THE DESIGN OF A 10 KVA CAPACITY INVERTER TO POWER MACHINE TOOLS IN THE MECHANICAL ENGINEERING WORKSHOP OF FEDERAL POLYTECHNIC, EKOWE

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ABSTRACT
Most equipment used in the industries and workshops require constant power supply to keep them running for optimal production and having them shut down abruptly is a bad practice, especially when dealing sensitive machine tools with programmable control commands. Advanced countries like USA, Japan, England, Germany, e.t.c. have been able to use different mechanical conversion techniques to create stable and constant power supply in their industries. The last decade has witnessed a growing population in the number of groups, persons and states demanding a more collective approach to innovative and alternative power generation, considering the renewable energy sources as an integral part of the world's energy mix.

INTRODUCTION
Nigeria as a country has witnessed low power supply for the past four decades. Poor and irregular supply of electricity is persistent in many parts of the country. Although, the power generating companies (GENCOS) and power distributing companies (DISCOS) are always presenting the end users with justifiable reasons for the outages, it is the thinking of many that they not in a firm grip of the situation, especially with the situation worsening in many places[The pointer,2016]. The problem of power failure may lower down production capacity of industries and reduce the efficiency of students' work practice in the polytechnic workshops. Due to the frequent power outage in the country and considering the fact that Federal Polytechnic Ekowe runs off grid, there is the need to build an inverter backup system to provide uninterrupted power supply to some very essential loads during down times of the generators.

An inverter is an electronic device or circuitry that changes direct current to alternating current. The input voltage, output voltage, frequency, and overall power handling depend on the design of the specific device or circuitry [Barnes and Malcolm, 2003].

There are three broad classifications of inverters: stand-alone inverters, grid-tie inverters and battery backup inverters. This study focuses only on the battery backup inverters. They are used as storage point to conserve energy during uptimes of the generators or grid and automatically change over to the stored energy during power cuts.

In the mechanical engineering workshops, most machine tools are been powered by electricity. Some of such machine tools are: milling machine, grinding machine, drilling machine, lathe, shaping machine, broaching machine and e.t.c. These are precision equipment used by students to learn and enhance their practical manufacturing and fabrication skills.

During training or rehearsal session, there may be power failure causing inconclusive lessons and as a result distort learning activities. There is therefore the need to build an inverter backup system that will continuously supply electricity in the workshop when there is power outbreak.

PURPOSES OF THE STUDY

The purpose of the study is to;

1. Outline and identify the various essential loads (machine tools) and their corresponding power consumption in the mechanical engineering workshop of the Federal Polytechnic, Ekowe.
2. Determine the maximum continuous load [MCL] of the workshop.
3. Ascertain the minimum capacity of the inverter capable of handling the minimum continuous load of the workshop.

SIGNIFICANCE OF THE STUDY

This study will be of benefit to both students and school management.
For students, the knowledge from the findings of the study will enable them determine the minimum continuous load which is a very fundamental feature in deciding the capacity of the inverter. Students will also have an easy introduction into solar electric power system as the inverter backup system is about 50% of a complete solar electric power system.
For school management, the knowledge from the finding of the study will enable them see the need to install inverter backup to enable students carry out practical work when there is power failure.

RESEARCH QUESTIONS

The following research question guided the study;

1. What are the most essential machine tools available in mechanical engineering workshop?
2. What is the minimum continuous load [MCL] of the essential machine tools?
3. What is the size of the inverter required to power the minimum continuous load of the machine tools?

SCOPE OF THE STUDY

The study is limited the designing of 10kva inverter battery system to power vertical milling machine [KY20V],vertical milling machine [KY20LV],SIEG 7X14MINI LATHE and other electrical loads.

METHODS

DESIGN OF THE STUDY

The researcher adopted fabrication and construction technique to assemble a 10KVA capacity inverter. First, the individual power requirement of each machine tool is determined by checking their individual power ratings.

Table1 shows the various electric load distributions of the essential machine tools in the workshop.

Table1
Electric Load Distribution of Machine Tools

S/NO	LOAD	QUANTITY	POWER RATING (WATT)	TOTAL POWER RATING (WATT)
1	VERTICAL MILLING MCHINE KY20V	2	600	1,200
2	VERTICAL MILLING MCHINE KY20LV	3	600	1,800
3	SIEG C3 7x14 MINI LATHE	4	350	1,400
4	GHOST LOADS	600		
	MINIMUM CONTINOUS LOAD (WATTS)	**5,000**		

INVERTER SIZING

In the design of an inverter backup electric system to power inductive loads, **Surge Factor** (**SF**), Crest Factor (CF) and Power Factor among other variables must be put into consideration. For the purpose of this research, the Minimum Continuous Load (**MCL**) of 5.0KW is doubled to account for all the variables including inverter efficiency.

The Minimum Continuous Load (**MCL**) expressed in kilowatts $= 5{,}000/1000 = 5.0\text{KW}$

The Minimum Required Capacity (**MRC**) $= \text{MCL} * 2 = 5.0 * 2 = 10.0\text{KW}$.

To determine the size of the inverter, the **Minimum Continuous Load** and the **Minimum Required Capacity** are critical since they represent the minimum running and start up capacities of the inverter. The inverter capacity must be greater than or equal to the **Minimum Required Capacity**.

This calculated **Minimum Required Capacity** guide the selection process in choosing from the available capacities in the Nigerian market.

Table2
Some Available Inverters in the Market

S/NO	MAKE	CAPACITIES		
1	LUMINOUS	7.5KVA/1200VDC/3PHASE	10KVA/180VDC/3PHASE	15KVA/360VDC/3PHASE
2	GENUS	7.5KVA/1200VDC/3PHASE	10KVA/180VDC/3PHASE	15KVA/360VDC/3PHASE

Finally, the inverter size is 10KVA /180VDC/3 PHASE of any of the available brands.

FINDINGS

Based on the findings from research question one, it was revealed that vertical milling machine[KY20V],vertical milling machine[KY20L V], and SIEGC3 7x14 MINI LATHE were considered most essential loads.

From research question two, it was revealed that the minimum continuous load [MCL] was calculated to be 5.0KW.

Finally, the inverter capacity was determined with reference to the calculated **Minimum Required Capacity** and selected from the available capacities in the Nigerian market.

CONCLUSION AND RECOMMENDATION

In all, 10KVA inverter was used to power nine machine tools and other ghost load. The minimum continuous load [MCL] of 5 KW was doubled to account for inverter efficiency and other variables. From table 2, Luminous and Genus both have capacities of 10KVA and 15KVA respectively which are readily available in the Nigerian market. Finally, it was recommended that school management of Federal Polytechnic, Ekowe should install an inverter system in the Mechanical Engineering Workshop to power machine tools in the advent of power failure.

REFERENCES

1. Barn and Malcolm,[2003].Practical Variable Speed Drives and Power Electronics Oxford: Newnes.97
2. The Pointer,[2016] *Frequent Power Outage*.WWW.thepointernewsonline.com