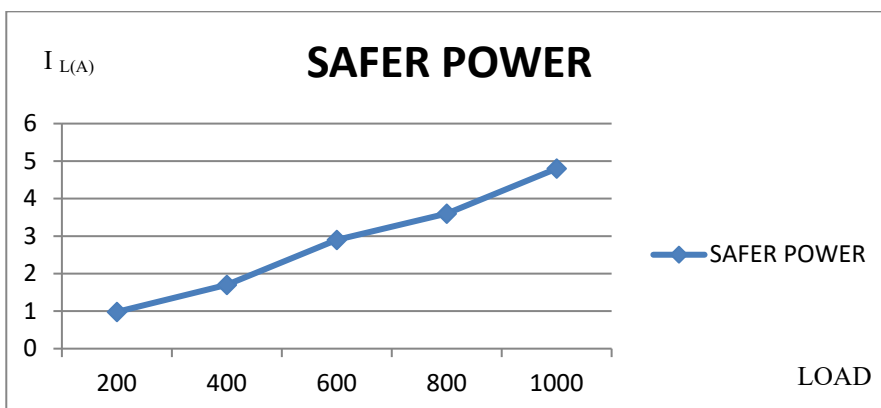


Figure 8: Safer-Power

In figure 8, it was observed that increase in load causes decrease in DC voltage. Sudden drop from 700WATT to 1000WATT

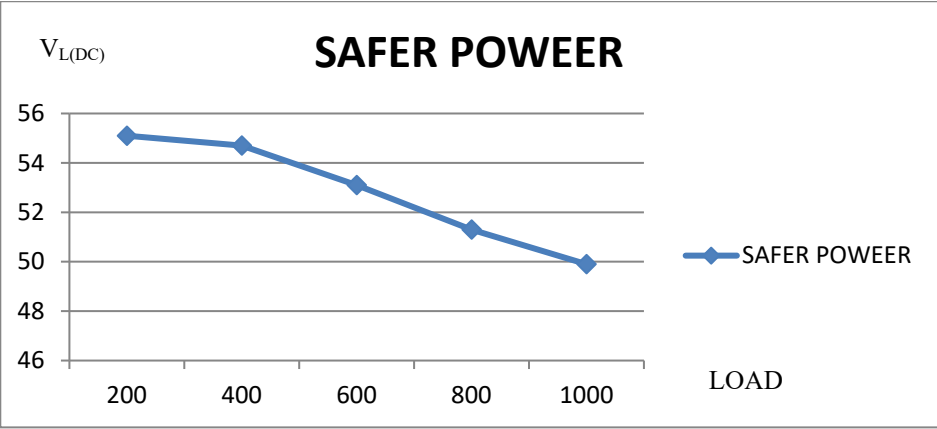
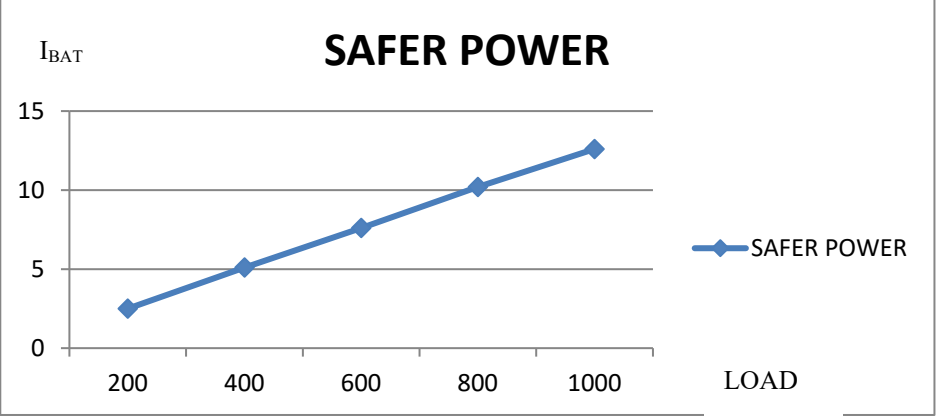


Figure 9: Safer Test



In figure 10, It was seen that increase in load lead to high discharging current.

Table 7: Inductive Load

VBAT	$V_{L(DC)}$	IBAT	V_{AC}	$V_{L(AC)}$	$I_{L(AMP)}$	LAOD WATT
54.2	54.0	2.9	219.0	218.5	1.12	200watt
54.2	51.5	7.3	219.0	217.7	1.8	300watt

Table 8: Mercury Inverter Resistance Load Test

VBAT	V_{DC}	IBAT	V_{AC}	$V_{L(AC)}$	$I_{L(AMP)}$	LAOD WATT
52.5	51.01	4.8	220.4	218.5	0.92	200
52.5	50.00	7.9	220.5	217.9	1.8	4000
52.5	49.05	12.4	220.4	216.8	2.7	600
52.5	48.9	15.7	220.5	214.3	3.6	800
52.5	47.7	18.9	220.5	212.0	4.8	1000

Figure 10: Safer Power

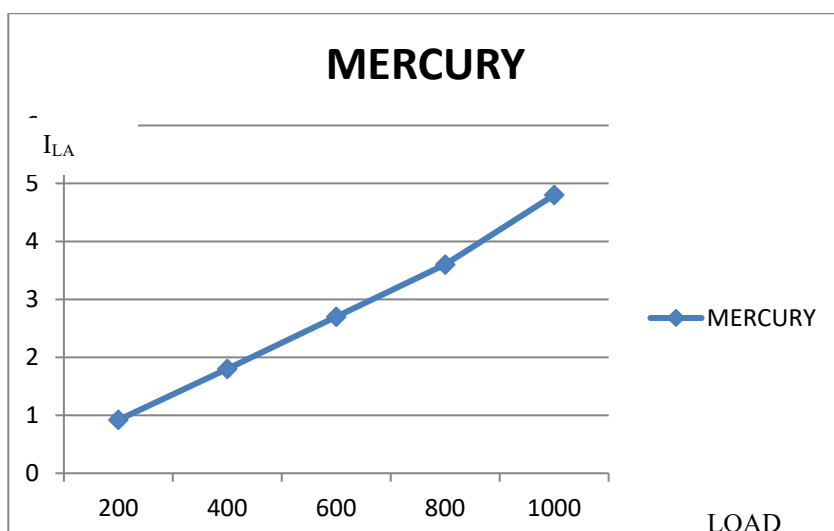


Figure 11: Mercury Inverter

In figure 11, graph show that, an increase in load lead to high increase in load current.

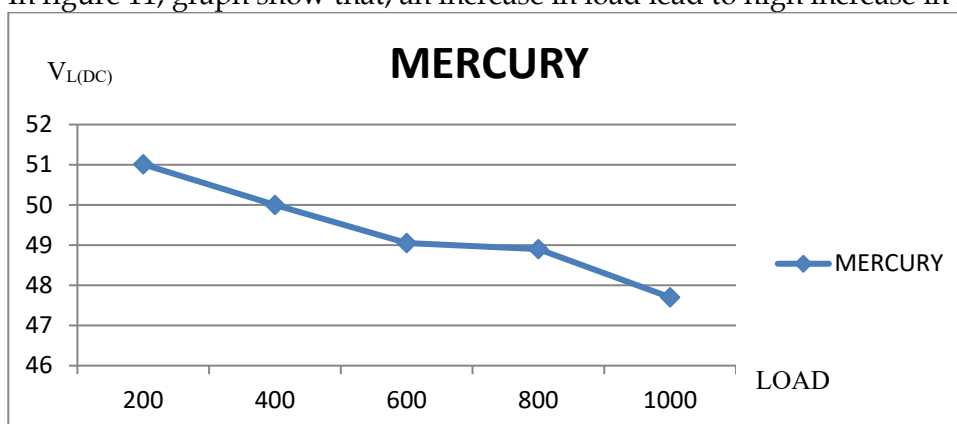


Figure 12: Mercury Inverter

In figure12 graph show that Increase in load, causes a high decrease in DC voltage.

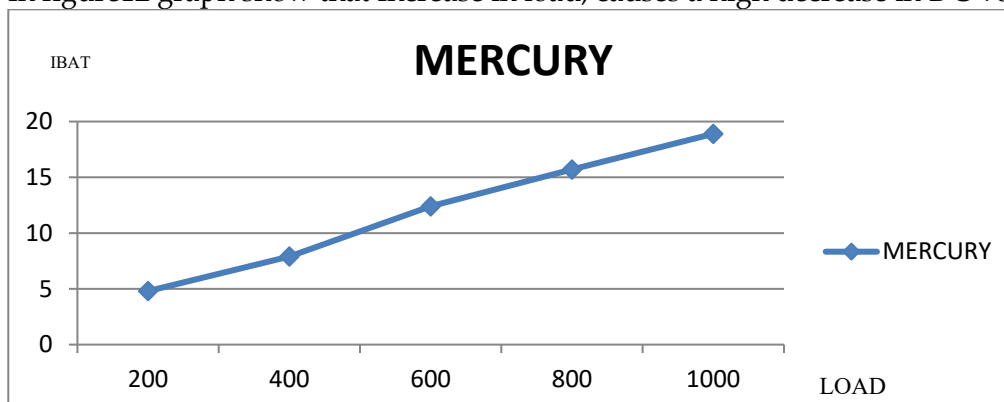


Figure 13: Mercury Inverter

Figure 13, it was seen that mercury inverter does not have a uniform load (watt) and battery discharging current

Table 9: Mercury Inductive Load Test

VBAT	$V_{L(DC)}$	IBAT	V_{AC}	$V_{L(AC)}$	$I_{L(AMP)}$	LAOD WATT
52.1	50.01	11.2	220.5	218	1.2	200watt
52.1	49.05	19.5	220	218	1.9	300watt

It was seen that mercury has effect on induction load.

Batteries are central to the performance of the inverter and a substantial part of the set-up cost goes into batteries. Sinergy battery protection is based on its CCCV (constant current and constant

voltage). Charging system that ensures regulated voltage to protect the batteries plates, extended batteries life and gives optimal delivery. Inverter Overload Protection: Sinergy 3.5KVA/48D have an overload protection mechanism with auto restating system. Rather than harm the system (equipment) any overload which result on a warning, a temporary switch-off and restarting and this continue this action is taken to reduce the load. Short-circuit in the wiring system could damage equipment. Not the sinergy inverter, tough, because it has inbuilt short circuit protection to safe guard itself.

Table 10: Performance of Selected power inverter used as case study.

DISCHARGING CURRENT (VBAT)				OUTPUT IN VOLTAGE				BATTERY VOLTAGE			
Su-kam	Sinergy	Mercury	Safer power	Su-kam	Sinergy	Mercury	Safer power	Su-kam	Sinergy	Mercury	Safer power
3.9	2.5	4.8	2.5	219.3	221.5	218.5	218.0	54.1	54.02	51.0	55.1
4.5	4.8	7.9	5.1	219.1	221.0	217.9	217.5	53.5	51.8	50.0	54.7
8.6	7.4	12.4	7.6	218.5	210.5	216.8	216.6	52.1	50.0	49.05	53.1
11.4	10.0	15.7	10.2	217.0	218.6	214.3	215.4	49.5	49.0	48.9	51.3
13.7	12.2	19.9	12.6	214.5	218.0	212.0	214.9	48.1	48.5	47.7	49.9

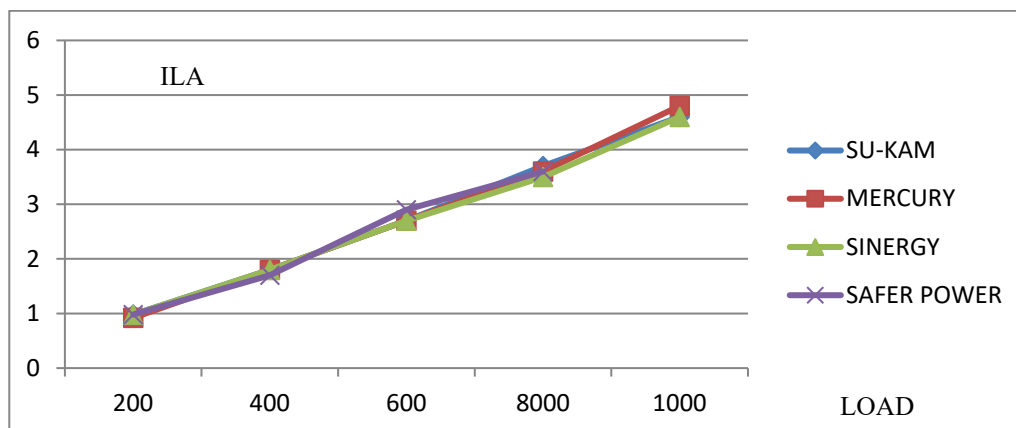


Fig 14: Four selected inverter used and load discharging current

Fig 14, result show that the four selected inverter used have almost the same load discharging current.

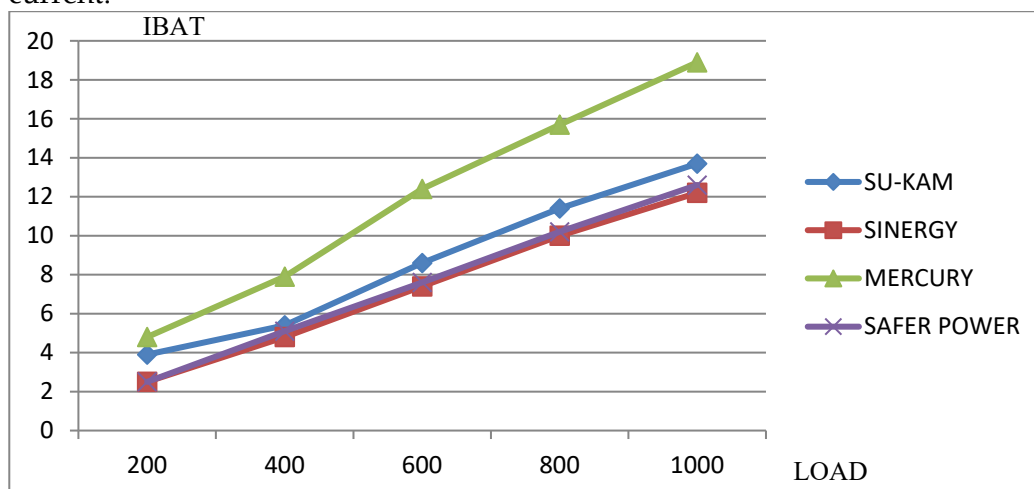


Figure 15: Comparism chart

Figure15, shows the four selected power inverted battery discharging current. It was seen that synergy has linear discharging current compared to others.

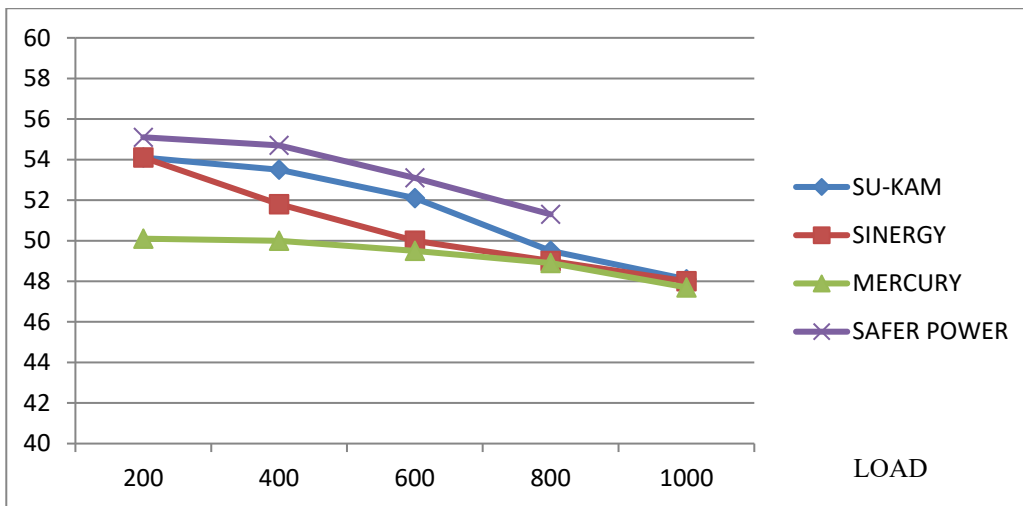


Figure 16: Comparism chart

Figure 16, Result shows their synergy, among the four selected inverters has linear discharging Load voltage.

The above performance result was due to the study and experiment carried out on this selected power inverter.

Table 11, below show the bill of quantity and it gives the relative cost per unit of material used and the total amount of the work.

Table 11: Bill of Engineering Measurement and Evaluation

s/n	item	Unit price	Quantities	amount
1	Four inverter and their battery	80,000	4	N320,000
2	Ac Cables 6mm	7000	1coil	N7000
3	Dc cables/lock 6mm	3000	1coil	N3000
4	Circuit breaker 200Ah	1500	2	N3000
5	Transportation/accommodation	30000	-----	N30000
6	Total			N363,000

CONCLUSION

Based on the experiment carried out on four selected power inverter as case study, It was noted that, Su-kam inverter have high DC Discharge current and also have low short-circuit over voltage protection that can easily damage the systems. Also mercury inverter was seen among the four selected power inverter used as the lowest of all, it has high delay in switching time, high hum noise. For safer power inverter it was recorded that, it was good and far better than mercury and Su-kam, but it has a high voltage drop and it charging current was not constant (no good charging circuit) which means that it can damage it battery easily. Finally, from the study it was seen that synergy inverter emerge as the best among the four selected power inverter use as case study, despite the fact that it has low publicity in market. Results showed that the Sinergy Power Inverter has the best performance. In terms of the battery discharge current, Sinergy is 35% (for the resistive) and 61% (for inductive test) more efficient compared to Mercury at an output load of 1 kW.

This work and experiment show, that most of the four power inverter use was 95% pure Sine Waves. The following recommendation is based on the experiment and test carried out during implementation of the work.

1. The result show that SINERGY has one of the best among other inverter in market, especially when it is been install wit it battery.
2. In other to enhance the life span of the inverter, it is recommended to install a load not more than the average power rating on the inverter.
3. It is recommended that inverter should be purchase directly from a registered dealers or company t avoid rebranded inverter.

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