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The Effect of Replacing The Variator Speed on Rod Feeder E120 Coating Machine on Production Results at PT. Alam Lestari Unggul

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ABSTRACT : *At PT Alam Lestari Unggul the control system is also inseparable from the fact that a Limited Liability Company involves workers. This workforce activity is directed to achieve the company's goals, where previously it only produced 500 tons per year, now 25,000 tons per year, so on the occasion of this assignment the author intends to help the company to determine the use of the data in this thesis to gain knowledge, analysis, anticipation, data on the value of electricity savings in the period to come. After doing calculations, analysis and data, using the existing system by reading the thesis that the author is trying to write, it is hoped that the company or those who read it can be used as a direction for analysis or as a guide.*
In principle, in replacing the Variator speed, the author uses an inverter as a tool, with the formula n = 120 x f /p, where the old process uses the Beire Variator Sumitomo by rotating the speed lever by looking at the speed reference by multiplying the motor speed by the range value (0.2 to with 0.8). Because it is based on the theories contained in the book as well as the existing experience in the welding electrode manufacturing industry, it is hoped that the production results will be in accordance with the targets of the company's management.For this achievement, a research methodology was created which previously used the Sumitomo Beire Variator with a Hitachi 3.7kW motor replaced with a Hithaci Inverter plus a 7.5kW Teco motor. Previously, the Beire Variator produced a maximum of 4,451.74 kg in one production with a speed of 900 rpm. After being modified with an inverter to control the speed and increase the capacity of the motor, the resulting production reached 8,728.91 kg with a motor speed of 1500 rpm.In the process of presenting this problem the author uses a calculation system in which the data is taken directly during the production process of the RD 260 type welding electrode with a wire diameter of 2.6 mm. Production results are obtained from the desired speed (eg 900 rpm) multiplied by the amount of results from the extrusion process (69 kg) divided by the speed or speed in the research process, namely 830 rpm, it will produce an average production yield of 75 kg in one process. Then from that result multiplied by the number of production processes in one day (70 times the process) you will get the production results in one day. Likewise with the process of calculating electricity payments before being changed by IDR 920,785.50 to IDR 329,854.56 after being modified.
KEYWORDS *Engineering planning, inverter, electrical engineering, industrial psychology.*

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I. INTRODUCTION

PT ALAM LESTARI UNGGUL is located on Jalan Raya Serang km 12, Tangerang. This company was founded in 1972 which was originally called NIKKO STEEL, but in 1983 the name officially became PT ALAM LESTARI UNGGUL which was inaugurated by Mr. Bakti Setia Darma. Initially PT Alam Lestari Unggul as a welding electrode manufacturer only produced around 500 tons per year, but now it has grown and increased production volume to around 25,000 tons per year with more than 70 types of welding wire.

Given the trust that has been given by other industries to PT Alam Lestari Unggul and to increase the progress of the company, as with other companies, PT Alam Lestari Unggul is required to immediately implement a more modern and efficient system.

In addition, the company's management wants maximum results from the machine purchased in 2014, where currently the production capacity of the coating machine is maximal, especially in the Rod Feeder section

which can be seen from the setting speed which is already maximal and the amperage of the driving motor is also on the verge of critical.

To face this fact, the Engineering Division is expected to help with this problem, so an analysis is needed that can help decision makers, one of the analyzes is to implement a planning system by engineering[1]. And one form of engineering support is the planning of an inverter as a motor speed controller which originally used a 3.7 kw motor including a beire variator replaced with a 7.5 kw electric motor with HITACHI INVERTER control on the E120 rod feeder machine in the COATING PRODUCTION MACHINERY division.

One of the planning models that has the most strategic values for the survival of the company is planning for efficiency, time, cost, labor and waste in order to get the results desired by management, especially the production division, considering that the production part is the most complex part in a company[2]. In the production section, all human resources, materials, methods, funds, and machines are collected. Good engineering planning will provide optimal quality support in the production process in the company which is one of the efforts to increase the company's efficiency, also in the end can lead the company to become a producer that is competitive in price, productivity and quality[3].

II. ENGINEERING MANAGEMENT

According to (Siswanto 2005: 28) Management is the art and science of planning, organizing , directing , motivating , and controlling people and work mechanisms to achieve goals .

The inverter here is a circuit capable of converting DC voltage to AC[4]. There are two types of inverters commonly used in electric power systems, namely:

1. Inverter with constant frequency and output voltage CVCF (Constant Voltage Constant Frequency).
2. Inverter with variable output voltage and frequency. Generally this type is used in the use of 3-phase electric pumps with a DC voltage source.

This inverter uses constant frequency and voltage and by using the SCR component as its AC voltage generator, it distributes quite a lot of power, even though the output voltage it produces is not very pure[3]. This inverter can be input with an input voltage of 220 VAC, while the output is 3 phase 380 volts.

The principle of a 3-phase inverter with a changing base frequency is the same as the principle of a 3-phase inverter with constant frequency and voltage as previously described, only in this inverter is added a circuit that is able to change the magnitude of the voltage change that occurs into a change in frequency.

Meanwhile, to find out the speed regulation process [5] with an inverter, the formula n (turn) =

$$n = \frac{120\ x\ f}{p}$$

where : n = Number of revolutions / speed
f = Frequency
p = number of poles

The symbol (p) is the pole or the number of poles of the electric motor that will be used to run the machine.

Motor load can be measured with three stages of calculation[6].

Stage I determines the input power with the following equation:

$$P_1 = \frac{V\ x\ I\ x\ PF\ x\ \sqrt{3}}{1000}$$

Where: P1 = Three-phase power in kW
V = voltage
I = Current , 3 phase mean value
PF = Power factor

Step 2 determines the power by taking the name plate value or the following equation:

$$P_r = HP\ x\ \frac{0,7457}{\eta r}$$

Where: Pr = Input power at full load in kW
Hp = Hp value on the name plate
ηr = Efficiency at full load (value from the name plate or from the motor efficiency table).

All electrical conductors used must be made of materials that meet the requirements, according to their intended use, and have been inspected and tested according to conducting standards issued or recognized[7] by the competent authority.

The rated voltage of the cable is divided into the following levels:

1) Low Voltage Cable : 230/400(300)V, 300/500(400)V, 400/690(600)V, 450/750(750(690), 0.6/1kV(1,2).
2) High voltage cables : 3.6/6kV(7.2kV), 6/10kV(12kV), 8.7/15kV(17.5kV), 12/20kV(24kV) and 18/30kV(36kV)

III. RESEARCH METHODOLOGY

Making welding wire can look like the process flow in Figure 1 below:

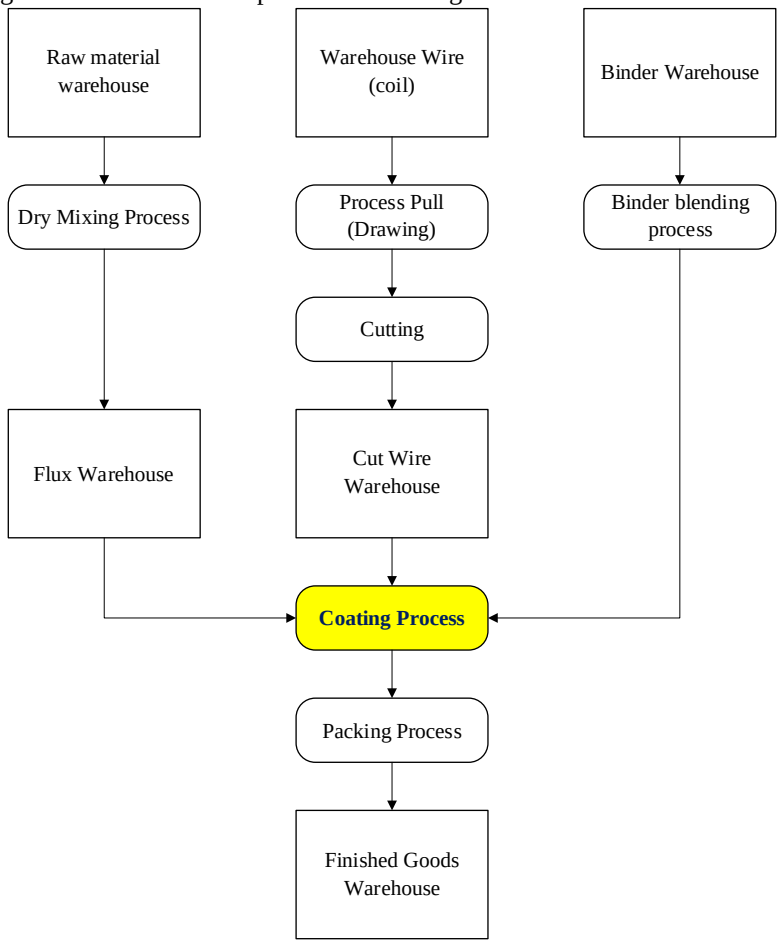

Figure 1. PT ALU's Production Process Flow

Description of the Production Flow above as follows:

a. Flux Dry Mix section
In this section, the process of mixing flux materials is carried out in accordance with chemical elements that refer to standards agreed upon by the American Welding Society (AWS), Japan Industrial Standard (JIS), etc.

b. Drawing Cutting Section
In this section, the wire drawing process is carried out according to the request, after which it is continued with the cutting process according to the length of the product.

c. Coatings Section
This section is the core process, in which the wire from the drawing cutting process will be joined together, the flux from the Dry Mixing process, and the binder from the mixing process to form welding wire. In this section there are many requirements that must be complied with, including

centricity, in the coating process must comply with established standards. In this section the author will try to do research on how to set the speed and calculate electricity savings using a media inverter.

d. Packing Section
In this section, the oven process is carried out according to applicable standards and there is a welding wire product packaging process according to the existing type and size.

e. Warehouse Section
In this section basically there is a storage process, at PT ALAM LESTARI UNGGUL there are many warehouses.

f. Quality Control
Serves as a filter regarding the output of goods before and after the goods are made. If this part is not thorough, it is possible that non-standard products will pass on the market.

g. Engineering
This part is sometimes considered unhelpful in a production process, where engineering is seen as a part that wastes the company's finances because it continuously buys spare parts needed in terms of maintenance and development. Where actually it is the engineering department that provides healthy and good machines to support the results desired by the company in getting good quality for customer satisfaction.

All production equipment and machinery meet product and quality standards at all times. The electric, maintenance, workshop sections are required to work together to achieve the desired production and quality together[8]. All equipment and machines are maintained preventively every day, carrying out maintenance, repair and modification activities so that production increases.

This analysis is used to determine the speed of the motor that affects the production results in the manufacture of welding electrodes.
This analysis is based on the formula for finding rounds (n) in the book Basic Electrical Engineering and Power Electronics[9]. The formula used is:

$$n = \frac{120\ x\ f}{p}$$

where : n = Number of revolutions / speed
f = Frequency
p = number of poles

Analysis of motor speed with a frequency setting system can be calculated later on the amount of production desired for setting target results from management.

The following is an example of a calculation to find the speed that is released from the motor with frequency settings, can be seen in Table 1 below:

Table 1: Example of calculating motor speed with frequency settings

No	*Speed frequency*(Hz)	Constant Value	*Pole*	*Speed Output Motor Rpm*
1	5	120	4	150
2	10	120	4	300
3	15	120	4	450
4	20	120	4	600
5	25	120	4	750
6	30	120	4	900
7	35	120	4	1050
8	40	120	4	1200
9	45	120	4	1350
10	50	120	4	1500

And the following is a graph of calculating acceleration with speed settings with an inverter, which can be seen in Figure 2:

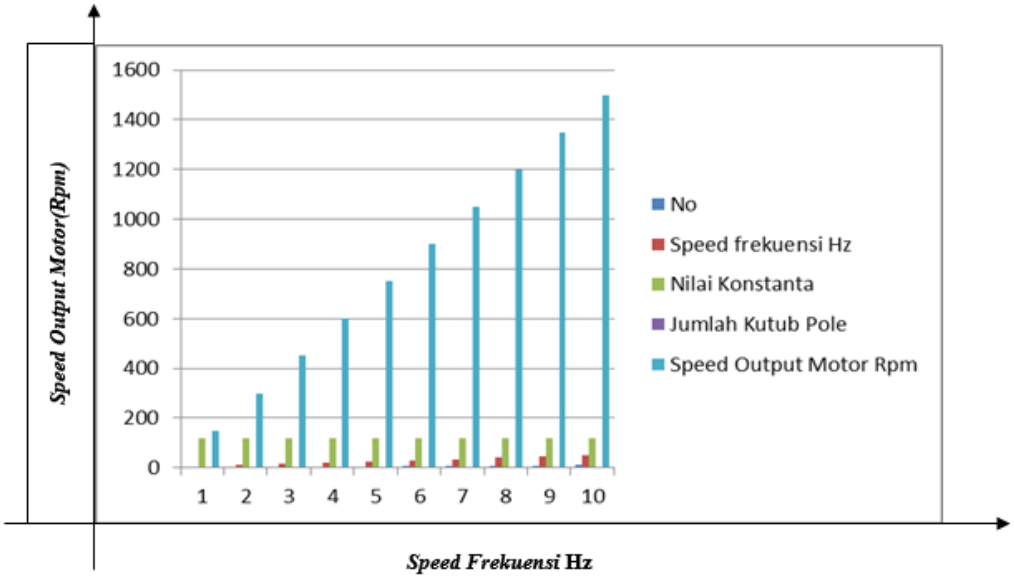

Figure 2 . Graph of calculating motor speed with frequency settings

Speed analysis using a beire Variator with an electric motor. This analysis is based on the data on the name plate of the variator speed with a 3.7kW motor where it shows 0.2. 0.3. 0.4. 0.5. 0.6. 0.7 to 0.8 with a motor speed of 1500 rpm.

IV. RESEARCH RESULTS AND DISCUSSION

In the manufacturing process, of course, not only counting the number of wires that come out because this is difficult to prove in real terms, but can only be presented through calculations, PT Alam Lestari Unggul applies data taken from the results of finished goods in the form of the specific gravity of the welding electrode, which is weighed one by one. process times. The following are the results of research in several production processes and the calculated production results can be seen in Table 2 below:

Table 2 . Research data on the production of RD 260 type welding wire in kilograms

No	Range Speed (Rpm)	Processing Time (minutes)	Total weight in (kg)
1	830	6	69
2	830	6	68
3	830	6	68
4	830	6	70
5	830	6	70
		Total Weight	345
		Average weight	69

So in this research process in one process it produces 69 kg of finished welding wire in an immature condition and must be in the oven before being used.

The following data on rejects occurred based on the production process can be seen in Table 3 below:

Table 3 . Welding Wire Scrap Result Data Before Modification

No	Date	Month	Electroda type Las	Wire (kg)	Scrap Results Flux (kg)	Rework (kg)	No
1	06.05.2022	Mei	2015	RD- 260,Q=2,6mm	1	11	423
2	07.05.2022	Mei	2015	RD- 260,Q=2,6mm	0,5	6	387
3	08.05.2022	Mei	2015	RD- 260,Q=2,6mm	1	9	398
4	09.05.2022	Mei	2015	RD- 260,Q=2,6mm	2	4	412

So the average yield of wire scrap = 1.12 kg, while the flux = 7.5 kg.

From the table above, the results of scrap scrap wire, flux, and rework material from a production process are obtained. The results of the rejected materials above are very influential in the production process where production is not smooth due to inadequate motor capacity, still too small not strong enough to run welding wire material that requires great power.
The following results of scrap data after modification of the Rod feeder machine can be seen in Table 4 below:

Table 4 . Welding Wire Scrap Result Data After Modification

No	Date	Month	Electroda type Las	Wire (kg)	Scrap Results Flux (kg)	Rework (kg)
1	01.06.2022	Juni	RD- 260,Q=2,6mm	1	5	177
2	03.06.2022	Juni	RD- 260,Q=2,6mm	0,5	5	120
3	15.06.2022	Juni	RD- 260,Q=2,6mm	1	4	86
4	24.06.2022	Juni	RD- 260,Q=2,6mm	1	2	142
5	01.07.2022	Juli	RD- 260,Q=2,6mm	2	5	212
6	02.07.2022	Juli	RD- 260,Q=2,6mm	2	3	208
7	29.07.2022	Juli	RD- 260,Q=2,6mm	1	3	177

So the result of scrap after being modified for wire is 1.2 kg while flux = 3.85 kg.

The following data on rejects occurred based on the production process from the beginning of May 2015 to the end of July 2015 can be seen in Table 5 below:

Table 5 . Welding Wire Scrap Result Data Before Modification

No	Date	Month	Electroda type las	Wire (kg)	Scrap Results *Flux (kg)*	*Rework (kg)*
1	06.05.2022	Mei	RD- 260,Q=2,6mm	1	11	423
2	07.05.2022	Mei	RD- 260,Q=2,6mm	0,5	6	387
3	08.05.2022	Mei	RD- 260,Q=2,6mm	1	9	398
4	09.05.2022	Mei	RD- 260,Q=2,6mm	2	4	412

So the average yield of wire scrap = 1.12 kg, while the flux = 7.5 kg.

From the table above, the results of scrap scrap wire, flux, and rework material from a production process are obtained. The results of the rejected materials above are very influential in the production process where production is not smooth due to inadequate motor capacity, still too small not strong enough to run welding wire material that requires great power.

Table 6. Comparison Table After and Before Modification

No	Item	Before	After
1	Speed setting	Lever Manual Speed Regulator, max speed = 900 Rpm, motor condition (high motor current 6.56 A, hot temperature ± 80º C)	The potentiometer is connected to the inverter, max speed = 1500 Rpm, motor condition (motor current 3.25A, hot temperature ± 50ºC)
2	Production result	Not yet calculated with the table, the maximum result is 5,237.34 kg.	Can be seen / calculated with the table, the maximum result is 8,728.91 kg.
3	Electricity Payment	High costs in 1 month (30 days) = IDR 920,785.50	Low cost in 1 month (30 days) = IDR 329,854.56
4	Repair and maintenance costs	Expensive, if Overhoul is almost the same as new price ± IDR 22 million	Cheap, the price of a new TECO brand motorbike is ± 7.5 million and a new inverter is priced at ± 6.5 million and there is a lot of supply on the market

Information :

1. Setting speed . In terms of engine and electricity, the use of a 7.5 kW inverter connected to a 7.5 kW motor is a recommended alternative, because by looking at the frequency table, the production results can be estimated based on the formula:

$$n = \frac{120\ x\ f}{p}$$

In terms of the results with the inverter, it is enough to turn the potentiometer and look at the frequency or speed of the motor, the desired speed will be obtained which is adjusted to the pressure, flow extruder, then the production results can be calculated/can be seen from the data after being modified. It can be seen in Table 16 on pages 55 and 56 above that the maximum speed is 900 rpm before modification and after modification it can reach 1500 rpm.

2. Production results. From the previous production results, they still saw the highest results in targeting production results that were not based on calculations or made up of matrices. In Table 15 on page 55 above, the maximum yield is 5,237.34 kg, while after modification, the maximum is obtained after multiplying the production target by 40%, which is 8,728.91 kg. An example of the method used is: If the Speed Variator is 830 rpm, the extrusion process time is 6 minutes, the speed is increased to 900 rpm, the following calculation is obtained:

$$\textbf{Processing time } (t2) = \frac{n1\ X\ \textbf{processing time } (t1)}{n2}$$

$$= \frac{\textbf{830 rpm X 6 minutes}}{\textbf{900rpm}}$$

= **5,53** minutes

So the extrusion process time if the speed is increased will also change faster for 5.53 minutes. Then the time for 1 shift is 420 minutes: 5.53 minutes = 75.9 times the process. Rounded 76 times.

If the production result in 1 process is 69 kg, then multiply it by 76, the result is 5,244 kg.

3. Electricity Payment. In electricity payments, it is clear from the table above that different results are obtained before and after the inverter is modified or installed. Before being modified, electricity payments in one month amounted to IDR 920,785.50. And after being modified, the electricity payment in one month is IDR 329,854.56.
   The company's profit from saving (Energy Saving) is Rp. 590,928.94 or 64% profit from the initial payment or before being changed.

4. Repair and maintenance costs.
   a. In terms of electricity: seen from the data above, it is clear that there are more advantages from the use of electric power, it is easy to repair because there are not many controls such as magnetic contactors, overloads, etc.
   b. From a mechanical point of view: the Beire Variator Speed type with a 3.7 kW motor for high pressure turns out to be incapacitated / lacking in capacity so that the motor current exceeds the maximum capacity of the motor and if the gearbox unit is damaged the repair fee can be double the price of a new motor and inverter 7, 5 kw.

   Therefore, if this is carried out properly, an optimal production process will be achieved as expected.

V. CONCLUSION

There are many benefits to installing a monitoring system — some of which strongly interrelate with each other. A properly designed and installed monitoring system offers a deeper understanding of the operational parameters of the system. A close appraisal of the data generated by a monitoring system can reveal a variety of overt and subtle opportunities, including:

Environmental —better knowledge of how energy is used allows you to identify an array of prospects to improve efficiencyand reduce energy consumption.

Reliability — assessment of data from the monitoring system can reveal existing or imminent issues that can adversely affect the operation and product within a facility. Historical data from monitoring systems can help locate and correct both acute and chronic problems, resulting in increased productivity.

Maintenance — Data trends can forecast and notify the appropriate people when discrete equipment parameters may be exceeded, allowing you to plan ahead instead of facing an unscheduled shutdown.

Financial — each benefit discussed above either directly or indirectly influences a business's bottom line. In most cases, the monetary impact from even one or two benefits can quickly justify the purchase and installation of a monitoring system.

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