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Electrical Safety System on Ice Tube Machine

Yuli Prasetyo[a], Basuki Winarno[a], R. Akbar Nur Apriyanto[a], M. Hanif Nur Kholiq[a]

[a]Engineering Department, State Polytechnic of Madiun, Madiun, Indonesia

A B S T R A C T

Ice is one of the products produced by cooling machines that can be used to lower the temperature. It is obtained from the process of changing the state of water into ice by cooling below the freezing point of water at 0°C. The process of cooling into ice is done by releasing heat energy which causes the surface of the water to harden. The use of ice-making technology can be done with the Smart Relay-based Fast Freezing Method. This method minimizes the manual system mechanism to increase ice production, one of which is Tube Ice. This research uses an experimental approach method to get the best results which will later be included in the PLC (Program Logic Controllers) and HMI (Human Machine Interface) systems in one Autonic Fort component. This research output is in the form of a smart tube ice machine (ice crystal). This ice machine can help the community in the culinary and fishery fields. With this tube ice machine, culinary entrepreneurs can get an ice supply quickly and hygienically. In contrast to the beam industry, which requires a large area and a lot of infrastructure. This smart tube ice machine can increase the productivity of the tube ice produced. This tube ice machine uses a design with a model and size that is very compact and easy to operate, does not require a large place. So that they can work as micro, small and medium enterprises that can support the community's economy.

Keywords: Quick Freezing Method, Smart Relay, PLC and HMI, Ice Tube

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1. Introduction

Ice Tube or ice crystal is a variant of ice cubes in the form of a tube or cylinder with a hole in the middle with certain dimensions. This variant of ice cubes is widely used by the public to mix drinks. This ice tube is more hygienic with a clear and neat appearance than ice cubes [1]. Ice is used in various sectors such as in the food and fishery sectors. This ice food sector is used to make mixed ice and other ice drinks. This ice fishing sector is used to cool the caught fish so they don't rot quickly.

In the usual ice production process, it still uses the conventional system which takes a long time. For example, a freezer machine at home, to be able to freeze ice perfectly takes approximately 12 hours, as well as ice blocks produced by factories. So to increase ice production, a research was carried out aimed at applying tube ice machine technology using smart relays. This tube ice machine was developed from a manual system to a digital control system using a smart relay [2]–[4]. With the development of this digital system, the production process is easy to control automatically and the maintenance process is easier to do. Ice mold machine used in the form of stainless steel pipes arranged vertically and lined up inside the evaporator whose number corresponds to the capacity machine. The refrigerant will be sprayed with high pressure into the evaporator containing pipes which are ice molds. Pipes the water will be pumped from the bottom up and then it will be down through the pipe hole that has been frozen by the refrigerant, so that water flowing through the pipe gets trapped and freezes. water that has not frozen will go down the water reservoir that is below then it will be raised again by the pump to the top to flow again into the in the pipe. So that in the pipe will form a layer of ice which getting thicker over time. After the pressure inside the evaporator is low enough, then the freezing process has been completed which will followed by the process of removing ice from the mold by 2 inject hot refrigerant gas from the condenser into the evaporators. So the ice will be released from the pipe and will go down. After the ice drops to the bottom the next process will be cut by a knife motor driven cutter. The cut ice will descend to in a rotating disk that moves with the cutting blade, then the ice will come out through the bending blade. After the ice runs out, the cycle will be start over again automatically.

With the development of the ice tube system, different components and electrical installation systems are certainly needed. A good and correct electrical installation greatly affects the running of an ice tube machine and the smart relay program. Therefore we need a safety system for electrical installations on the ice tube machine [5].

2. Methods

2.1. MCB

The load of the compressor, condenser and cutting motors used in the ice tube machine is a 3 phase electric voltage used is 380V and the value of each phase on PLN electricity is 40A, the MCB that is used is a 3 phase MCB with 62A amperage value. The load of the water pump motor used in the ice tube machine is 1 the electric voltage phase used is 220V and the

* *Corresponding author.*
E-mail address: yuliprasetyo2224@pnm.ac.id.

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phase value at PLN electricity is 6A, the MCB used is a 1-phase MCB with an amperage rating of 10A.

Figure 1. (a) MCB 3 Phase; **(b)** MCB 1 Phase.

2.2. Research Scheme

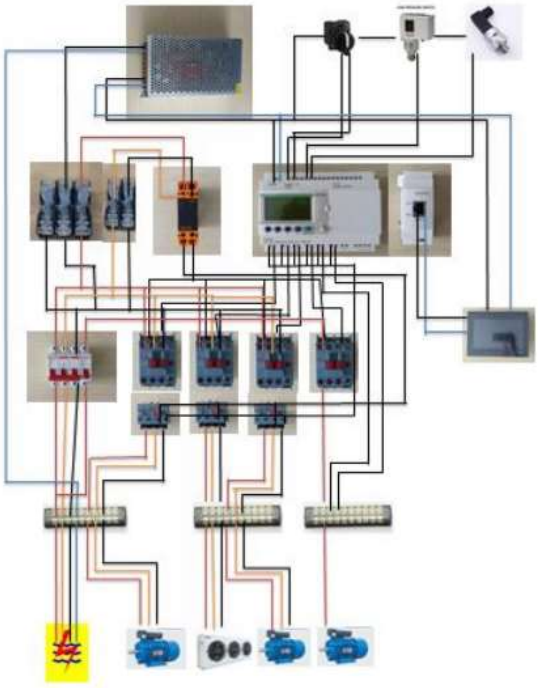

Figure 2. Research Scheme

The design model of the wiring design that I made is the system electrical safety on the ice tube machine that is connected to the source 380V AC. To start the circuit work, first source from pln enter the terminal block then enter the 3 phase mcb and 1 phase mcb after that from the 3 phase mcb from pln it enters the compressor contactor, condenser, and cutting then the single phase mcb enters the contactor water pump. From the mcb something goes into the fuse for use lighting volt meter, ampere meter, power supply, phase protection relays. Then from the protection phase the relay enters the contacts contactor. From the power supply into the plc then output from the plc enter the NO contactor. After entering the contactor then enter again to the thermal overload relay after that to the terminal block then out to the electric motor.

Figure 3. Installation of electrical components and wiring

The wiring lines for the cables on the panel are as follows:

- Source 380 V from PLN enters the terminal block
- After leaving the terminal block then enter the MCB 3 Phase
- From the 3 Phase MCB, the R phase is connected to the 1 Phase MCB which is next to MCB 3 Phase
- After the RST phase MCB is connected to the contactor Compressor, Condenser, Cutting and for single phase MCB connect to the water pump contactor.
- From the 3 Phase MCB there is something connected to the fuse
- After the Fuse is connected to the Power Supply, Phase Protection Relay, and 2 Led Pilot Lights.
- From the Power Supply the jumper is connected to a source 24 of PLC and connect to HMI
- The output of the PLC which is COM in the jumper is then connected to NO Overload Relay which works as contact for control program from PLC
- From the Fuse connected to the Phase Protection Relay then connected NC Thermal Overload Relay from Compressor jumper to Condensor, and to Cutting. Phase Protection Relay serves as double security apart from Thermal Overload Relay in case of overvoltage exceeds the specified limit it will cut off the current electricity automatically.
- Thermal overload relay serves as a current safety will automatically disconnect when the load exceeds the limit.
- Phase Protection Relay works to secure the existing motor on the ice tube machine it works as a circuit breaker automatically when there is an overvoltage.
- NC of Thermal Overload Relay connected with switch ON OFF on the panel door.
- Then PLC is connected with Modbass and connected with an Ethernet cable to connect with HMI.

3. Results

Figure 4. implementation of electrical safety system panels on ice tube machines

The picture above is a test on panel components with connecting a 380 V PLN source to the system's ice tube machine panel safety on the wiring panel circuit is as follows:

1. Phase Protection Relay as a safety for electric motors on ice tube machine by connecting from MCB 3 source Phase RST goes to L1 L2 and L3 Phase Protection Relay
2. Then from the Phase Protection Relay connected to magnetic from the Thermal Overload Relay which functions as a contact voltage on contactor
3. If there is an excessive voltage from the load from the PLN Load then the Phase Protection Relay will detect interference excessive voltage and will break or close the contact source voltage and current from the contactor so that all contactor will turn off.
4. Then if the RST voltage from PLN is missing, it's wrong single phase on Phase Protection Relay will detect interference then it will disconnect or close the voltage source contact and current from the contactor so that all contactors will be off.
5. If when connecting the RST phase from PLN is reversed, then the Phase Protection Relay won't work so it's automatic contact of the contactor there is no incoming voltage and current and the contactor will not turn on.
6. Thermal Overload Relay is also a safety for the motor electricity in the tube ice machine.
7. If there is an excess voltage that exceeds the setting limit on Thermal Overload Relay then the NC contact will disconnect voltage and current so that the contactor will be off.

Figure 5. Voltage Measurement on **(a)** Cutting Motor; **(b)**Condenser.

Table 1. Data Phase Protection Relay.

L1	L2	L3	NO	NC
R	S	T	OFF	ON
S	T	R	ON	OFF
T	R	S	ON	OFF
R	T	S	ON	OFF
Phase R Lost	S	T	ON	OFF
R	Phase S Lost	T	ON	OFF
R	S	Phase T Lost	ON	OFF

The table above is a circuit system on the safety phase protection relay where if L1, L2, L3 the phase sequence is correct RST then the phase protection relay will automatically detect NO (OFF) and NC(ON), then if L1, L2, L3 the phase order is reversed RTS, STR, TSR then the relay will automatically detect NO (ON) and NC(OFF). And when the RST phase loses one of its phases then the relay will cut off the contact or open the NO contact so that the flow the power supply will be cut off

4. Conclusion

The electric safety system on the ice tube machine will cut off the current and the mains voltage automatically if there is a high voltage excess. The electrical safety system serves to secure the motor electricity used in tube ice machines. The electrical safety system on the ice tube machine will disconnect voltage and current on the contactor if there is a loss of one of the RST phase from PLN. The use of the Phase Protection Relay is for safety double after Thermal Overload Relay.

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