CHAPTER ONE
INTRODUCTION

1.1 Overview

All the water that used it in the factory must be provided with continuous and safe sustainable supply of water the water supply in the factory must be controlled to be continuous and protected from pollution. The source of water in the factory is and artesian well , water is pumped to saving tanks then distribution to the internal net , It controlled by pumps ,motors and values etc ... The problem of this traditional way of control is those pumps ,valves and other components " flow meters, level meters ..Etc. “which can be damaged and stop all the system, location of the damaged element is difficult and time consuming . To improve the system of controller we have to remove all this traditional elements and build new PLC unit controlled and supervised by elements of SCADA. ASCDA systems at their fundamental level are Industrial Control Systems. They are computer based control systems that monitor and control industrial processes that exist in the physical m world. SCADA systems can be found in manufacturing facilities, oil production and processing, pharmaceuticals, energy, water treatment and distribution, and the list goes on. They are the best control method for processes that have large amounts of data that need gathering and analysing, or are spread over large distances, or require critical control in fast paced processes.

1.2 Problem Statement

Due to the traditional control system the water can be over flow of the tanks and damage all the machines in the factory and it is difficult to supervise it and it take time to fixed it .

1.3 Proposed Solutions

Use SCADA system to monitor and control the water flow in the all factory .

1.4 Research Aims and Objectives

The main aim of the project is to design SCADA system to control and supervisor the water net and supply .

The objectives are

- To propose a control system using SCADA.
- To simulate the proposed system.
- To evaluate the system performance .

1.5 Methodology

The PID diagram will be designed and the needed component "plc, pumps, valves, sensor " will be chosen and their ratio decided as required. The system is divided to lines which in turn were devided to sections contains different element, The plc Input /out put is connected with the devices and the control program was written using structure text .The simulation of the SCADA is run and the result is discussed.

1.6 Thesis outlines

The thesis is written in five chapters

Chapter 1 : Introduction

Which include problem statement along with proposed solution .

Chapter 2 : Literature review

Highlight the prevous studies and explain different parts of the proposed system.

Chapter 3 : system design

Explain the method used to design the system .

Chapter 4 : simulation resulted discussion

Highlight simulation result with different screen and explain and discuss the result .

Chapter 5 : conclusion and recommendation

Summarize the work done and highlight several point for future work .

CHAPTER TWO

2.THEORETICAL BACKGROUND

2.1 overview

In 2010 Mr.binqin and mr.dongyan were designed remote SCADA system of secondary pressurization pump station uses a PLC controller, through the friendly human machine interface to control and monitor. The designed system shows that the control system has high degree of automation, and stable and reliable performance, largely reducing the acquisition time and meeting the control requirements [1],[2].

In 2012 mr.xin ma was designed the SCADA system for longnan water corporation it is include (master terminal unit (MTU)-communication system (CS)-two class dispatch center and RTU and the SCADA designed based on Ethernet.[3],[4].

In 2014 mr. Adrian Korodi, and mr.IoanSilea were designed Specifying and Tendering of Automation and SCADA Systems: Case Study for Waste Water Treatment Plants providing a set of information that has to be contained by an adequate technical documentation for automation and SCADA works.[5],[6].

In 2010 mr. Amir Firoozshahi was designed Intelligent and Innovative Monitoring of Water Treatment Plant in Large Gas Refinery the Monitoring System has been successfully designed, installed, commissioned and started up. All features accessed. Operators are working by this system easily and satisfied.[7],[8].

2.2 Programmable Logic Controllers (PLC)

Programmable logic controllers, also called programmable controllers orPLCs, are solid-state members of the computer family, using integrated circuits instead of electromechanical devices to implement control functions.They are capable of storing instructions, such as sequencing, timing,counting, arithmetic, data manipulation, and communication, to controlindustrial machines and processes.

Programmable controllers have many definitions. However, PLCs can be thought of in simple terms as industrial computers with specially designed architecture in both their central units (the PLC itself) and their interfacing circuitry to field devices (input/output connections to the real world).

PLCs have the great advantage that the same basic controller can be used with a wide range of control systems. To modify a control system and the rules that are to be used, all that is necessary is for an operator to key in a different set of instructions. There is no need to rewire. The result is a flexible, cost effective, system which can be used with control systems which vary quite widely in their nature and complexity. [9].

2.2.1 PLC Internal Architecture

The basic internal architecture of a PLC consists of a central processing unit(CPU) containing the system microprocessor, memory, and input/output circuitry, as shown in Figure (2.1). The CPU controls and processes all the operations within the PLC. It is supplied with a clock with a frequency of typically between 1 and 8 MHz This frequency determines the operating speed of the PLC and provides the timing and synchronization for all elements in the system.

The information within the PLC is carried by means of digital signals. The CPU uses the data bus for sending data between the constituent elements, the address bus to send the addresses of locations for accessing stored data and the control bus for signals relating to internal control actions. The system bus is used for communications between the input/output ports and the input/output unit.[10].

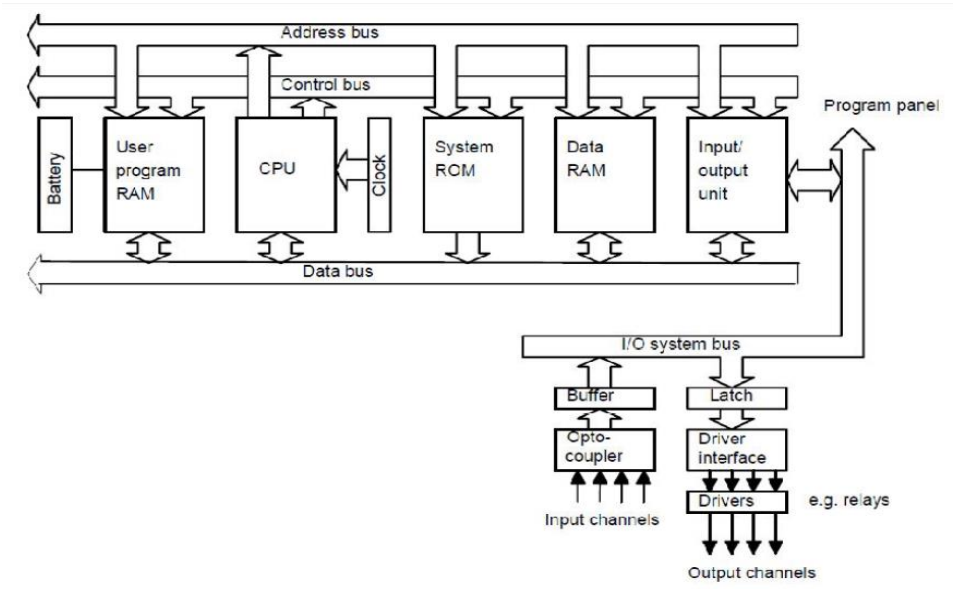

Figure (2.1): PLCInternalArchitecture

2.2.2Operation Principles

The input/ output (I/O) system is physically connected to the field devices that are encountered in the machine or that are used in the control of a process.

These field devices may be discrete or analog input/output devices, such as limit switches, pressure transducers, push buttons, motor starters, solenoids, etc.

The I/O interfaces provide the connection between the CPU and the information providers (inputs) and controllable devices (outputs). During its operation, the CPU completes three processes:

Reads or accepts the input data from the field devices via the input interfaces.

Executes or performs, the control program stored in the memory system.

Writes or updates the output devices via the output interface.

This process of sequentially reading the inputs, executing the program in memory, and updating the outputs is known as scanning as shown as figure (2.2) illustrates a graphic representation of a scan.[1]

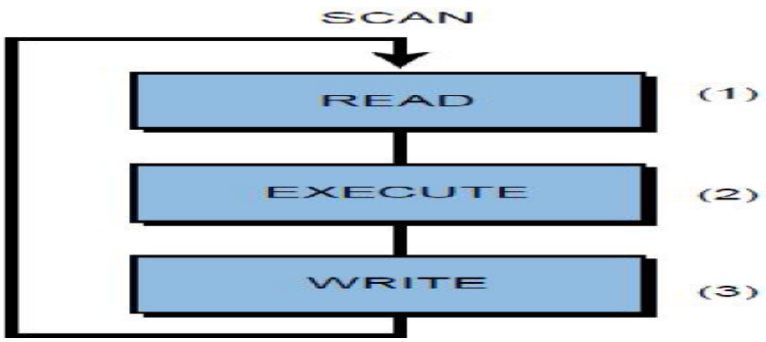

Figure (2.2):PLC Scanning

The input/output system forms the interface by which field devices are connected to the controller as shown as figure (2.3). The main purpose of theinterface is to condition the various signals received from or sent to externalfield devices. Incoming signals from sensors (e.g., push buttons, limit switches,analog sensors, selector switches, and thumbwheel switches) are wired toterminals on the input interfaces

Devices that will be controlled, like motor starters, solenoid valves, pilot lights,and position valves, are connected to the terminals of the output interfaces. Thesystem power supply provides all the voltages required for the proper operationof the various central processing unit sections. [1]

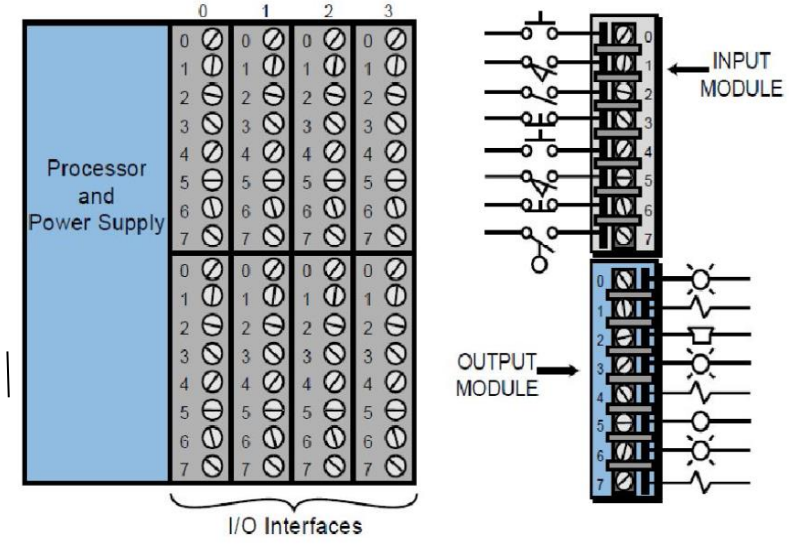

Figure (2.3): PLC Input/outputInterface

2.2.3 PLCProgramming

Programs for microprocessor-based systems have to be loaded into them inmachine code, this being a sequence of binary code numbers to represent theprogram instructions. PLCs are intended to be used by engineers without anygreat knowledge of programming, this is a means of writing programs whichcan then be converted into machine code by some software for use by the PLC microprocessor, and this method of writing programs became adopted by mostPLCmanufacturers.

The standard, published in 1993, is IEC 1131-3 (International ElectroTechnicalCommission), the IEC 1131-3 programming languages are ladder diagrams(LAD), instruction list (IL), sequential function charts (SFC), structured text(ST), and function block diagram (FBD), as shown in Figure (2.4).diagrams a very commonly used method of programming PLCs is based on theuse of ladder diagrams. Writing a program is then equivalent to drawing aswitching circuit. The ladder diagram consists of two vertical lines representingthe power rails. Circuits are

connected as horizontal lines, i.e. the rungs of theladder, between these two verticals.[12]

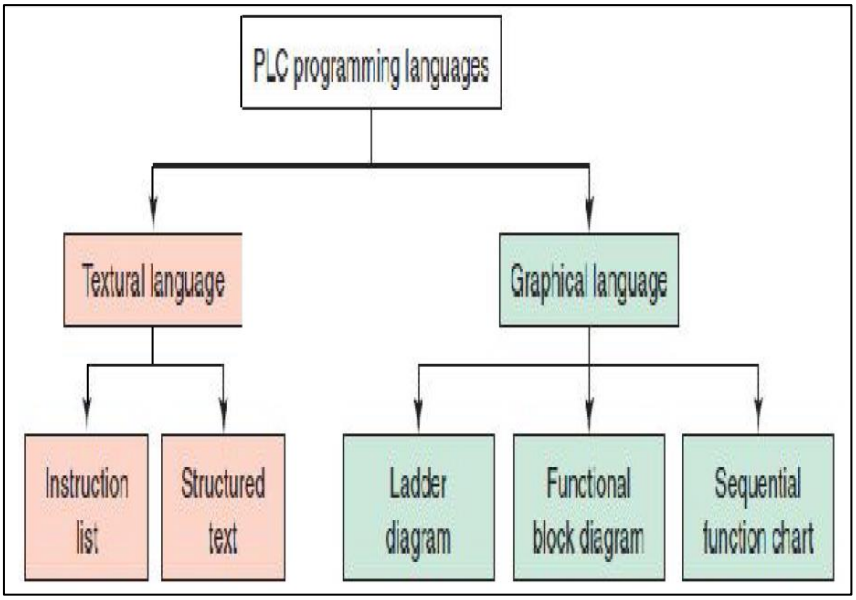

Figure (2.4): PLC ProgrammingLanguages

2.2.4 PLC Advantages

- **Flexibility:** One single Programmable Logic Controller can easily run many machines.
- **Correcting Errors:** In old days, with wired relay-type panels, any program alterations required time for rewiring of panels and devices.
  With PLC control, any change in circuit design or sequence is as simple 24 as retyping the logic. Correcting errors in PLC is extremely short and cost effective.
- **Space Efficient:** Today's Programmable Logic Control memory is getting bigger and bigger this means that we can generate more and more contacts, coils, timers, sequencers, counters and so on. We can have thousands of contact timers and counters in a single PLC.
- **Low Cost:** Prices of Programmable Logic Controllers vary from few hundreds to few thousand dollars.
- **Testing:** A Programmable Logic Control program can be tested and evaluated in a lab.
- **Visual Observation:** When running a PLC program a visual operation

can be seen on the screen. Hence troubleshooting a circuit is really quick,
easy and simple.[8]

2. 3 SCADASystem

SCADA IS (Supervisory Control and Data Acquisition). SCADA is a systemthat collects information from sensors and from the components of the ControlSystem, and sends the data to the main Computer for the purpose of:Management, supervision, Control and MonitoringSCADA System is inventedin order to allow the Operator to control this net or even more complicatednetworks through his computer. And informs the Operator whether the circuitsare normal or not.

The system will warn/alert of any problem in any circuit. In fact, SCADA
System. Is more developed than that: It allows the computer to review anddisplay the received data, draw graphs (curves) to explain the data values withina certain period of time. Also, it compiles the information and outline it theform of Report. [13]

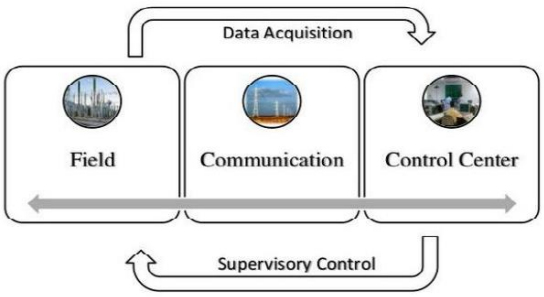

Figure (2.5):SCADA Systems

2.3.1 SCADA System Capacities

1. Adding more control buttons for the pages to do one or more jobs.
2. Design of indicators to show the working situation and the current condition atthe station.
3. Display of text messages or drawing to show the state of the work flow or thewarning.
4. Send orders from the keyboard to deal with all pages or with one single page.
5. Monitoring & Control to display all alerts in different forms.
6. To exchange information available at the station with another site of work.
7. Control of the Quality of Production.[14]

2.4 Siemens network Automation Step7 Control Center (SINAUT ST7cc).

SINAUT ST7cc is the tele-control system based on SIMATIC ST7, consistsOftwo independent systems:

2-4-1 **SINAUT MICRO**

Tele-control system for monitoring and controlling distributedplants using DSL on the basis of SIMATIC S7-200 and WinCC flexible or WinCC explorer as aresult ofits bidirectional communications capability, SINAUT micro can handlesimple tele-control tasks.

2-4-2 SINAUT ST7cc

Versatile tele-control system based on SIMATIC S7-300,S7-400 and for fullyautomatic monitoring and control of process terminals which exchange data withone or more control centers or with each other via a WAN or over Ethernet.

Configuration is carried out using STEP 7.SINAUT ST7 is a tele-control system based on SIMATIC S7(S7-300 and S7-400)for fully-automatic monitoring and control of process terminalswhich exchange data with one ormore control centers or witheach other via a wide range of WAN media.

The modular design and the support of a huge variety of networkforms andoperating modes including IP-based networks permitthe design of flexiblenetwork structures that can also contain redundantlinks.By using all forms oftransmission media, the networks canbe optimally adapted to the respectivelocal conditions.The SINAUT ST7cc system is based on SIMATIC S7systemsS7-300, S7-400. It supplements these systems with the specificSINAUT hardwareand software components listed below.

Hardware Components

1. TIM communications modules.
2. DSL

Software Components

SINAUT ST7cc Engineering Software.[16]

- **TIM Communications Modules**

The central component of the SINAUT ST7cc hardware is the Tele-controlInterface Module (TIM). It is used by the S7 CPU or control center PC for data exchange via the relevant SINAUT network, optionally with the SINAUT ST7.

The TIM is housed in an S7-300 enclosure and is available in two basic versions:

- **TIM 3V-IE/TIM 3V-IE Advanced Module**

The TIM 3V-IE is a SINAUT communication module for the SIMATIC S7-300. It has anRS232 port, to which an appropriate external modem can be Connected for data transmission via a conventional WAN. In the case of the TIM 3V-IE,SINAUT communication can be processed alternately via one of the two interfaces, while in the TIM 3V-IE advanced both interfaces can be operated simultaneously.

When used in a node station, TIM 3V-IE Advanced can, for example, Exchange data over its RS232 interface over a radio network with the lower-level stations.

It is then connected to the control center over a fiber-optic cable. In this configuration, data can be exchanged between each of the SINAUT stations regardless of which network they are situated in order to disconnect the networks, the connection in the control center can be made via a TIM 4R-IE or, as in the example, directly to the Ethernet interface of the PC as shown figure(2.7).[16]

- **Benefits Of TIM 3V-IE/TIM 3V-IE Advanced**

1. Flexible option for connection to any IP-based WAN.
2. For universal use with S7-300, S7-400, C7 compact control System and control center PC
3. Simplified maintenance through replacement of modules without PG.
4. Reliable storage of important data.
5. Remote programming and remote diagnostics (PC routing) in

Parallel with data transmission via the WAN or IP-connection

Saves time and money.

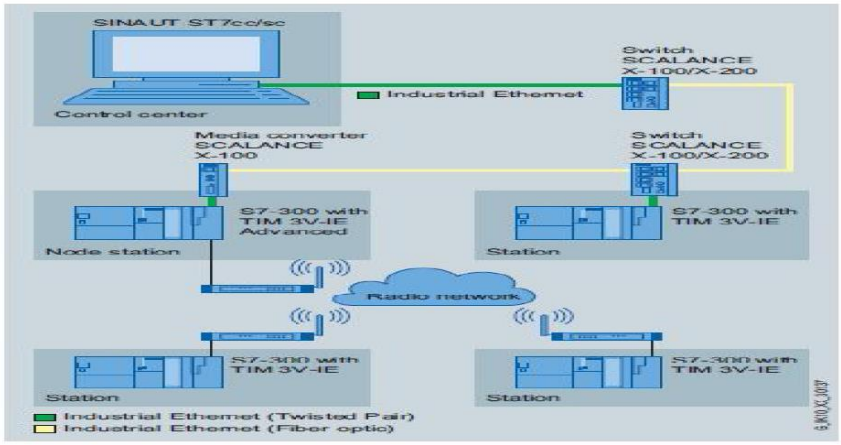

Figure (2.6): Node StationofTIM 3V-IE Advanced Module

2. TIM 4R-IE Module

The TIM 4R-IE has two RS232/RS485 interfaces for SINAUT data transmission via conventional WANs and additionally two RJ45 interfaces for connection to IP-based networks (WAN or LAN). This TIM can be used as a communications processor ina SIMATIC S7-300.but is particularly suitable as a SINAUT communications processor for a SIMATIC S7 400 or the control console PC (SINAUT ST7cc or ST7sc). It is then connected without S7-300 CPU a standalone device via one of the two Ethernet interfaces to the S7-400 or the PC.

In a node station with a SIMATIC S7-400 the TIM 4R-IE is connected to the S7-400 via one of its two Ethernet interfaces and can, for example, exchange data by radio with the subordinate stations via an RS232/RS485 interface. It is then connected to the control center via the second Ethernet interface. In this configuration, data can be exchanged between all of the SINAUT stations regardless of which network they are situated as shown figure (2.9). [16]

Benefits of TIM 4R-IE

1. Flexible connection capability to up to four SINAUT networks
2. For universal use with S7-400 and control center PC as well as with S7-300.
3. Compact module with 4 WAN interfaces saves installation Space in the rack and cabinet

4. Reliable storage of important data.

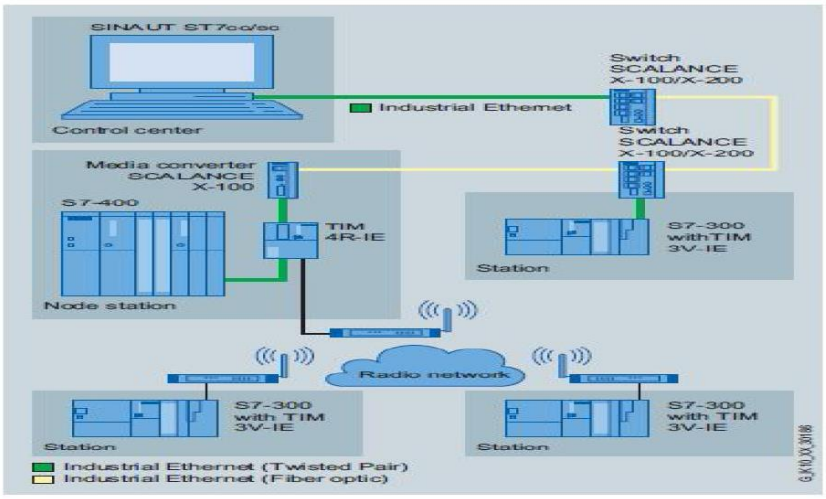

Figure (2.7):Node Station of TIM 4R-IE Module

2.5 DSL Router

The DSL router must be able to handle the Port Forwarding property. With Port Forwarding the router waits for data packages at a configured port and forwards them to a certain port in the internal network. For the MSC protocol any port (starting from port 1025) can be used which will be forwarded to the MSC Server via Port Forwarding.

MSC (Micro Switching Centre) is Ethernet based proprietary protocol which has been developed for cost-effective VPN networks in Telecontrol Systems.

The authentication of the MSC client at the MSC server takesplace with the username and password and the net data are encoded via a pre-shared key .The connection is initiated by the MSC client.[17]

2.6 pump :

is a device that moves fluids (liquid or gases) by mechanical action. It can classified into three major groups according to the method they use to move the fluid to three type:

1- Direct lift
2- Displacement
3- Gravity pumps

Pumps can also classified by their method of displacement into

1- positive displacement pumps
2- Velocity pumps
3- Gravity pumps
4- Steam pumps

2.6.1 Positive displacement pumps:

A positive displacement pumps makes afluid move by trapping a fixed amount and forcing (displacing) that trapped volume into the discharge pipe >

Some positive displacement pumps use an expanding cavity on the suction side and decreasing cavity on the discharge side . liquid flows into the pump as the cavity on the suction side expands and the liquid flows out of the discharge as the cavity collapses , the volume is constant through each cycle of operation .

2.6.2 Type of Positive displacement :

A positive displacement pump can be futher classified according to mechanism used to move the fluid

- Rotary – type positive displacement
- Reciprocating – type positive displacement
- Linear – type positive displacement

A rotary pumps are very efficient because they can handle highly viscous fluids with higher flow rates as viscosity [18]

Rotary positive displacement pumps fall into three main type :

1) Gear pumps
   A simple type of rotary pump where the liquid is pushed between two gears .
2) Screw pumps
   The shape of the internals of this pump is usually two screws turning against each other to pump the liquid
3) Rotary vane pumps
   Similar to scroll compressors these have a cylindrical rotor encased in a similarly shaped housing . As the rotor orbits , the vanes trap fluid between the rotor and the casing , drawing fluid through the pump .

2.7 Valve

Is device that regulates directs or controls the flow of a fluid by opening closing or partially obstructing various passage ways .valves are technically fittings but are usually discussed as a separate category . In an open valve , fluid flows in a direction from higher pressure to lower pressure.

2.7.1 Type of valve :

Valves are quite diverse and may be classified into a number of basic type. Valves may also be classified by how they are actuated

- Hydraulic
- Pneumatic
- Manual
- Solenoid valve
- Motor

Valve operating positions :

Valve positions are operating conditions determined by the position of the disc or rotor in the valve . some valves are made to be operated in a gradual change between two or more positions.

1) Return valves
2) Non – return valves

Allow fluid to move in 2 or 1 directions respectively

1- Two – port valves
2- Three – port valves
3- Four – port valves

2.8 Sensor

Is a device module or subsystem whose purpose it to detect events or changes in its environments and send the information to other electronic and it used with other electronics .

The used of sensors have expanded beyond the traditional fields of temperature , pressure or flow measurement [19]

sensor can be classified based on power or energy supply requirement of the sensor :

1) Active sensor :
   Sensor that require power supply example photoconductive cell
2) Passive sensor :
   Sensor that don't require power supply example : Radiometers .

Also can classificated based on property :

1) Temperature : this device collects information about temperature from source and converts into a form that is understandable by other device such ass thermistors , thermocouple .
2) IR sensors : this device emits or detects infrared radiation to sense a particular phase in the environment the basic idea is to make use of IR LEDs to send the infrared waves to the object . Another IR diode of the same type is to be used to detect the reflected wave from the object . the diagram is show below
3) UV sensors : these sensors measure the intensity or power of the incident Ultraviolet radiation . this from of electronagnatic radition has wave lengths longer than X- rays but is still shorter than visible radiation. Example UV phototubes light sensors .
4) Pressure sensors : is a sensor which senses pressure and converts it into an analog electric signal whose magnitude depends upon the pressure applied
   - Strain gauge
   - Capacitive pressure sensor
   - Piezoelectric pressure sensor

2.8.1 Level sensor

It is one of the very important sensors and play very important role in industrial applications . it's classified based on sensing points

- Signal point level sensors
- Multi – point level sensors
- Continuous level sensors

Also classification based on sensing principle :

- Float level sensors : in these level sensors a float moves with the liquid surface
- Resistive , capacitive : variable resistors are widely used in fuel level sensing , connected to lever arm with a float moves a cross continuous resistive tack
- Pressure Based Level Sensors : It relies on the principle that the difference between two pressures is equal to the height of the liquid multiplied by specific gravity. So, force at the bottom of the fluid container depends only upon the

height of the liquid level and therefore, with the measured hydrostatic pressure and the knowledge of specific gravity of the fluid, level measurement is performed

2.8.2.Ultrasonic Level Sensors :

Ultrasonic level instruments operate on the basic time-of-flight principle using sound waves to determine liquid/solid/slurries level.Ultrasonic Level sensors comprises of two elements; a high efficiency transducer and, an associated electronic transceiver. Complete return trip time between transmitted ultrasonic pulse and reflected echo is measured to determine the fluid level The frequency range for ultrasonic methods is in the range of 15...200 kHz. The lower frequency instruments are used for more difficult applications; such as longer distances and solid level measurements and those with higher frequency are used for shorter liquid level measurements. They can be used as single point level sensor or continuous level sensors.

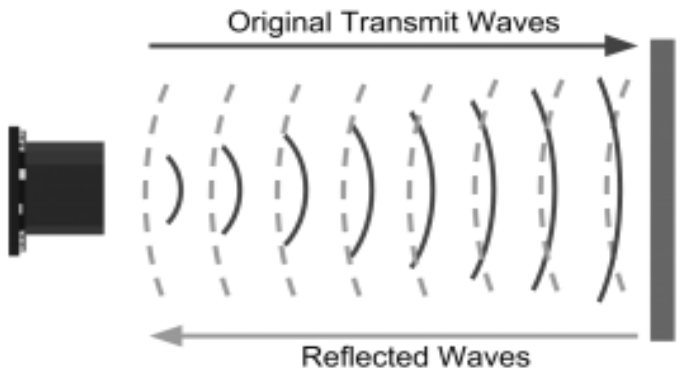

Figure (2.8) ultrasonic sensor

2.8.3.Dry run Sensors :

dry run guard that works as an effective solution for protection the water pumps against dry running. Minimum water-level monitoring feature in the circuit is realized using suspended sensor probes to ensure that the water pumps will not run under a

dry condition. Besides, switch-on and return-delay features prevent the pumps from unwanted brief operation when handling turbulent underground water

2.9 Motors

An electric motor is an electrical machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and winding currents to generate force in the form of rotation.

There are two type of motor

1- DC motor
2- AC motor

2.9.1 Motor Composed :

1- Rotor :Main article In an electric motor, the moving part is the rotor, which turns the shaft to deliver the mechanical power. The rotor usually has conductors laid into it that carry currents, which interact with the magnetic field of the stator to generate the forces that turn the shaft. Alternatively, some rotors carry permanent magnets, and the stator holds the conductors.

2- Bearings : The rotor is supported by bearings, which allow the rotor to turn on its axis. The bearings are in turn supported by the motor housing. The motor shaft extends through the bearings to the outside of the motor, where the load is applied. Because the forces of the load are exerted beyond the outermost bearing, the load is said to be *overhung*.

3- *Stator :* The stator is the stationary part of the motor’s electromagnetic circuit and usually consists of either windings or permanent magnets. The stator core

is made up of many thin metal sheets, called laminations. Laminations are used to reduce energy losses that would result if a solid core were used.

4- *Air gaps :*The distance between the rotor and stator is called the air gap. The air gap has important effects, and is generally as small as possible, as a large gap has a strong negative effect on performance. It is the main source of the low power factor at which motors operate. The magnetizing current increases with the air gap. For this reason, the air gap should be minimal. Very small gaps may pose mechanical problems in addition to noise and losses.

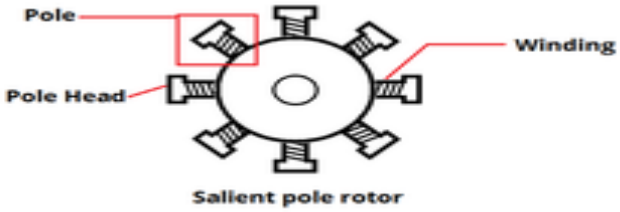

Figure (2.9) Salient-pole rotor

5- Windings: Windings are wires that are laid in coils, usually wrapped around a laminated soft iron magnetic core so as to form magnetic poles when energized with current.
6- Commutator: is a mechanism used to switch the input of most DC machines and certain AC machines. It consists of slip-ring segments insulated from each other and from the shaft. The motor's armature current is supplied through stationary brushes in contact with the revolving commutator, which causes required current reversal, and applies power to the machine in an optimal manner as the rotor rotates from pole to pole. tors.

2.10 Dc Motor

Direct-current motors are extensively used in variable-speed drives and position-control systems where good dynamic response and steady-state performance are required. Examples are in robotic drives, printers, machine tools, process rolling mills, paper and textile industries, and many others. Control of a DC motor, especially of the separately excited type, is very straightforward, mainly because of

the incorporation of the commutator within the motor. The commutator brush allows the motor-developed torque to be proportional to the armature current if the field current is held constant. Classical control theories are then easily applied to the design of the torque and other control loops of a drive system

The mechanical commutator limits the maximum applicable voltage to about 1500 V and the maximum power capacity to a few hundred kilowatts. Series or parallel combinations of more than one motor are used when dc motors are applied in applications that handle larger loads. The maximum armature current and its rate of change are also limited by the commutator DC motors are widely used in industrial applications, robot manipulators and home appliances, because of their high reliability, flexibility and low cost, where speed control of motor are required. Therefore, more advanced control techniques need to be used which will minimize the noise effects, there are three basic approaches to intelligent control: knowledge based expert systems, fuzzy logic, and neural networks.

2.10.1 Advantages and disadvantages of DC motor:

Advantages of DC motors:

- Speed control over a wide range both above and below the rated speed: The attractive feature of the dc motor is that it offers the wide range of speed control both above and below the rated speeds. This can be achieved in dc shunt motors by methods such as armature control method and field control method. This is one of the main applications in which dc motors are widely used in fine speed applications such as in rolling mills and in paper mills.
- High starting torque: dc series motors are termed as best suited drives for electrical traction applications used for driving heavy loads in starting conditions. DC series motors will have a staring torque as high as 500% compared to normal operating torque. Therefore dc series motors are used in the applications such as in electric trains and cranes.

- Accurate steep less speed with constant torque: Constant torque drives is one such the drives will have motor shaft torque constant over a given speed range. In such drives shaft power varies with speed.
- Quick starting, stopping, reversing and acceleration
- Free from harmonics, reactive power consumption and many factors which makes dc motors more advantageous compared to ac induction motors.

Disadvantages of DC motors:

- High initial cost
- Increased operation and maintenance cost due to presence of commutator and brush gear
- Cannot operate in explosive and hazard conditions due to sparking occur at brush (risk in commutation failure)

2.10.2 Types of DC Motor:

- Separately exited DC motor
- Self-exited DC motor these are further classified into several types:
    - DC shunt motor
    - DC series motor
    - Brushless DC motor
    - Compound motors

2.10.3 Separately excited DC motor:

The field windings are used to excite the field flux. Armature current is supplied to the rotor via brush and commutator for the mechanical work. Interaction of field flux and armature current in the rotor produces torque. Figure 2.1 shows the equivalent circuit of separately excited DC motor.

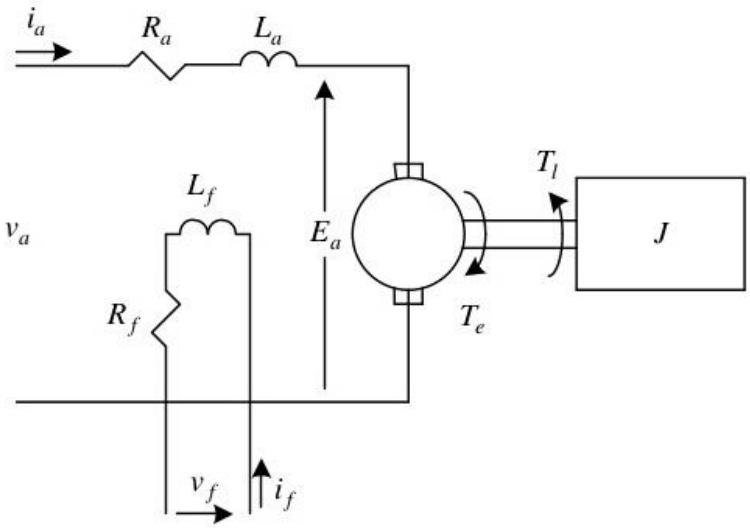

Figure (2.10) Equivalent circuit of separately excited DC motor

CHAPTER THREE

System Design

3.1 overview :

This chapter is about describing the flow chart , block digram and the description of the system .

3.2 System Block Diagram :

The block diagram consists of sensors (level ,pressure switch ,dry run ,prosimity) , PLC (program logic control) , actuators (pumps, valve) .

The sensors connected to PLC input which send the data to the SCADA software then the program send the signal to the actuator throw PLC output , if the tanks became full then the sensor send another signal to the PLC input from that the pumps will stop .

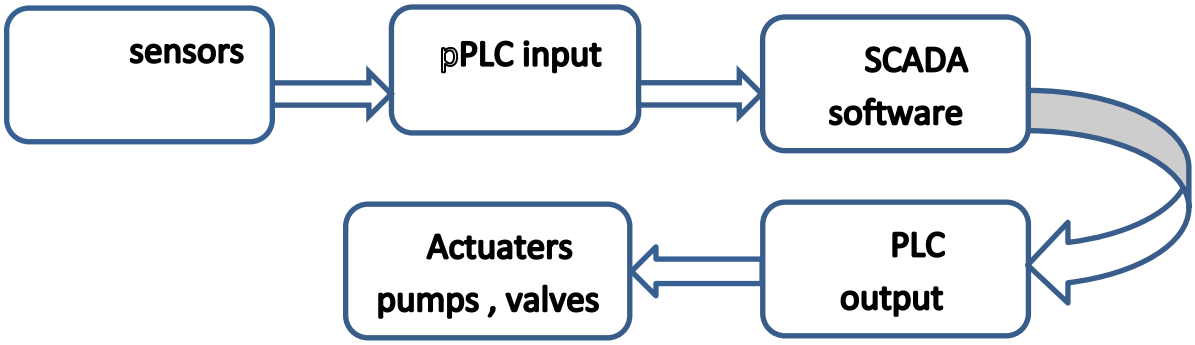

Figure (3.1), Block diagram

3.3 Description of the System:-

The system has being installed using the following components :

- Pressure switches
- Dry run switches
- Level switches
- Proximity sensors
- PLC
- Pumps
- Valves

3.4 Signal movement:-

The system is designed as following :

1- The level switches of the main tank connected with PLC in pin (I10.0,I10.1,I10.2) and the filter in pin (I11.0) ,the pressure switches and the dry run for the main pumps was connected with PLC in pin (I12.0 ,I12.1,I12.2 ,I13.0,I13.1,I13.2)

2- The level switches for tank1and 2 connected with PLC in pin (I20.0,I20.1,I20.2,I21.0,I21.1,I21.2), the transfer pumps was connected with pin (I23.0 ,I23.1 ,I23.2) and the pressure switches and dry run switches for the same pumps connected with PLC in pin (I24.0 ,I24.1 ,I24.2 ,I25.0 ,I25.1,I25.2) .

3- The bypass pumps connected with PLC in pin (I26.0 ,I26.1 ,I26.2) and the pressure switches and dry run switches for it connected with pin (I27.0 ,I27.1 ,I27.2 ,I28.0 ,I28.1,I28.2)

4- The level switches for the tank HR connected with pin (I37.0 ,I37.1) and the level switches , pressure switch ,dry run and pump for tank A was connected with pin (I43.0 ,I43.1 ,I40.0 ,I41.0 ,I42.0) , the level switches , pressure switch ,dry run and pump for tank B was connected with pin (I49.0 ,I49.1 ,I46.0

,I47.0 ,I48.0) , the level switches , pressure switch ,dry run and pump for tank C was connected with pin (I55.0 ,I55.1 ,I52.0 ,I53.0 ,I54.0) , the level switches , pressure switch ,dry run and pump for tank D was connected with pin (I61.0 ,I61.1 ,I58.0 ,I59.0 ,I60.0) , the level switches , pressure switch ,dry run and pump for tank E was connected with pin (I67.0 ,I67.1 ,I64.0 ,I65.0 ,I66.0) , the level switches , pressure switch ,dry run and pump for tank F was connected with pin (I73.0 ,I73.1 ,I70.0 ,I71.0 ,I72.0) , the level switches , pressure switch ,dry run and pump for tank make up air was connected with pin (I79.0 ,I79.1 ,I76.0 ,I77.0 ,I78.0).

Table (3.1) PLC input /output connection

No	Device	PLC pin
1	Emergency stop button	I 0.0
2	Control on relay	I 0.1
3	Stop push button	I 0.2
4	Start push button	I 0.3
5	Reset push button	I 0.4
6	Filter input	I 11.0
7	High high level switch	I 10.0
8	High level switch	I 10.1
9	Low level switch	I 10.2
10	Pump motor 1	I 14.0
11	Pump motor 2	I 14.1
12	Pump motor 3	I 14.2
13	Over pressure switch 1	I 12.0
14	Over pressure switch 2	I 12.1
15	Over pressure switch 3	I 12.2
16	Dry run switch 1	I 13.0
17	Dry run switch 2	I 13.1
18	Dry run switch 3	I 13.2
19	High high level switch to tank 1	I 20.0
20	High level switch to tank 1	I 20.1
21	High high level switch to tank 2	I 21.0
22	High level switch to tank 2	I 21.1
23	High high level switch to tank 3	I 22.0
24	High level switch to tank3	I 22.1
25	High high level switch to tank AF	I 32.0
26	High level switch to tank AF	I 32.1
27	Low level switch to tank 1	I 20.2
28	Low level switch to tank 2	I 21.2
29	Low level switch to tank 3	I 22.2
30	Pump motor 1	I 23.0
30	Pump motor 2	I 23.1
31	Pump motor 3	I 23.2
32	Bypass pump motor 1	I 26.0
33	Bypass pump motor 2	I 26.1

34	**Bypass pump motor 3**	**I 26.2**
35	**Pump motor to tank AF**	**I 31.0**
36	**Over pressure switch to pump 1**	**I 24.0**
37	**Over pressure switch to pump 2**	**I 24.1**
38	**Over pressure switch to pump 3**	**I 24.2**
39	**Dry run switch to pump 1**	**I 25.0**
40	**Dry run switch to pump 2**	**I 25.1**
41	**Dry run switch to pump 3**	**I 25.2**
42	**Over pressure switch to bypass pump motor 1**	**I 22.0**
43	**Over pressure switch to bypass pump motor 2**	**I 27.1**
44	**Over pressure switch to bypass pump motor 3**	**I 27.2**
45	**Dry run switch to bypass pump 1**	**I 28.0**
46	**Dry run switch to bypass pump 2**	**I 28.1**
47	**Dry run switch to bypass pump 3**	**I 28.2**
48	**Over pressure switch to tank AF**	**I 29.0**
49	**Dry run switch to tank AF**	**I 30.0**
50	**High high level switch for tank HR**	**I 37.0**
51	**High level switch for tank HR**	**I 37.1**
52	**High high level switch for tank A**	**I 43.0**
53	**High level switch for tank A**	**I 43.1**
54	**High high level switch for tank B**	**I 49.0**
55	**High level switch for tank B**	**I 49.1**
56	**High high level switch for tank C**	**I 55.0**
57	**High level switch for tank C**	**I 55.1**
58	**High high level switch for tank D**	**I 61.0**
59	**High level switch for tank D**	**I 61.1**
60	**High high level switch for tank E**	**I 67.0**
61	**High level switch for tank E**	**I 67.1**
62	**High high level switch for tank F**	**I 73.0**
63	**High level switch for tank F**	**I 73.1**
64	**High high level switch for tank make up air**	**I 79.0**
65	**High level switch for tank make up air**	**I 79.1**
66	**Pump tank A**	**I 42.0**
67	**Pump tank B**	**I 48.0**
68	**Pump tank C**	**I 54.0**
69	**Pump tank D**	**I 60.0**
70	**Pump tank E**	**I 66.0**
71	**Pump tank F**	**I 72.0**
72	**Pump tank make up air**	**I 78.0**
73	**Over pressure switch to tank A**	**I 40.0**
74	**Dry run switch to tank A**	**I 41.0**
75	**Over pressure switch to tank B**	**I 46.0**
76	**Dry run switch to tank B**	**I 47.0**
77	**Over pressure switch to tank C**	**I 52.0**
78	**Dry run switch to tank C**	**I 53.0**
79	**Over pressure switch to tank D**	**I 58.0**
80	**Dry run switch to tank D**	**I 59.0**
81	**Over pressure switch to tank E**	**I 64.0**
82	**Dry run switch to tank E**	**I 65.0**
83	**Over pressure switch to tank F**	**I 70.0**
84	**Dry run switch to tank F**	**I 71.0**
85	**Over pressure switch to tank make up air**	**I 76.0**
86	**Dry run switch to tank make up air**	**I 77.0**
87	**Pump motor 1**	**Q 14.0**

88	**Pump motor 2**	**Q 14.1**
89	**Pump motor 3**	**Q 14.2**
90	**Pump motor 1**	**Q 23.0**
91	**Pump motor 2**	**Q 23.1**
92	**Pump motor 3**	**Q 23.2**
93	**Bypass pump motor 1**	**Q 26.0**
94	**Bypass pump motor 2**	**Q 26.1**
95	**Bypass pump motor 3**	**Q 26.2**
96	**Pump motor to AF tank**	**Q 31.0**
97	**Pump for tank A**	**Q 42.0**
98	**Pump for tank B**	**Q 48.0**
99	**Pump for tank C**	**Q 54.0**
100	**Pump for tank D**	**Q 60.0**
101	**Pump for tank E**	**Q 66.0**
102	**Pump for tank F**	**Q 72.0**
103	**Pump for make up air**	**Q 78.0**
104	**External emergency**	**Q 0.0**
105	**Control on indicator**	**Q 0.1**
106	**Stop indicator**	**Q 0.2**
107	**Start indicator**	**Q 0.3**
108	**Fault indicator**	**Q 0.4**
109	**Filter start output**	**Q 11.0**

3.3 process flow control

Figure (3.2) shows the flow chart of whole system ,which also process of how the pumps work and how the backup pumps work.

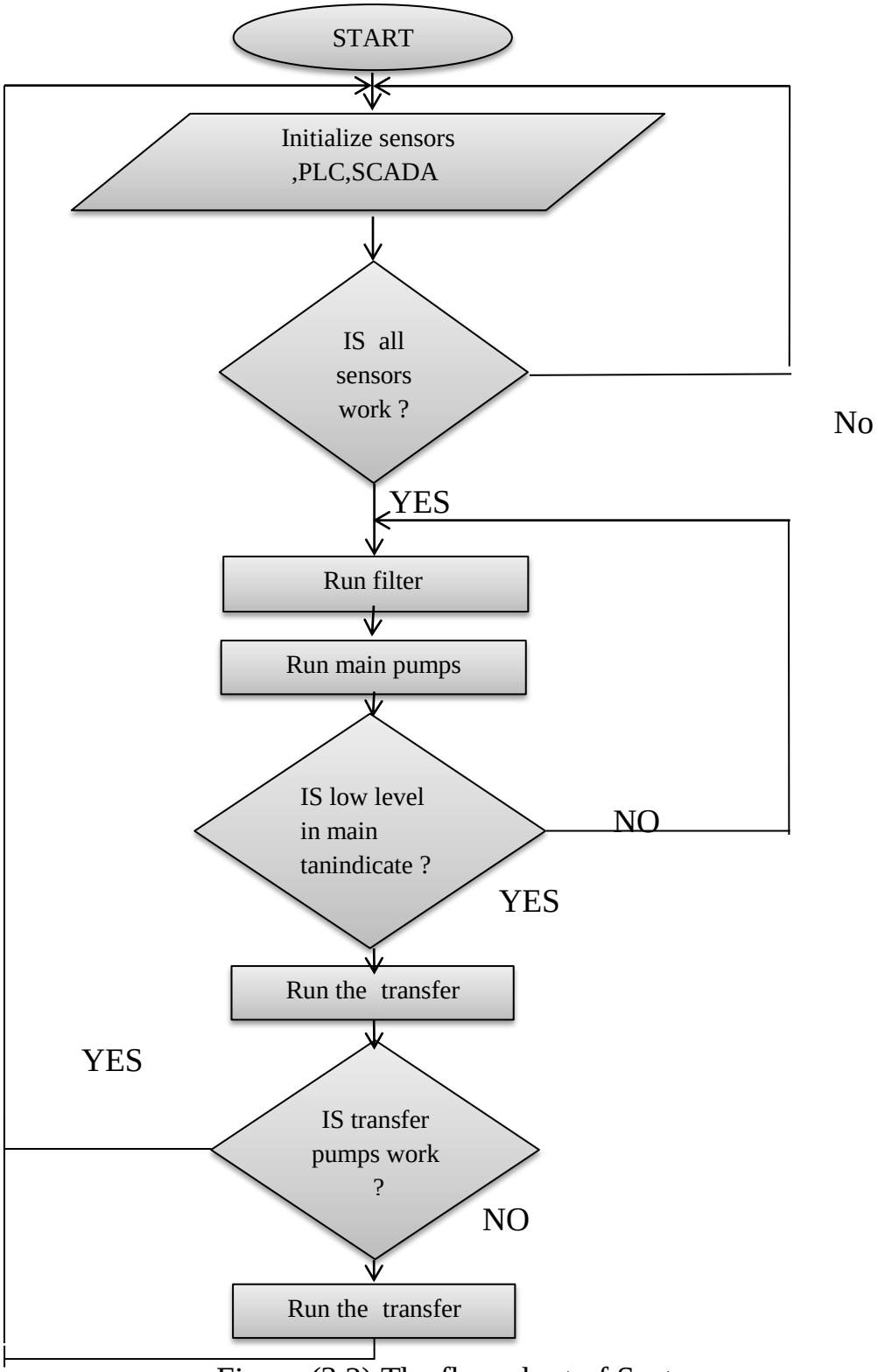

Figure (3.2) The flow chart of System

Chapter Four

Result and Discussion

4.1 overview:-

The system was divided into three part :

- Water supply
- Transfer
- Distribution

The system have being configured using start push button , if the low level for the main tanks indicate and the filter and all pressure switches and dry run switches are ready then the main pumps work automatically , there is three pumps and they work sequentially .

The first pump start work for 20 sec then it is stop and the second pump start automatically , when it finished the 20 sec the pump stop and the third pump work until the main tank is full and it show that by high level indicators , and the transfer start work , it's work by the same way that the main pumps work and same sequentially and it pumping the water to two tanks and continue until the high level indicate and the water pumping to distribution area .

If there is any problem in the storage tank of the transfer pumps the water pumping to distribution area by the by pass pumps and there is 8 tanks is distribute depend on the used and need in the factory .

Avery tank has pump to pumping the water and it stop after the high level indicate and they is a valves used to ensure that the flow of water has stopped , and it work again when the level indicate .

4.2 Case (1) first pump work:

When the water level is low than the low level for the main tank (1-BLL01) indicate and high level doesn't indicate then the main pumps start working , pump1 work after check the pressure switch (1-PSB01) , dry run switch (1-PSB04) and the filter (1A01FC) are work as shown in figure (4.1) .

The green colour mean the device works , the orange colour mean it's ready to work ,and the grey one mean it doesn't work , the Blow colour indicate to the flow of water in the pips .

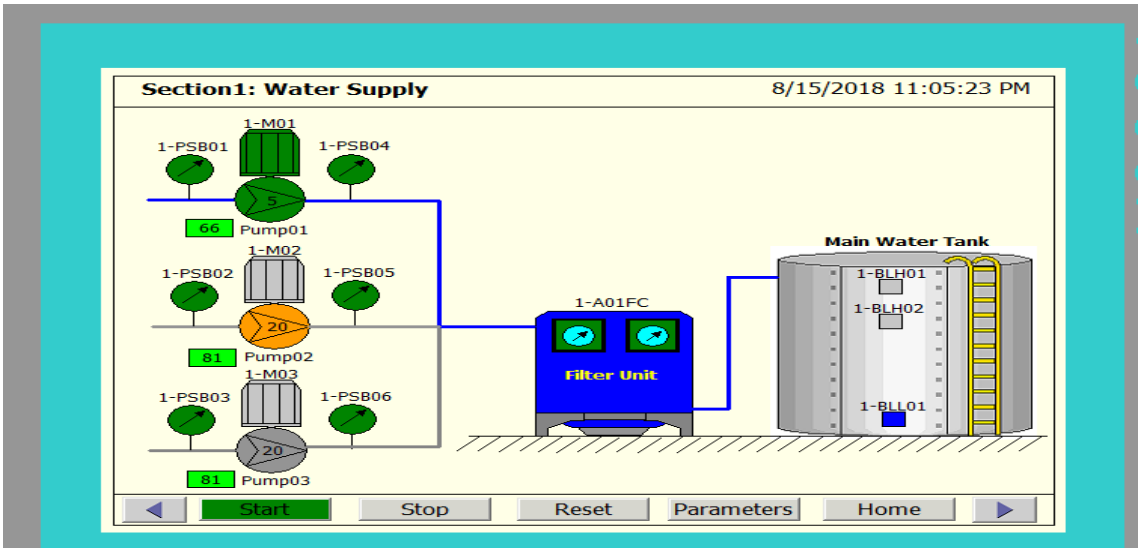

Figure (4.1) the first pump work

4.3 Case (2) second pump work :

after pump 1 finish his 20 sec the pump stop and the second pump work after check the pressure switch (1-PSB02), dry run switch (1-PSB05) and the filter , the third pump is ready to work as show in figure (4.2).

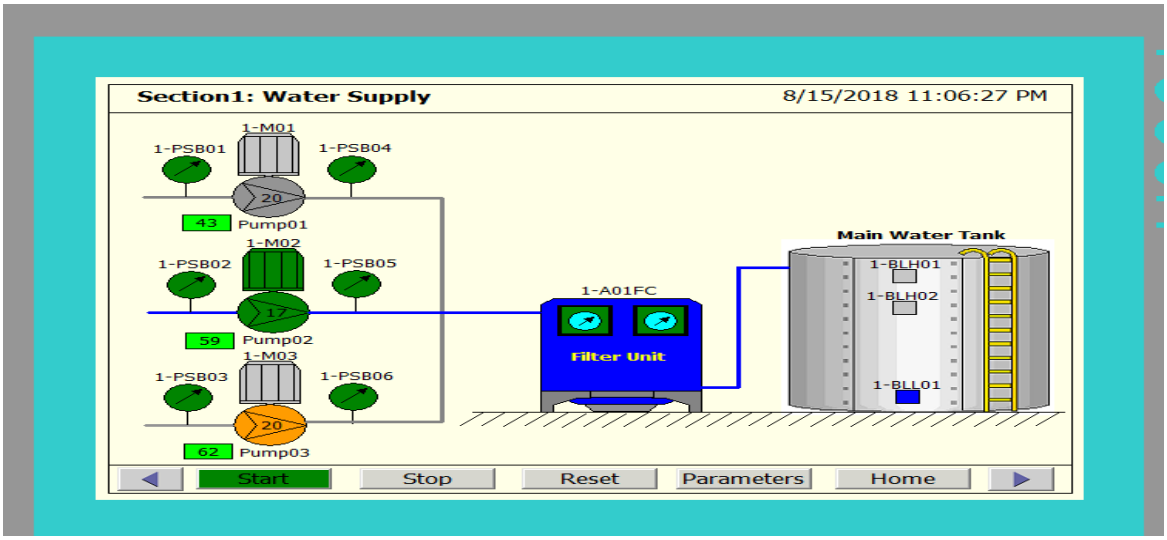

Figure (4.2) the second pump work

4.4 Case (3) tank was full and pump stop ：

When the water level rich to the high level (1-BLH02) then all pumps will stop until the water level decrease then the high level as show in figure(4.3) .

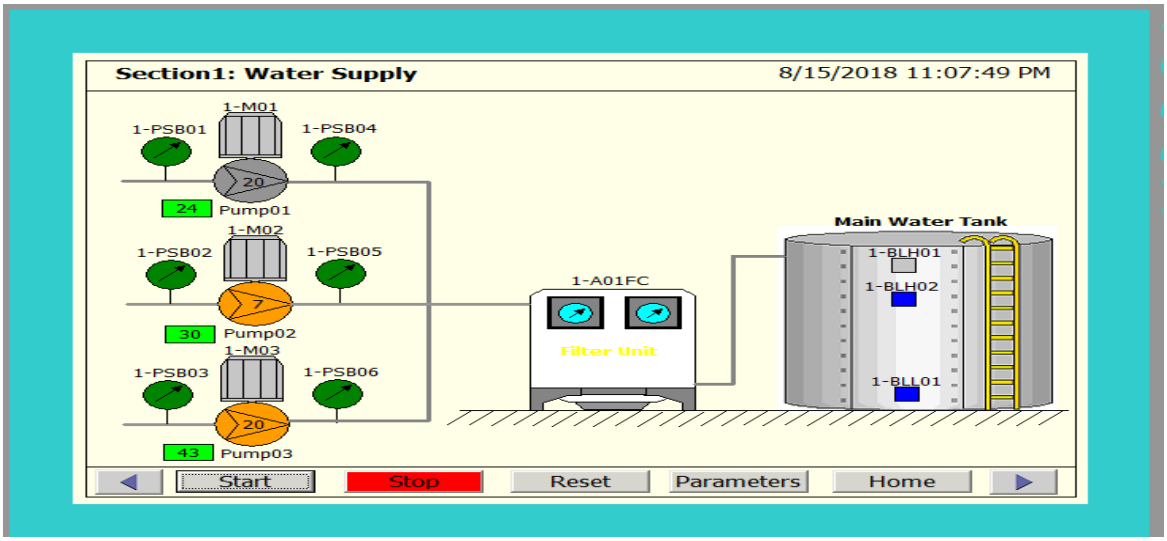

Figure (4.3) the tank was full and pump stop

4.4 Case (4) pump 2 was stop:

If there is any problem in any sensor such as the pressure switch of pump 2 (1-PSB02) then the pump will stop and it excludes from the sequence until the problem fixed and the reset indicator indicate to show the supervisor there is a problem , the red colour show the disable device as show in figure (4.4).

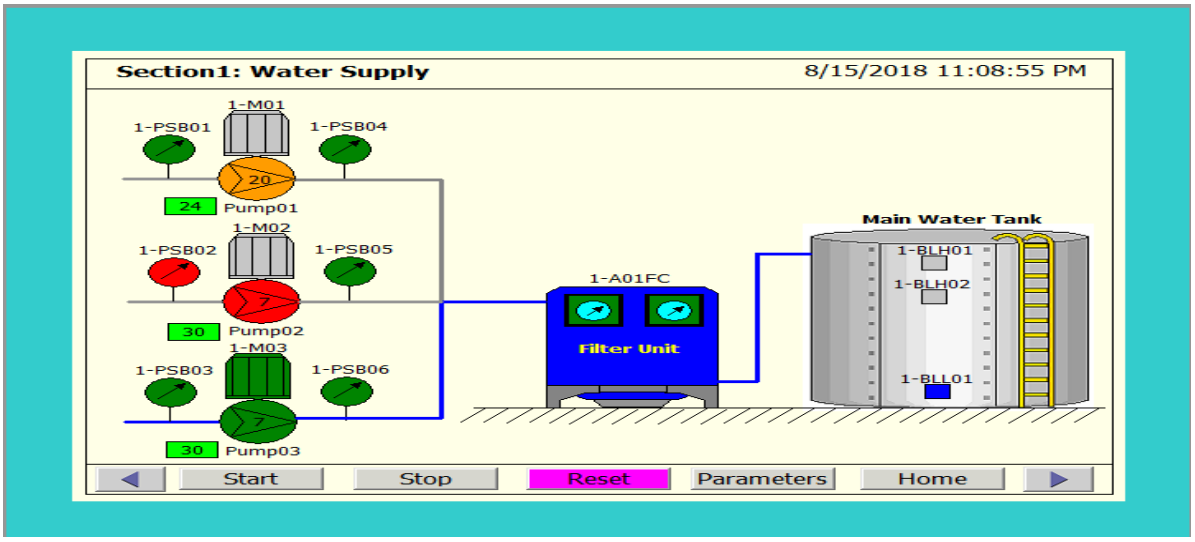

figure (4.4) pump 2 was stop

4.5 Case (5) pump 1,3 stop because over:

Every pump have time over due , the pump will excludes if it retch to this time , and there is indicator show that as it show in figure (4.5) .

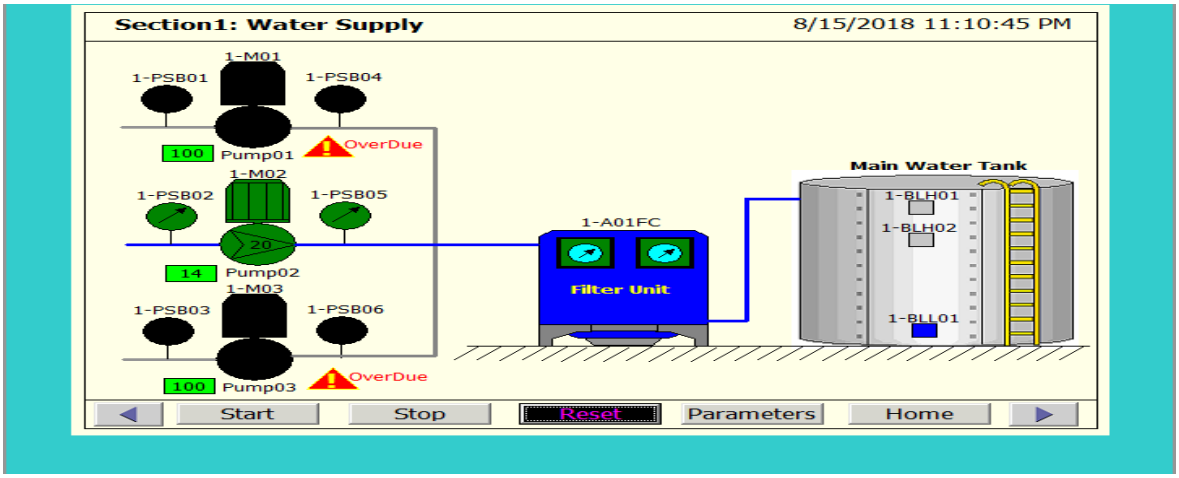

figure (4.5) the pump 1,3 stop because over due

4.6 Case (6) the filter stop:

If there is any problem in the filter then all the pump will stop as well the stop and the reset puch button indicate , the red colour show the supervisor the disable devise as show in figure (4.6) .

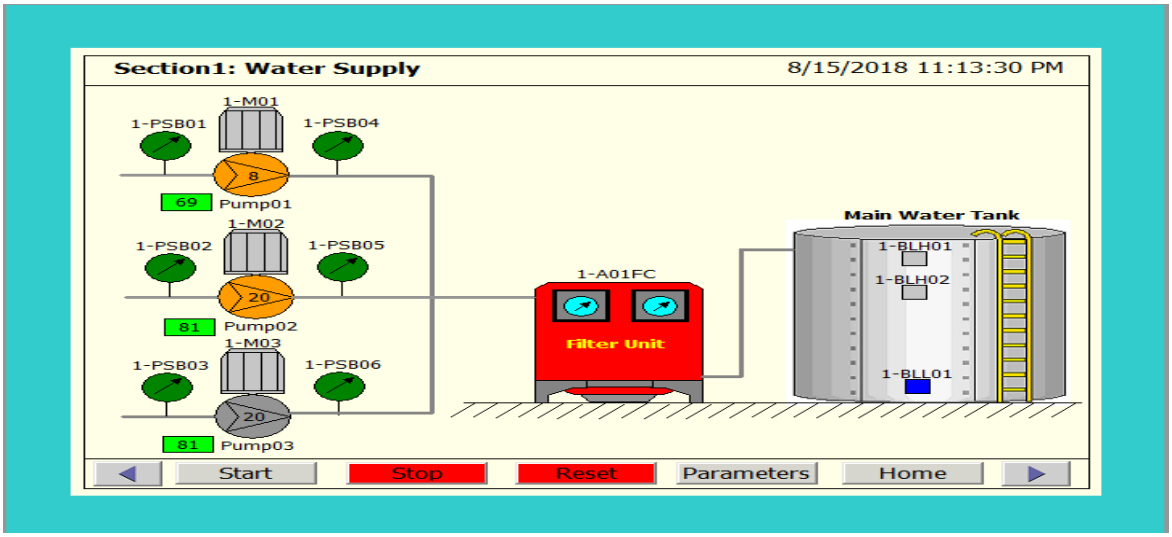

figure (4.6) the filter stop

4.7 Case (7) pump2 is work:

In this case pump 2 in the water transfer is work after pump 1 stopped and the high level sensor doesn't indicate also the pressure switch (2-PSB02) and dry run switch (2-PSB05) are work so the water flow to tank 1 and tank 2 as show in figure (4.7) .

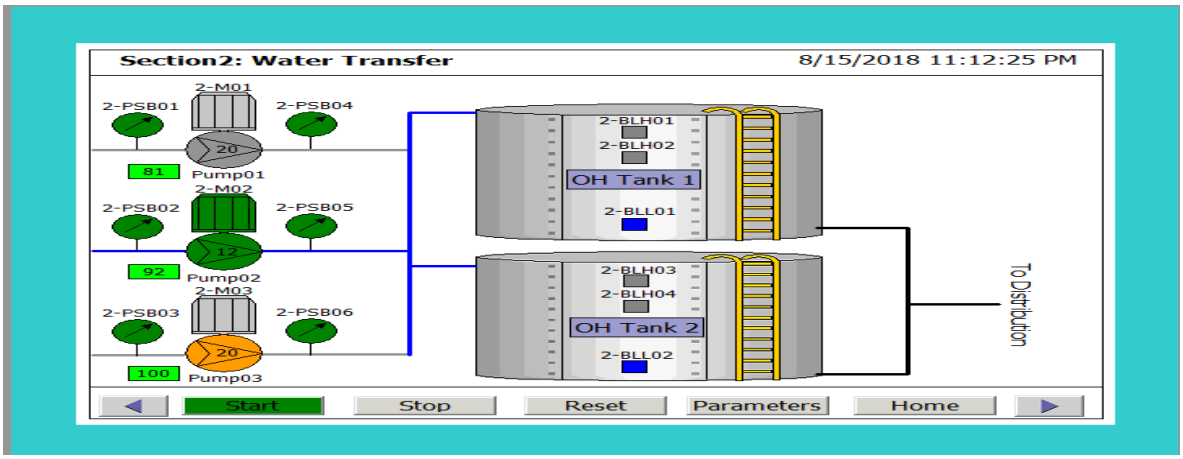

Figure (4.7) pump2 is work

4.8 Case (8) high high level indicate:

If high high level sensor indicate such as (2-BLH03) then all water transfer pump will stop immediately as show in figure (4.8)

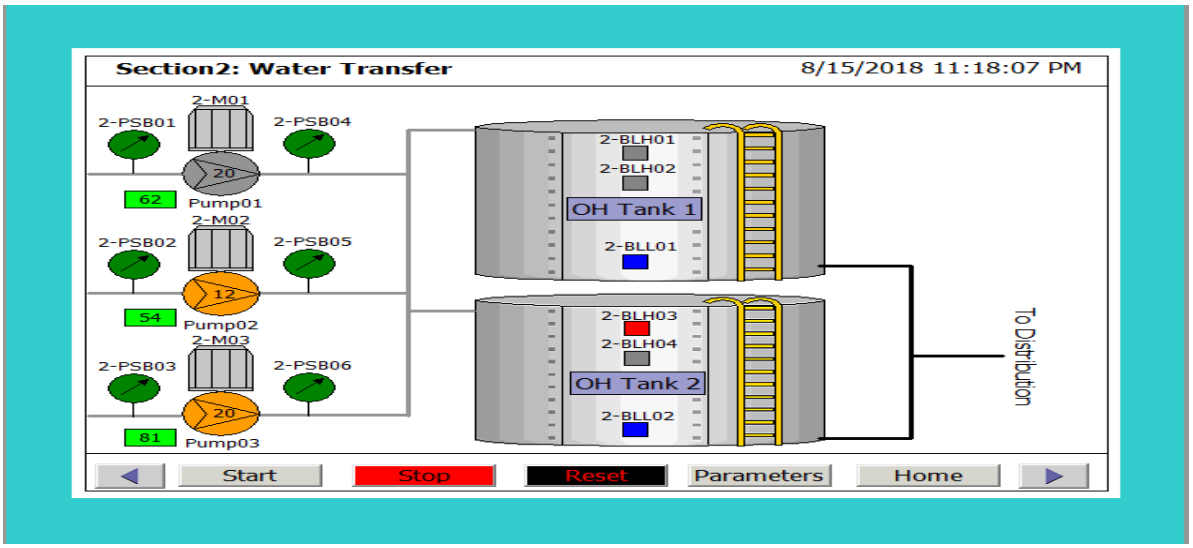

figure (4.8) high high level indicate

4.9 Case (9) bypass pumps work:

When the transfer pumps didn't work due to some problem then the bypass pumps will work to supply Distribution area by the water and the pumps work by the same sequence of main pumps as show in figure (4.9).

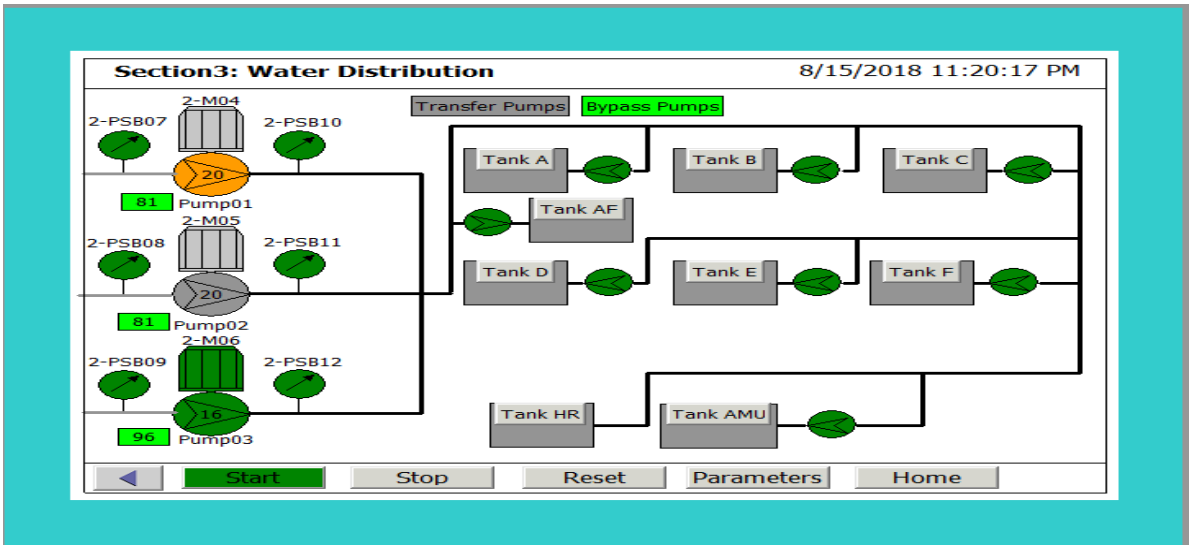

Figure (4.9) bypass pumps work

4.10 Case (10) the water supply to tank A:

Take tank A as example for all distribution tanks , the water pumping to the tank throw pump A after check pressure switch and dry run (3-PSB01) ,(3-PSB02) and the valve is open and the low level (3-BLH03) , high level (3-BLH04) didn't indicate as show in figure (4.10) .

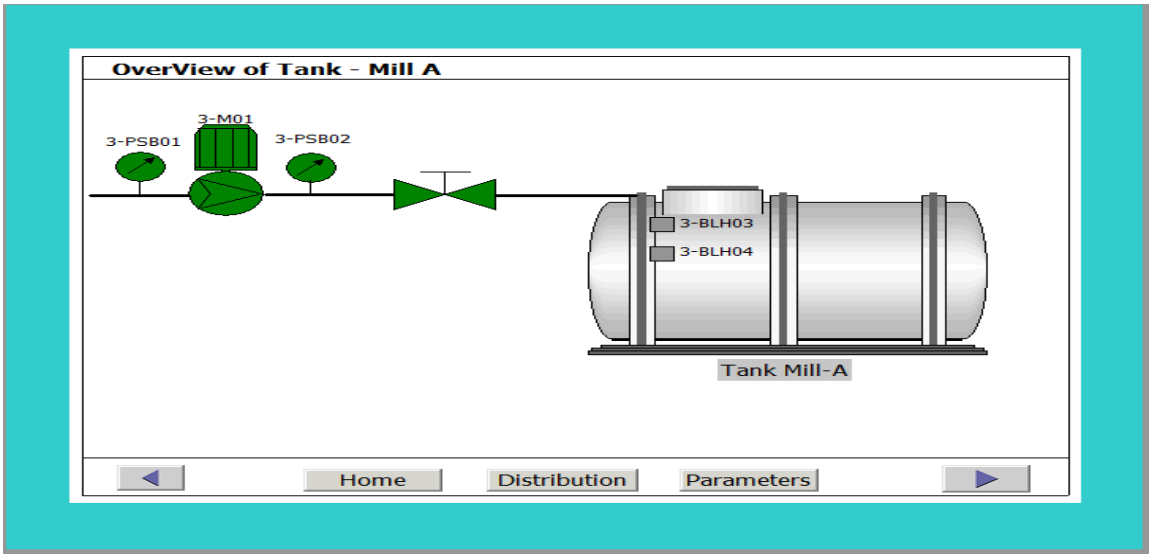

Figure (4.10) how the water supply to tank A

4.11 Case (11) pump stop and the valve showdown:

when the water level retch the high level indicator then the pump stop and valve showdown as show in figure (4.11.1) , also you can see the tank was full and pump stop from the main screen for distribution as show in figure (4.11.2) .

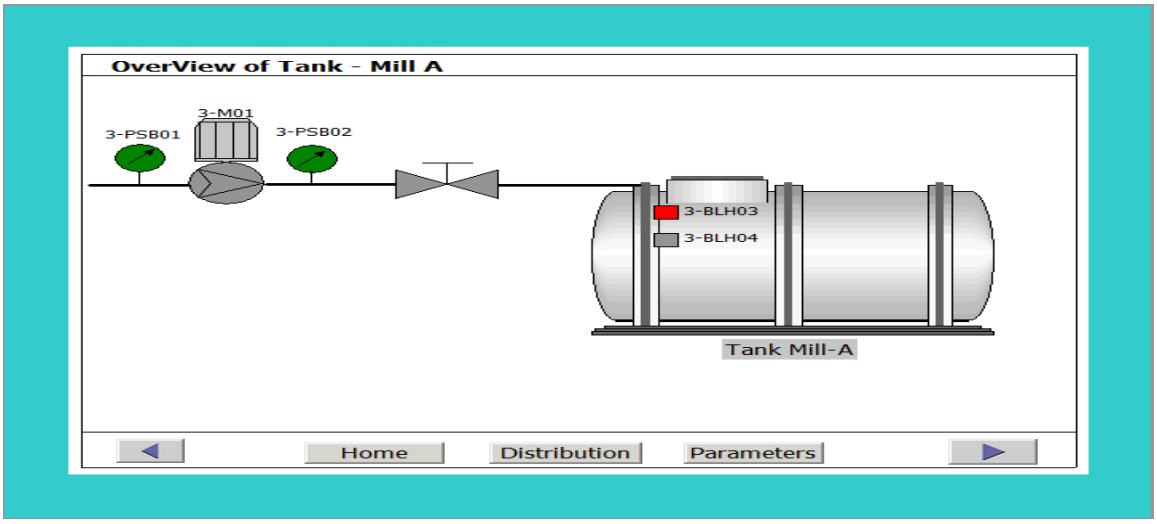

Figure (4.11.1) the pump stop and the valve showdown

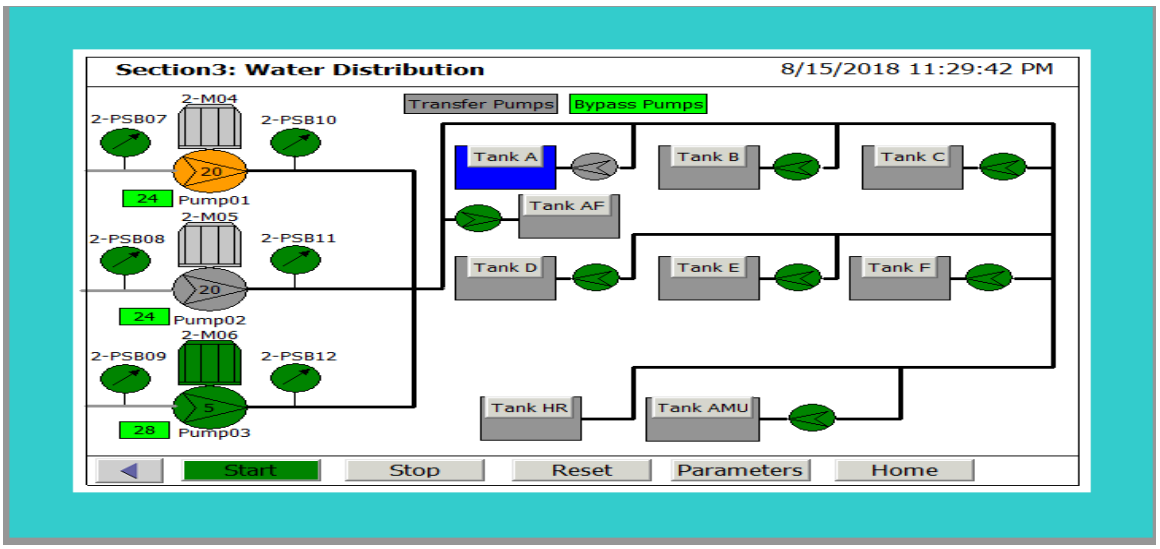

Figure (4.11.2) the main screen of distribution

4.12 Case (12) pump A stop:

If one of the sensor disable such as the pressure switch (3-PSB01) then the pump stop until fixed the problem as show in figure (4.12) .

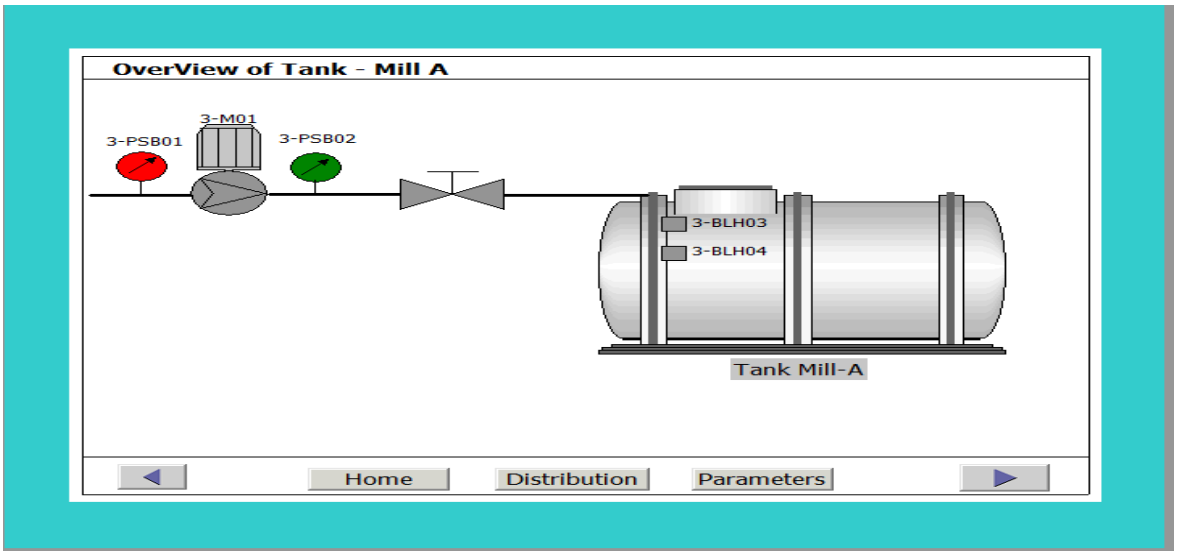

Figure (4.12) pump A stop

4.13 Case (13) the distribution area doesn't work :

If the transfer pump doesn't work and there is a problem in bypass pumps the distribution section stop and distribution push button indicate and there is siren also indicate and you can stop the siren from mute pushbutton until fixed the problem as show in figure (4.13) .

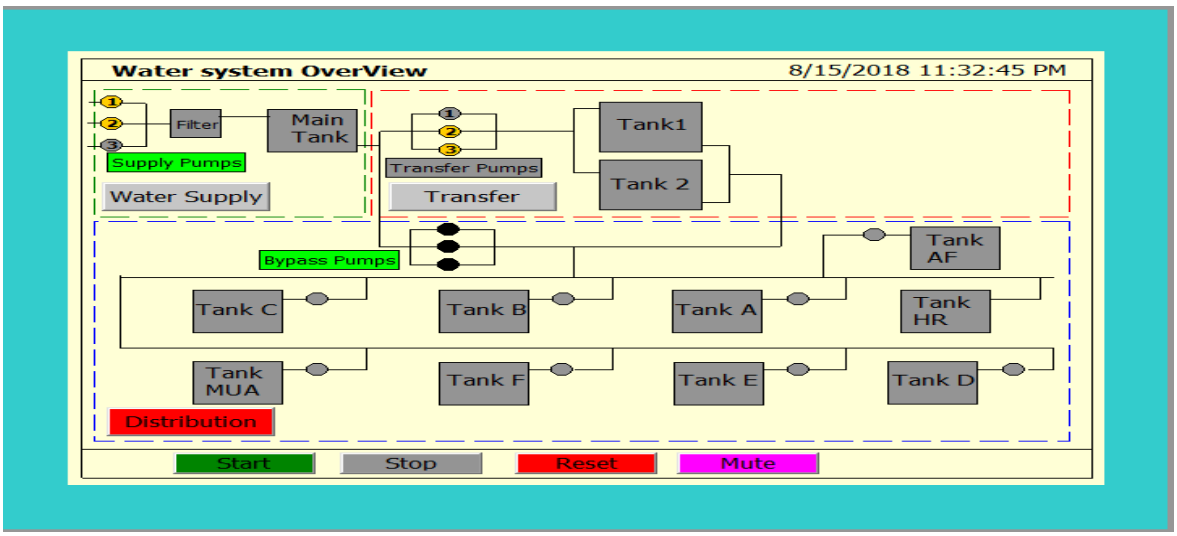

figure (4.13) the distribution area doesn’t work

CHAPTER FIVE

Conclusion and Recommendation

5.1 Conclusion:-

As a Conclusion ,the objective for the project were covered and achieved , This is done by implementing . the main advantages you can supervisor and control of the water flow also water flooding from tanks has stopped by two sensors one of them work when the tank has been full and the second one when the water start flooding and it stop all the system immediately .

There are backup pumps to flow the water to the tank when the main pumps was fault and it confirmed that water wasn't cut off.

In the event of malfunction in any device is directly alarm where it is repaires before the problem magnifies .

5.2 Recommendations:-

This project still has many improvements that should be done to improve it accuracy and reliability. There are some suggestions for the future research and development.

1- Adding security system to control access into project .

2- Adding digital sensor to enhance accuracy .