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Design starting capasitor motor submersible pump with Zelio SR2B121FU

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Abstract
In the single phase induction motor cannot start itself. To be able to start their own, the motor requires tools that are used at the start or during the motor is running. For this type of submersible pump motor capacitor is outside the motor, because the motor submersible pump immersed in water. At the present time in Indonesia starting submersible pumps have faced problems, especially relay on the capacitor is not able to work optimally, so do some research to design a submersible pump starting to improve. This research is a case study that aims to improve the performance of a single-phase submersible pump. Submersible pump motor works with DOL method. This method produces a high starting current is 27 A in a time of 0.25 seconds. Flow starting on coils 10 A and just walk around 0.25 seconds. After 0.25 seconds coils are disconnected from the main circuit so no current flows. Working voltage on the capacitor 110 V and is only used for starting in a time of 0.25 seconds. Graph speed submersible pump motor produces 2950 rpm speed at 2.5 seconds. System starting capacitor single-phase submersible pump more effectively by using Zelio SR2B121FU. Starting of submersible pumps with DOL method has a starting current of 27 A and full load current 10 A. Penegendalian submersible pump motor single phase using Zelio SR2B121FU provide security in operating it. The time needed to disconnect the capacitor from the coils using RSL1PVBU relay by 0.25 seconds.

Keywords: motor capasitor controller, capacitors motor, submersible pump

1. Introduction

Deep well used to the small industry, residential lots that use submersible pump motor single phase. Motor used is starting capacitor motor type. This motor has advantages in terms of technical and economical aspects. Technical point of this bike has great power, the construction is simple, sturdy and easy maintenance, while economically the motor has a low price. But in reality a single-phase submersible pump motors often run into problems when the motor is working. Starting capacitor used often damaged. This is due to the starting capacitor relay does not work effectively to disconnect the capacitor from the circuit when the motor speed is already above 75% (M.Babu, 2016) [9].

One alternative to overcome the shortage of motor capacitor submersible pump is programmed using the system controller. Control system is programmed to set the starting capacitor and the pump control process. Along with technological development or operation of a motor control system which is inexpensive and easily used. Operation is easy and cheap that using Zelio smart relay. Zelio smart relay included in the Schneider PLC families and does not require a lot of I / O as well as facilities used simple. Based on these descriptions author tries to make the starting capacitor control systems and pump control submerisble. By using a programmable controller systems Zelio smart relay is expected to reduce the problem at the motor starting capacitors. The pump is a machine or mechanical equipment used to raise the liquid from the lowlands to the highlands or to drain fluid from the low-pressure areas stricken area of high pressure and flow rate as well as an amplifier on a network system piping. This is achieved by creating a low pressure at the inlets or the suction and high pressure at the exit or discharge of the pump (V.Vivek, 2002) [20].

Submersible pump (pump-unders) is also called the electric submersible pump (ESP) is operated pump in the water and will be damaged if operated in a state there is no continuous water. This type of pump has a minimum height of water that can be pumped and must be met when working so that the pump long life time. This type of pump type centrifugal pump. Centrifugal pump itself principle works to change kinetic energy (velocity) of fluid into potential energy (dynamic) through a rotating impeller in the casing (M.Babu, 2016) [9].

Fig 1: Submersible pumps

Here are the advantages of this type of submersible pumps:

a) Low maintenance cost
b) Not noisy, because it is in the well
c) The pump has a natural coolant, because his position is submerged in water
d) The pump system does not use a long drive shaft and bearing, so the problem is common on the surface of the pump (Jet Pump) such as bearing and shaft wear does not occur.

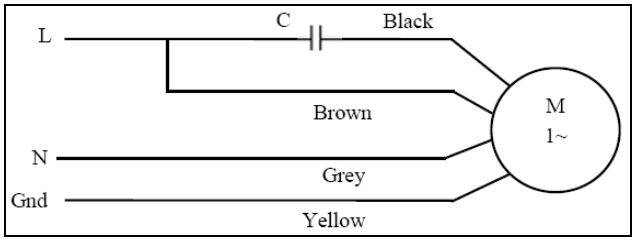

Fig 2: System connection to the motor capacitor

On this kind of Grundfos submersible pump motors are given a sign with a different cable colors. To be connected to the capacitor with cable color black, while the color of the cable connected to the power grid. Construction of single phase induction motor is almost equal to the three-phase induction motor rotor cage, which distinguishes the stator coils form a single phase coil. Single phase induction motors are usually equipped with the necessary centrifugal switch the starting time, the switch will disconnect the supply voltage to the coils after the motor reaches a speed of 75% s.d 100% of the nominal speed of the motor. By connecting a single phase induction motor to a source of alternating voltage single phase, the stator coils will generate the sinusoidal flux (T. R. Brinner, 2004) [19]. The magnetic flux is only a pulsation flux, flux is not a swivel, so it does not rotate the rotor at rest, just round the flux generated. So the single-phase induction motor can not start itself. To be able to start their own, motors require tools, there are tools used at the start or during the motor is running. Construction of motor capacitor is almost the same as split phase motors, the difference is only in the addition of unit capacitors connected in series with the primary coil or coils. Capacitors are usually placed on the outside of the motor or be inside the motor home (Sapna Khanchi, 2013) [16]. During the period from the start and the auxiliary winding primary coil is connected to a voltage source and closed centrifugal switch position. Coils connected in series with the capacitor and centrifugal switch. After the rotation of the motor to reach 75% of the nominal speed centrifugal switch will be open so that the motor only works with the main coil only. Round magnetic field to be generated in the motor so arises a phase difference of 90 ° between the primary coil with electric coils. Capacitors are used to carry current to the coils to achieve the maximum price before the current from the primary coil reaches its maximum, so the flow of the coils will precede the current from the primary coil. This condition will produce a rotating magnetic field in the stator, which will result in the motor rotor will rotate. At the start motor will generate torque start (asut) is high when the capacitor connected in series with coils. Installation of capacitor increase the phase angle between the coil current. Equivalent circuit capacitor motors start when the starting (starting) can be expressed by the following equation (Gupta J. B., 2005):

$$X_C = \frac{1}{\omega C} = X_a + \frac{R_a R_m}{|Z_m| + X_m}$$

$$C = \frac{1}{\omega\left\{X_a + \frac{R_a R_m}{|Z_m| + X_m}\right\}}$$

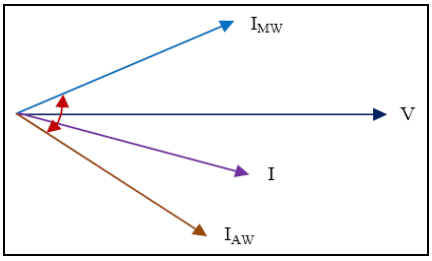

Fig 3: Vector capacitor currents start

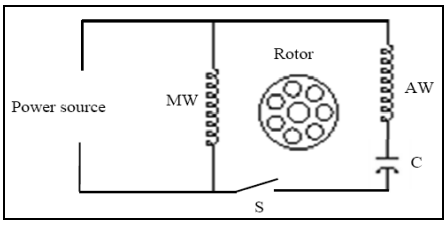

Fig 4: Circuit capacitor start

Zelio Smart Relay is made by Schneider Telemecanique. Available in two models, namely models of compact and modular models. If necessary you can add I / O modules addition (expansion I / O modules), both I / O and discrete I / O analog. Some other options can also be added (MODBUS communications and Memory Module). Programming on Zelio Smart Relay can be done in two ways, first using a programming console (provided the screen and program buttons integrated on the device Zelio) and the second using the help of a PC (personal computer) (N.R.Chitragar, 2015).

2. Methodology

2.1 Data observation

Observations conducted data includes data deep well, pump motor specification. Motors used GRUNDFOS SP 3A - 15. The pump is installed at a depth of 80 meters.

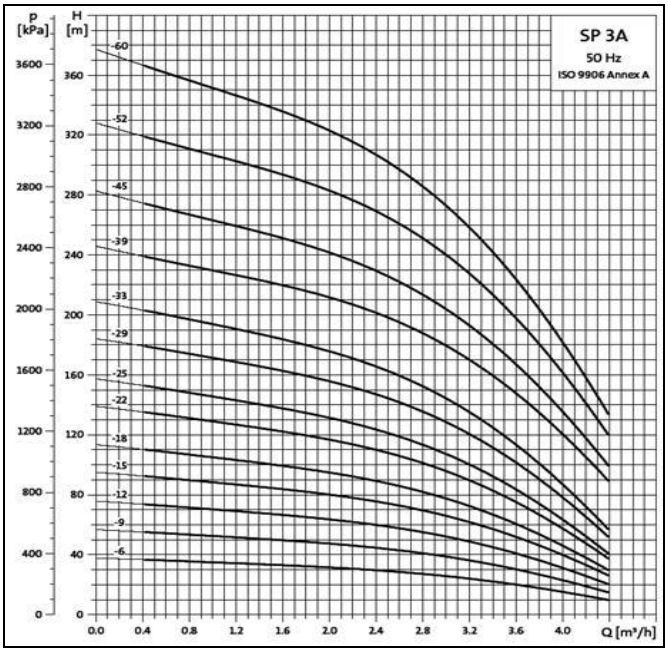

Fig 5: Caracteristic of the submersuble pump SP 3A-15 (Grundfos, 2014).

Grundfos pump used with the following data:
a) Type SP 3A-15
b) Capacity 3m^3/ jam
c) Source voltage single phase
d) 2 pole (2950 rpm)
e) 50 Hz
f) 1,1 KW

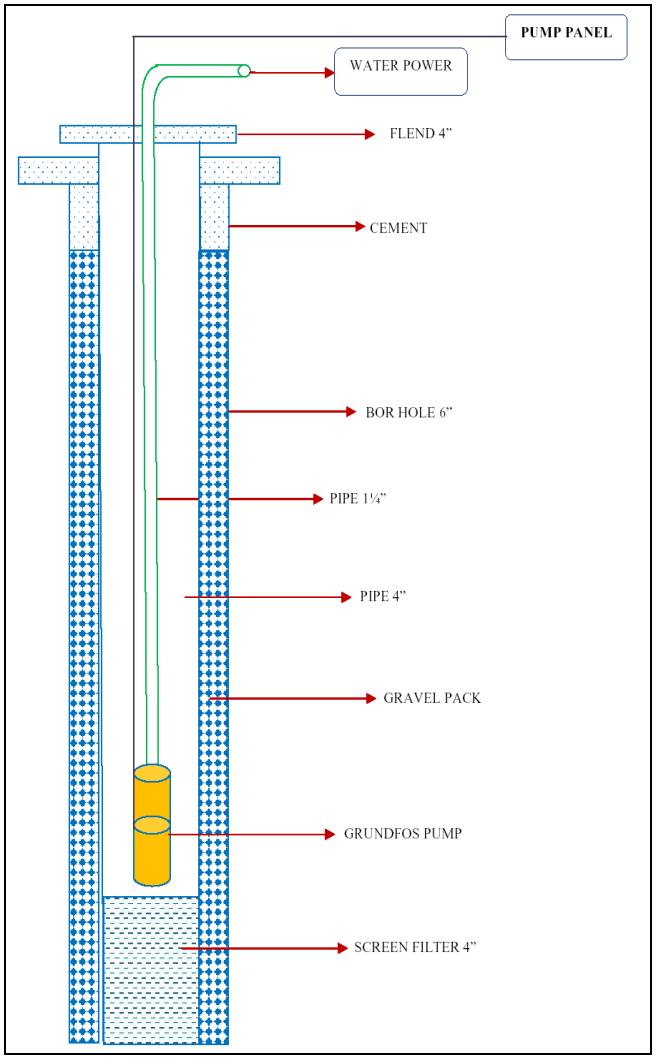

Fig 6: Deep well construction

2.2 The design of the control circuit and power

Control circuits using the following components:
a) PLC Zelio SR2B121FU.
b) Relay RSL1PVBU.
c) Pilot lamp 220 V.
d) Pushbutton (start dan stop).
e) Selektor switch (Man, Off, Auto).
f) WLC (water level control).

In designing the power circuit shown in Figure 3.4 is only required component of magnetic contactor (MC), overload relays (OL) and MCB single phase. Motor pumps used to have a voltage of 220 V. The capacitors used starting the pump motor has a value of 225 µf, 220 V. Used as a relay output interface Zelio PLC with a magnetic contactor (MC) and the interface between the motor coils and capacitors.

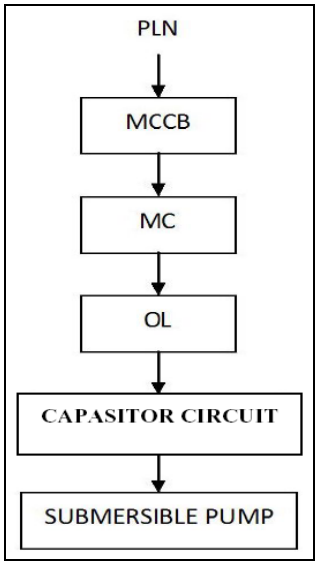

Fig 7: The design of power circuit

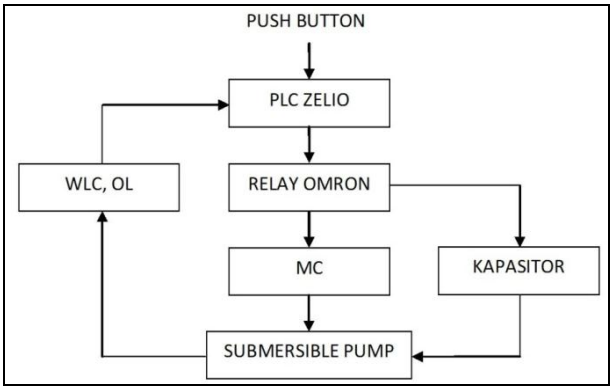

Fig 8: The design of the control circuit

3. Results and Discussion

3.1 The results of the program design LD

In designing the program using Zelio Zelio Soft 2.0 and the selected language program ladder diagram (LD). In the manufacture of ladder diagram to follow the algorithm control process shown in Figure 10. At the time of initial conditions WLC sensor will provide information on the water level in the tank and deep well. If the condition of deep well water level is less, then the submersible pump can not or should not work. If the water level is less than or empty tank, the submersible pump should work to replenish water in the sump. Starting relay pump motor capacitor is governed by omron relay controlled by program Zelio Soft 2.0. In the design of submersible pump control can be done manually or automatically. Work or cessation of submersible pumps depends on the sensitivity of the sensor WLC.

To run the submersible pump motor starting relay capacitor is required to work for two seconds to disconnect the capacitor from the motor coils. Submersible pumps can be operated manually or automatic performed with the selector switch (I1 and I6). Input from Zelio SR2B121FU is more current sensors (OL), water tank level sensor and wells (single WLC) and push button start and stop.

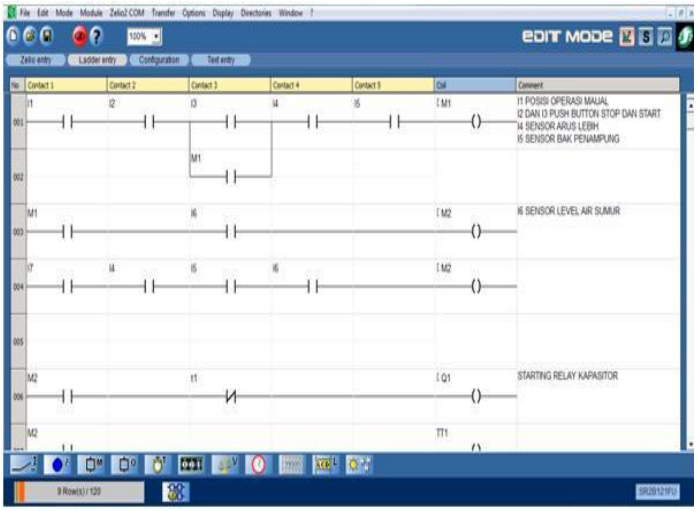

Fig 9: LD starting capacitors and sensors

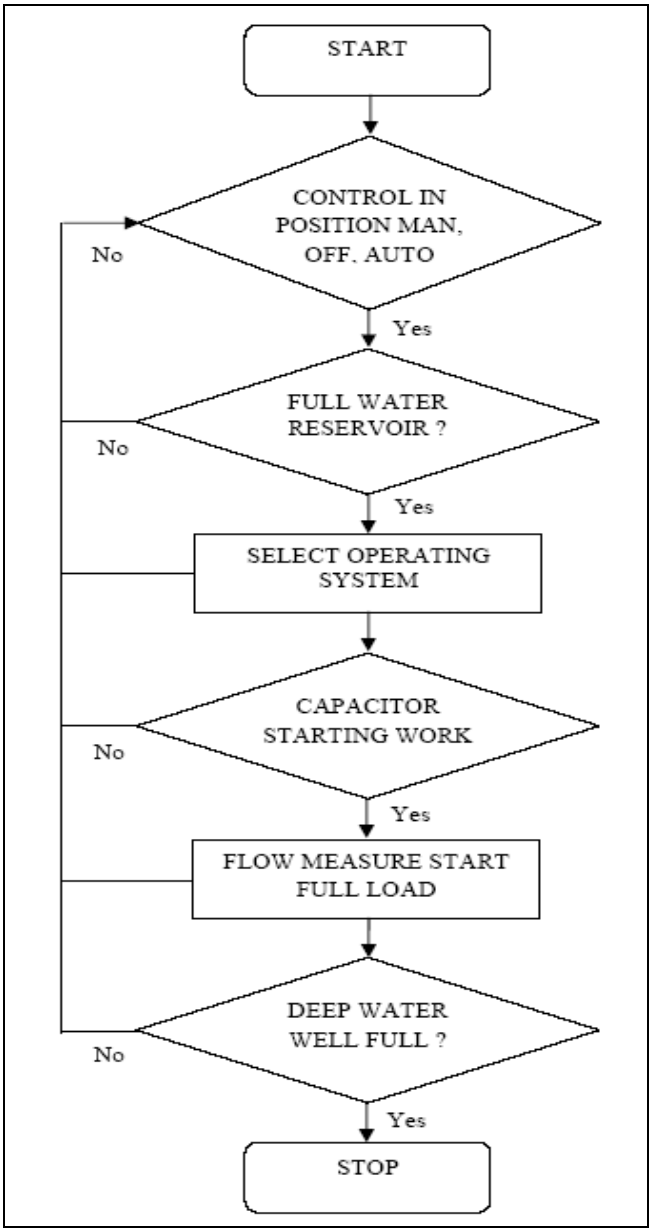

Fig 10: Algorithm Zelio Soft program

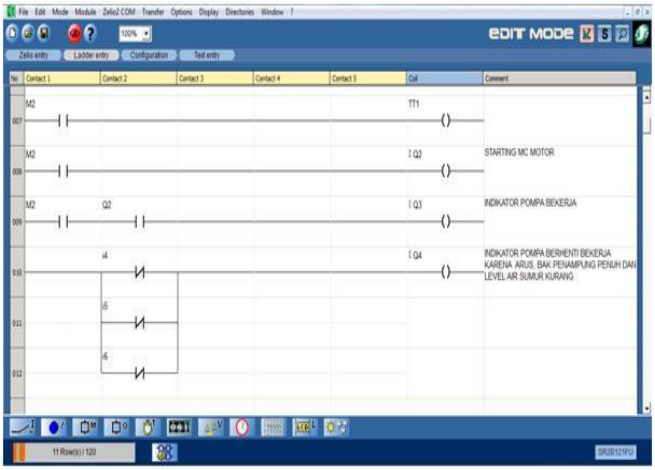

Fig 11: LD Starting the motor and pump indicator

Submersible pump motor works with DOL method. This method produces a high starting current is 27 A in a time of 0.25 seconds. Graph primary coil current and the coils are shown in Figure 12 and Figure 13. Motor used to work at full load current of 10A.

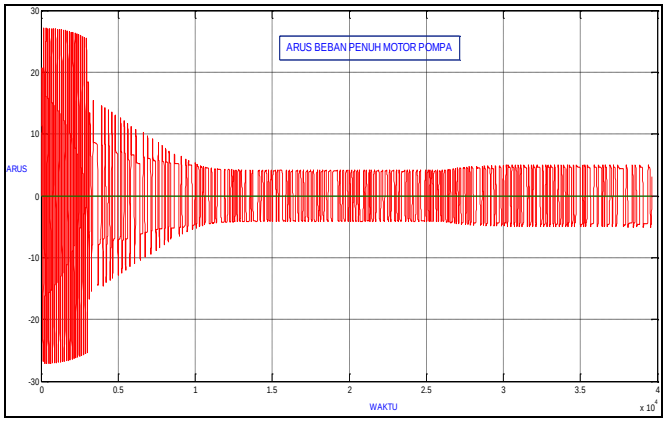

Fig 12: Starting current and full-load current.

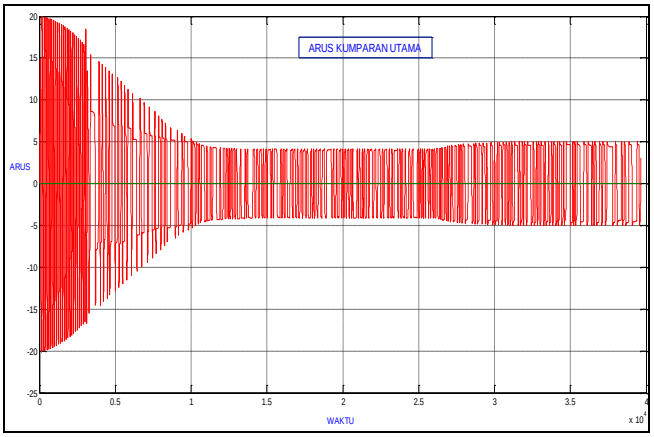

Fig 13: Current main winding

In the figure 13 indicates current coils starting at 10 A and just walk around 0.25 seconds. After 0.25 seconds coils are disconnected from the main circuit so no current flows. Working voltage on the capacitor 110 V and is only used for starting in a time of 0.25 seconds.

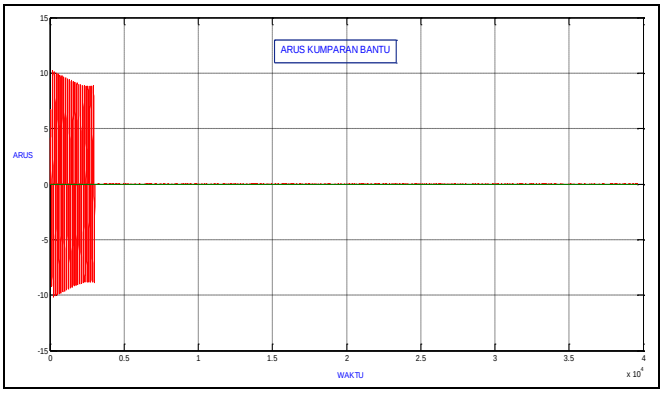

Fig.14. Current auxiliary winding

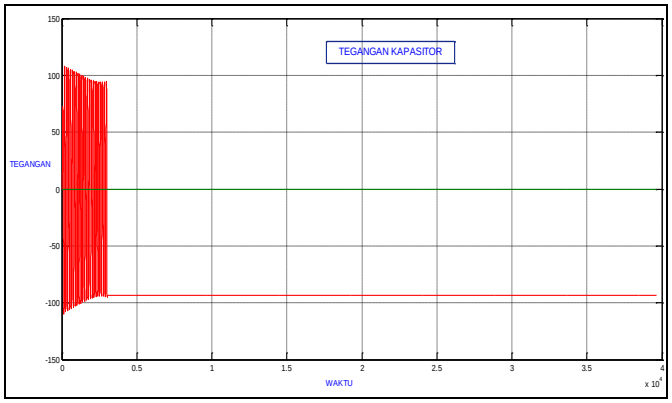

Fig 15: Voltage capacitors

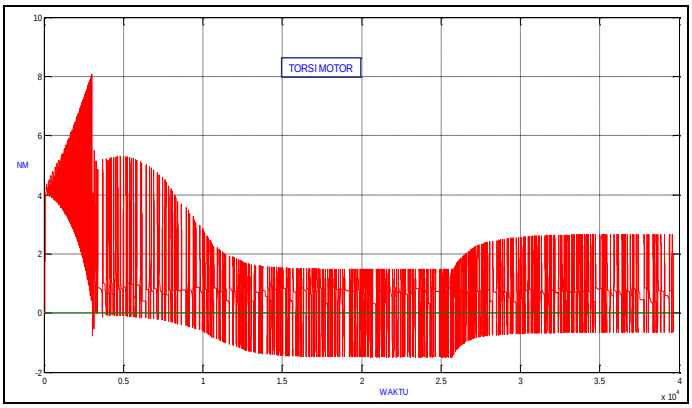

Fig 16: Torque motors

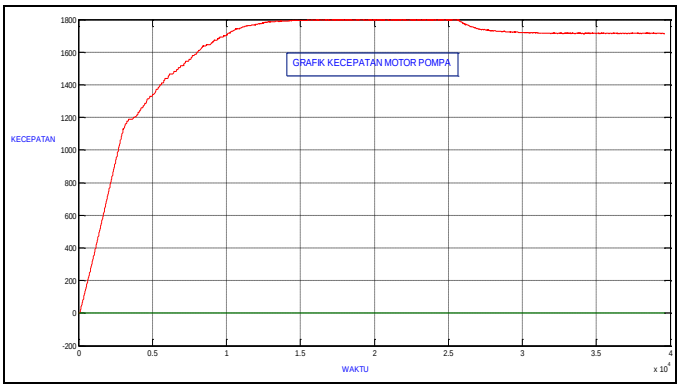

Fig 17: Submersible motor speed

Submersible pump motor speed graph shown in Figure 17 which shows the speed of 2950 rpm in 2.5 seconds. In the process of controlling the pump is equipped with a pump indicator work and the pump stops working (for overcurrent / OL break, the water level tank is full, the water level of wells less). When the relay starting capacitor is not working motor current is 27 A. This causes the submersible pump motor may burn if safety overcurrent (OL) does not immediately cut off the motor of the source voltage of 220 V.

4. Conclusion

Submersible pump motor has advantages in terms of its technical and economical. Technical point of this bike has great power, the construction is simple, sturdy and easy maintenance, while economically the motor has a low price. But in reality a single-phase submersible pump motors often run into problems when the motor is working. Starting capacitor used often damaged. This is due to the starting capacitor relay does not work effectively to disconnect the capacitor from the circuit when the motor speed is already above 75%. One alternative to overcome the shortage of motor capacitor submersible pump is programmed using the system controller. Control system is programmed to set the starting capacitor and the pump control process. Along with technological development or operation of a motor control system which is inexpensive and easily used. Operation is easy and cheap that using Zelio smart relay. Zelio smart relay included in the Schneider PLC families and does not require a lot of I / O as well as facilities used simple. Based on these descriptions author tries to make the starting capacitor control systems and pump control submerisble. By using a programmable controller systems Zelio smart relay is expected to reduce the problem at the motor starting capacitors. The pump is a machine or mechanical equipment used to raise the liquid from the lowlands to the highlands or to drain fluid from the low-pressure areas stricken area of high pressure and flow rate as well as an amplifier on a network system piping. This is achieved by creating a low pressure at the inlets or the suction and high pressure at the exit or discharge of the pump.
Based on the design, testing and analysis has been done in this study, it can be concluded as follows: to run the submersible pump motor starting relay capacitor is required to work for two seconds to disconnect the capacitor from the motor coils. Submersible pumps can be operated manually or automatic performed with the selector switch (I1 and I6). Input from Zelio SR2B121FU is more current sensors (OL), water tank level sensor and wells (single WLC) and push button start and stop. The use of WLC Omron in detecting water levels in the water tank and the water level in the wellbore work effectively provide information to the smart relay. At first sensor WLC will provide information on the water level in the tank and deep well. If the condition of deep well water level is less, then the submersible pump cannot or should not work. If the water level is less than or empty tank, the submersible pump should work to replenish water in the sump. Starting relay pump motor capacitor is governed by omron relay controlled by program Zelio Soft 2.0. In the design of submersible pump control can be done manually or automatically. Work or cessation of submersible pumps depends on the sensitivity of the sensor WLC. The use of programming languages ladder diagram (LD) is very helpful in the design process starting submersible pump motors. In designing the power circuit is only required component of magnetic contactor (MC), overload relays (OL) and MCB single phase. Motor pumps

used to have a voltage of 220 V. The capacitors used starting the pump motor has a value of 225 µf, 220 V. Used as a relay output interface Zelio PLC with a magnetic contactor (MC) and the interface between the motor coils and capacitors. While the design of the control circuits required components, ie PLC Zelio SR2B121FU, Relay RSL1PVBU, pushbutton (start and stop), selector switch (three positions), and the WLC (water level control). Grundfos pump used with the data include: Type SP 3A-15, capacity of 3 m^3 / hour, source voltage single phase, 2 pole (2950 rpm), 50 Hz, 1.1 KW. Grundfos pump mounted on a deep well with a depth of 80 meters.

Submersible pump motor works with DOL method. This method produces a high starting current is 27 A in a time of 0.25 seconds. Graph primary coil current and the coils are shown in Figure 12 and Figure 13. Motor used to work at full load current of 10A. In the figure 13 indicates current coils starting at 10 A and just walk around 0.25 seconds. After 0.25 seconds coils are disconnected from the main circuit so no current flows. Working voltage on the capacitor 110 V and is only used for starting in a time of 0.25 seconds.Submersible pump motor speed graph shown in Figure 17 which shows the speed of 2950 rpm in 2.5 seconds. In the process of controlling the pump is equipped with a pump indicator work and the pump stops working (for overcurrent / OL break, the water level tank is full, the water level of wells less). When the relay starting capacitor is not working motor current is 27 A. This causes the submersible pump motor may burn if safety overcurrent (OL) does not immediately cut off the motor of the source voltage of 220 V.

Development of the starting capacitor for submersible pumps still very much needed, because some brands are still a lot of submersible pumps have problems in starting capacitors, so that the submersible pump efficiency is still low. Starting capacitor submersible pumps can be developed using a microcontroller and handler are already using kogic fuzzy controller.

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