EFFECT OF LOAD VARIATION ON INVERTER

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ABSTRACT

The effect of load variation on 1.4kVA, 24/220volts, 50Hz, single phase inverter is presented in this work. The inverter is fed from a 120A-H, 24volts battery to produce a 220volts, 50 Hz to power alternating current loads. The no-load voltage was recorded to be 24volts. Eight, 200watts filament bulbs were used as loads in this experiment. The load was varied in step increment of 200watts by bulb addition. As the load increases, the load current and voltage and terminal voltage of the battery were recorded. The plot of the load versus the terminal voltage of the battery revealed step differential and that a linear relationship exist between the current and the applied load. The higher the load, the more the current drawn, hence the extent of continuity of supply depends on the ampere-hour rating of the battery and the amount of current drawn by the load. The results will assist individuals using stand alone inverter based power converter and electrical power systems operators in a co-generation configuration involving inverters.

KEYWORDS: Battery, Ampere-Hour, Resistive load, Current, Terminal voltage

INTRODUCTION

The most prominent and convenient way of storing large quantity of electrical energy for later usage is the batteries. The electrical energy which is unipolar form (direct current) is used in charging the batteries thereby storing electrical charges, which will flow as current when an external circuit is connected to the terminals of the battery. The quantity of the electrical energy stored depends on the Ampere-Hour rating capacity of the battery (Martin,1979). The energy stored in the battery can be used directly to power dc load, depending on the voltage requirement and can also be converted to alternating current to power ac loads through an inverter Evbogbai, Ekeh, Akhadelor and Ejodamen; 2004). Solar cells are major sources of d.c power to charge the batteries or power the inverters directly (Chihchinag and Chihming,1998; Evbogbai and Nsiah,2008; Evbogbai,2010). Other sources are fuel cells and the output of a rectifier.

Inverters convert d.c power to a.c power at desired output voltage and frequency (RETScreen International, 2004). The a.c output voltage could be fixed at a fixed or variable frequency. This conversion can be achieved either by controlled turn-on and turn-off devices such as bipolar junction transistors, metal oxide semiconductor field effect transistors for low and medium power, while forced commutated thyristors are used for high power applications. The important industrial applications of inverters include variable speed a.c. motor drives, induction heating; aircraft power supplies, uninterruptible power supplies and high voltage d.c. transmission link. The various types of inverter circuits are available in the literatures (Singh and Khanchandani, 2003).

The effect of varying load on the terminals voltage of the inverter and the batteries is examined in this work. A black box model approach is adopted for the inverter in a two port network arrangement (Edminister and Nahvi; 2003). The work is imperative because it allows the user to determine the current drawn under different load conditions and the extent to which the battery will maintain continuity of supply. The findings will also assist individuals, corporate bodies and power systems operators in selecting inverters and battery banks to meet their load requirement for the time of usage.

MATERIALS

The materials used in this experiment are

1. 1.4kVA, 24/220Volts, 50Hz, single phase, pure sine wave mo power inverter(Users manual, 2010).
2. 2 x 12Volts, 120AH
3. 8 x 200Watts filament lamps
4. 2 Digital Multimeter (Model DT9205A)
5. Clip on Ammeter
6. Connecting leads.

EXPERIMENTAL PROCEDURES

The two 12Volts 120AH batteries are connected in series to produce 24Volts, 120AH which fed the input terminals of the inverter taking polarity into consideration. The variable loads(8 x 200Watts) was connected to the output terminals of the inverter via the ammeter to measure the load current, while the voltmeter is connected across the load to determine the terminal voltage of the inverter.

At the commencement of the experiment the terminal voltage of the battery bank was measured and recorded. The no-load voltage at the output terminals of the inverter was also measured and recorded. The load was varied in steps of 200Watts by addition of one 200Watts filament bulb, the ammeter and voltmeter readings were recorded. The experimental data was used to plot battery voltage-Load, load-current and load-voltage curves.

RESULTS AND DISCUSSION

The capacity of the battery = 120AH 1

The output power P, of the inverter is

$$P = VI\cos\phi \qquad 2$$

Where V is the output voltage in volts, I is the current in Ampere and $\cos\phi$ is the power Factor. For 100% efficiency, the

Output power = Input power. 3

For purely resistive load, power factor is unity, hence the current I, drawn from the battery by the inverter is

$$I = \frac{P}{V} \qquad 4$$

$$I = \frac{1400}{24} = 58.33A$$

Therefore from equation 1, the time take for the battery to supply the full load is

$$t = \frac{120}{58.33} = 2.06 hours$$

The Load-Battery terminal voltage characteristics curve is shown in Figure 1. From this Figure it is obvious that as the load increases, the terminal voltage of the battery decreases. It is also evident in the Figure that this relationship is not linear, but step differential. The no-load voltage of the battery was 24volts, but at a load of 200watts, the current drawn from the battery was 0.71A and the terminal voltage of the battery was 23Volts. A steep increase in load of 200watts to 800watts revealed a linear increase in load current up to 2.75A and a battery terminal voltage of 22volts. Increase in load beyond this point to 1.4kW (full load) shows a further increase in the load current to4.74Ampere and terminal of the battery remains at 22Volts.A further increase in load to 1.6kW shows that the current drawn was 5.48Ampere and the terminal voltage remains at this point. Beyond 1.4kW, an over load tripping circuits operate within some seconds after about 8 beeps to protect the systems against overload.

Figure 2 shows that the current drawn is proportional to the load. As the current drawn increases, the terminal voltage of the battery drops as shown in Figure 3. A critical analysis shows that Figures 2 and 3 are identical. The relationship between the load – voltage and load- current characteristics are analogous as shown in Figures 4 and 5, hence, the current and voltage are in phase. This implies that the load is purely resistive. Figure 6 shows the Volts-Ampere of the inverter and wattage ratings of the load. This further confirms that the load is purely resistive and a linear relationship exists between the load and the load current.

CONCLUSION

Inverters will continue to play pivotal role in electric power system network since dc power must be converted to ac for alternating current loads.The power converted by inverters depends on the load and the extent depends on the ampere-hour capacity of the battery. It should however be noted that highly inductive loads such as electric motors and transformers, higher capacity inverter are required for smooth operations.

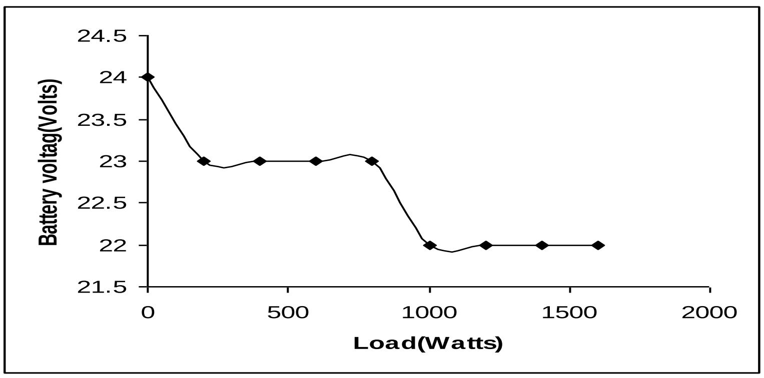

Figure 1 Effect of load on the terminal voltage of the battery.

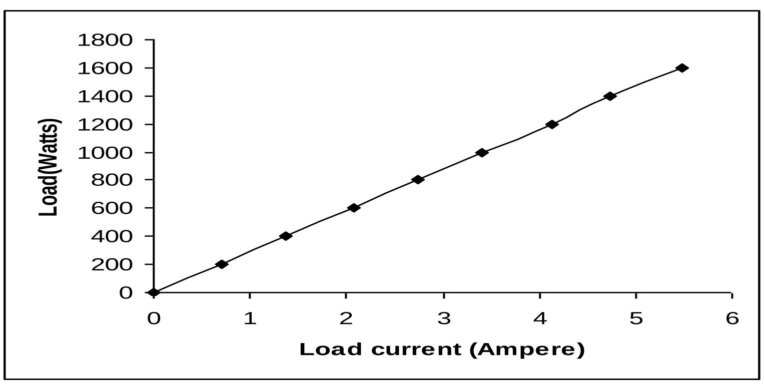

Figure 2 Load-current characteristics of 1.4kW, 220V, 50Hz inverter.

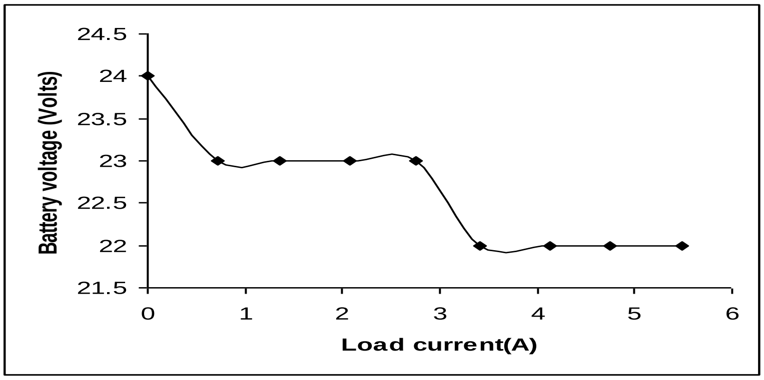

Figure3 Effect of load current on the terminal voltage of the battery.

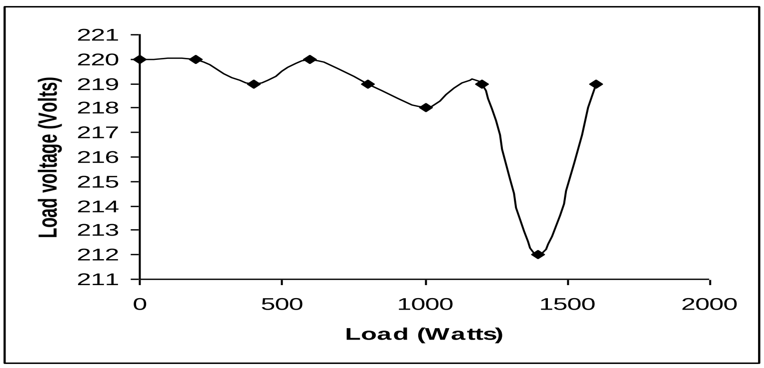

Figure 4 Load-voltage characteristics.

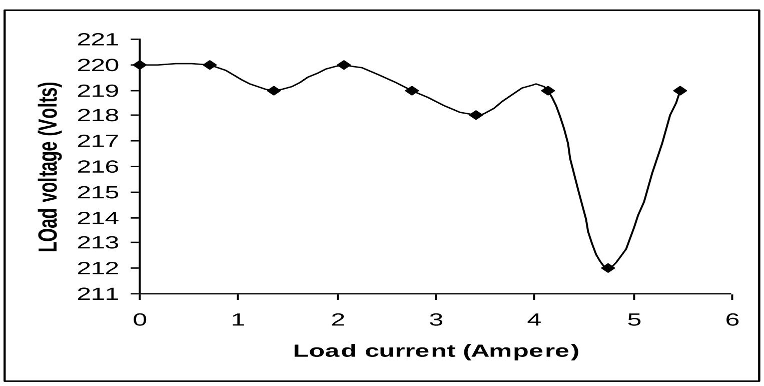

Figure 5 Current-voltage data for the loads.

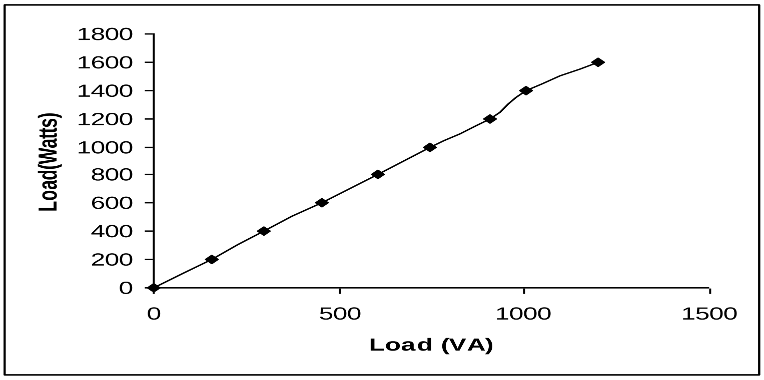

Figure 6 Wattage versus Volt-Ampere characteristics.

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