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Automation of Humidity Control in Spinning Mill

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Abstract— This Paper involves that Automation of Humidification Plant in textile Application – Humidification is the critical parameter, which defines the quality of the yarn. Here there are two Axial Flow Fan which absorbs fresh air from atmosphere through Inlet Damper and passes to Louver here it reduces the flow of dust particle. In between Louver and Mist Eliminator water storage tank is there, through pump it spray water for cooling the warm and moist air flow from Louver. Then passes into Mist Eliminator which eliminates water particles and send cool air into Duct. Through Duct the air flow into Spinning and Conning sections of Humidification Plant for maintaining the Humidity. Dust and Air from plant get discharged from trench through exhaust fan through Outlet Damper.

To maintain Humidity of Spinning and Conning Section in between 35-50 RH. If inside the department RH% is below set value .Now the pump starts automatically and cool air flow inside Relative Humidity reaches maximum set value .Then the pump goes off automatically. This will continue throughout the day and maintain the inside Relative Humidity with in the set limit.

Keywords—*Relative Humidity, Damper, Mist Eliminator, Axial Flow Fan.*

I. INTRODUCTION

A humidifier is a device that maintains and increases humidity (moisture) in a single room or an entire building. In the home point humidifiers are commonly used to humidify a industry room, while whole-house or furnace humidifiers, which is connected to a HVAC system, provide humidity to the entire house. Medical ventilators often include humidifiers for keeping patient's comfort and happy. Humidifiers are used in commercial, institutional, or industrial contexts, often as part of a larger HVAC system.

However, there are not many occasions where humidity is more of an issue to relax and take rest. During the processing of textiles .Get it wrong and it can reduce production, damage machines and hurt staffs. Get it right and you should control temperature and Relative Humidity to improve quality. Excessively low humidity may occur in hottest places, dry desert climates, or indoors or outdoors in artificially heated spaces. In winter, especially when it is cold outside the room, air is heated indoors, the humidity may drop as low as 10-20%. This low humidity may lead to death , by drying out membranes, such as the lining of the heart and brain and can cause respiratory problems. The low humidity also can affect wooden furniture, causing shrinkage and loose joints or cracking of pieces. Books, papers, and cloth may shrink or warp and become brittle in very low humidity.

In addition, static electricity may become a major problem in conditions of low humidity, destroying semiconductor devices and causing annoying statically of textiles, and causing dust and small particles to stick stubbornly to electrically charged surfaces.

II. BLOCK DIAGRAM AND WORKING

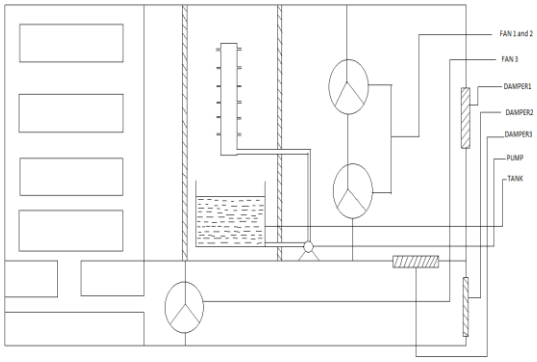


Fig 1: Block diagram of spinning mill plant

There are two inlet fans and one Exhaust fan used for providing necessary air to the tank. The tank is used for spraying the moisture content in the air to the duct. Damper is used for opening and closing of valves. Tract is used for sending unnecessary hot air through the exhaust fan to the atmosphere.

A. Parts of Spinning Mill

1Axial flow fan:

An axial fan is a type of air-compressor that increases the pressure of the air flowing inside it. The blades of the axial flow fans forced air to move simultaneously to the shaft about which the blades rotate. In other words, the flow is axially in and axially out, linearly and equally. The design priorities in an axial fan revolve around the propeller that creates the pressure difference inside the damper and hence the suction force that retains the flow across the fan. The main elements that need to be studied in the designing of the propeller include the blades and their design. In aircraft, helicopters, hovercrafts, ships and hydrofoils. They are also used in wind tunnels and cooling towers. If the propeller is exixting propulsion, then efficiency is the only parameter ofinterest and other parameters power required and flow rate are considered of no use. In case the propeller is used to a fan, the parameters include power, flow rate, pressure rises and efficiency is maintained.
An axial fan consists of much fewer blades i.e., two to six, as compared to ductile fans. Axial fans is operated at high specific speed i.e., high flow rate and low head pressure and hence adding more blades will block the high flow rate required for its operation. Due to fewer blades, they are unable to maintain their geometry on the flow, making the rotor geometry and the inlet and outlet velocity triangles are tend to be meaningless. Also the blades are made very long with varying blade sections along the radius.

Fig: 2: Axial flow fan

2 Mist eliminator:

Mist elimination or demisting can be defined as the separation of liquids from gases. The first and most widely used separator and detector were comprised of impaction devices in packed columns, such as packing and perforated plates. Cyclonic separators were later found and developed out to lower the height of the packed columns. Then wire mesh mist eliminators were invented to lower the pressure drop of the cyclones moisture separators and improve the collection efficiency of smaller droplets.

The wire mist moisture content eliminators, commonly referred to as knight mesh mist eliminators, collect droplets by the inertial impaction and inteseperation mechanisms of collected rust foam. The wire mesh separators are commonly used to collect droplets above 5 microns in dia. However, when the separation of droplets in the 1-3 µm is required, these wire mist eliminators are largely not affected because of the mesh's random structure, irregular density, and coarse fiber diameters.

Mist Eliminators that are manufactured using good tensile quality material. These eliminators contains water particles in the single pass of air. Range of Mist Eliminator is also provided with PVC and normal running fins, which offers less resistance to air flows rather than being light and flexible.

Listed below are the salient features of mist eliminator range:

Less maintenance

Long lasting performance

Resistant to rugged environment

Fig 3: Mist eliminator

3 Air washer

A device for cooling and wiping air in which the entered warm and moist air is cooled below its dew point by refrigerated water so thatalthough the air leaves nearby saturation with water vapour, it has less moisture per unit volume than when it entered.Apparatus to wash particularmaterial and dissolvable impurities from air by passing the airstream through a liquid bath or spray.A water spray system or device for cleaning, humidifying, or dehumidifying the air.The part of an air-conditioning system in which the air is free from dust and given to the desired humidity by means of a spray of water.To meet specific industrial customer clients, we manufacture products and export over a wide range of vaste quality Air Washer (Evaporative Cooling and condensing Unit) or Industrial in cooling Systems. Simply used for cleaning the material and cooling the heat inside the system and moist air that enters into these damper to a level where it melts dew point when come in contact with refrigerated water. These units help in minimizing the moisture content of air and keeping them fresh from its actual content. The spray or liquid bath in these washers helps in minimizing the dissolvable impurities and particles. Engineered with precision these products are polished using steel of superior quality that is galvanized.

Features:

Specifications:

Capacity ranging: from 2500cm to 8500cm

Material with stainless steel orifice plate

4 Air louver

These washers are provided with modern spray nozzles that are made using abs. Our range of Prefabricated Air Washer is highly efficient and is available in market with clamps for easy maintenance, simple in construction and long life. It is used for opening in a door or window that has one or more slanting strips to allow air to flow inside and outside while keeping out during winter and summer one of the slanting strips of a louver It is an opening provided with one or more slanted fixed or adjustable fins to allow the flow of air, moisture content but to exclude rain or sun or to provide privacy. It is a finned or vanned device for controlling a flow of air or the radiation of light. It is a fin or shutter of a louver.

Fig: 2.3 Air louvers

2.1.5 Airfoil damper:

The aluminium aerofoil damper is a low leakage high performance control damper with extruded aluminum airfoil blades. Blades are completely covered within the frame allowing the damper to be directly mounted to a louver, filter frame, or similar application with no blade interfering with damper. Smooth profile extruded aluminum airfoil blades insure the lowest resistance to airflow in systems. They are available in various sizes, dimensions and finishes. These are manufactured using high grade of aluminium extraction profiles. Our range of Aluminum Dampers is provided with aerofoil aluminum extruded blades, abs lining arrangements and outer casing, which is made from heavy gauge GI sheets. All these equipment further helps us in ensuring the smooth and need operation, thereby suiting the auto control with actuators.

Fig 4: Air foil damper

III. COMPONENTS AND HARDWARE

Fig 5: DOL Sensors

DOL 114 is a higher –precision sensor for measuring relative humidity and temperature. It is intended for application in livestock houses but is also well suitable for a number of industrial applications.

The sensor features two to 4 to 20mA analogue outputs with very low output resistances and full protection against short circuits and wiring failures.

The special senor element and the built-in Teflon filter enables application in livestock houses with constantly high humidity. The sensor can be supplied with build-in connector or cable according to requirement.

Sensor is microprocessor-controlled and has a two-colour light diode (LED) to communicate the operation status and the error diagnostic. Sensor can be applied with LED for applications where this is needed.

Table 1: Specifications

	Humidity measurement	Temperature measurement
Measuring range	0-100% RH	-40 ^{0}C-60^0 C
Accuracy 1	±2% RH(40-85 %)+3% RH(10-95%)at 0-40^0 c	±10^0 c-40^0 c: ±0.5^0 c
Output Signal	0.16 mA/%RH	0,16 mA/^{0} C,0 C at 10.4 mA
Time constant	2min	2min
Supply voltage	11-30 v Dc	11-30 V DC
Supply current	20mA at no load 70mA at max load	20mA at no load 70mA at max load
Load	490-1k at 24 v dc supply voltage	490-1k at 24 v dc supply voltage
Recommended load	500	500
Output current	20mA per output(current limited)	20mA per output(current limited)
Output impedance	<1Ω	<1Ω
Temperature, operation and storage	-40 ^{0}C -60 ^{0}C	-40 ^{0}C -60 ^{0}C
IP classification	IP 67	IP 67
Cable	2 m.4 x22AWG/0.34 mm	2 m.4 x22AWG/0.34 mm
Max.cable length	100m @0.75mm,200 m,@1.50mm	100m @0.75mm,200 m,@1.50mm
Shipment weight ex.connector	150g	150g
Measure, shipment	275x200x20mm	275x200x20mm

1 Switched Mode Power Supply(SMPS)

The prevailing DC power supply architecture in most technology systems is the Switch-Mode Power Supply (SMPS), which is known for its ability to handle moving and changing loads efficiently. The power signal path of a typical SMPS includes passive, active, and magnetic compass components. The SMPS reduces the use of lossy components such as resistance and linear-mode transistors, and endeavour components that are (ideally) lossless: switch-mode transistors, capacitors, and magnetic.

Like a normal power supply, the switched mode power supply also converts the available unregulated ac or dc input voltage to a regulated and converted dc output voltage. However in case of SMPS with input supply drawn from the ac mains, the input voltage is foremost rectified and filtered using a capacitor in mF at the rectifier output. The unregulated form of dc voltage across the capacitor is then interfaced to a high frequency dc-to-dc converter. Most of the dc-to-dc converters implied in SMPS circuits have an intermediate high frequency to change ac conversion stage to facilitate to operate in need of a high frequency transformer for voltage scaling and isolation. The high frequency transformer used in a SMPS circuit is much shorter in sizing and weight compared to the low frequency transformer of the linear power supply circuit. The 'Switched Mode Power Supply' owners its name to the dc-to-dc switching converter for conversion from unregulated dc input modified voltage to regulated dc output varying voltage. The switch employed is turned 'ON' and 'OFF' (referred as switching) at a high range frequency. During 'ON' mode the switch is in saturation mode with negligible voltage drop across the collector,drain,earthed and emitter terminals of the switch where as in 'OFF' mode the switch is in cut-off mode with no need of current through the collector and emitter terminals. On the contrary the voltage-regulating switch, in a linear regulator circuit, always maintains its stability in the active region. In this thesis firstly a simplified schematic switching arrangement is described that omits the transformer action. In fact there are several other switched mode dc-to-dc converter circuits that do not use a high frequency transformer. In such SMPS circuits the unregulated input dc voltage is fed to a high frequency voltage chopping circuit such that when the chopping circuit (often called dc to dc chopper) is in ON state, the unregulated voltage is given at higher range to the output circuit that includes the load and some filtering circuit. When the chopper is in OFF state, no way of magnitude of voltage is applied to the output side. The ON and OFF durations are efficiently controlled such that the average dc voltage applied to the output circuit equals the desired magnitude of output voltage. The ratio of ON timer to running time (ON + OFF time) is known as duty ratio of the chopper circuit. A high switching power supply frequency (of the order of 100 KHz) and a fast control over the duty ratio results in application of the desired mean voltage along with ripple movable wave voltage of a very high frequency to the output side, consisting of a low pass filter circuit followed by the load. The high frequency ripple in voltage is effectively filtered using minimum need values of filter capacitors and inductors.

SMPS technology rests on power semiconductor switching devices such as Metal of Oxides Semiconductors Field Effect Transistors (MOSFET) and Insulated Gate Bipolar Transistors (IGBT). These devices offer fast moving times and are able to withstand erratic voltage spikes. Equally important, they dissipate very little power in either the running or dead states, achieving high efficiency with low heat dissipation. For the most part, the switching device determines the overall performance of an SMPS. Key measurements for switching devices include: switching loss, average power loss, safe operating area, and more.

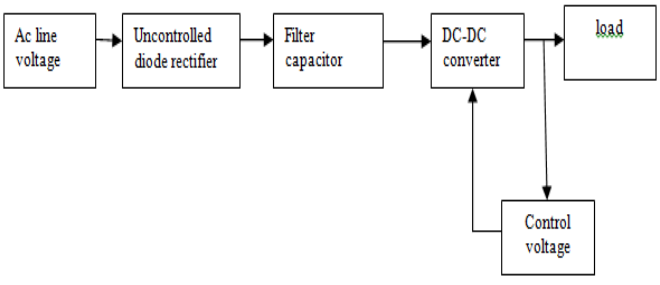


Fig 6: Block diagram SMPS

2 Programmable logic controller (PLC)

Programmable Logic Controller (PLC) was newly named Programmable Controller (PC) but this has caused some confusion when personal computers became more common. Thus to avoid confusion, PLC is widely used compared to PC. The original PLC was just a simple on and off device. Therefore it was very suitable to replace simple relay applications. Since the early days, manufacturers of PLC have added numerous features and enhancements to PLC. Now it has the capability to handle complex tasks such as position control, process control and other difficult applications. The speed of operation and case of programming has also improved drastically.

PLC is really an industrial computer as its hardware and software have been specifically adapted to the industrial environment. It is an electronic microprocessor based control system that monitors input signals to detect changes from devices such as limit switches, push buttons and sensors. Based on the status of input signals, PLC will react by producing output signals to drive output devices like motors, relays, alarm and contactors to on or off state. This is done with a control application program stored within the PLC memory. The program will execute according to predefined sequence of operations. PLC is widely used in the industrial sector as it has some major advantages. First of all, the wiring of PLC is much less compared to conventional relay control system. Modification can be quite difficult with all these wiring in the conventional.

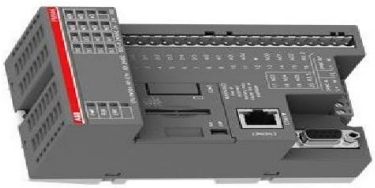


Fig 7: Programmable logic controllers

3 Human machine interface (HMI)

HMI stands for Human Machine Interface. This is the interfacing between the user and the controller. The HMI is the controller user interface panel. The panel comprises a numeric keypad and a LCD screen that displays text. The keypad is used to input data into the application, such as Timer values. The PLC's Display screen can show operator messages, variable information from the program and system information. HMI messages are created in the Display Editor. Variable information fields are created in the Variable Editor. The user interface in a manufacturing or process control system. It provides a vga based visualization of an industrial control and monitoring system. Previously called an "MMI" (man machine interface), an HMI typically maintains its product in an office-based Windows computer that communicates with a specialized computer in the plant such as a programmable automation controller (PAC), programmable logic controller (PLC) or distributed control system (DCS). Contrast with OI.

See PAC, PLC,DCS,SCADA,HMI, GUI and user interface. These interface products can range from a basic LED status indicator to a 22-inch TFT panel with touchscreen interface. HMI applications require mechanical robustness and resistance to water, dust,air,foam moisture, a wide range of temperatures, and, in some environments, secure communication.

Fig 8: Human Machine Interface

Table 2 Technical Specifications

Parameter	Value
Touchscreen technology	Resistive
Back-up battery	3V 50mAh Lithium, rechargeable, not user-replaceable, model VL2330
Fuse	Automatic
Serial Port	RS-232, RS-485, RS-422 software configurable
User memory	Flash 128 MB for CP620, CP630, CP635 including –x, -x-WEB Flash 256 MB for CP651, CP661, CP665, CP676 including –x, -x-WEB
Recipe memory	Flash
Hardware clock	Clock/calendar with back-up battery
Accuracy RTC (at 25 °C operating)	< 100 ppm

Table 3: Environment Conditions

Parameter	Value	According to
Operating temperature (surrounding air temperature)	0 °C … +50 °C	EN 60068-2-14
Storage temperature	-20 °C … +70 °C	EN 60068-2-14
Operating and storage humidity	5 % … 85 % RH not-condensing	EN 60068-2-30
Vibrations	5 Hz … 9 Hz, 7 mm $_{p-p}$ 9 Hz … 150 Hz, 1 g	EN 60068-2-6
Shock	± 50 g, 11 ms, 3 pulses per axis	EN 60068-2-27
Protection class	IP66 front panel *	EN 60529

Table 4: Durability Information

Parameter	Value
Backlight service life (LED type)	MTBF value: 40,000 hrs (time of continuos operation until the brightness of the backlight reaches 50 % of the rated value when the sorrounding temperature reach 25 °C), see [1]
Battery lifetime	10 years if the surrounding temperature is 25 °C 5 years if the surrounding temperature is 40 °C
Front foil (without directly expose to sunlight or UV ray)	10 years if the surrounding temperature is 25 °C
UV Resistance	Indoor applications: After 300 hrs cycled humidity in QUV accelerated weathering, some yellowing and brittleness may be present.
Touch panel (resistive film, analog)	1,000,000 or more of activations, see [2]
Touchscreen reliability	> 1 million operations

3.4 LADDER PROGRAMMING:

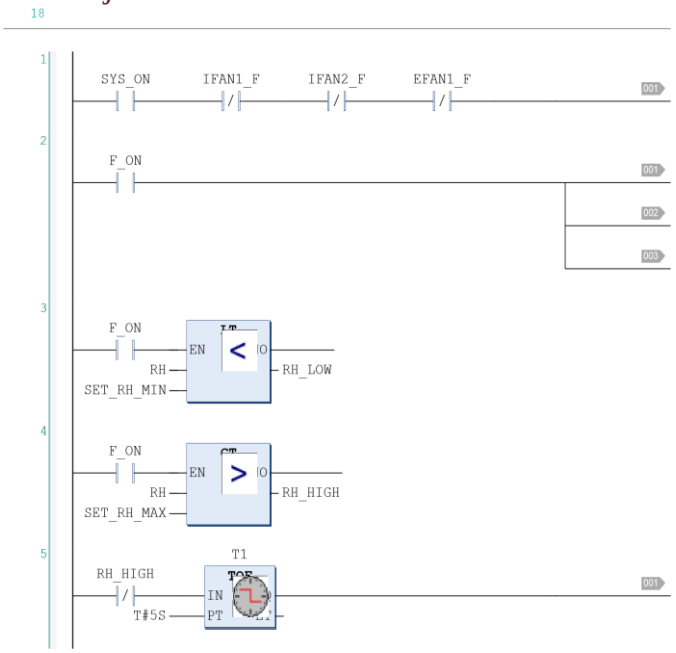
IoStandard, 3.4.1.0 (System)
- IBase, * (System)
- CmpErrors, * (System)
- SysTypes, * (System)

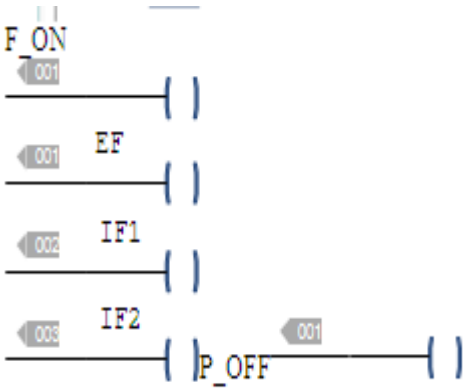
Standard, 3.4.1.0 (System)
Util, 3.4.1.20 (System)
- #Standard

M258 PLCSystem, 1.0.2.6 (Schneider Electric)
- #SysMem
- Standard, 3.4.1.0 (System)
- #CAA File
  - #CAA Types
    - #SysCpuHandling
      - #SysMem
      - SysTypes, * (System)
      - CmpErrors, * (System)
  - #CAA Tick
    - #CAA Types
      - #SysCpuHandling
        - #SysMem
        - SysTypes, * (System)
        - CmpErrors, * (System)

#CAA TickUtil
#CAA Types
#SysCpuHandling
#SysMem
SysTypes, * (System)
CmpErrors, * (System)
#CAA Behaviour Model
#CAA Types
#SysCpuHandling
#SysMem
SysTypes, * (System)
CmpErrors, * (System)
#CAA TickUtil
#CAA Types
#SysCpuHandling
#SysMem
SysTypes, * (System)
CmpErrors, * (System)
#CAA Tick
#CAA Types
#SysCpuHandling
#SysMem
SysTypes, * (System)
CmpErrors, * (System)
#CAA Async Manager
#CAA Types
#SysCpuHandling
#SysMem
SysTypes, * (System)
CmpErrors, * (System)
#CAA Memory
#CmpApp
SysTypes, * (System)
#CmpEventMgr #CmpErrors

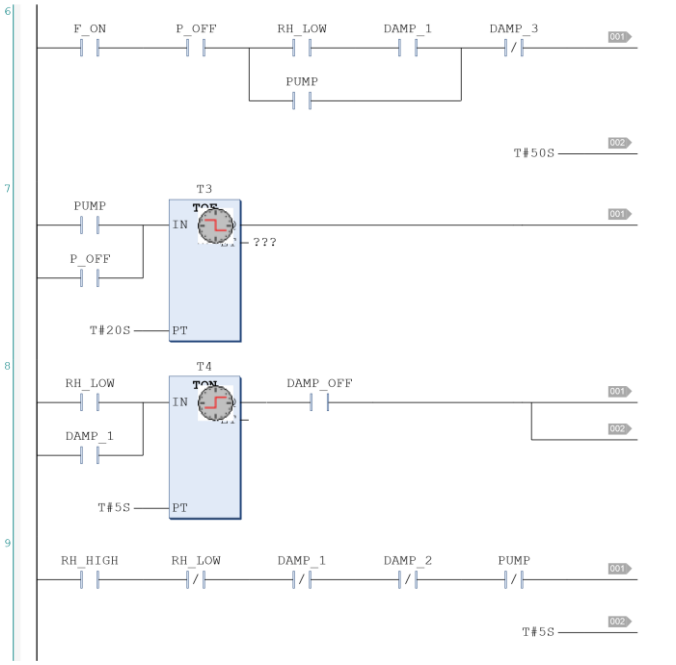
#CAA Types
#SysCpuHandling
#SysMem
SysTypes, * (System)
CmpErrors, * (System)
#SysTimeCore
#SysDir
#SysTypes
PLCCommunication, 1.0.2.14 (Schneider Electric)
#SysMem
#Standard
M258 Relocation Table, 1.0.0.4 (Schneider Electric) #SysMem





1. POU

PROGRAM POU
VAR
F_ON: BOOL;
SET_RH_MIN: INT;
RH_LOW: BOOL;
SET_RH_MAX: INT;
RH_MAX: BOOL;
RH_HIGH: BOOL;
T1: TON;
P_OFF: BOOL;
DAMP_3: BOOL;
T2: TON;
T3: TOF;
DAMP_OFF: BOOL;
T4: TON;
PT: TON; 17 END_VAR



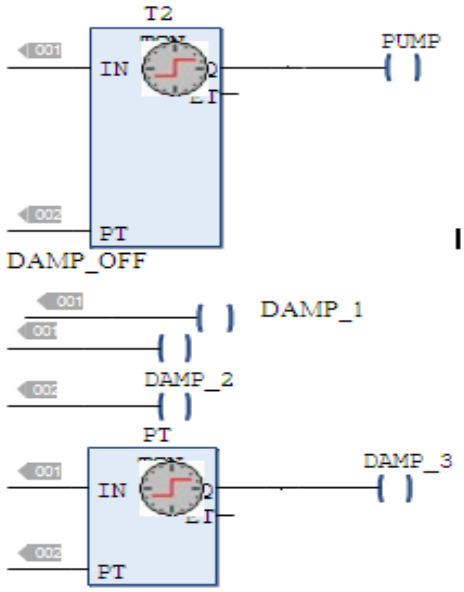


Figure 9: Ladder Programming

Task Configuration
Max. Number of cyclic tasks: 4
Max. Number of freewheeling tasks: 1
Max. Number of event tasks: 8
Max. Number of external event tasks: 8

MAST
Priority: 15
Type: Cyclic
Interval: 20 Units: Ms
Watchdog: Active
Watchdog Time: 100 Units: Ms
Watchdog Sensitivit:1 POUs:
Expert
Expert Configuration
Parameters:
Run/Stop Input,
Type: BYTE,
Value: 16#FF,
Default Value: 16#FF,
Alarm Output,
Type: BYTE,
Value: 16#FF,
Default Value: 16#FF,
Rearming Output Mode,
Type: BYTE,
Value: 0,
Default Value: 0,
Immediate Outputs Mapping,
Type: WORD,
Value: 0,
Default Value: 0,

I/O Configuration
Visible Name Base Type Value Default Value (if different)
Run/Stop Input ENUM None Alarm OutputENUMNone
Rearming Output Mode ENUM Auto
Immediate Outputs Mapping WORD 0

PowerDistribution
Expert I/O Mapping
Input Parameters:
Channel: IB0,
Type: BYTE,
Address: %IB0,
Channel: I0,
Type: BOOL,
Address: %IX0.0,
Description: Main power 24 Vdc for controller, fieldbus power Supply and slice power supply (True when no 24V is applied),
Channel: I1,
Type: BOOL,
Address: %IX0.1,
Description: Power 24 Vdc expert modules (True when no 24V is applied),
Channel: I2,
Type: BOOL,
Address: %IX0.2,
Description: Power 24 Vdc I/O (True when no 24V is applied),

Information
Name: POWER
Vendor: Schneider Electric
Version: 2.0.31.14
Order number: POWER
Description: POWER module

COCNLUSION

A prototype of the spinning mill been successfully designed and spinning mill temperature and humidity is maintained within the range.

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