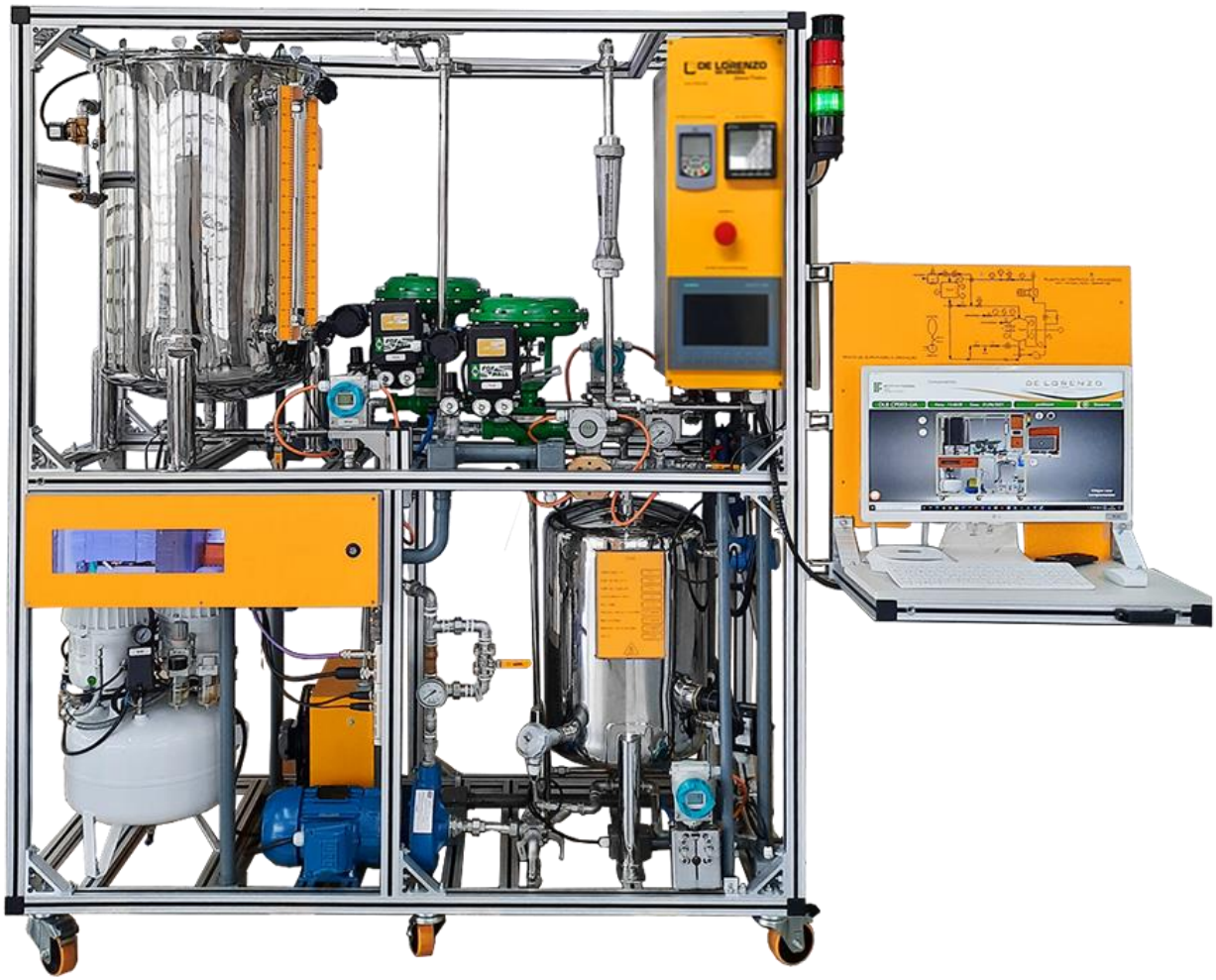
AUTOMATION

PROCESS CONTROL PLANT WITH PROFINET, PROFIBUS, RS485 AND IO-LINK
DL CP003-UA



This pilot plant of theoretical and practical training offers the possibility to study the control in open loop and in closed loop of the four typical processes used in the industry: LEVEL / PRESSURE / TEMPERATURE / FLOW.

It also allows the study of the behavior of the respective sensors and transmitters which, when communicating with the PLC, provide a total view of the process, by means of PROFIBUS-DP and PROFIBUS-PA communication from the PROFINET bus and IO-Link communication from PROFIBUS-DP.

- ✓ **PROFINET AND PROFIBUS DP/PA COMMUNICATION.**
- ✓ **IO-LINK AND MODBUS COMMUNICATION**
- ✓ **HMI WITH SCADA SOFTWARE.**
- ✓ **ALL-IN-ONE WORKSTATION**
- ✓ **VIRTUAL PROCESS SIMULATOR.**
- ✓ **POSITIONING VALVES.**
- ✓ **PRESSURIZABLE TANK**
- ✓ **THREE-PHASE MULTIMETER.**
- ✓ **OPTION FOR REMOTE PLANT MONITORING**

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ARCHITECTURE

The DL CP003-UA has the Siemens PLC S7-1200 as its control unit, which emulates the typical operations of industrial plants that, due to circumstances, use a larger PLC, such as the S7-300/400/500.

The PLC communicates with the sensors and controllers (via PROFIBUS-PA protocol), the seven-inch HMI (via PROFINET protocol) and the data acquisition station with SCADA and WIFI software. The customer can add a second PC/WIFI station.

COMMUNICATION FEATURES BETWEEN SENSORS AND CLP

PROFIBUS is the communication interface solution that meets the manufacturing and process automation requirements and, in the latter case, complies with field devices such as: Pressure, temperature, flow, level transmitters, converters, positioners, etc. It can be used as a substitute for the 4 to 20 mA standard which, although safe, has no intelligence.

There are potential advantages of using this technology, which, in summary, are: reliable information transmission, variable state treatment, self-diagnosis, shorter start-up time, among others. It also allows a reduction in installation costs compared to conventional systems.

PROFIBUS PA allows measurement and control via a single two-wire line and allows maintenance and connection/disconnection of equipment even during operation without interfering with other stations, such as potentially explosive areas. PROFIBUS PA was developed in cooperation with users of the Control and Process Industry (NAMUR), meeting the special requirements of this application area.

PILOT SYSTEM MANAGEMENT

In addition to the PLC S7-1200, the system has a Siemens HMI SIMATIC model with a 7” color liquid crystal display with touchscreen and control keys. This HMI allows you to analyze electrical and hydraulic data during the various stages of the process. The SCADA software (supplied) will follow the process and create databases.

The PC/W station allows to follow the processes during the checks of the meshes to be chosen with keyboard and mouse; these peripherals communicate with the station via the Bluetooth protocol. A second (customer's) station can evaluate the program in use and eventually modify or evaluate the data that will be produced by the SCADA software.

NPTV SIMULATION SOFTWARE

Virtual reality software for experiments and practices of individual processes. A simulator provided with the process plant allows students to study control strategies involving each of the process variables: Pressure, flow, level and temperature, and each student can implement control functions using the PLC (or PLC simulator) within the virtual environment. The simulator includes challenges that involve the implementation and tuning of controllers, for each type of variable studied (PNTV), it also allows to verify whether the student achieved the expected results (automatically), and all this in real time, just like in a real plant. As in a game, whenever the student deploys the controller to the stated objectives, the virtual environment itself automatically validates the solution and opens access to the next activity. The simulator is supplied with a communication driver for Siemens PLCs and ABB driver (for CLP CODESYS), with MODBUS TCP communication. In addition, the system acts as a development and editing station.

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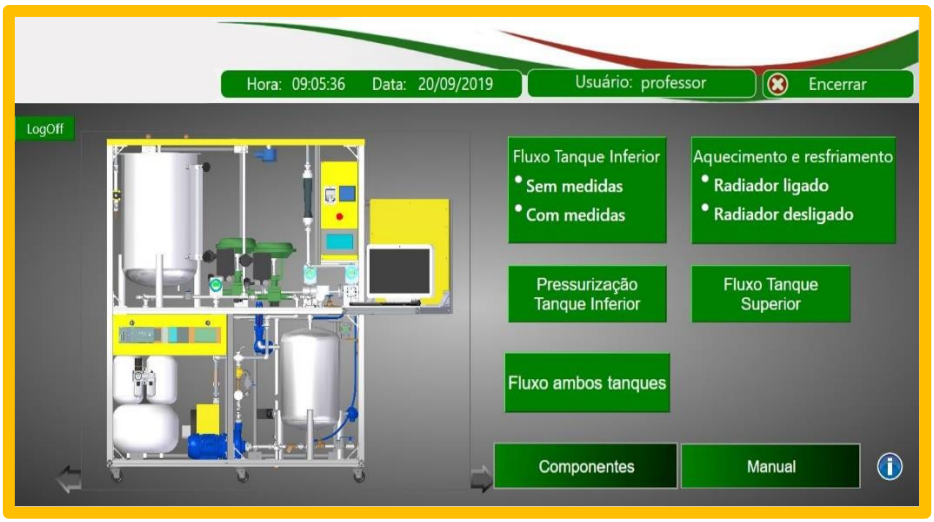
PROGRAMMING, EDITION AND APPLICATION SOFTWARE

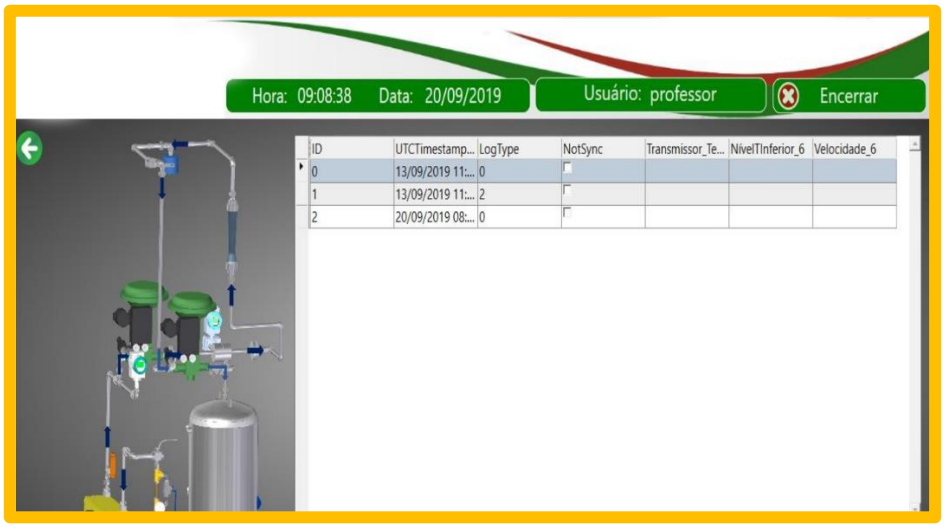
The plant is licensed to use software that incorporates features to control the entire process, with real-time monitoring capability; real-time graphic interface; real-time publishing of graphic process screens; reporting tool, data storage for history, screen editor. The plant is supplied with TIA PORTAL software for the control and communication application.

SCADA software for process control, event diagnostics and database creation. The operation of the Industrial Plant allows changes in the controlled variables, including the control of heating and cooling of the fluid between ambient temperature and 65 degrees Celsius.

IO-LINK CONCENTRATOR

The PROFIBUS to IO-Link converter is installed on the PROFIBUS-DP bus, the IO-Link Hub Module has four M12 connectors to connect IO-Link devices, one of these connectors is connected to the lighting tower and the other three will be available for study and practice. Students will be able to program/parameterize IO-Link devices.





AUTOMATION

MAIN ELEMENTS

1- STRUCTURE

The metal structure is designed to ensure adequate stability and rigidity for the correct operation of the DL CP003-UA pilot plant. For this purpose, reinforced structural profiles in extruded and anodized aluminum are used, with a section of 40 x 40 mm and approximate external dimensions of 1,700 x 700 x 2,000 mm (CLA). The system also features 6 wheels and locks for easy assembly movement, designed to support the total weight of the system, even under maximum load.

2- POWER CONTROLS AND SAFETY PANEL

Box with approximate dimensions of 500 mm high X 500 mm wide x 250 mm deep, built in 1020 steel plate, with 1.5 mm thickness, chemically treated, painted by an electrostatic process with epoxy paint. This box contains all the elements for power and safety controls, including command switches, push buttons, traffic lights, emergency switch, to activate and stop the power supply to instruments and equipment, and also has a 7" HMI that operates the system. An HMI that drives the hydraulic pump via the frequency converter and a three-phase multimeter to measure the main power parameters of the system. For a greater measure of safety, the plant has a general emergency function, which consists of cutting the power supply to the compressed air, electric and pump motor modules, and in addition a lighting tower.

3- COMMUNICATIONS PANEL WITH CONTROLLER AND BUS

Box approximately 500 mm high X 750 mm wide x 200 mm deep, built in 1020 steel plate, with 1.5 mm thickness, chemically treated, painted by an electrostatic process with epoxy paint. The Programmable Logic Controller (PLC) and communication modules are installed on this panel. This panel has an acrylic cover for viewing the components and LEDs of the internal elements, which are also lit with a LED strip.

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4- WINDOWS STATION

Data display unit supplied with a switch that connects HMI/PLC to a PC, and a station with Intel i5 2.7GHz processor, HD 256GB, USB 2.0 ports and USB 3.0 ports, HDMI ports, 10/100 ethernet network, 300 W source, High Definition 21” LED display, Bluetooth keyboard/mouse, Windows 10 software.
The station can maintain control of the meshes involved in the process and work with monitoring software.
The PC/WIFI station keeps control of the information obtained and builds the database and the HMI monitors the process, presents graphs and tables of values (consumption and parameters). This station is articulated and has height adjustment for improved operator ergonomics.

5- UPPER TANK

Top tank built in bright polished cylindrical stainless steel with a capacity of up to 140L (acrylic can be ordered by the customer), with a thickness of 4 mm, in a cylindrical format with a diameter of 500 mm and a height of 700 mm (with a % scale and level display column, transparent), installed in the structure. The side of this tank has M16 process connections for level switches mounted on the top and bottom. The system water is supplied by this tank through a solenoid valve or a manual valve, located in a line on the upper left-hand side. The bottom end of this tank has lines and an outlet valve that interconnect with the bottom tank and the water extraction system. A hydrostatic level indicator is located inside the tank.

6- LOWER TANK

Pressurized lower tank in bright polished cylindrical stainless steel with a diameter of 400 mm and a height of 500 mm with a thickness of 4 mm and for pressurization up to 9 kg/cm^2, with a capacity of up to 60 L and with ½ " NPT inlet pipe and water flow outlet point with stainless steel pipe, installation of pressure gauge and filter element for the inlet of water from the upper tank with a minimum flow rate proportional to the equipment demand. This tank also contains standard protections for pressure relief, pressure switch and descriptive memory on the side of the reservoir, which also has connections for lower and upper level outlets for the differential pressure transmitter and valve to allow pressurization.

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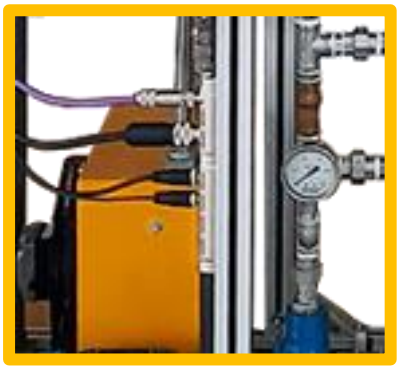
7- HYDRAULIC PUMP

Centrifugal pump, 1.5 hp three-phase, for filling the primary and secondary tank installed in the bottom of the structure, line connections: 1 "BSP with reduction to ½" BSP; operating pressure at outlet: Up to 4 BAR; maximum flow, at outlet working pressure: Up to 4 m^3/h, controlled by the control panel via frequency converter with PROFINET protocol. The suction line has filter elements and the discharge has a pressure gauge and a check valve.

8- SILENT AIR COMPRESSOR

1 hp air compressor, with a noise level of 48 (dB(A)/1m), manufactured according to current regulations (NR12/NR13), air receiver certified by INMETRO. It has a pressure switch with main on/off switch, air intake filter, heat shield in the electric motor, mechanical valve for overpressure relief and a capacity of 24 liters. Contains a pneumatic holding unit with pressure regulating valve to supply the bank with an actuation range of 0 to 700 kpa (0 to 100 psi), with low pressure regulating valve, 0 to 200 kpa.

9- HEAT EXCHANGER



Heat exchanger to cool down the fluid with a temperature differential of 20°C/h with an axial fan. Approximate size 350 x 200 x 300 mm (CLA) 1300 RPM, 3 phase, 60 W, maximum flow 100 l/min, pressure 35 bar, PLC controlled.

10- LEVEL TRANSMITTER

Differential pressure level transmitter with the following characteristics: Process connection: ½ ”BSP (with adapters); flange material and adapters in nickel-plated carbon steel; bleed material in stainless steel; sheath grade IP 65 (minimum); element type with metal diaphragm; calibration 0 to 750 mm H_2O; range: 0.0125 to 0.25 bar; accuracy: +/- 0.1% SPAN; Power supply: 24 VDC; Output: protocol for PROFIBUS-PA digital communication, configuration possible via portable programmer via PROFIBUS-PA protocol, and at least partial configuration (most important parameters) directly on the instrument; Local indication present with LCD display, item material: AISI 316L; O-rings; PTFE; Aluminum housing; Process fluid: Water; Maximum pressure: 2 kgf/cm^2; set local span and zero. Located under bottom tank, as recommended by the manufacturer and with proper tubing installed on top and bottom of tank.

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11- PRESSURE TRANSMITTER

Manometric pressure transmitter fitted to measure the pressure in the hydraulic pump discharge line, with the following characteristics: Process Login: ½ ”BSP; Material for flanges and adapters: Stainless steel; Bleed material: Stainless steel; Electrical connection: Cable gland ½ ”BSP; Degree of protection: IP 65; Element type: Metallic diaphragm; Calibration: 0 to 3.0 Kgf / cm^2; Range: 0.625 to 25 bar; Accuracy: +/- 0.1%, Power supply: 24 VDC; Output: digital communication protocol: PROFIBUS-PA; local display: Present with LCD display; maximum pressure: 7 kgf / cm^2; zero and span adjustment.

12- FLOW TRANSMITTER

Differential pressure transmitter with 3/4” orifice plate in 316 stainless steel, braided for flow measurement with the following characteristics; process connection: ½” BSP (with adapters); flange material and adapters in nickel-plated carbon steel; stainless steel, Bleed material; envelope classification IP 65; element type with metal diaphragm; calibration 0 to 750 mmH_2O; Range: 0.0125 to 0.25 bar; accuracy: +/- 0.1%; power supply: 24 vdc; output: PROFIBUS-PA; with local parameterization of the most important parameters, local indication present with LCD display, item material: AISI 316L; O-rings; PTFE; Aluminum housing; Process fluid: Water; Maximum pressure: 2 kgf / cm^2; zero setting and local span. Located on the hydraulic pump discharge line.

13- TEMPERATURE TRANSMITTER

Temperature transmitter with local indication and with sensor type PT100 set for 0 to 100°C range and PROFIBUSPA output signal, installed in the metal structure near the pressurized and heated bottom tank. The PT-100 heat resistance has a KNC head r.1 /2 BSP 6 mm diameter shank; KNC die-cast aluminum head; 6 mm x 150 mm stainless steel shaft; 1/2 BSP process connection and located on the side of the bottom tank.

14- LEVEL POSITIONING / LEVEL REGULATING VALVE

2x 1/2" BSP diameter proportional control valve, normally closed, 150 lbs class diaphragm-type actuator, carbon steel body and stainless steel internals, electro-pneumatic positioner with 4 - 20 mA command direct from the PLC, commanded via an external air compressor. The valves are located between the two reservoirs, one for level control and one for flow control.

15- HYDROSTATIC SENSOR

Hydrostatic level transmitter located in the top tank, in 316 stainless steel, range: 0 to ... 0.078 bar (0.8 mH2O), Power: 10 to 30 VDC, Output: 4 to 20 mA (2 wires), working: -20 to 85 °C.

16- CONDUCTIVE LEVEL SWITCH

Installed on top of the bottom tank. It has the following specification: Header: - G1 Epoxy painted aluminum, Electrical connection: 1/2 "NPT Cable Press, Process fitting: 1/2" NPT in 316 stainless steel, insertion length L=50 mm in 316 stainless steel, Power: 85 ... 240 Vac; Operating fluid: Water; Allows the hydraulic pump to shut off automatically when the switch is actuated.

17- LEVEL SENSOR

The float sensor indicates by means of an ON/OFF signal when the liquid level has been reached, installed on the side of the tank from the inside, through a Ø16mm orifice. The top tank has 2 float level sensors, one installed on the top and the other installed on the bottom.

18- MANOMETER

Analog pressure gauge, Ø63mm ball, total AISI-304 stainless steel, single scale 0 to 100 psi, glycerin filled, vertical outlet connection, 1/4 " BSP thread, accuracy 1.6% F.E. class A.

19- PRESSURE SWITCH

KPI 36 Danfoss pressure switch, used to switch off electrical equipment in accordance with the set pressure range, limited to 9 kgf/cm^2, according to the maximum permitted pressure in the lower tank. This can be used to turn the hydraulic pump on or off. It can be used in both liquids and gases, such as compressed air.

20- DIRECT ACTION PRESSURE REDUCING VALVE

Safety and relief valve, for operation with open air hood with lever, model VSA-110 DN 1/2 "x 1/2". Body, castle, and open top in nodular casting GGG 40.3, stainless steel interior, seat with polyurethane insert, BSPT-type threaded process connection. Designed to work at 9 kgf/cm^2. Located on the lower tank for pressurization exercises.

21- ANALOGUE FLOW METER

Rotameter installed in the discharge pipe for water with 0.4 ~ 4.0 m^3 / h flow range; Temperature: Max 70 °C; Pressure: Max 10 Kgf/cm^2; Measuring tube in: Polycarbonate; Nut: Aluminum. Terminal material: Aluminum.

22- FLOW TAP

½” BSP flow switch installed after the rotameter. Characteristics: Maximum permitted temperature: 60°C; minimum permitted speed: 0.5 m/s; minimum permitted flow: 20 LPM; maximum permitted pressure: 10 kgf/cm^2.

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23- ELECTRIC RESISTOR

Electric resistor that allows temperature variation Immersion model, shielded, 3000 W. Power interface to control heating by solid state electrical resistor, to be controlled by the PLC. It is 300 mm long and a 1" 1/2 BSP thread.

24- ANALOG THERMOMETER

Angled bell thermometer, anodized aluminum shield, 1/2" BSP male thread, white round capillary, 0 to 100 °C scale

25- THERMOSTAT

Temperature-operated alarm or control switch for chemical, petrochemical, food, power generation, industrial equipment and general industries with detection and activation at 50°C for power circuit protection.

26- DIRECTIONAL VALVES WITH MANUAL OPERATION

The system features 5 stainless steel valves, 3-way directional flow and manual activation, allowing the student 32 different flow configurations.

27- SOLENOID VALVE

NF 1/2" BSP 2-way solenoid valve, voltage 24 VDC installed at the top for automatic water loading in the system, requiring it to be connected by a ½" hydraulic hose present in the laboratory.

28- FREQUENCY INVERTER

WEG CFW500 frequency converter to drive a 1.5 hp motor, with PROFIBUS-DP communication allowing PID adjustment for pressure and flow control.

29- PROGRAMMABLE LOGIC CONTROLLER

Siemens brand PLC - model S7-1200, with TIA-Portal software license, installed in the PBX with configurable analogue inputs and outputs; 24 VDC digital inputs and outputs in number consistent with system operation,

- 01 PROFIBUS-DP communication module
- 01 PROFIBUS-PA communication module

30- HMI

Siemens HMI SIMATIC model with 7” color liquid crystal display with touchscreen and control keys. This HMI allows you to analyze electrical and hydraulic data during the various stages of the process. The SCADA software (supplied) will follow the process and create databases.

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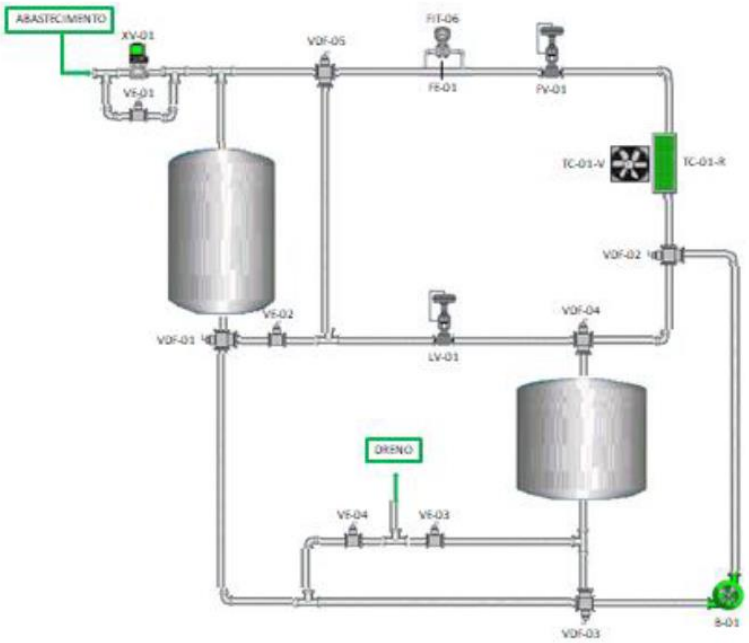
31- MULTIMETER

For measuring electrical quantities in different processes, the multimeter provides over 60 real-time parameters, including voltages, currents, powers (active, reactive, and apparent), power factors, phase angles and active and reactive power demands.

SIMPLIFIED HYDRAULIC FLOW DIAGRAM



All system components are properly identified according to current technical standards.

DOCUMENTATION

Together with the DL CP003-UA, the following are provided:

- Instruction, equipment maintenance and operation manuals,
- Programming, configuration and application manuals for configurators and software tools
- Manual for installation, operation, and maintenance of the Didactic Plan.
- Simulator operation manual also provided
- Detailed script of the standard experiments that can be performed at the plant;
- Single-line diagram of the plant;
- Descriptive memory of the communication of the monitoring system with the programmable controller;
- Detailed Plant mechanical, electrical and instrumentation drawings.