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Development of a Programmable Logic Controller Based Control System for a Water Plant

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ABSTRACT

The primary objective of this study is to use programmable logic techniques to control the operation of water sucking pumps to supply Bait Elmal plant from the S stream. Basically the proposed system works as follows: the raw water sucking pumps controlled by level sensors inside the water reservoir. The sand filter washing process is automatically initiated by level sensors installed inside the filter basin. Some are used to measure water flow rate and turbidity for adjusting the addition of chemicals

Practically the reservoir has been controlled by using two sensors connected to the raw water pumps through a Programmable Logic Controller (PLC). The filter washing process valves are open and closed automatically by a signal coming from a control unit. The readings of flow rate, pH, and turbidity devices are used as inputs to the PLC with the aid of a program designed for automatically adjusting the addition of chemical materials

Finally, a complete control system has been successfully tested, where the sucking pumps are installed to supply Bait Elmal water plant from the river Nile. The result obtained prove the reliability and applicability or the system with more advantages at Bait Elmal plant or any similar drinking water plant.

Keywords: PLC, Water Treatment Control Systems

INTRODUCTION

Today, providing of adequate drinking water supplies is a common issue across the world due to the rapid growth of population everywhere Control is an integral part of water plant system (Gil and Passino, 2004 Control systems have evolved over time, where in the past most system- were controlled manually. More recently electricity has been used controlling systems based on relays. The development of low cost computer has brought the most recent revolution, the Programmable Loci: Controller (PLC). Such modern control techniques are applied in water treatment process to meet hygiene conditions (Jack, 2008).

This study considers Khartoum State Water Corporation (KSWC) as a highly populated area sample that depends on the Blue and White Nile rivers as main sources of drinking water with primary focusing on a water treatment station, known as Bait Almal, located on the Niles junction at the White Nile bank. Basically, there are problems at Bait Almal station, i.e. water level instability together with the impurity content of White Nile water, which causes the use of excess chemical material that leads to higher production cost (Ali, 2008).

To handle the above mentioned problems a PLC automated control systems has been suggested by this paper to manage the production process and raise its efficiency to the best possible level without use of excess chemical materials (Parr, 2003). Therefore it is important that the proposed automated system works efficiently to get the most profit out of the production process, as well as, to ensure the safe operation of the plant and to prevent possible fatal accidents or even catastrophic disasters that might affect the environment (Tahvonen, 2006). Potential unwanted incidents at the plant can be reduced with a well working safety automation system, as it can remarkably reduce the overall cost and possible human errors. Thus high reliability on the proposed automation system is mandatory for economical and safety reasons.

The rest of the paper is organized as follows: the next section presents the recommended modifications for controlling Bait Elmal plant. Section 3 covers PLC main components and applications. Section 4 explains the proposed control system using PLC techniques. The developed control system has been implemented in Section 5, followed by the conclusion in the last section.

PROPOSED MODIFICATIONS FOR CONTROLLING WATER TREATMENT PROCESS

This section explains the existing water treatment process as well as suggesting new techniques to promote operation performance, production efficiency and reduce the cost. The new control techniques mainly focus on operation of pumps, filter backwashing, addition of chemical materials and water reservoir level.

Controlling of Sucking Pumps Operation

Operation of these pumps is based on delta/star control circuit (starter) established at the Nile bank, beside the pumps, the action of start/stop is applied manually by pressing start / stop pushbuttons. These pumps generally operate at the voltage 415 V -3 phases. As shown on Fig. (l), the starting circuit comprises three contactors (KI, K2 and K3) with a timer to mange the starting conditions of the pumps.

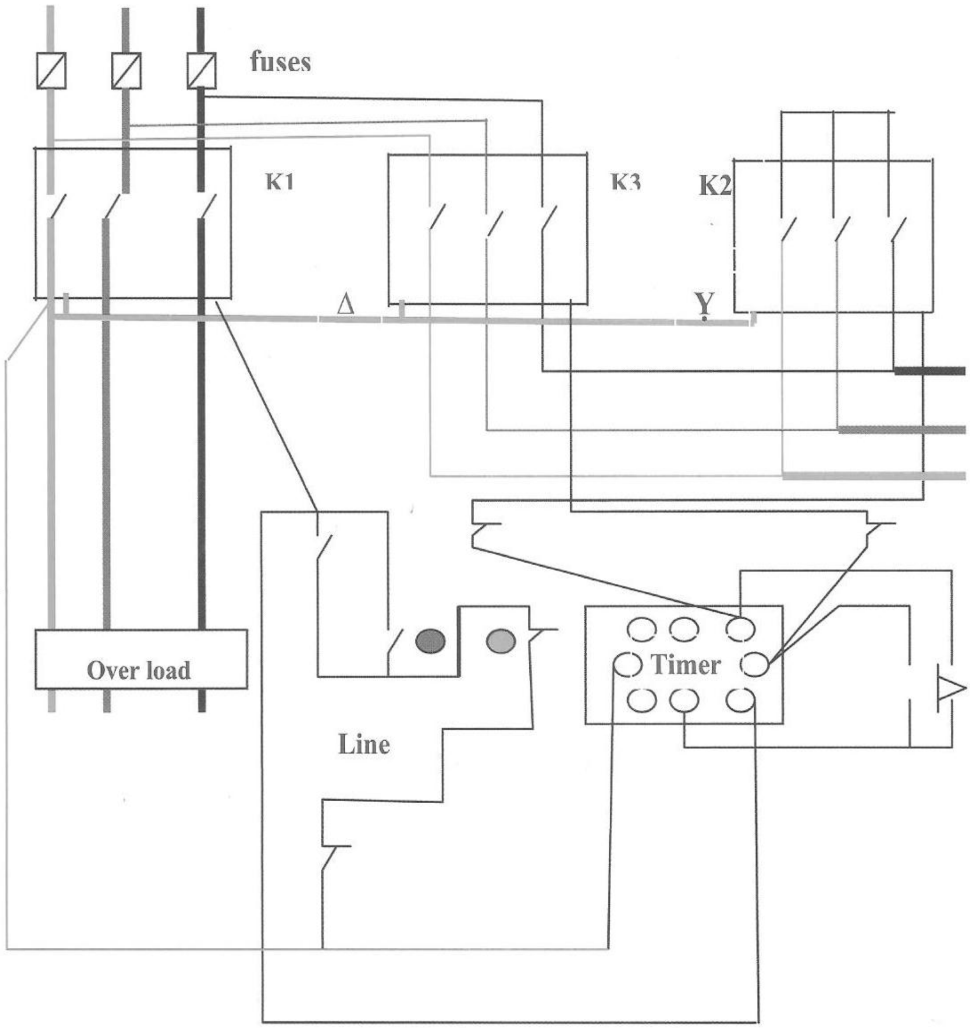


Fig. 1: Control circuit of the pump operation

This contactor KI insures the main supply to the pump and with the help of auxiliary element protects the pump from overload and short circuit condition. The contactor K2 works to initialize the start condition of the pump (Star condition(Y)) for a short time, adjusted by a timer.

The contactor K3 operates simultaneously when (K2) releases (by means of interlock) to inject full supply voltage to the pump (Delta condition (A)).

Suggested control: the research aims to locate the sucking pumps on floating lunch linked to Shambat Bridge. While the operations of the water sucking pumps can be controlled by a computer system using PLC (Parr,1999), i.e. replacing the manual control system. Water from all pumps is collected in a main pipe (collector) and a water flow meter is located at the end to give the total withdrawn water quantity.

Filters Backwashing

During the filtration process, panicles suspended in the filtered water are removed largely through entrapment within the filter media. As more and more fluid is passed through the filter, the suspended particles accumulate within the media, reaching levels that lead to one of two detrimental events. They can either cause the head loss within the filter to reach excessively high levels, or they can become pushed through the filter, resulting in product water turbidities that reach unacceptable levels (EPA, 2002). Therefore, in order to maximize the use of a given filter, it becomes necessary to remove these entrapped particles from the media itself. Filter backwashing is the process by which this is accomplished. From an operational standpoint, backwashing is initiated when either one of the two mentioned conditions occurs, water level in the filter reaches impermissible level or more commonly, after a preset run-time interval has been reached.

Suggested techniques:

Filter efficiency depends on its ability to produce perfect filtered water through a day. This efficiency can be controlled by installing water level sensor in the filter basin. When this water level exceeds impermissible level, backwashing operation is executed automatically with the program aid. To permit automatic backwashing, old valves must be replaced by controlled ones which open and close automatically (Dodd and Fettig, 1999).

Controlling of Reservoir Level

One of the important things in water treatment process is how to keep reservoir water level which is changed according to quantity of consumption water in the city and the quantity of filtered water during day hours. To keep reservoir level, the number of raw Water operating pumps will be increased in case of level drop, stop in case Of overflow, otherwise it will be constant. This process is executed by taking discrete readings from reservoir using sensors and with the aid of a program the level can be controlled (Ali, 2008).

Controlling of Chemical Materials

Water purification and safety depend on added sedimentation and disinfection chemical materials, which are defined by reading of parameters concerning with quantity and quality of raw water.

There is a chemical room for, preparing chemical materials. This unit includes feeding machines, chemical coagulants daily tanks and other equipment. The chemicals added are: Poly Aluminum Chloride: Extra power inorganic Aluminum salt used as cationic coagulant, max permissible dose is 250mg/l. Chlorine Gas: Oxidant use in trace dosage for the removing bacteria, recommended dose is 1mg/l (Ali, 2008).

Suggested Techniques:

sensors can be implemented to measure some variables like flow rate (m3/h), Ph (H+), and turbidity (N TU). The required instruments to be used in order to control production are shown on Fig. (2).

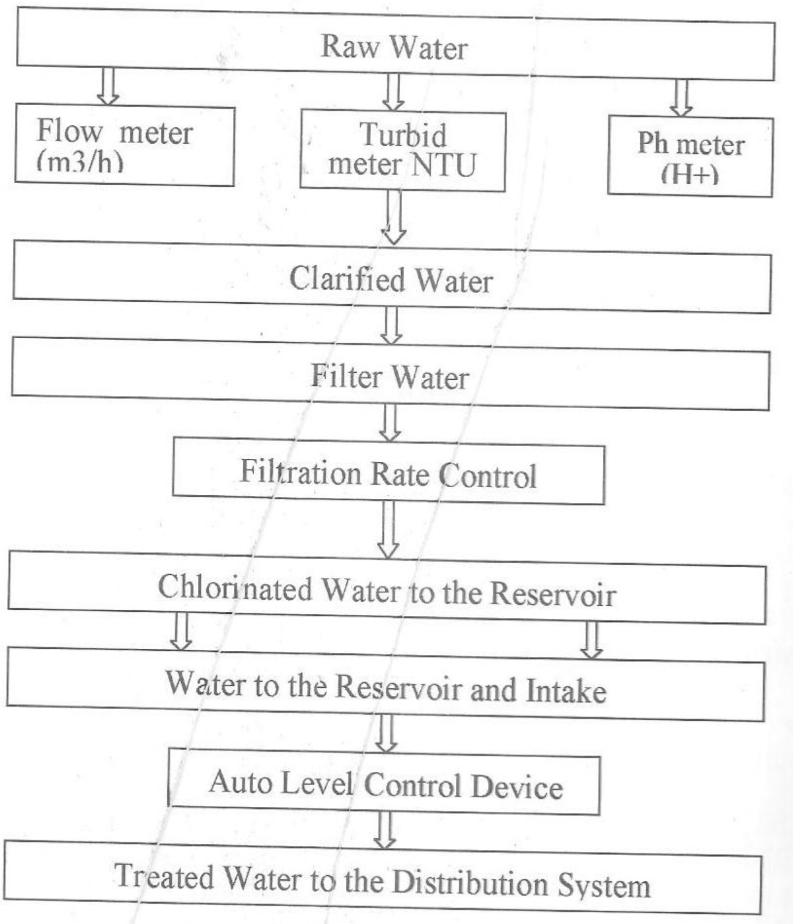


Fig. 2: Control instruments

PROGRAMMABLE LOGIC CONTROLLER

The advent of the programmable logic controller (PLC) began in the 1970s, and has become the most common choice for manufacturing control systems (Dunning, 2001). PLCs have been gaining popularity on the industry because of the advantages they offer (Jack, 2008): cost effective for controlling complex systems; flexible and can be reapplied to control other systems quickly and easily; computational abilities allow more sophisticated control; troubleshooting aids make programming easier and reduce downtime; reliable components make these likely to operate for years before failure.

PLC hardware: the most essential components are (Rabiee and Fardo, 2001): power supply, Central Processing Unit (CPU), and Input/Output (1/O) modules. Figure (3) illustrates the major components (Cox, 2000).

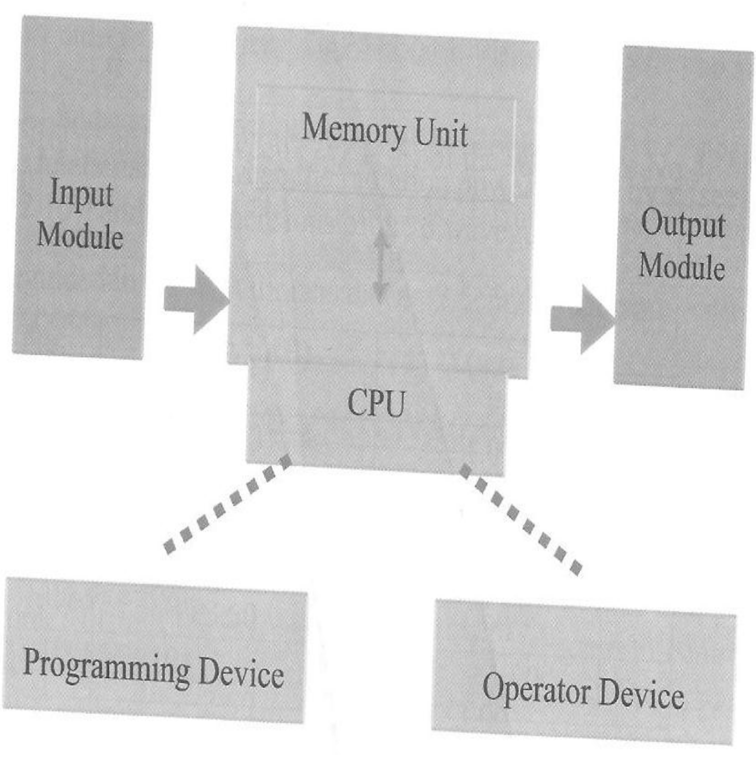


Fig. 3: PLC Components

Input module should be connected to a group of physical elements such as electric switches, sensors, thermometer, liquid level detectors and other sensors. Input module receives the analogue signals from these elements and transfers them to logic signal and forwards it to CPU for controlling the overall operation of the system.

Central processing unit (CPU) is a decision making center of PLC. It receives and processes logic signal sent by input module; decides relevant action according to stored instruction; issues control instructions to output module (Hughes, 2000).

The output module receives instructions from CPU and transfers it to either logic or analogue signals used to control a group of actuator devices. A typical operator unit can help an operator to: display information for various controllable processes; enter or modify parameters. Programming device is a special device for writing and transferring programs to the PLC, e.g. a computer can be used.

PLC operation: initially when the PLC is turned on it will check it's own hardware and software for faults (Parr, 2003). If there is no problem it will copy all the input values into the memory, this is called input scan. Using the inputs the ladder logic program will be executed, this is called logic scan. The outputs will be updated using the temporary values in the memory, this is called output scan. This process is typically repeated 10 to 100 times per second (Bolton, 2000). Figure (4) shows the basic operation stages.

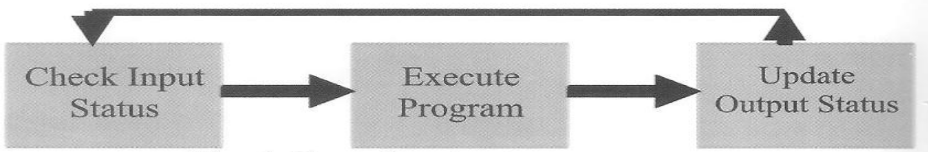


Fig. 4: Scanning steps

CONTROL SYSTEM DEVELOPMENT

Controlling of the Motor

Figure (5) explains a motor starter (M) which is wired in series with a normally open (NO) momentary pushbutton (Start), a normally closed (NC) momentary pushbutton (Stop), and the normally closed contact of an overload relay (OL).The NO start pushbutton is connected to the input 10.0 while the NC stop pushbutton is connected to input 10.1.

The NC overload relay (OL) contact as part of motor starter is connected to input 10.2.

The input (10.0 - 10.1 -10.2) are forming an AND circuit and used to control the operation of output (Q0.0).

The logic state of input bit 10.1 is logic I because of the NC-stop pushbutton . The logic state of input bit 10.2 is logic 1 also because protective OL is NC. By programming a NO-contact QO.O is added to ladder logic which is in direct relation with output (QO.O) and forms an OR circuit with input (10.0). Motor starter is connected to output QO.O at output module.

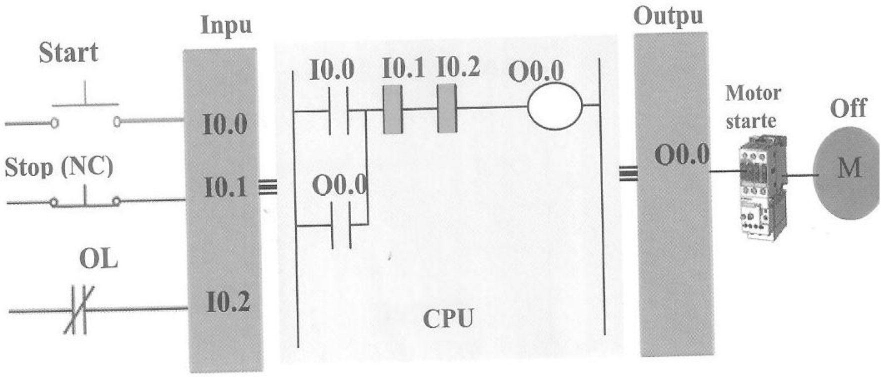


Fig. 5: Ladder diagram for motor start/stop

When start pushbutton is pressed, CPU receives logic I signal from input 10.0 at input module. This will cause contact 10.0 at ladder logic to close. In this case, all contacts on ladder logic I state and so the logic condition of output Q0.0on this ladder logic is logic I as illustrated in Fig. (6). Then CPU will send logic I state to output QO.O at output module which activates motor starter to operate the motor.

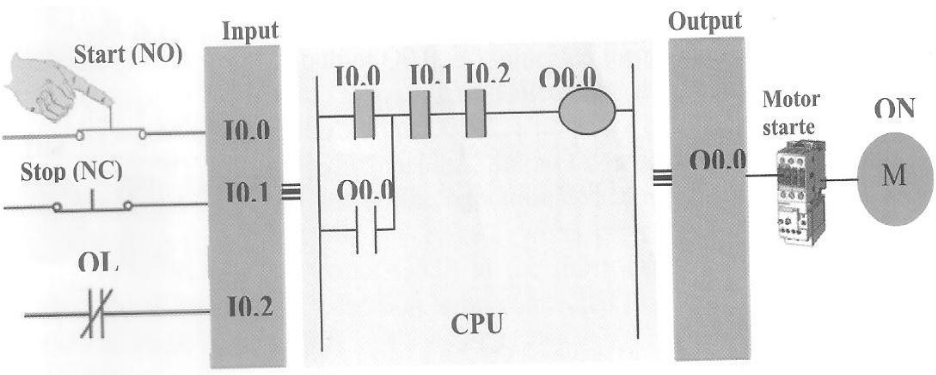


Fig. 6:Start is pressed and motor is ON

At next scan operation, the contact QO.O (input QO.O) related to output QO.O will close so the output QO.O will continue at operation position even when start pushbutton is released because logic I state still exists between the two sides of ladder logic as illustrated in Fig. (7).

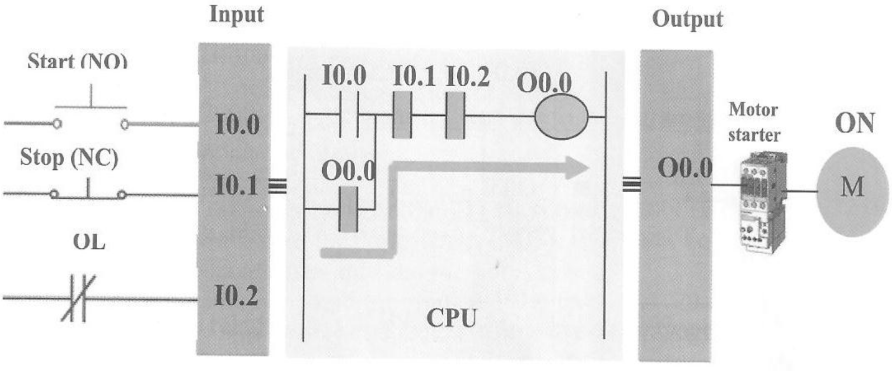


Fig. 7: Start is released and logic I still existing

Motor operation will continue unless stop pushbutton is pressed. In this case the logic state of input 10.1 will change to logic 0, so logic 1 between the two sides of ladder logic does not exist as illustrated in Fig. (8). Consequently, the logic state of output Q0.0at ladder logic is 0. The CPU will send logic 0 signal to output Q0.0at output module to stop motor operation.

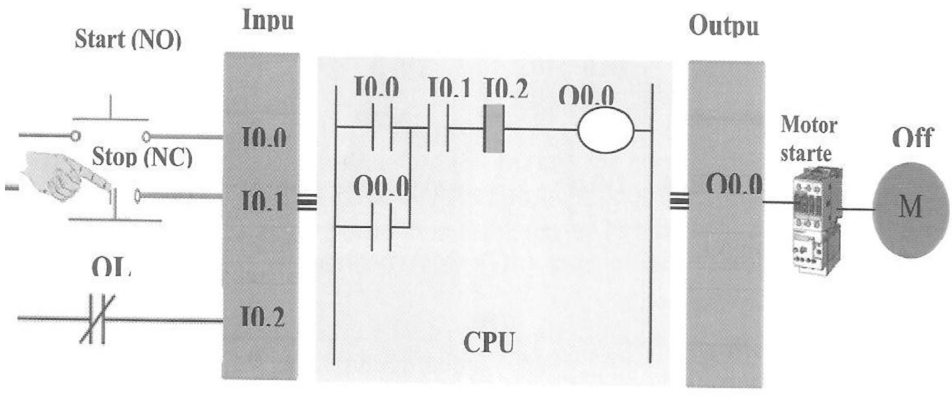


Fig. 8: Stop is pressed and motor changes to off

When normal closed (NC) stop pushbutton is released Fig. (9), the logic state of input 10.0 will become true and so the program is ready till NO start pushbutton is pressed again.

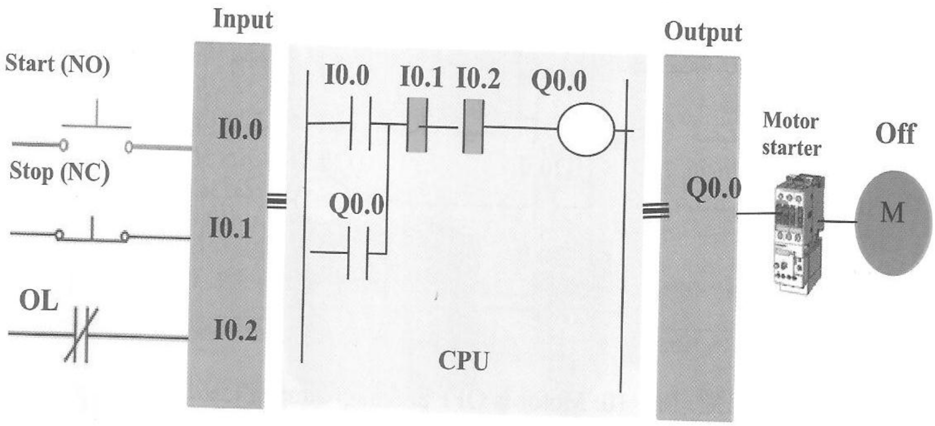


Fig. 9: Stop is released and program is ready to start again

The application can be easily expanded to include indicator lights for RUN and STOP conditions to show the motor status. In this example a RUN indicator light is connected to output QO.1 and a STOP indicator light is connected to output QO.2.

It is possible to notice through the ladder logic that the NO contact (input Q0.0) related to output Q0.0, is connected through the second ladder logic stage to the output Q0.I and the NC contact at the third stage of the ladder logic is connected to output Q0.2.

When Q0.0is at OFF position, the NO contact (input Q0.0) at the second stage will open and so the operation indication lamp connected to output Q0.1 is at OFF state.

The NC contact (input Q0.0) at the third stage of ladder logic is closed and so the stop indication lamp connected to output Q0.2 is at ON state as shown in Fig. (10).

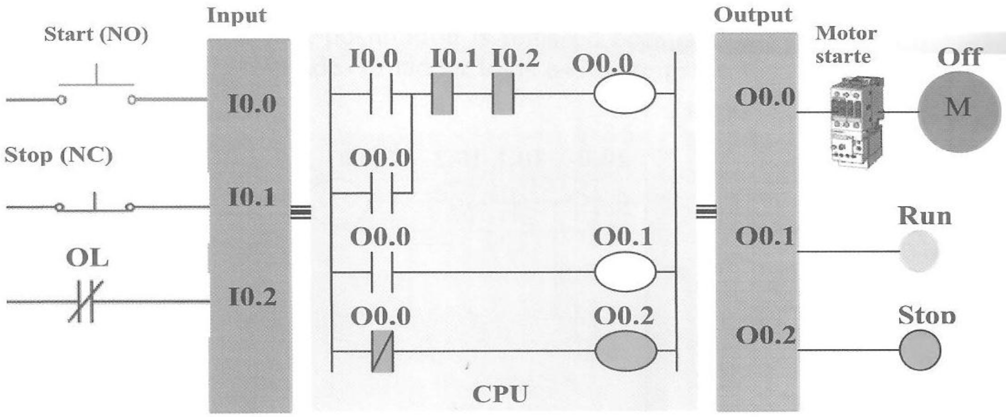


Fig. 10: Motor is OFF and stop lamp is ON

When start pushbutton is momentary pressed, the state of output Q0.0will be logic I and the motor is operated. The NO contact Q0.0at the second stage of ladder logic changes to logic 1 state (closed), and so output Q0.I will light the operation indicating lamp. The NC contact Q0.0at the third stage of ladder logic changes to logic 0 state and so the indication lamp connected to output Q0.2 will go off as shown in Fig. (11).

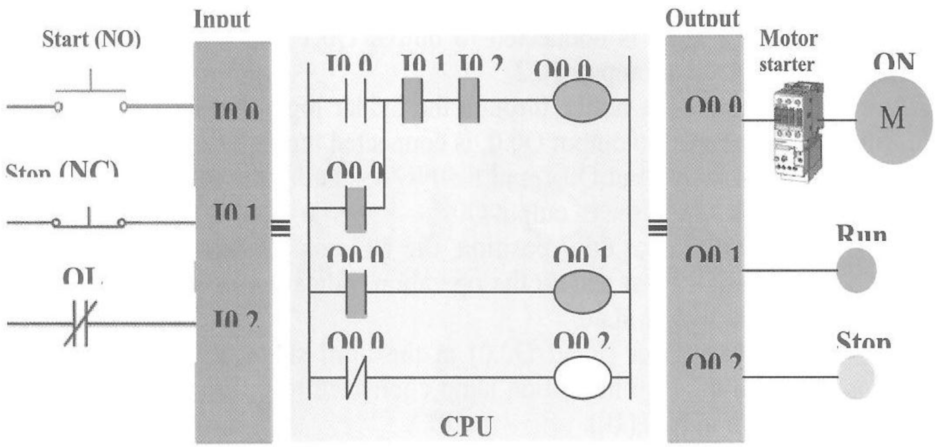


Fig. II: Motor state is ON and start lamp is ON

Controlling of the Reservoir Water Level

A reservoir contains purification water. The water is pumped to the city, and the reservoir water level is changed. To get level established, the reservoir is controlled by using two level sensors connected to the raw water pumps through PLC as shown in the Fig. (12).

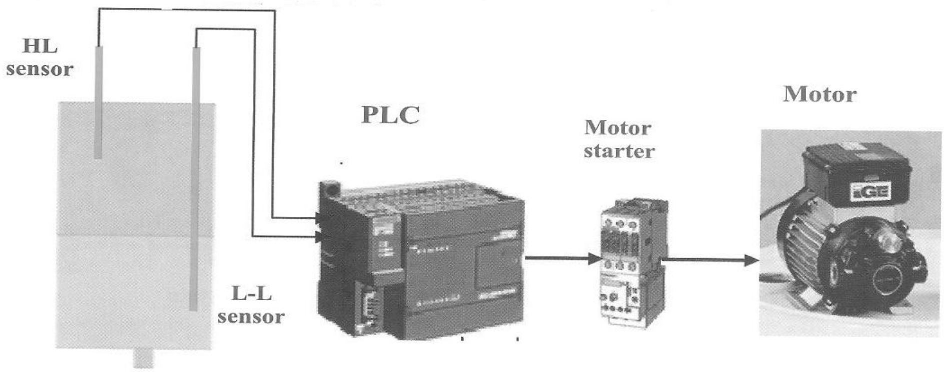


Fig. 12: Sensors connected to the raw water pump through a PLC

To make this possible it is important to define the raw water sucking pumps which are working continuously through a day and others which are programmed to operate as auxiliary pumps when there is a reduction in the reservoir level.

The auxiliary pumps are required to operate (on state) till the water level reaches the low level (L-L) sensor and then stops. When the water level in the reservoir decreases below the low level (L-L) sensor, the auxiliary pump is required to operate again.

In this system we need two inputs (sensors) and one output (pump). Both two input level sensors are of the type normally closed level sensors. When a sensor is not immersed in water it will be at operation state, and at non operation position when it is immersed.

First scan process:

When the reservoir is empty, both sensors are at operation state (ON), as illustrated in Fig. (13), and so the logic I states of inputs (10.0&10.1) are logic I and due to this, the state of output QO.O is true.

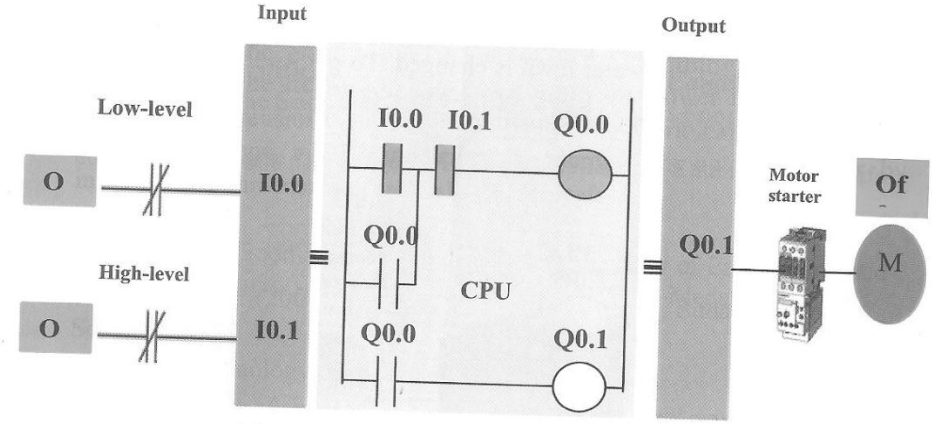


Fig. 13: First scan; both sensors are at ON state

Second scan process:

Input Q0.0 is activated at both ladder logic stages which leads to output Q0.1activation, as illustrated in Fig. (14) and so the pump starts operation to fill the reservoir.

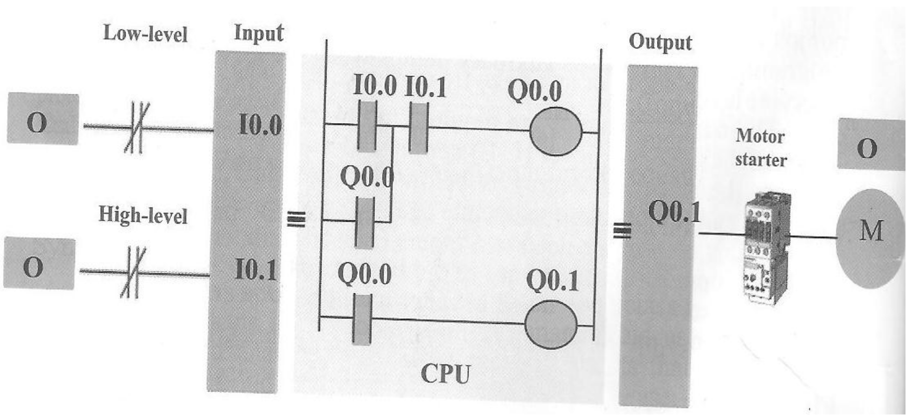


Fig. 14: Second scan; Q0.1activated through Q0.0

The scan process is repeated so many times and the state of inputs remain constant at the same state till the water immerses the low level sensor. At this point, low level sensor changes to OFF position and so input 10.0 state changes to false condition without affecting the pump operation because the logic state of the route between the two vertical lines of the ladder logic is still true as illustrated in Fig. (15).

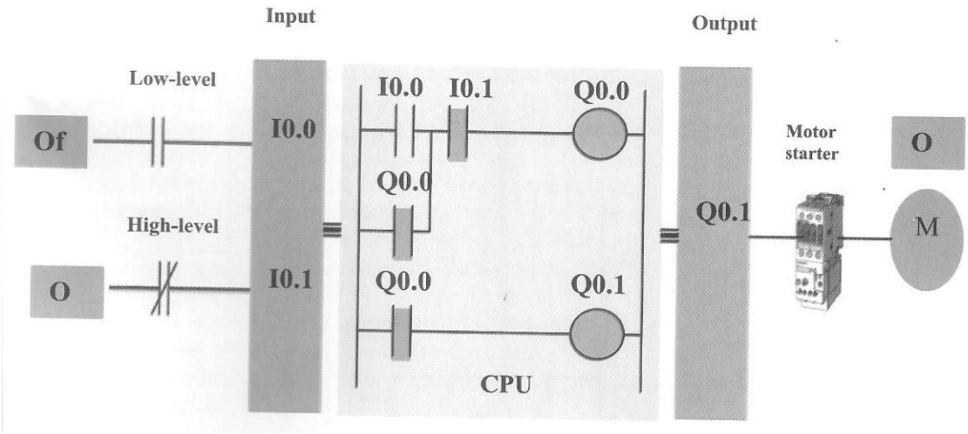


Fig. 15: L-L sensor changes to OFF without affecting output

This scan process will repeat many times and the pump will continue filling the reservoir till the water immerse the higher level sensor, where H-L changes to OFF and then the logic state of input 10.1 becomes false. Consequently, there is no true state route between the two sides of ladder logic and so the logic state of output QO.I becomes false and the pump stops as shown in Fig. (16).

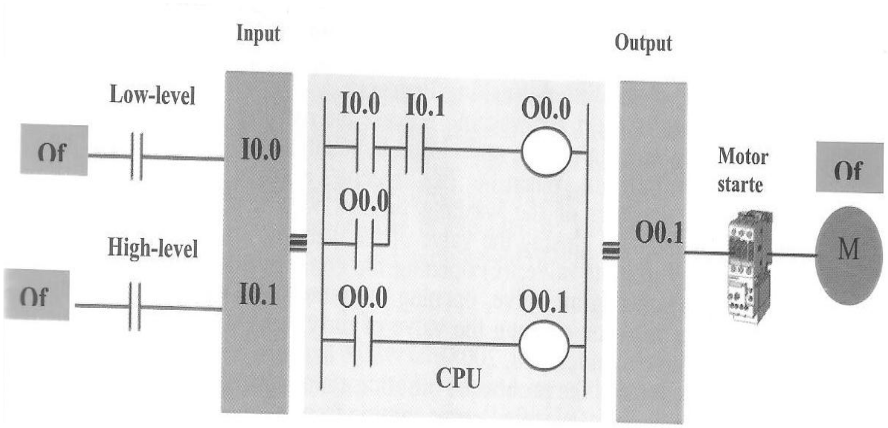


Fig. 16: H-L sensor changes to OFF and output is OFF

Scan process will repeat many times while water withdrawal from the reservoir by the drain outlet continues till the water level decreases below high level sensor where the sensor changes to operating state (ON) and so the logic state of input Q0.I changes to true as shown in Fig. (17). In spite of that, the pump will not operate because there is no complete route of the true logic state between the two sides of the ladder logic.

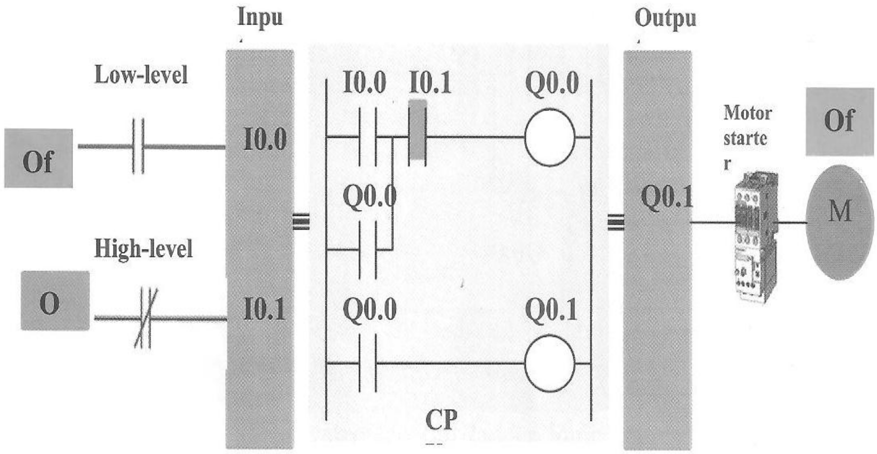


Fig. 17: H-L sensor changes to ON

Water level decrease continuously and the pump remains stop till the water level becomes below the low level (L-L) sensor where the sensor changes to position true. Here the logic state of input 10.0 changes to true and so there is a route of true logic state between the two sides of ladder logic which leads to activate the output, and then to operate the pump to fill the reservoir.

Controlling of the Filter Washing Process

To control the filter washing process the research suggests using of new valves, which are open and closed automatically by a signal coming from the control unit. When the PLC receives a signal from the filter, It determines the start of the washing process with a program doing the following steps: (a) closing the valve of the water coming from basin; (b) closing the filtration valve; (c) opening the compressed air valve for two minutes; (d) closing air valve, opening the pure water valve for washing and at the same time opening the valve of dirty wash water to pass. This step takes three minutes (Ali, 2008). After all these steps the process of filtration starts normally by opening the filter and the valve of clarified water coming from basin.

Controlling of Chemical Materials

Water purification and safety depend on added sedimentation and disinfection chemical materials, which are defined by reading many parameters concerning with quality and quality of raw water. Sensors are invoked to measure flow rate (m /h), Ph (H+) and turbidity (N TU), where readings are used as inputs to PLC. Hence, the addition of chemical materials is automatically adjusted (Ali, 2008). Thus a complete PLC based control system has been developed as in shown in Fig. (18}.

RESULTS AND DISCUSSION

This section describes the real implementation of the proposed control system. Initially, the main control circuit has been setup as shown in Fig. (19), where the PLC has been interconnected with inputs (level sensors and pushbutton switches) and outputs (motor starter and lamp indicators). Then a program (ladder logic) has been written, including all the steps for controlling the water treatment process as described in the previous section. The ladder logic has been transferred to the PLC.

Thus, different steps of water treatment process have been successfully tested under various settings and conditions.

Motor Operation Control Test

Figure (20) demonstrates experimental tests of the controlling program for operating and stopping the pump. A normally open Start pushbutton is wired to the first input (II), a normally closed Stop pushbutton is wired to the second input (12), and normally closed overload relay contacts (part of the motor starter) are connected to the third input (13). The first input (II), second input (12), and third input (13) form an AND circuit and are used to control normally open programming function contacts on Network l. II status bit is a logic I because the normally closed (NC) Stop Pushbutton is closed. II status bit is a logic I because the normally closed (NC) overload relay (OL) contacts are closed. Output QI is also programmed on Network l. In addition, a normally open set of contacts associated with QI is programmed on Network I to form an OR circuit. A motor starter is connected to output QI. When the Start pushbutton is depressed the CPU receives a logic I from input II. This causes the 11 contact to close. All three inputs are now a logic l. The CPU sends a logic I to output QI. The motor starter is energized and the motor starts.

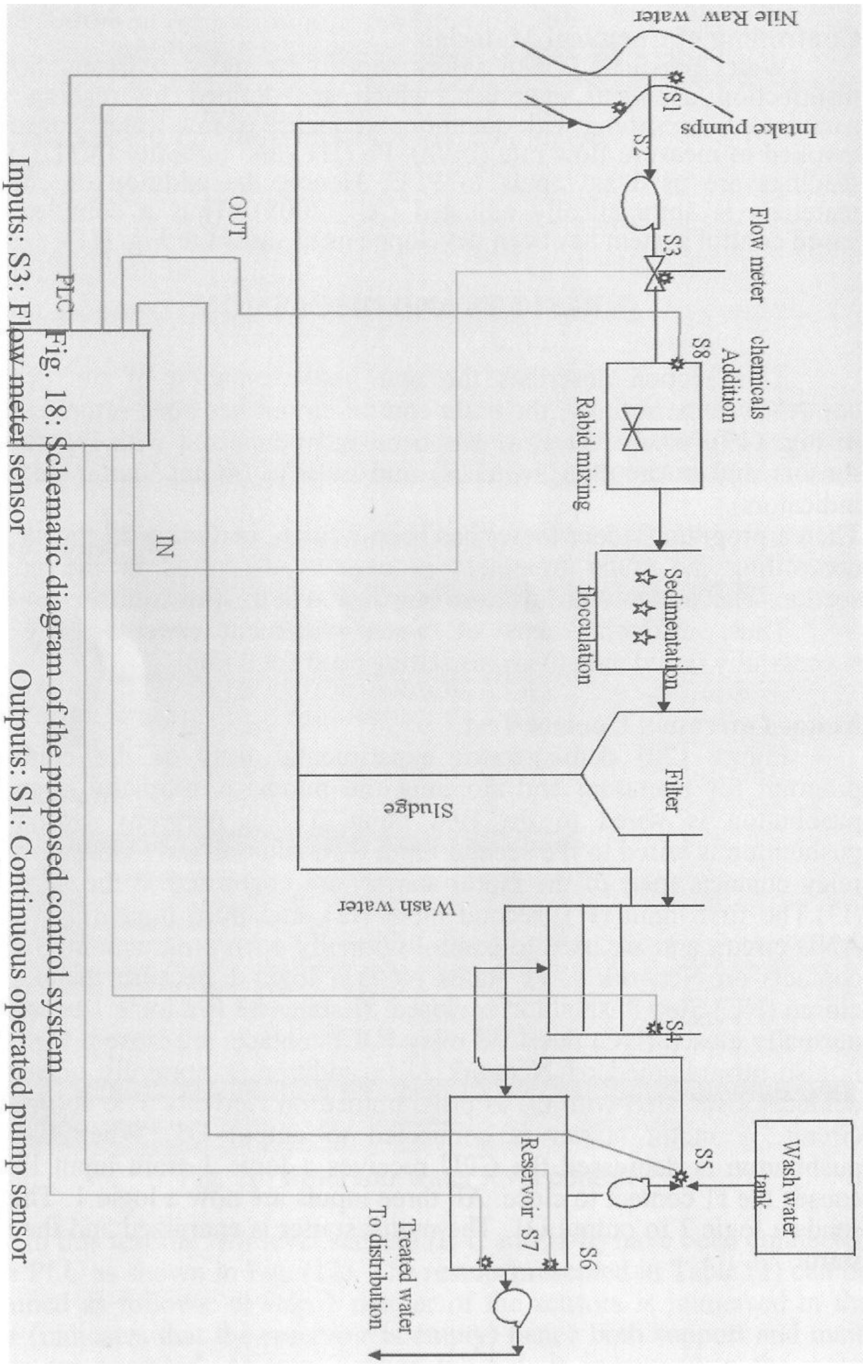


Fig. 18: Schematic diagram of the proposed control system

Inputs: S3: Flow meter sensor
S4: Filter basin level sensor
S6: High level sensor
S7: Low level sensor

Outputs: S1: Continuous operated pump sensor
S2: Auxiliary operated pump sensor
S5: Backwashing sensor
S8: Added chem.. sensor

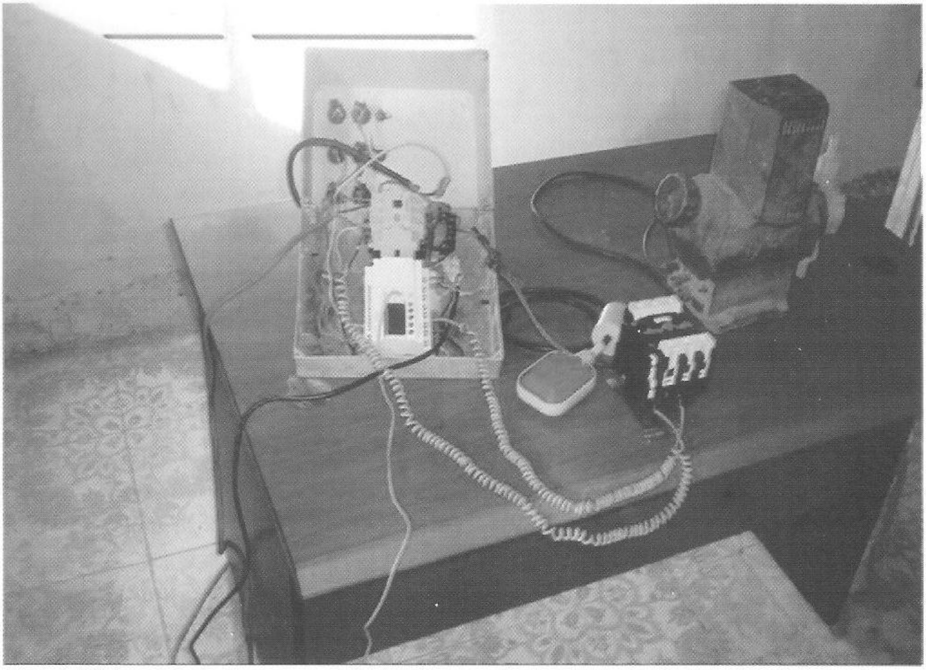
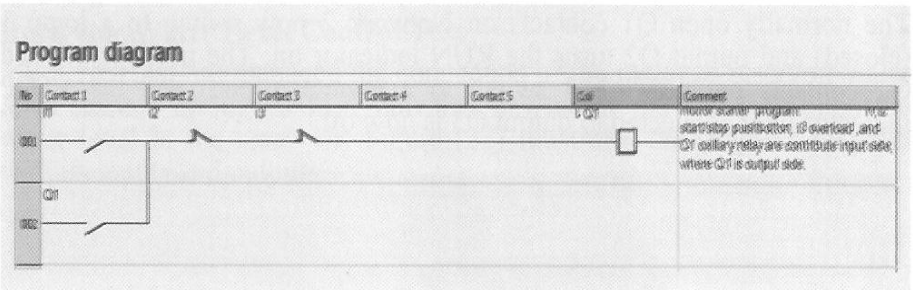


Fig. 19: Control circuit setup



Physical inputs

No	Symbol	Function	Lock	Parameters	Location of (L/C)	Comment
I1	I	Discrete inputs	---	No parameters	(1/1)	
I2	I	Discrete inputs	---	No parameters	(1/2)	
I3	I	Discrete inputs	---	No parameters	(1/3)	

Physical outputs

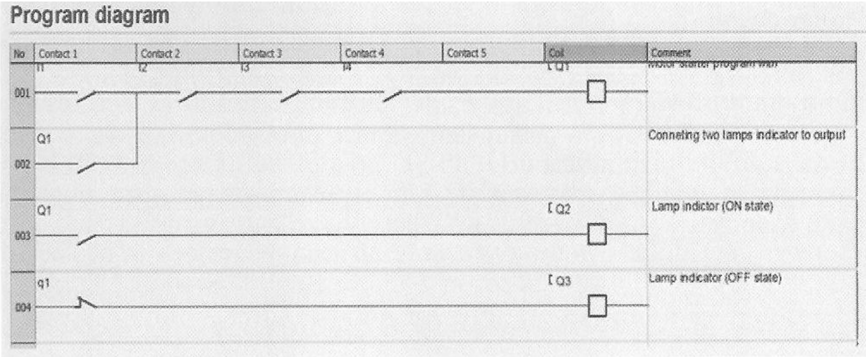
No	Symbol	Function	Latching	Location of (L/C)	Comment
Q1	Q	Discrete outputs	No	(1/6) (2/1)	

Fig. 20: Motor operation control

Figure(21) includes indicator lights for RUN and STOP conditions, In this test a RUN indicator light is connected to output Q2 and a STOP indicator light is connected to output Q3.

It can be seen from the ladder logic that a normally open output QI is connected on Network 2 to output Q2 and a normally closed QI contact is connected to output Q3 on Network 3. In a stopped condition output QI is off. The normally open QI contacts on Network 2 are open and the RUN indicator, connected to output Q2 light is off. The normally closed Q2 on Network 3 lights are closed and the STOP indicator light, connected to output Q3 is on.

When the PLC starts the motor output QI is now a logic high (On). The normally open QI contacts on Network 2 now switch to a logic I (closed) and output Q2 turns the RUN indicator on. The normally closed QI contacts on Network 3 switch to a logic 0 (open) and the STOP indicator light connected to output Q3 is now off.



Physical inputs

No	Symbol	Function	Lock	Parameters	Location of (L/C)	Comment
I1		Discrete inputs	---	No parameters	(1/1)	
I2		Discrete inputs	---	No parameters	(1/2)	
I3		Discrete inputs	---	No parameters	(1/3)	
I4		Discrete inputs	---	No parameters	(1/4)	

Physical outputs

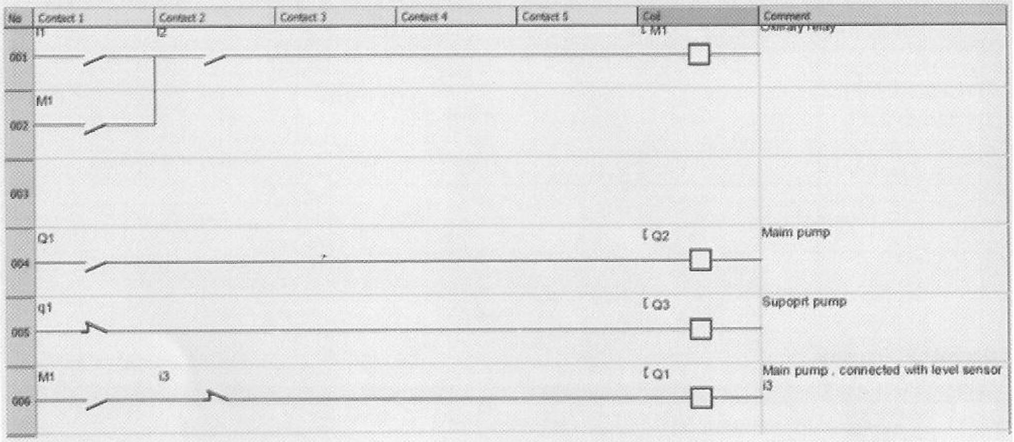
No	Symbol	Function	Latching	Location of (L/C)	Comment
Q1		Discrete outputs	No	(1/6) (2/1) (3/1) (4/1)	
Q2		Discrete outputs	No	(3/6)	
Q3		Discrete outputs	No	(4/6)	

Fig. 21: Motor operation control with two lamps

Reservoir Water Level Control Test

This test has managed the connection of the motor to reservoir water level sensors through a PLC unit that has monitored and controlled the water level in the reservoir. Figure (22) illustrates the program diagram with its inputs and outputs.

Program diagram



Physical inputs

No	Symbol	Function	Lock	Parameters	Location of (L/C)	Comment
I1		Discrete inputs	---	No parameters	(1/1)	
I2		Discrete inputs	---	No parameters	(1/2)	
I3		Discrete inputs	---	No parameters	(6/2)	

Physical outputs

No	Symbol	Function	Latching	Location of (L/C)	Comment
Q1		Discrete outputs	No	(4/1) (5/1) (6/6)	
Q2		Discrete outputs	No	(4/6)	
Q3		Discrete outputs	No	(5/6)	

Configurable functions

No	Symbol	Function	Lock	Latching	Parameters	Location of (L/C)	Comment
M1		Auxiliary relays	---	No	No parameters	(1/6) (2/1) (6/1)	

Fig. 22: Reservoir water level control

In this test the two level sensors (L-L and H-L) have been connected to the PLC as shown in Fig. (12). The results presented in Table (1) can be explained as follows: at step I neither of the sensors is immersed in the water (indicates that the reservoir is empty) hence both support and main pumps are operated. At step 2 when the L-L is immersed in the water (means that water in the reservoir gets above the low level) the support pump is stopped while the main pump is still operating. At step 3 when the two sensors are immersed in the water (assumes that water in the reservoir gets above the high level) both support and main pumps are stopped. At step 4 when only L-L is still immersing in the water (water in the reservoir becomes between low and high level) both support and main pumps are still stopping. Step 5 repeats step 1 (water in the reservoir gets below the low level). The above steps been repeated more than five times which provided the same results. In addition to the stability of the system it has been observed that the system is highly responsive.

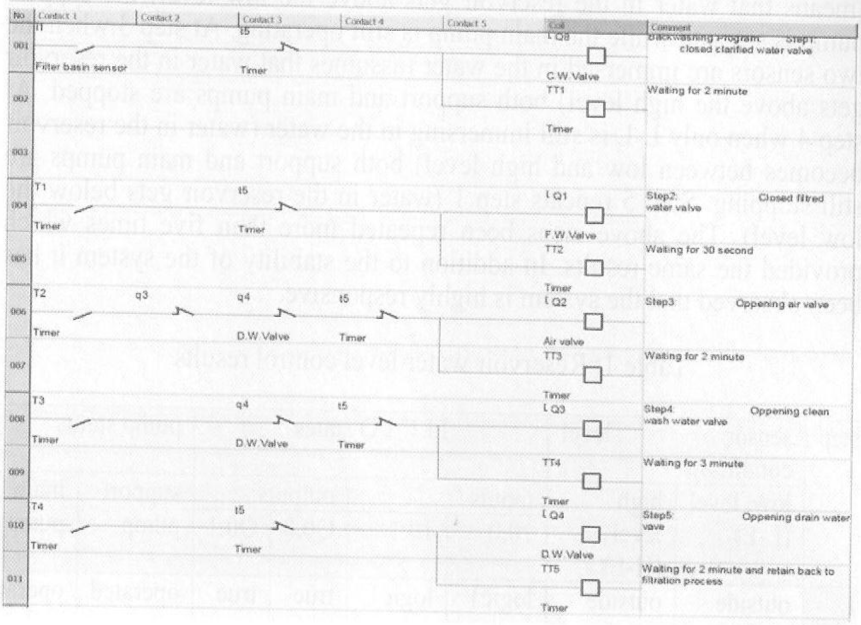
Table I : Reservoir water level control results

step	sensor conditions level		PLC I/O states				pump status	
	low level (L-L)	high level (H-L)	inputs		outputs		support pump	main pump
			10.0	10.1	Q0.0	Q0.1		
1	outside water	outside water	logic1	logic1	true	true	operated	operated
2	immersed in water	outside water	Logic0	logic1	false	true	stopped	operated
3	immersed in water	immersed in water	Logic0	Logic0	false	false	stopped	stopped
4	immersed in water	outside water	Logic0	logic1	false	True	stopped	stopped
5	outside water	outside water	logic1	logic1	true	True	operated	operated

Filter Washing Process Control Test

A program for backwashing process with its corresponding inputs, outputs and timing diagrams have been presented in Fig-(23). In this test five timers (from T T1 to T T 5) are set within the PLC program to control the time for each step of the filter washing process. Also five indicators are connected to the outputs of the PLC to represent the valves which are involved in the filter washing process.

Program diagram



Physical inputs

No	Symbol	Function	Lock	Parameters	Location of (L/C)	Comment
I1		Discrete inputs	---	No parameters	(1/1)	Filter basin sensor

Physical outputs

No	Symbol	Function	Latching	Location of (L/C)	Comment
Q1		Discrete outputs	No	(4/6)	F.W.Valve
Q2		Discrete outputs	Yes	(6/6)	Air valve
Q3		Discrete outputs	No	(6/2) (8/6)	
Q4		Discrete outputs	No	(6/3) (8/3) (10/6)	D.W.Valve
Q8		Discrete outputs	Yes	(1/6)	C.W.Valve

Configurable functions

No	Symbol	Function	Lock	Latching	Parameters	Location of (L/C)	Comment
T1		Timers	Yes	Yes	See details below	(2/6) (4/1)	Timer
T2		Timers	Yes	Yes	See details below	(5/6) (6/1)	Timer
T3		Timers	Yes	Yes	See details below	(7/6) (8/1)	Timer
T4		Timers	Yes	Yes	See details below	(9/6) (10/1)	Timer
T5		Timers	Yes	Yes	See details below	(1/3) (4/3) (6/4) (8/4) (10/3) (11/6)	Timer

Fig. 23: Filter backwashing process control

Thus when the PLC receives a signal from the filter it derives an output to one of the valve indicators, i.e. operates one of the valves for a period of time as set by the corresponding timer. In this test all washing steps have been successfully carried out using different sets of configurations, where Table (2) demonstrates a complete cycle of the filter washing process.

Table 2: Filter washing process control results

step	valve	PLC timers configuration		operation
		timer	time	
1	C.W. Valve	TT1	2 minutes	closing of clarified water valve
2	F.W. Valve	TT2	30 seconds	closing of filtered water valve
3	Air Valve	TT3	2 minutes	opening of air valve
4	C.W.W. Valve	TT4	3 minutes	opening of clean wash water valve
5	D.W. Valve	TT5	2 minutes	opening of drain water valve

CONCLUSION

This study addresses the problem of water level instability together with the impurity content of White Nile water, which causes the use of excess chemical materials leading to a higher production cost. As an alternative solution this research suggests the Blue Nile stream to be the main water source by applying a control system to operate water sucking pumps, located on floating lunch connected to Shambat Bridge, for supplying Bait Elmal plant.

The control system has been fully developed based on a Programmable Logic Controller (PLC). It operates as follows: the reservoir has been controlled by using two sensors (high and low) connected to the raw water pumps through a PLC. The filter washing process valves are open and closed automatically by a signal coming from a control unit. The readings of flow rate, Ph, and turbidity devices are used as inputs to the PLC with the aid of a program designed for automatically adjusting the addition of chemical materials.

It can be concluded that the developed control system has been successfully tested, where the sucking pumps are installed to supply Bait Elmal water plant from the Blue Nile The results obtained prove the reliability and applicability of the system with more advantages at Bait Elmal plant as a typical drinking water plant.

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