ENERGY MANAGEMENT IN AGRICULTURAL IMPLEMENTS AND TRACTOR TRAILER INDUSTRY

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Abstract: The growing demand for the agricultural implements in the recent past has attracted many entrepreneurs to up SMEs for the fabrication of the required items. Tractor trailer and other agricultural implements fabrication industry is one of the prominent SME. Indian population and the per capita electrical energy consumption are on the rise. This has created lot of pressure on energy demand and hence, energy generation. Energy generation requires energy sources and capacity addition. Due to limitations, India to cater to the increasing demand has resorted to purchasing electrical energy from other countries. This has additional burden on the BoP. One of the approaches to reduce this burden is to identify the sources of energy loss and minimise. In energy management literature this is addressed as energy auditing. In the present study, energy auditing has been conducted in seven industries pertaining to the fabrication of agricultural implements and tractor trailers, located in Haveri, district head quarter in Karnataka State. The survey has been made over a period of 4 months. The detailed data acquisition, analysis and the focused energy conservation opportunities have revealed that the energy savings up to 30% to 40% can be achieved.

Keywords: 'Balance of Payments (BOP), Energy consumption SMEs, energy audit, possible energy saving, identifies the waste

1. INTRODUCTION

Agriculture plays a major role in Indian economy and provides food and raw material for living things. India has second largest population country in the world with a population of 1,339.18 million in 1 July 2017 and an annual growth rate is about 1.3 percent. More than two third of rural population and 56 percent of the people depend on agriculture as their (Mahindra Dev, 2012; Gopalakrishnan, and Thorat, 2015; Gajendra Singh, 2015). Total land area of the India is 297 million hectares in which 142 million hectares are used as agriculture land. It contributes 14 percent gross domestic product (GDP) during 2016-17 at current prices from the level of 56 percent in 1950. The service and industrial sector in year 2016-17 contribution of 53.66 per cent and 29.02 per cent of the nation economy. The challenge faced by the agricultural sector is to meet the food supply for ever growing population in the India (Gajendra Singh, 2015).

Since 1947, increase in production of food grain and raw material excides fivefold due to increase in population of the country. This was achieved by introduction of improved agricultural implement, equipment's, machineries and (Mahai, 2013; Gajendra Singh, 2015), increase the use of agricultural implement and machinery leads to increase in agricultural implement and machinery manufacturing industries. Almost all agricultural implements and machinery industries in rural as well as urban are working with traditional technology or energy inefficient technology and belonging in MSME's categories. The inefficient technology or method for manufacturing of agricultural implements machinery leads to pollution. Ministry of environment and forest (MOEF) repots 2012, in its reported that70 percentage of pollution contribution from SME's.

Managing of energy need appropriate indictors and energy auditing. Saygin et al., (2011) said that physical energy indicators and energy efficiency indicators developed by Farla and Blok, 1997 and Phylipsen et al, 1998 were employed in manufacturing sector across the world. Energy benchmarking is useful for understanding energy use patterns, identifying inefficiencies in energy use (Ke et al., 2013). Energy audits focus on technical and economic issues. Energy audits are the direct tools to reduce energy consumption (Su et al., 2013). Energy audit is a practical way to evaluate performance of energy systems. Present study describes the energy consumption pattern of the fabrication industries, energy consumption by the induction motor of the different machines/equipment and its performance in terms of load, efficiency and energy conservation opportunities.

Based on the above facts it is found that, the energy efficiency has been recognized as a primary means to increase the competitiveness of the industrial sectors, and in particular for small and medium-sized enterprises (SMEs), in which energy efficiency measures (EEMs) are scarcely implemented.

2. ENERGY AUDING

Energy audit emphasis on " the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and action plan to reduce energy consumption". In general energy audit is defined as the transformation of energy conservation idea in to reality by adopting new technology or energy efficient measures for economical viable solution. The energy audit was conducted in seven Agricultural implement and tractor trailers units at Haveri district head quarter, Karnataka State, India, to identify energy consumption pattern by the various equipment or machineries. The energy audit was conducted in September and December -2017. The agricultural implement and tractor trailer industries chosen for the present study are involved in the manufacturing of reversible ploughs,

hydraulic ploughs, fixed ploughs, disc ploughs, rotary tillers, cultivators, seed drills, disc harrows disc ridges, tractor trailer, tractor tankers , trolleys, etc. They are also involved in the repair and maintenance work of other implements also during the course of manufacturing/repair the energy is consumed by the various equipment utilised for the fabrication process. The major share is grabbed by arc transformer welding, gas welding or gas cutter, angle/ hand grinder, bench grinder, cut off saw, drilling machine, lathe, power hacksaw, painting set up. Along with these major equipment minor amount of energy is also consumed for industrial lighting and fan system. In the present study an exclusive focus has been made on the energy consumption pattern of the industry and the methods to minimise the same. In view of the aforementioned objective the energy audit has been carried out in three different phases, namely, pre audit phase, audit phase and analyses phase. Based on the analysis made and the arrived conclusions, few recommendations for energy conservation opportunities (ECOs) will be proposed

2.1. Pre audit phase

The preliminary audit involves a walk through analysis of the industries by simple observation and interaction starting with shop floor workers till managers of the industry. This has been carried out to identify the instrument required for energy audit and energy saving opportunities in that industrial sector. Initially, a visual inspection has been performed to get process details and associated energy issues. From the visual inspection and the brainstorming sessions made with people involved in the process, the following inferences were made,

- Idling time more in welding processes
- Ceiling fans operated without regulator
- Almost all industries use incandescent and fluorescent tube lights
- Mild steel scrap was littered in the various section
- Welding cable skinned at many locations leading to arc and loss of power

The preliminary visual inspection has yielded in many loopholes in the power consumption and has shown a wide arena for the power saving opportunities. In view of this and the status of the industry few of the instruments have been utilized to collect the data of energy usage of the industry in the existing status. During this preliminary energy audit (PEA), a detailed data acquisition has been made to collect the data required with the aid of digital multi meter, digital taco meter, tong tester, power factor meter, measuring tape, etc.

The visual inspection has revealed two major aspects; one is the scattered mild steel scrap on the shop floor which will lead to the accidents and the undesired usage of the lights. The other is the skinned welding cables causing short circuits and being a major cause for energy loss. Apart from these the fans used in the industries are operate without any regulators again adding to energy loos. Majority of the energy loss is found to happen in the idle time of the machines. Since the work is concentrated much of the fabricating industries, a very high amount of energy loss is found to occur at welding machine, which is a prominent piece of material in these fabricating industries. These observations have been made in seven industries located in Haveri industrial cluster, operated with varied type of man power and the management, with respect to their educational qualifications and the mindset.

The collected data for all the industries was carefully analyzed in the PEA, with a particular focus on the energy saving opportunities. By and large by pre audit phase the analysed data have resulted in the aforementioned drawbacks. Based on the detailed analysis of the data, condition of the industry, nature of operating, the management policies, etc. the following recommendations have been proposed:

- Keep the shop floor neat and tidy by avoiding the scattered M.S. scrap.
- Fitting electronic regulator for fan or replacing the conventional fan with energy efficient fan
- Replacing fluorescent tube lights with LED fluorescent
- Try to minimise the welding idling time
- As far as possible use short length welding cable and avoid skinned cable or at the least provide proper electric insulation

2.2. Detailed Audit Phase

Apart from the fans, lightings, other supporting elements and appliances, the fabricating industry utilizes few major equipment, which are most essential for the process of fabrication. In this detailed audit phase much attention has been given to the energy consumption and the saving opportunities in such major equipment's. After a round of observation it was found that there is a wide scope for the energy saving in these machines and equipment due to this reason a detailed data acquisition and analysis has been made in this regard. The study has been carried out in all seven industries for duration of four months between September 2017 to December 2017. During this period the data acquisition and performance tests were conducted for each of machines and equipment. The available medias of fabrication in each industry with its power ratings are given table 1.

Table 1 depicts the details of the power ratings of the different machines/equipment utilized during the course of fabrication. From the above it can be seen that the total load of all machines/equipment in each of the industry is much higher than the sanctioned load.

This case may be viewed seriously, only if all the machines/equipment are set in operation simultaneously. Since the study has been made in the fabricating industry, where this extreme case of utility does not persist. Neglecting this, the energy consumption patterns and the performance study on these machines/equipment has been carried out in the present work.

Table: 1 Power ratings of the available equipment/ Machines

Industries		A		B		C		D		E		F		G	
Sl No.	Equipment / Machinery	No's	Capacity	No's	Capacity	No's	Capacity	No's	Capacity	No's	Capacity	No's	Capacity	No's	Capacity
1	Arc Welding M/C	2	15hp Each	2	15hp Each	3	15 HP Each	3	17hp Each	3	15hp Each	2	15hp Each	2	15hp Each
2	Gas Cutter/ Welding	1		1		1		1		1		1		1	
3	Hand Grinder	2	3hp Each	1	3hp	2	3hp Each	2	3hp Each	2	3hp Each	2	3hp Each	1	3hp
4	Heavy Duty Chop Saw	1	3hp	1	3hp	1	3hp Each	1	3 HP	1	3hp			1	3hp
5	Power Hacksaw							1	1 HP						
6	Compressor set up	1	1hp	1	2hp	1	2hp	1	1 HP	1	1.5hp	1	1hp	1	1hp
7	Lathe							1	3 HP						
8	Drilling			2	1hp, 2hp	2	1hp, 2hp	2	1hp Each	2	2hp Each				
9	Total Machine load (HP)	7	40hp	8	41hp	10	59hp	12	67hp	10	59.5hp	6	37hp	6	37hp
10	Total Lighting load (HP)	0.67		1		1.39		1		1.37		0.55		0.41	
11	Total load (HP)	40.67		42		60.39		68		60.87		37.55		37.41	
12	Sanction Load (HP)		15	12		17.5		45		14		5		15	

The power consumption of the typical machines used in the fabrication industries chosen for the present study are show in the table1. During this detailed audit phase the same were physically verified and studied for their full capacities. This energy consumption pattern in the Haveri industrial cluster has been studied for duration of four months between September 2017 to December 2017. In this phase of the study the actual power consumption of the machines/equipment were observed and noted for their useful hours of working. The same data is collected for all seven industries under consideration. The pattern of energy consumption of these machines/equipment has been pictorially represented in the figure 1.

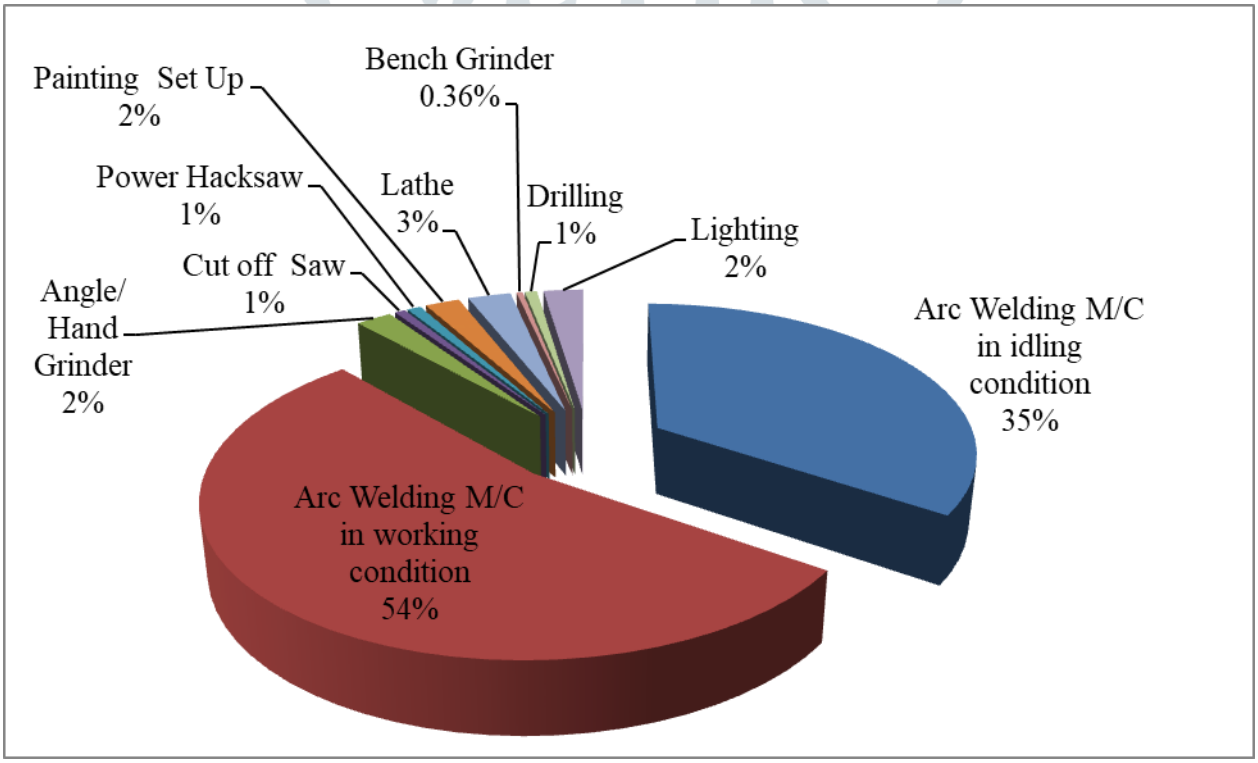

Figure: 1 Energy consumption pattern

Figure 1 depicts energy consumption pattern, by this it can be inferred that the most of the energy in these industries is consumed by the welding machines. Due to this reason much attention has been given to welding machine in this present study.

Performance test on machineries/equipment and appliances

In order to carry out the performance test, each machines/equipment work has been observed carefully during actual working. The efficiency of the each machine/equipment has been calculated using the empirical equation (Berens,1978 and Chirakalwasan, 2007). The load on the machines/equipment motor, its power consumption and the efficiency has been shown in table 2. This table gives the summary of the details of machines/equipment in each industry.

Table: 2 performance test on machineries and appliances

Type of equipment's	Capacity in hp	Load on motor in percentage	Power consumption in kWhr	Efficiency in % age
Power hacksaw	1	50 to 60	0.5 to 1.14	22 to 45
Painting/ compressor setup	1	60 to 70	0.45 to 1.2	36 to 50
	2	60 to 65	1,2 to 1.45	40 to 55
Lathe	3	45 to 65	3 to 3.3	35 to 40
Drilling machine	1	50 to 60	0.6 to 0.71	55 to 60
	2	30 to 40	0.74 to 0.85	30 to 35
Heavy duty chop saw	3	-----	0..88 to 2.32	---
Hand grinders/ Angle grinder	3	----	0.61 to 2.27	---
Pure transformer arc welding	15 to 17	Close circuit	10 to 15	30 to 50
		Open circuit	2.5 to 5	0

For all the machines/equipment, shown in table 2, the performance tests have been carried out in all the industries. The detailed discussion on each of the machine/equipment is made in the successive sections. The consideration of the machine/equipment and the associated industry has been made based on the utility/usage.

Performance test for power hacksaw

Performance test on the power hacksaw was conducted in "D" industry. In this industry the power hacksaw is used for cutting the metal plates and angles to the required dimensions as per the drawing. An observation made during the course of actual working of hacksaw has revealed that the motor is consuming more power rather than it's rated. The machine was consuming 1.5hp, whereas its rated power is 1 hp. After repeated observation and the technical inspections, few reasons for this mismatch have been found, like, the poor maintenance, damaged windings, improper coolant usage, skinned wires leading to short circuits. Also in many cases it was observed that the operator was untrained and unskilled. These aspects prevailing to the practical conditions of the industry D, has led to the very poor efficiency of the power hack saw to the extent of 21.18 % to 30%.

Performance test for lathe

Performance of the lathe machine was conducted in "D" industry, where the usage of that found to be high. Majority of the turning operation and few of the drilling operations were carried out on the lathe in these fabrication industries. The lathe machines used in almost all the industries were found to be out dated. Due to this reason the lathe has many worn out parts, especially the guide ways, motor and other drive systems. Due to the presence of these almost obsolete parts, the machine consumes more power rather than it's rated one. This case found to be more pronounced in D industry, because of the maximum usage of the lathe. From this study it was found that the lathe is using almost 30% to 50% more energy as compared to its rated energy of 3hp. Due to this extra energy consumption for the same machine hour, the efficiency of the machine will be very less, which varies between 34.10% to 42.5% under loading conditions.

Performance test of drilling machine

In majority of the chosen industries the drilling machine is a common facility, adopted for drilling of holes in plates, angles and bars. The drilling machine study is made in industry B and E where the utility of this was found to be more. During the study it was found the machine spindle alignment was not proper and that too without right foundation. This misalignment of the spindle has made the collet and the drill bit off axis, which has in turn increased the energy consumption by increased thrust on the drill bit, causing the motor to overload. During this study it was found that the 1 hp drilling machine in industry B is consuming the rated energy only due to the normal loading conditions, but the efficiency is found to be 55% to 60%. The industry E has lesser load on the machine that is around 30% to 40%, due to this the efficiency is found to be very less about 30% to 35%.

Performance test of heavy duty chop saw and hand grinders

Heavy duty chop saw with 14 inch blade and a hand grinder with 4 inch blade have been extensively used in these fabrication units for the purpose of cutting and finishing operations. Both the machines are of DEWALT make with standard power ratings and specifications. Since these machines are new and have a very good motor the loss of power is very less in these machines and efficiency is found to be good. The energy consumption may increase with reduced efficiency of motor winding or worn out windings [11, 12]. The pattern of energy consumption is found to be satisfactory, except in few cases. The exception is identified in the usage of the blades, in majority of the cases that is for grinding, cutting, polishing, etc. the blade used was found to be same. Usage of same blade for all the operations will cause slight reduction in the efficiency and may lead to dangerous accidents. Usually the cutting and grinding machine operations are highly susceptible to the variety of blade used to carry out the specific operations.

Performance test of rectifier transformer arc welding machine

Welding machine is prominent equipment used in all fabrication industries. In the chosen seven industries, the industry E is making use of this machine to a maximum extent. In view of this the result of the performance study made in this industry has been discussed. It is found that the machine used is not maintained in properly to have good aviation or oil cooling arrangements. This has led to the efficiency drop age in the transformers, which it turn the efficiency of the machine. The power ratings were observed during the operating conditions, the machine having 16 kVA, was found to have an operating voltage of 60 volts and 5kWhr, under open circuit (idle condition). The same machine has 16 kVA, with a voltage drop to 20 volts and power increase to 15kWhr, under closed circuit (working condition). During this condition the machine efficiency was observed to be 30% to 40% only. By this it can be inferred that the maximum energy loss in these fabrication industries is found to be in welding machines and a much attention should be given to these machines.

Performance test for painting set up

In most of the fabrication industries the spray painting setups were used. The maximum painting work was identified in industry E. The typical painting set up has got a compressor as power unit and a spry gun as a media to enforce the color on the items. In this industry E, the capacity of the set was 1hp, but the actual power consumed during the operation was found to be 1.5 hp. This increase in the energy consumption is attributed by the drive systems, clogged spray guns, leakage in the hose connecting the compressor and the gun, unskilled labors, improper stand of distances, etc. Due to all these lacunas the efficiency of the painting set up is around 40% to 55%.

The performance study reveals that in studied almost all industries efficiency is less than 60 % and in some of these industries consuming more than the rated power under variable load because of old age/obsolete of machines, improper maintenance mechanical parts and power transmission system, improper coolant usage leads to damaged windings, and skinned wires leading to short circuits, air leakage etc. In pure transformer arc welding machine minimising the idling time and enhancing proper maintenance will leads to increase efficiency and reducing the energy consumption.

2.3 Analyses and recommendation for energy conservation opportunities (ECOs)

Based on the actual study made in these industries with respect to the energy efficiency of the major machines/equipment and appliances, and analyzing the actual status of the energy consumption, a few recommendations have been made. After the successful implementation of the suggested recommendations on ECOs, the targeted industries can achieve much savings as shown in the table 3.

The efficiency of the power hacksaw can be increased and can achieve the reduction in greenhouse gases by rewinding the motor in D industry. The details of which have been shown in the row D_{PH} of the table 3. By reducing the idling time of the painting set and by the proper maintenance of power transmission system (belt drive) and rewinding of motor , quite a large amount of savings can be achieved in industry E , as shown in the row E of the table 3. On the similar ground the rewinding the lathe machine motor in industry $D_{LM,}$ can also bring much saving opportunities.

Table.3 Recommended energy conservation opportunities in surveyed in SMEs

Industry	Annual electricity saving in KWh	Annual Saving in Rs	Initial investment in Rs	Annual Greenhouse gas reduction in Kgs				Pay back In months
				CO_2	SO_2	CO	NOx	
D_{PH}	516	3276.6	800	479.88	3.61	2.37	2.218	3
E	528	3352.8	3000	491.04	3.70	2.43	2.270	11
D_{LM}	1336.70	8488.045	1500	1243.13	9.36	6.15	5.747	2
W_{All}	50444.3	320321.6	483000	46913.2	353.1	232.0	216.910	14

As a common machine in all the industries, welding machine has grater usage and higher consumption of energy. Replacing the rectifier transformer arc welding machine with inverter arc welding may lead to highest energy economy and can prove to be the environmental friendly system. The details of the ECOs for the welding machine are as depicted in the row W_{All} of the table 3.

3. CONCLUSIONS

The present study has aimed at the energy saving opportunities in the tractor trailer and other agricultural implements fabrication industries. A cluster of seven industries has been chosen for the study and the auditing has been made. The detailed data analysis and the study of the mechanical systems involved, has come up with certain ECOs in these industries. From the study it is found that the motors and the welding machines are the major energy consuming machines. The replacement old motor

with energy efficiency motor can play major rule in the possible reduction in energy consumption. Also it is emphasized that a proper maintenance of the mechanical equipment will go a long way in reduction of energy consumption. In pure transformer arc welding machine by reducing idling time, one can save 35 to 40% of the total energy consumed by the fabrication industries. Replacement energy efficient motor with existing motor or by rewinding the motors, one can save more than 40 to 45 % of total energy consumed by the fabricating industries. Also, it is found the suggested energy conservation recommendations have much impact on the greenhouse gases in these industries, enabling a healthy working environment for the labours.

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