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Preliminary electrical energy audit analysis of automotive control cable industry

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ABSTRACT: *Opportunities for energy efficiency improvement exist in industrial sector which has revealed from various studies in different countries have shown that significant energy-efficiency improvement opportunities exist in the industrial sector, many of which are cost-effective. Therefore Indonesia as the second largest car manufacturing country in South East Asia definitely has huge energy efficiency opportunities from automotive industry. In this paper, preliminary electrical energy audit analysis of automotive control cable industry has been done and found several field fact finding including inappropriate motor sizing, less useful of variable speed drive in low speed drawing machine operation and automotive control cable energy performance.*

KEYWORDS: *electrical energy audit, energy performance, variable speed drive.*

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I. INTRODUCTION

Indonesia's commitment to reduce greenhouse gas emission by 26 percent in 2020 was announced at the 15th Conference of the Parties in Copenhagen. The number was elevated to 41 percent with the international support in G20 meeting in Pittsburgh. The commitment is now organized in Presidential Decree 61/2011. The goal will fulfilled with renewable energy development and energy conservation particularly from the energy sector. Prior to this regulation, Government of Indonesia has released Government Regulation 70/2009 which oversee the energy user of more than 6,000 Tone Equivalent to conduct periodically energy audit.

The car manufacturer industry of Indonesia has become significant part of the country's manufacturing activity as many of the world's car famous corporations have expanded production capacity in Southeast Asia's largest economy. Indonesia has trailing rather far behind Thailand as the second largest car manufacturing country in Southeast Asia. Indonesia has controls about half of total car production in the ASEAN region as Indonesia's total installed car production capacity numbers has reach 2.2 million units per year in 2017.

As the second largest car manufacturing nation in Southeast Asia and the ASEAN region, it should however be conclude that there is a huge energy saving potential in automotive industry which has been became our object of energy audit. Furthermore the energy audit has been conducted in control cable manufacturer for automotive industry located in Tangerang, West Java province of Indonesia.

The audited control cable manufacturer has been operated in Indonesia for 40 years and supply parts for automotive industry in Indonesia and ASEAN region. It has two main section named as Production facility and Assembly facility. The production facility consist of four areas including inner product, outer product, inner meter cable and outer meter cable while the assembly facility operates to construct the component parts of control cable as a finished product.

II. ELECTRICAL ENERGY AUDIT

A series of activities in the industrial plant production process will not be separated from the availability of electrical energy. In its use, electricity dominates compared to other types of energy, such as steam [1].The dominance of electrical energy as mentioned above is easy to understand because the production process equipment continues to be updated. Equipment that was originally based on steam energy has been replaced with electrical energy, for example pumps. Changes in the energy base directs the industry towards a more practical and efficient condition.

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Electrical energy performance of an industrial plant is an important factor that needed to develop an energy management planning, furthermore to evaluate the electrical energy performance the plant management needs to do an energy audit. The common steps of an electrical energy audit are [1]:

a) preparation and planning
b) desk data collection
c) operating practices observation and field measurements
d) data analysis
e) reporting of the results and recommendations

Main object that needs to evaluate in electrical energy audit including of Electrical System and Motor Load including Air Compressed system. The energy audit focus should include power quality assessment, power sizing and production operation pattern.

III. METHODOLOGY

Energy audit for industrial sector conducted firstly depends on the size, function and type of the industry and secondly depends on the how much the magnitude and potential of energy savings and cost reduction desired. Therefore energy audit for industry can be classified into two types: walk-through or preliminary audit and diagnostic audit [2].

The preliminary audit is the simplest and quickest type of audit which involves at least interviews with site operating personnel, facility utility bills and other data operation analysis, and a walk-through of the facility aiming to identify any inefficiency possibility. The preliminary analysis helps the energy auditor to have a general picture of the plant operation and energy use [3]. Furthermore it will helps the energy auditor to make a detail measurement plan and diagnostic.

However, preliminary audit in this study has been conducted more detail. The cable control company is a Japanese corporation focusing in the fabrication and marketing of cable control for two and four wheel vehicles. The company has several overseas manufacture facility included the one that has been field visited. Field visit works including power quality measurement at MDPs, investigation on air compressor and three motors as high energy consumption representation.

IV. RESULTS AND DISCUSSION

4.1 Monthly Energy Bill

There are three sources of energy consumption of the factory: electricity, fuel oil and liquefied petroleum gas while the energy consumption figure can be seen in figure 1.

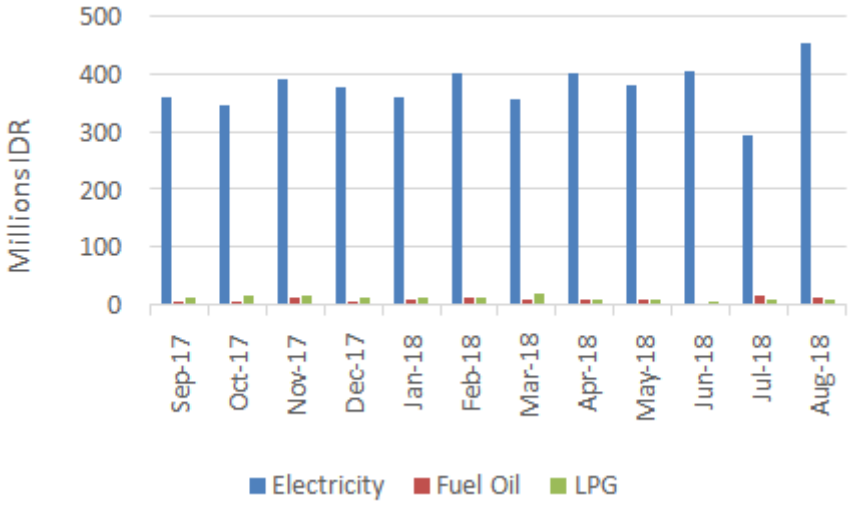


Fig. 1 Monthly Energy Bill

Monthly energy bill figure shows that the lowest energy consumption was in July 2018 and the highest in August 2018. This could be understood as a seasonal production cycle, since there is a two week national holiday in July 2018. However, it can be seen that the main source of energy for the factory is came from electrical power, the 2017-2018 year to year data shown that annually electrical energy bill took portion 94.1%. Therefore the focus of energy audit will be only on electrical energy.

4.2 Monthly Electrical Energy Consumption

Monthly energy use data was collected from company energy billing which took place from August 2016 until August 2018 as shown in figure 2.

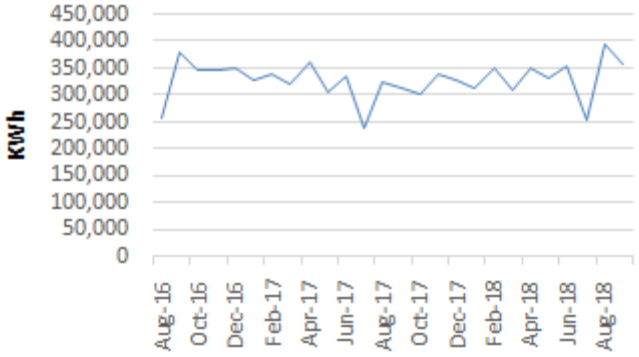


Fig. 2 Monthly Electrical Energy Consumption

The minimum value energy consumption was 240,100 kWh in July 2017 and 256,300 kWh in July 2016. The maximum value was 393,580 in August 2018. Energy consumption in the factory relatively has a constant value at the specific range along year 2016 until 2018. Minimum value reached at July because of seasonal long Muslim holiday at that month.

4.3 Electrical System

Electrical power for the manufacture facility is mainly supplied from electrical power state owned company. Total installed capacity from the Electrical Power Company is 1,600 kVA with total capacity of transformer is 2,000 kVA. The transformer feed main distribution panels (MDP) which there are two MDP named as MDP 1 for Production Facility and MDP 2 for Assembly facility. Furthermore electrical energy use pattern was determined from those two MDPs.

The main load of the factory is rotating machines for cable drawing, coiling and stranding. All the machines is driven by induction type motor, while several of the big size motor already equipped with inverter drive system. The production facility produces four type of products names as inner product, outer product, inner meter cable and outer meter cable. Total motor capacity is 1,400 kW with inner product area as the most energy consuming which took 67% portion as can be seen on figure 3.

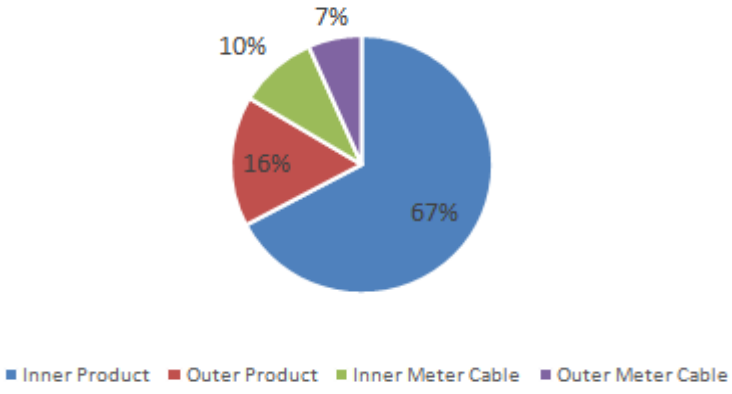


Fig. 3 Motor Load Proportion

4.4 Load Profile

Factory load profile was measured at Main Distribution Panel of Production and Assembly facility. The measurement was conducted using power analyzer and data recording was set at every 3 second during 24 hours measurement.

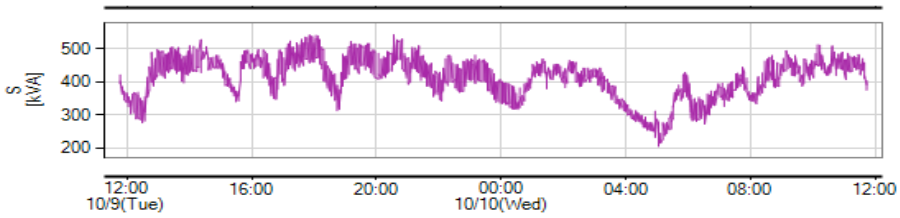


Fig. 4 Factory Load Profile measured at MDP Production

The factory uses 2 units of transformer from the main incoming which feeds to the MDP Production and MDP Assembly therefore the measurement has to be done at each of MDP since there is no single feeder at the low voltage side. The load profile at MDP Production as shown in figure 4 describes factory seasonal peak load and low load during break time. The maximum load is 543.42 kVA and the minimum load is 205.77 kVA at 5 AM.

4.4.1 Load Factor

The load factor was calculated by summarized the maximum value of kVA at MDP Production with MDP Assembly and compare the value with maximum utility contract capacity of the factory. The measured power at the MDP Production lies in between 205.77 - 543.42 kVA and for assembly facility it lies between 26.10 - 322.31 kVA. Therefore we can calculate the load factor as 54%taken into account the sum of maximum power of MDP Production and MDP Assembly, which is considered as low load factor.

Increasing load factor by decreasing utility contract capacity may decrease electricity bill. The utility charges the user an amount of fixed cost based on contract capacity multiply by forty hours and electricity tariff. Therefore using the latest tariff 1,035.78 IDR, decreasing contract capacity by 1,200 kVA could save 16,572,480 IDRs monthly.

4.4.2 Motor Load.

Most of motor load is located in inner product area whilst the size is varied from 5.5 – 30 kW. There are two motors that measured with power quality analyzer to identify power quality analyzer parameters of the machines.

4.4.2.1 Cable Drawing Machine MSD 02

Cable drawing machine MSD 02 operates at 270 radian per minute which using induction motor as the prime mover and equipped with variable speed drive. The motor capacity is 30 kW with nominal radian per minute 1,500 rpm, while the measurement conducted from 16.00 PM until 9.00 AM. The measured power utilization value of the motor is varied from 0-18.29 kW with average value as 12.18 kW. Motor power factor values varied from 0-0.8578 with average value as 0.5564.

Considering the maximum load of the motor, then the load factor of the motor is 61% and decrease to 40.6% if using the average value. However, the load factor value is too low and the use of variable speed drive is not worth for its value. Therefore it is recommended to change the motor with lower capacity and lower speed.

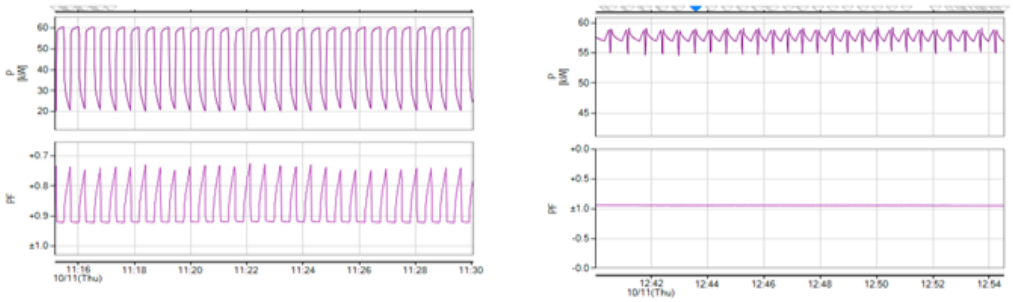
4.4.2.1 Cable Stranding Machine MIT 07

Motor for cable stranding machine MIT 07 operates at 500 radian per minute. The motor is 28 years old and equipped with direct online starter, the name plate capacity is 22 kW and nominal radian per minute 1,500 rpm, while the measurement conducted from 14.19 PM until 15.51 PM. The measured power utilization value of the motor is varied from 0-59.23 kW with average value as 4.55 kW. Motor power factor values varied from 0-0.8319 with average value as 0.265.

Considering the maximum load of the motor, then the load factor of the motor is 240%, however this cannot be true, considering the motor starting system using direct on line starter. Therefore we use average value for the load factor calculation which the value is 20.7%. However, the load factor value is too low, therefore it is recommended to change the motor with lower capacity and lower speed.

4.4.3 Air Compressor

There are four air compressors which used to serve production and assembly facility. One unitfor production facility with 37 kW capacity and operating pressure set as 6 kgf/cm^2, and the other 3 units for assembly facility. All of the 3 units using the same 55 kW capacity and 6.3 kgf/cm^2, while only one unit equipped with variable speed drive and operating pressure set as 6.5 kgf/cm^2.



(a) (b)

Fig. 5 Power and Power Factor Trend line (a) on off control and (b) VSD control.

Figure 5 shows the trend line pattern of power and power factor for air compressor using on off control (a) and VSD Control (b). The figure shows that it is most likely that the use of VSD is not worth the value of the VSD because of the energy consumed of the air compressor with VSD control is about the same with then one that using on off control.

4.5 Energy Performance

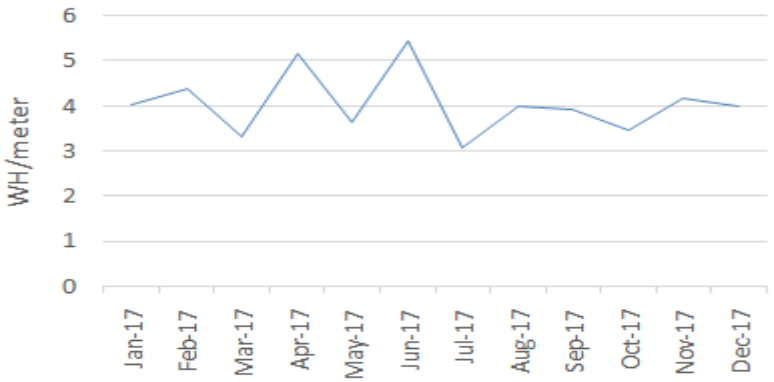


Fig. 6 Energy Performance

Energy performance was defined as the ratio between an output delivery quantity and energy input [4]. There are three kinds of output delivery of the factory named as drawing product, rolling product and endless product which all of those product is quantified in meters. Since the energy input involved in production process only in electricity form whilst the energy unit in watt hour (WH), therefore the energy performance unit quantified in WH/meter which means that the bigger the value shows factory bad performance and vice versa. The energy performance can be seen as in figure 6, the best performance was in July 2017 (WH/meter = 3.08), the worst performance was in June 2017 (WH/meter = 5.44) and averagely value was 4.05 WH/meter.

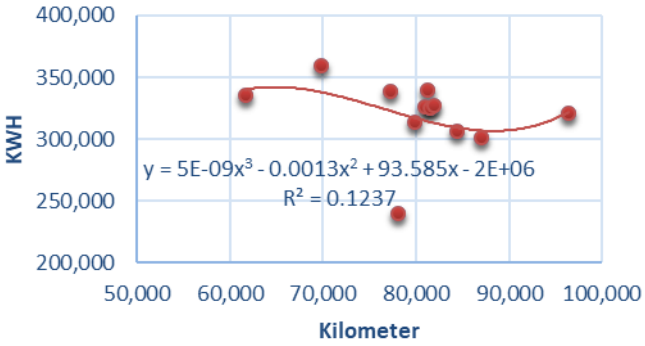


Fig. 7 Trend line between Input and Output

Figure 7 shows the trend line between Input Energy in KWH and Output Product in kilometer length. The trend line regression of polynomial in order 3 shows that the most optimum energy uses lies on production output capacity 88,000 kilometers length.

V. CONCLUSION

Preliminary electrical energy audit has been done in control cable industry with several recommendations and field facts including:

Energy performance—averagely energy performance value was 4.05 WH/meter in 2017. However there is no benchmarking value for typical industry, yet it can be concluded that the most optimum production output capacity of the factory lies at 88,000 kilometers length.

Mismatch motor sizing — measurement of two motors have shown that the motor sizing and specification are not appropriately chosen particularly on capacity sizing and nominal speed of the motor.

Detailed Audit — it is necessary to do detail audit, particularly to investigate mismatch in motor sizing. Appropriately motor sizing and specification will increase motor efficiency and consecutively saving energy bill.

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REFERENCE

[1]. R. Khandare, A. K. Pandey and R. Deepak, "Electrical Energy Audit (A Case Study of Tobacco Industry)," International Journal of Engineering and Applied Sciences, vol. 2, no. 3, 2013.

[2]. A. Hasanbeigi and L. Price, Industrial Energy Audit Guidebook:Guidelines for Conducting an Energy Audit in Industrial Facilities, China Energy Group, 2010.

[3]. P. Bhukya, "Preliminary Electrical Enery Audit Analysis of Mineral Based Industry," International Journal of Scientific and Research Publications, vol. 4, no. 5, pp. 1-6, 2014.

[4]. S. Fawkes, K. Oung and D. Thorpe, Best Practices and Case Studies for Industrial Energy Efficiency Improvement – An Introduction for Policy Makers, Copenhagen: UNEP DTU Partnership, 2016.

[5]. S. Palaloi, S. Turinno, Z. and L. , "Audit Energi di Industri : Sistem Kelistrikan," in Prosedur Standar dan Teknik Audit Energi di Industri, Tangerang Selatan, B2TE BPPT, 2015, pp. 69-124.