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ENERGY LOSSES IN UPS SYSTEMS

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ABSTRACT

This study takes upon the question about how much energy does a typical UPS System (Uninterrupted Power Supply) wastes during a complete charge discharge cycle.

Keywords: UPS System, Energy

INTRODUCTION

The aim of this study was to estimate the losses on a larger scale due to use of Power Inverters to store energy as backup power when the mains supplied by the power supplier fail. It is a common practice in much of the power starved India for the households and offices to depend on power invertors to supply uninterrupted power supply in case of a power failure.

SETUP OF A TYPICAL INVERTOR

A power inverter setup available in market consists of a module that amongst various functions, performs conversion of D.C power stored in lead storage batteries to smooth sinusoidal A.C output power. A part of the module is devoted to charging a discharged set of batteries using the A.C mains when it is available. Various added features include a front panel which shows charging status, mains ON/OFF, battery power level indicator etc. Over the years industrial R&D has led to increasingly capable setups with improved features like UPS type performance, faster battery charging, bigger batteries etc. However one has to stand near a inverter to understand the tremendous heat released around it.

AIM

The aim of this experimental study is to estimate the amount of energy wasted during one complete cycle of charging and discharging of a typical battery.

EXPERIMENTAL SETUP

The idea is to measure the amount of energy used to fully charge a deeply discharged battery and then measure the amount of energy delivered while it gets completely discharged. Most of the modern inverter set ups provide for a sudden cut-off when the battery discharges thereby enabling one to estimate practically recoverable energy from a typical set up.

Fig 1. Uninterrupted Power Supply (UPS)

RESOURCES USED

1. The inverter in this study used was the **Luminous LB (600VA rating) Sine wave UPS**.
2. The battery used for the study was Luminous **Inver last Tall Tubular battery (LT 500**).
3. A desert cooler was used as a load, which comprised of a fan and a small water pump. (The load was continuously operated from the inverter power as its battery discharged continuously.)

PROCEDURE USED

1. The battery was first allowed to discharge normally by operating it on various home appliances on a normal load after cutting it off the mains.

2. The battery was then taken to a professional charging setup where it was taken out of deep discharge by continuously charging it. The state of charge of the battery was indicated by the panel on the Inverter and the Battery was fully charged as per the indicator.

3. From the measured values the energy stored in the battery was estimated as follows:

   a. Energy Stored in the Battery = Capacity of the battery x Mean voltage across the battery

   b. While charging the battery the voltage across the battery was sampled using a D.C voltmeter (least count = 0.1V)

4. During the observation it was found that the voltage increased from an initial value of **12.5 V to 12.8V** towards the last portion of the charge.

   a. The capacity of the battery used was **150A**h as per the specification sheet of the manufacturer.

   b. Assuming that the charging voltage is **12.5V** for most conservative estimate of the energy stored.

5. The amount of energy stored therefore is nearly = (150Ah) x (12.5V) = **1875 watt hours**.

6. The battery was then allowed to discharge by operating a desert cooler which uses a water pump and a fan.

   a. The connecting wires used in running the desert cooler were minimal.

   b. The current through the connecting wire was measured using an AC Ammeter (Least Count .01A).

7. The ammeter indicated nearly a constant current of around **0.54A**during the discharge.

   a. The time till the inverter setup indicated a completely charged battery was measured using a clock which measures time correct to within ±1s.

8. This time interval was measured to be around **9h and 30min**.

9. The total energy delivered by the battery = Current flowing in the connecting wire x time duration of discharge x constant voltage delivered by the inverter)

10. Thus, Energy delivered = (.54A) x (220V) x (9.5h) = **1128.6 watt hours.**

11. This shows that only 1128.6 watt hours of energy was recovered out of the total 1875 watt hours,
Thus 112.86/1875 x 100 = 60.19 %

12. The data indicates that for every cycle of charging and discharging the energy wasted may be as high as around 40%

RESULT

Simple projections using the population of Karnal town households can be made.

i. Karnal city as per the latest census has a population of nearly 2,86,974. Being a urban milieu if we assume one inverter set per 10 individuals we get nearly 2,8700 such inverter sets.

ii. Assuming a one discharge cycle during a typical summer day, the amount of energy wasted per inverter household amounts to 2.14 x 107 Watt Hour of energy per day, and 2 x 109 Watt hour over the entire summer season. Which is a huge amount!

CONCLUSION

These statistics reveal that an extremely large amount of energy is wasted in an energy starved country like India. Efforts may be made by the planning agency to minimize the losses. As compared to energy shortfall on peak demand days, the wasted amount is really quite a large fraction that energy. The society would be better off without these devices as that could really mean much shorter and more tolerable power cuts for all the population.

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