Analysis Of The Efficiency Of Using A 3-Phase Induction Motor As Pump Drive At PDAM Surya Sembada Surabaya

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Abstract. *An induction motor is an electrical device that converts electrical energy into energy. Electric machines use various types of drives, such as water pumps. Applications in transportation equipment, household equipment transportation tools, and large-scale industry. for several reasons. To get the best performance, the induction motor supply must be checked for quality problems, such as changes to the motor power supply. This research analyzes and measures the effect of three-phase induction motors using different power sources from 380 Volts. The motor used is a 3 phase motor at PDAM Suraya Sembada which is located on Jl. Ngagel Tirto V No. 53, Ngagelrejo, district. Wonokromo, Surabaya, East Java. In completing this research, we used the method of mathematical calculating formulas for validation and comparison. The data taken were current, rpm (speed), voltage, cosphi. This research found that a threephase induction motor at 379 Volts had an effect of 84.27%, while the overall average in this study had an average efficiency value of 73%-75*

Keywords:*Three Phase induction motor, Efficiency, Voltage, Performance, Power Quality*

BACKGROUND

The 3-phase induction motor is one of the motors used by industry because of its many advantages such as low price, durability, reliability, simple construction, and does not require maintenance. Recently, a company's problem with using electric motors in the long term was that they did not pay attention to their efficiency values. However, due to environmental concerns and limited energy sources, fuel costs are expected to increase continues to improve now and in the future. To get maximum results from your motorbike, you need to recalculate the useful value of your old motorbike. If it turns out to be far from the manufacturer's efficiency value, then it needs to be recalculated.

THEORETICAL STUDY

AC induction motors are widely used motors. Motor power comes from magnets in the rotor and stator. Therefore, this motor is induction. The rotor (moving part) of this motor does not have a relative difference between the rotation of the rotor and the magnetic field (spinning magnetic field)of the stator current.
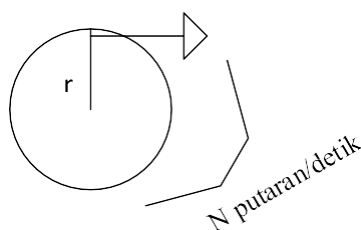
Figure 1*Induction motor*

A three-phase induction motor rotates at a constant speed, from no load to full load. Frequency affects the speed of this motor, so adjusting the speed becomes difficult. However, three-phase induction motors have many benefits, including their simplicity and robust price

Disadvantages of Induction Motors

1. Without reduction effect, speed cannot change.

2. In contrast to DC or shunt motors, 3-phase induction motors speeddecreases as the load increases.

3. The initial coupling of the mouth is low compared to DC Shunt.Advantages of induction motors

4. Simple and strong (most squirrel cage construction).

5. Cheap and easy service

6. High impact. Normal rotating conditions do not require brushes, and the powerloss caused by them is reduced.

7. No additional start or sync required.

Torque in Induction Motors

Uniform torque is the rotation of the torque shaft measuring the force resulting from the working environment. Draw a wheel with the work of r F Bewton's force causing the object to rotatewith n revolutions/second

To calculate the motor torque at full load, with

formula:

$$T = \frac{5252}{\text{Calculating Rotation Angle speed (omega)}}$$
$$= 2 \cdot r/60$$

Where:

=Torque (NM) Hp= Horsepower 5252=Constant

Pout=Induction motor output power

=rotational angular speed

Power factor

Power Factor is the difference between current and voltage, and cosine is the difference between them. Power Factor is an active-passive ratio. This step determines the connection status. The operating effect is measured by the power factor (cos). In a motor, electrical energy becomes mechanical energy in the rotor. Motorcycle Mechanical power induction is used for many needs.

The input power of the electric motor is calculated by

P in= √3 x V x I x cosθ

The apparent power of the motor is calculated using the formula:

S= √3 x V x I

Induction Motor Output Power is calculated using the formula

Pout= x

Angular speed is calculated by:

$$= 2 \frac{}{60}$$

Electrical energy is calculated by:

W= P x t

Power in Induction Motors

In S1, watts are a measure of the change in energy over time in the form of voltage and current. The power applied by the load at any time is equal to the voltage drop across the load (volts) multiplied by the current passing through.

Active, reactive, and electric power are divided into three types. as follows
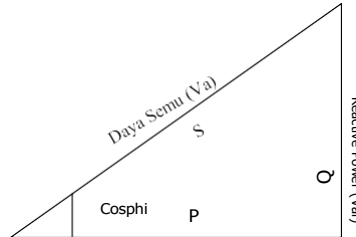
Active Power (watts)

***Picture*2** *Power Triangle*

Theoretically, time is divided into three categories: active, reactive, and apparent

- Active energy (P) is measured in watts (w).
- Reactive power (Q) is the power caused by reactance components. Reactive power can be formed from the reactance that causes it, namely XL and Xc reactive volt amperes.
- Apparent power (S) is the vectorial sum of active and reactive power with

2. **Phase Induction Motor Equivalent Circuit**

R2
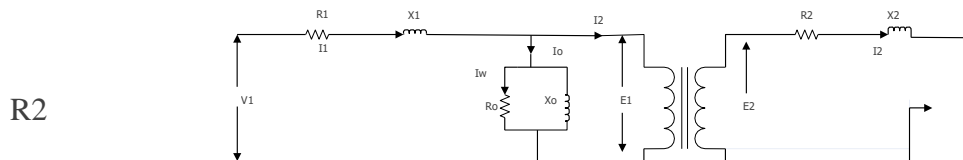
Figure 3.*Equivalent Circuit Approximation*

Induction Motor Efficiency

Machine efficiency is the extent to which the machine can convert mechanical energy into electrical energy. The effect depends on the roughness of the induction motor, not the design machine. It is called the ratio between wild power and input days and is usually added to the equation:

$$\eta = \frac{\quad}{\quad} \times 100\%$$

With η = Motor efficiency (%)

At low rated loads, the loss is still greater than the effect. How mom grows. When initial and variable losses are equal, the effect increases and peaks. The maximum effect is 80-90% of the machine's rated output, while larger motors have higher values. If the applied load is higher than the maximum effect value, the losses increase faster than the output, consequentlythe efficiency is reduced.

Factors that influence efficiency are:

1. New Motor: More Efficient

2. Capacity, for most equipment, motor efficiency increases withcapacity rate.

3. Speed. High-speed motors are usually more efficient.

4. Motor type: motors with large rotors are more efficient than motors with smaller rotors.

5. Temperature. Fan-driven total engine efficiency (TEFFC) is better than screen-protected anti-drip motors.

6. Motor winding can result in reduced efficiency.

7. Load. Motor efficiency will differ from load efficiency.

Several factors reduce the effect of motor induction:

1. Unstable motor voltage (V-unvalance) reduces motor performance and life in third phase technology.

2. Unstable voltage at the motor terminals causes a situation knownas I-unbalance.

3. Current instability causes torque which results in machine vibration and stress, resulting in short torque and torque.

4. The motor becomes hotter in an unstable voltage power supply.

Motor performance depends on the quality of steady-state force and current frequency compared with baseline values. Fluctuations in voltage and frequency that are greater than the accepted values have an impact on detrimental motor performance and unequal motor voltage. Due to the voltage difference in the three phases. This is also caused by different cable sizes in the distribution system.

RESEARCH METHODS

In this research, quantitative data collection was used to collect the required data. Mrtimatic data retrieval. This research aims to determine the effect size of a 3-phase induction motor as a pump driver at PDAM Surya Sembada Surabaya. It is hoped that this research will help companies to be better at maintaining 3-phase induction motors.
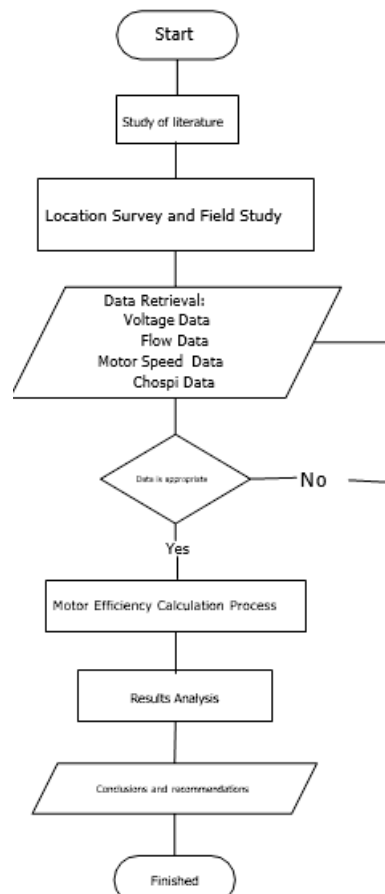
***Figure 1**. Research Flow Chart*

Figure 1 shows the entire research process, from planning to completion and analysis. At the start of your research, collect references from journals and books from the internet and libraries. PDAM Surabaya then used assistance tools to collect data.

The data collected is induction motor specification data because it functions as a general indicator of whether the motor is not functioning. Because the aim is to determine the average value, PHBTR panel data is available. a. Panel PHBTR can provide data. After collecting data, calculate the effect value manually.

Required Data

The data is data taken from the results of surveys and field observations on induction motors distributed at the Surya Sembada Usrabaya dip dam. The following is the data that will be used for calculations

1. Output Power (watts)

2. Voltage (V)

3. Current (I)

4. RPM (Nr)

5. Input Power (Wat)

6. Power Factor (Cosφ)

Data on 3 Phase Induction Motor Specifications at PDAM

Table 1Induction Motor Specification Data

V	Hz	Kw	r/min	A	Cosphi
680	50	200	1480	204	**088**
Y 400	50	200	1486	352	**0.86**
680	50	200	1484	211	**0.87**
Y 380	50	200	1484	356	**O.87**
440	50	200	1487	321	**0.85**
460	50	200	1488	314	**0.85**

Table 1 is a table of specification data for an induction motor with a power of 200 kW used in PDAM Surya Sembada Surabaya.

RESULTS AND DISCUSSION

From the research results at PDAM Sembada Surabaya, which is located in the Ngaggeldistribution PDAM, data were obtained as written in Table 1.

Table 1 Induction motor measurement data on day 1

Motorcycle	Current (I)	Voltage (V)	Cosphi	Rpm	Efficiency
1	283	379	0.89	1487	**86.41%**
2	241	377	O.87	1485	**88.56%**
3	275	377	0.87	1488	**88.32%**
4	281	376	0.86	1478	**88.89%**
5	277	376	0.86	1484	**86.15%**

Calculation of Induction Motor Power Efficiency for pump work

From the data obtained above, the power value of the 3 phase induction motor to the pumpis calculated:

Motorcycle 1

The first step after getting the research data results is to look forinput power

Input Power (P in)

Input Power (P in)

Known = V = 379 (Volts)

I = 283 (Amperes)

Cos Phi = 0.89

Asked = Incoming power (P in)

Answer

P in = $\sqrt{3}$x V x I x Cos Phi

= $\sqrt{3}$x 379 x 283 x 0.89

= 165.34 KW

After getting the input power, KW is converted into HP

Pin $= \dfrac{165.34}{746}$

= 221.63 HP

After obtaining the input power, it is converted to the cellphone. So look for value

$= \dfrac{5252}{(\ )}$

$= \dfrac{221.63\ (\ )\ 5252}{1487}$

= 782.78 Nm (Newton Meters)

Next, look for power. Calculate the motor's rotational angular speed (rad/s)
Radians Per Second

$= 2\ \dfrac{}{60}$

$= \dfrac{2\ 3.14\ 1487}{60}$

= 186.76 rad/s

Next, after obtaining the value of the torque and the value of the rotational angular speed of the motor, the output power Pout is calculated using equation 2.9

Pout= x T

=186.76 rad/s X 782.78 Nm (Newton Meters)

= 146,191 Kw

After the output power and input power are obtained, the final step is to find the efficiency value

η= x 100%

η= $\dfrac{146{,}191\ Kw}{165.34}$ x 100%

η=88.41 %

Based on calculations that are in accordance with the data from research data in the first results in Resultskam, the efficiency value is 88.41%, with this the efficiency of a 3-phase induction motor is not good because the standard good efficiency value is at 80%. It is necessary to check and maintain the motor so that the efficiency value is good. Motor performance could be better.

The graphic results of the efficiency calculations for each motorbike show significant changes not significant
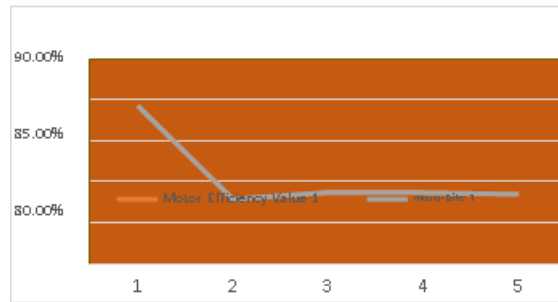
Figure 1.*Graph of motor efficiency values*

Figure 1 shows the graph for motorbike 1 which is averaged from day one to day five. From the graph above, it shows that there are changes that are not too significant from the first day to the 5th day, the first day shows an efficiency value of 84.27% and whereas on days 2 to 5 the efficiency results show an average of 73% change in efficiency itself. bias due to hot motor temperature and also bias due to load not being optimal.

CONCLUSIONS AND RECOMMENDATIONS

1. 3 phase induction motor for PDAM Surya Sembada Surabaya water pump work. Theaverage input and output power values for 5 motors are as follows:
   Motor 1 Pin Power is 158.44 kW, and Pout Power is 116.75 kW Motor 2 Pin Power is 133.77 kW, and Pout Power is 100.88 kW Motor 3 Pin Power is 165.61 kW, and Pout Power is 122.02 kW Motor 4 Pin Power is 161.31 kW, and Pout Power is 120.39 kWMotor 5 Pin Power is 154.73 kW, and Data Pout is 114.40 kW

2. 3 phase induction motor for water pump work at PDAM Surya Sembada Surabaya, an average of 5 motors work at the following efficiency values:
   Motor 1 Efficiency Value Obtained from Calculation Results is 73.70% Motor 2 Efficiency Value Obtained from Calculation Results is 73.68% Motor 3 Efficiency Value Obtained from Calculation Results is 75.83% Motor 4 Efficiency Value Obtained from Calculation Results is 73.58% Motor 5 Efficiency Value Obtained from Calculation Results is 73.69%

Based on the data above, the efficiency value is still less than the maximum efficiency, which is around 80% -85% of the maximum load, orfactory efficiency.

THANK-YOU NOTE

In this section, the researcher would like to thank all parties who have provided support and contributions to the research. The researcher thanks the editorial team for their time in publishing this research.

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