

Mixer Control System for Brick Making Based on PLC Omron CP1E-NA20DR-A



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ABSTRACT

Keywords

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Bricks play a very important role in the construction of houses. No matter how beautiful a house is, without bricks, it cannot be said to be a house. With the development of architecture, bricks are not limited to the protection of the house, the role of bricks is now shifting towards a broader architectural design or construction. This research was conducted by designing hardware and software design and research materials. This hardware consists of several parts and ways of working in producing bricks, ranging from the frame as a support, control panel from PLC, pneumatic system, soil milling place, and 3-phase induction motor as a drive for the milling process so as to produce soil that is ready for molding. In programming the OMRON CP1E NA20DR-A PLC, supporting software is needed, namely CX-ONE software. CX-ONE software is designed on the software arranged according to the working principle, the volume of the mixture between 2 liters of soil and 2 liters of water using a delta circuit then a brick dough is produced that can be used properly. The existence of this tool is expected to make it easier to produce bricks.

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1. Introduction

Red brick is an artificial stone made from clay or unmixed materials, dried in the sun for several days, then fired at high temperatures until it is hard enough not to crack when immersed in water [1]. Soil has several distinctive properties, namely when it is wet it has plastic properties but when it is dry it becomes hard, whereas when it is burned it becomes strong and solid [2]. Bricks are a building material in the form of rectangular prisms, solid and used for the construction of building walls, which are made of pure clay with or without additives and fired at a certain temperature [3]. In general, red bricks have a color that is not nearly all the same, but most are brownish red. Unlike the case with red bricks, the surface of the face bricks is usually smoother and smoother [4]. The type of brick that is very often used today is brick made of clay or clay [5]. The compressive strength obtained by bricks using a mixture of clay, dust and sand meets the permissible pressure strength standards (SNI = 25-250 kg /cm²) which is around 26.67 kg/cm² - 104.67 kg/cm² [6]. In order to produce good concrete brick mixer results, it is necessary:

1. Motor: 2.35 Hp or 1.75 Kw with a minimum rotation of 30 Rpm and a maximum rotation of 1500 Rpm.
2. Shaft material: S50C AISI 1050 with a diameter of 25.76 mm and a length of 1000 mm.
3. Bearing: Mounting type Radial Ball JIS B1520.

4. Transmission: Belt type --V Type B -109.
5. Pulley: Diameter of small pulley: 4 In Diameter of large pulley: 6 In [7].

PLC is a special microcontroller system for industry, meaning a set of software and hardware adapted for application needs in the industrial world [8]. Control system A control logic program with 3 connection functions, namely PLC processor control, input current and a computer as a time controller, can monitor and output is connected to the motor process by making bread in the form of a ladder diagram. The workings of making bread and the application of tools that can affect timeliness in order to obtain the best and most efficient results. Produce better processed products with minimal resources [9]. Programmable Logic Controller (PLC) is an electronic computer device that is so easy to use (user friendly) and has control functions for various types and different levels of difficulty [10].

A 3-phase induction motor has a construction similar to other types of electric motors. The 3-phase induction motor has two main parts, namely the stator and the rotor. The stator is the stationary part of the motor, while the rotor is the moving part of the motor [11]. The lines of induced flux force from the stator coil will cut the rotor coil resulting in an electromotive force (Emf) or induced voltage [12] between the rotor rotation and the magnetic flux rotation there is a difference in rotation which is called slip [13]. The 3-phase induction motor is the most widely used drive device in the industrial world [14] this means that of all types of induction motors, the 3-phase induction motor is the most stable motor under normal conditions when supplied with a balanced 3-phase system [15].

The Star-Delta circuit is one of the motor circuit systems used to run electric motors with the aim of reducing high starting current spikes [16]. Agitating the star-delta motor means that the motor circuit is connected to a star when starting, and connected to a delta when running [17] with the aim of reducing the incoming voltage to the motor coil [18].

This study aims to find out how the mixer works for making bricks with PLC, to know the standard mix of brick soil dough, and to know the working system of the ladder diagram in the CX-Programmer software.

2. Method

This research was conducted at the system design stage, both in hardware design and software design as well as research materials.

This hardware consists of several parts and working methods in producing bricks, starting from the frame as a support, the control panel from the PLC, the pneumatic system, the soil mill, the 3-phase induction motor as the driver of the grinding process so as to produce soil ready for printing.

In programming the OMRON CP1E NA20DR-A PLC, it requires supporting software, namely the CX-ONE software. CX-ONE software is designed on software that will be compiled according to working principles.

2.1. Tables and Figure

After doing hardware and software design. Then, an automatic brick making machine is made that is ready to use, Fig. 1.



Fig. 1. Automatic brick making machine

The PLC OMRON CP1E-NA20DR-A has several indicators that display the state when the PLC is running [10]. Table 1 of the indicators found on the Omron CP1E-NA20DR-A PLC which displays the state when the PLC is running [19].

Table 1. Indicators on Omron PLC

Indicator	Status	Information
PWR	ON	Power is provided to the PLC
	OFF	Power is not supplied to the PLC
RUN	ON	PLC operates in run or monitor mode
	OFF	PLC is in program mode or an error has occurred
ERR/ALM	ON	A fatal error has occurred (PLC operation has stopped)
	BERKEDIP	A non-fatal error has occurred (PLC operation continues)
	OFF	Indicates normal operation
INHHL	ON	All outputs turn off
	OFF	Normal
PRPHL	BERKEDIP	Communication (either sending or receiving) is taking place via the peripheral USB port
	OFF	No communication
BKUP	ON	User program, certain parameters or words in dm area are being written to backup memory
	OFF	There is no backup process
COMM	ON	Data is being transferred through the peripheral port
	OFF	Data is not currently being transferred through the peripheral port

2.2. Equation

Flux is generated from the stator coil which creates a current, if a 3-phase voltage source is connected to the stator terminals. The flux in the stator is generally fixed, the following is equation (1) the stator rotation speed.

$$Ns = \frac{f \cdot 60}{P} \quad (1)$$

Ns = stator speed (rpm)

P = Number of poles on the motor

f = Frequency (Hz) [20]

2.3. System Design

The 3-phase source is connected to the 3-phase MCB at R,S,T. Then the 3-phase current from the MCB is connected to contactor 1 at the R,S,T contacts. the output on the U, V, W contactor is connected to the 3-phase motor U1, V1, W1, then the U2, V2, W2 motor is connected to the 2 U, V, W contactor. R,S,T on contactor 2 is connected to contactor 1 on R,S,T so that a star circuit occurs. Contactor 3 U, V, W is connected to contactor 2 on U, V, W, while R, S, T on contactor 3 is connected or mixed so that a star circuit occurs. Then, the 1-phase source is connected to a 1-phase MCB which will be a source for the PLC which consists of several components such as push buttons and contactors [21].

From this explanation it relates to the components used and the number of components in the research design including the tools and materials used, namely: 1 3-phase MCB, 1 1-phase MCB, 3 contactors 1 push button on, 1 push button off, 3-phase induction motor, PLC Omron CP1E-NA20DR-A, clay and water can be seen in Fig. 2.

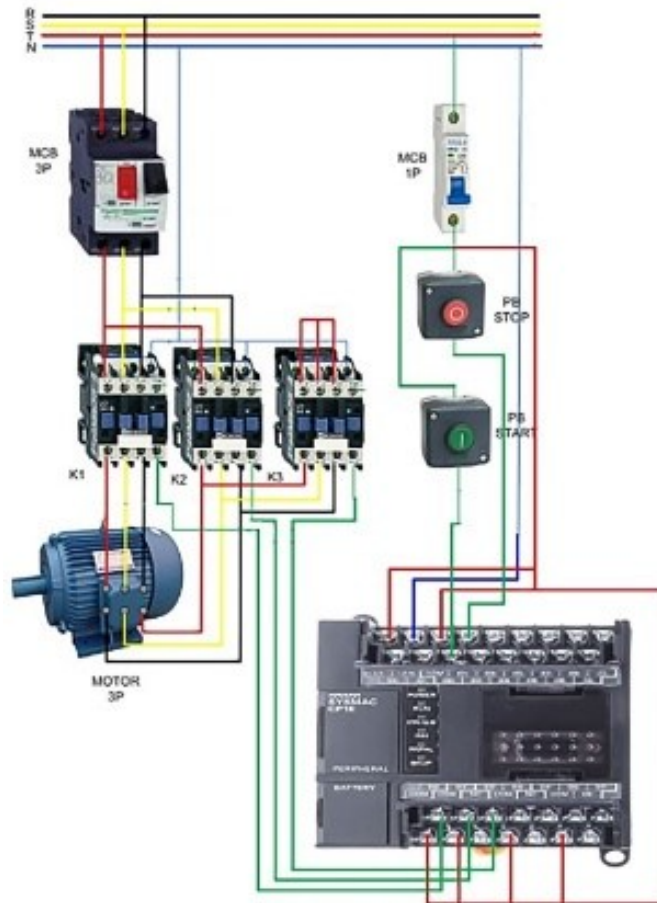


Fig. 2. Wiring star-delta circuit

The resulting block diagram has two block diagrams, namely the star block diagram and the delta block diagram can be seen in Fig. 3 and Fig. 4.

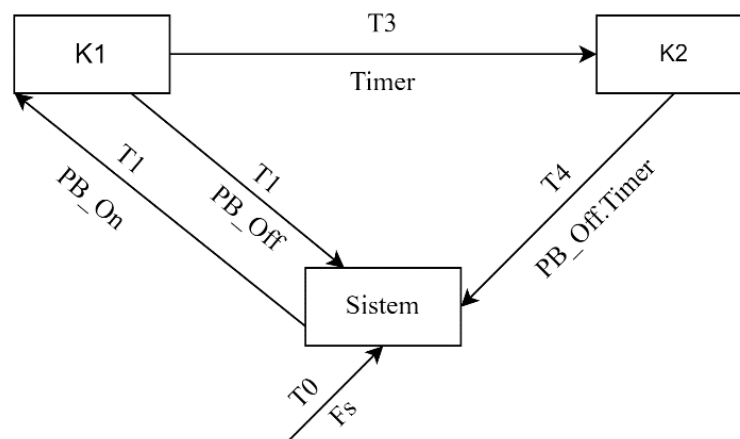


Fig. 3. Star block diagram

Based on the star block diagram, several equations are obtained
Transition equation (2).

$$T0 = Fs$$

$$T1 = Sistem \times Pb_On$$

$$T2 = K1 \times Pb_Off$$

$$T3 = K1 \times timer$$

$$T4 = K2.Pb_Off \times Timers \quad (2)$$

Equation of circumstances (3).

$$System = (System + T0 + T2 + T4) T1$$

$$K1 = (K1 + T1) T2 + T3$$

$$K2 = (K2 + T3) T4 \quad (3)$$

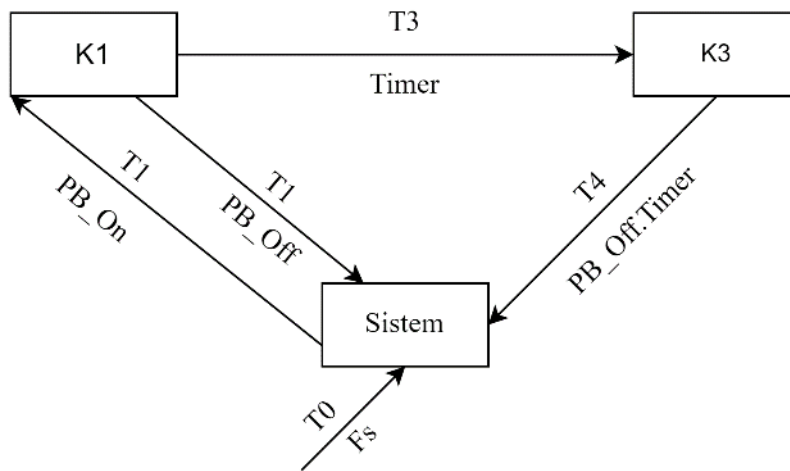


Fig. 4. Delta block diagram

Based on the star block diagram, several equations are obtained
Transition equation (4).

$$T0 = Fs$$

$$T1 = System \times Pb_On$$

$$T2 = K1 \times Pb_Off$$

$$T3 = K1 \times timer$$

$$T4 = K3 \times Pb_Off \times Timers \quad (4)$$

Equation of circumstances

$$System = (System + T0 + T2 + T4) T1$$

$$K1 = (K1 + T1) T2 + T3$$

$$K3 = (K3 + T3) T4$$

2.4. Algorithm

To operate the brick maker, it is necessary to use the CX-Programmer program shown in Fig. 5.

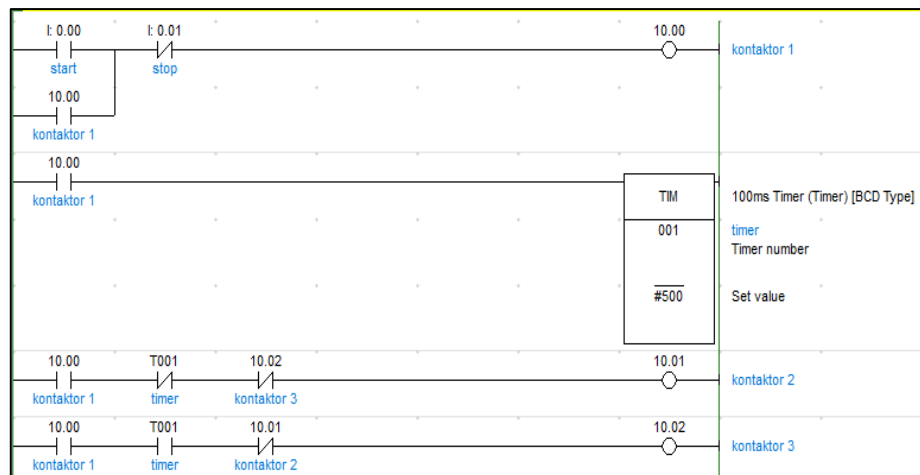


Fig. 5. Star-delta program

Fig. 5, the Star-Delta program on the CX-Programmer. Has different input and output addresses, where the addresses are shown in Table 2.

Table 2. Input and output PLC program

Inputs	Output
Starting: 0.00	Contactora 1: 10.00
Stops: 0.01	Contactora 2: 10.01
	Contactora 3: 10.02
	Timer: TEAM 001

The program has a way of working. When the start button (0.00) is turned on it will turn on contactor 1 (10.00) and the motor is in a start circuit condition, then contactor 1 will turn on the timer (TIM 001), after the timer runs for a predetermined time of 50 seconds it will turn on contactor 2 (10.01), then contactor 2 will turn on contactor 3 (10.02) so the motor is in delta circuit condition. Then to cut off the circuit, turn on the stop button (0.01) as shown in Fig. 6.

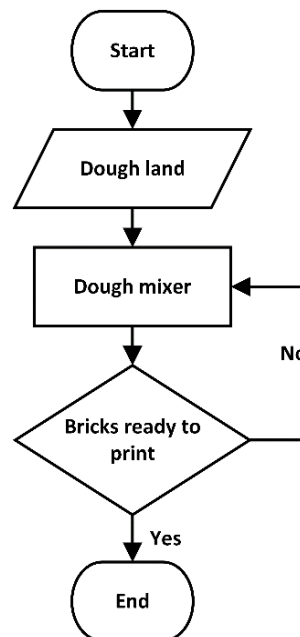


Fig. 6. Flowchart




3. Results and Discussion

After conducting tests on the Star-Delta series, tests were then carried out on the brick dough.

3.1. Testing on the star circuit

The test results from the series of stars can be obtained that the mixture that has an almost perfect mixture is a mixture of 2 liters of soil and 2 liters of water. Whereas in a mixture of 1 liter of soil and 2 liters of water the result is too liquid, as well as in a mixture of 2 liters of soil and 1 liter of water the results are too thick can be seen in Table 3.




Table 3. Testing on the star series

Series Type	Volume	Current (A)	Speed (rpm)	Results
Star	2 liters of soil 1 liter of water	15.8	2998	
	1 liter of soil 2 liters of water	16	2987	
	2 liters of soil 2 liters of water	15.8	2990	

3.2. Testing on the delta circuit

The test results from the delta circuit can be obtained that the mixture that has the perfect mixture is a mixture of 2 liters of soil and 2 liters of water. Whereas in a mixture of 1 liter of soil and 2 liters of water the result is too liquid, as well as in a mixture of 2 liters of soil and 1 liter of water the results are too thick can be seen in Table 4.

Table 4. Testing on delta circuits

Series Type	Volume	Current (A)	Speed (rpm)	Results
Delta	1 liter of soil 2 liters of water	16.8	2994	
	2 liters of soil 1 liter of water	16.4	2991	
	2 liters of soil 2 liters of water	16.6	2992	

4. Conclusion

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