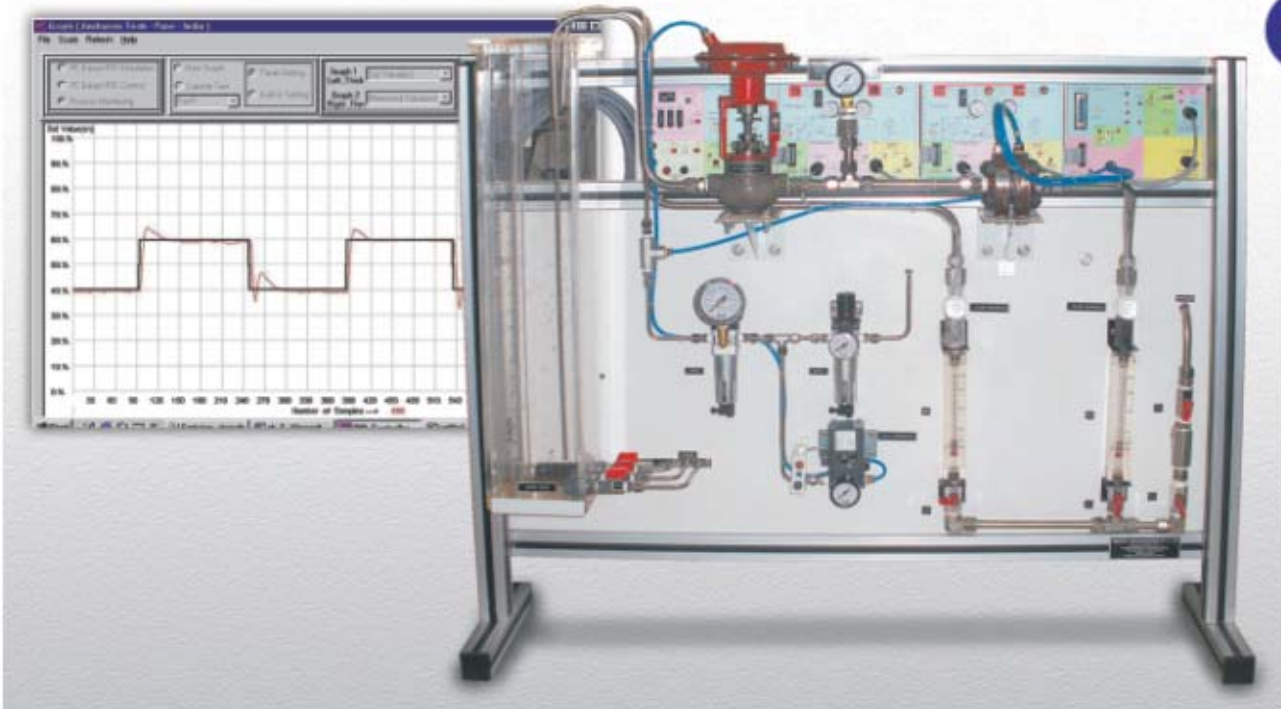


PROCESS CONTROL TRAINER (Model : XPO-PCT) [a family of training systems]

Flow - Level / Pressure - Temperature - Flow / Coupled Tank / Heat Exchanger / PH



TECHNICAL SPECIFICATIONS (CONTROLLER SECTION)

- ◆ **Computer Interface panel (CIP/PCT1)**
 - Connects to PC (P4/XP) parallel port through 25 pin M to F cable / 1.5mtr.
 - 4 ADC channels I/P: 0 to 2.5V FS with 1no input simulation pot. 1 DAC channel O/P 2.5V FS.
 - V to I function block: I/P 0 to 2.5V & O/P 0-20 or 4-20mA (100 load) switch settable.
 - I to V function block : I/P 4 to 20mA & O/P 0 - 2.5V
 - USB converter to interface 25 pin D connector on CIP panel to USB using PIC18F microcontroller 28 Pin SOIC enclosed in 25 Pin D shell using Type A to mini B cable.
 - Optionally hardware module of square root extractor is provided so that PLC/Panel mount PID may be interfaced.
- ◆ **Instrumentation Power supply cum Multichannel DPM panel (EMT 8)**
 - $\pm 12V/500\text{ mA}$, $+5V/300\text{ mA}$, Unregulated 17V dc/750 mA, line synchronizing signal, 13V / 3 Amp.
 - Multi channel DPM for digital display of process parameters.
 - 20 pin FRC power bus to supply power to neighbouring panels.
- ◆ **Thyristor Actuator cum signal conditioning panel (TAP) / CE2x 2Nos.**
 - Optionals: Thyristor bridge based 0-200V/3A using cosine firing circuit, I/P 0 to 2.5Vdc.
 - Supports signal conditioning for RTD, Pressure sensor with Instrumentation Amplifier & flow sensor (water / air) with F to V converter to generate 0-2.5Vdc (FS).
 - Optionally facilitates closed loop control experiments based on temperature, light intensity, speed measurement using built in P/PI controller as well as external Analog / Digital PID controller.
 - 2No. panels may be needed to cover signal conditioning needs of the selected process.

- ◆ **PC (P4/XP/WIN7/FAT32) based digital base PID controller (PC not in scope of supply but P4/XP/WIN7 with parallel /USB port needed)**
- **Online monitoring / Data acquisition / PID Software** on Installable (CD) works under XP, WIN7. PC with parallel port / USB needed.
- **Operating modes**
 - Simulator Mode :** Tests data stored in files (*.txt) & Draw graph for all P,PI,PD & PID modes.
 - Process Monitoring Mode :** Draw graphs of analog data presented at CH 0 & CH 1 of CIP. Cursors for X & Y axis for measurement & online graphs saving for reproduction.
 - PID controller Mode**
 - PID controller with parameter like Integral Time T_i (0.01-64000), Sampling Time T_s (0.1-99.9), Derivative Time T_d (0-99.9), Proportional Band P_b (1-999), Derivative Gain K_d (1-999), Set Value R_n (0-99.9), PID output Upper Limit U_h (0-99.9), PID output Lower Limit U_l (0-99.9).
 - Facility to set units for output viz. (%), $^{\circ}\text{C}$, RPM, V, mm, LPH, kg/cm^2 , msi/cm , Degree. Optionally experiments with advance process control scheme viz; Ratio, Cascade, feedforward with Aux PID, Ratio station & FF transfer function calculator, Alarm setting, ON/OFF control, square root extractor for Orifice.
 - Function Generator : Sine / Triangular / Square wave generator with frequency 0.01 Hz to 1 Hz, Amplitude is 0 to 2.5 V i.e. 0 - 100%.

SALIENT FEATURES

- ◆ Lightweight, yet sturdy, tabletop, Aluminium profile flat panel setup, with SS (304/316) piping for and wide angle view of every component in process. No hidden parts.
- ◆ Individual control loops as well as Advance control schemes like Ratio, Cascade, Feed forward, **coupled tank** made easy for student.
- ◆ Connection through polarized FRC connectors, sturdy 4mm Banana sockets & Patch cords enabling quick setting up of variety of process control experiments.
- ◆ P4/XP / win 7 window based PID controller (**DDC**) software package with P, PI & PID control, Ratio & cascade control, three operating modes, Online graph drawing & data acquisition modes (**SCADA**). PC not in scope of supply

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Choice of Process set up : Must select one or more of following options:

Process loops Parameters	Flow / Level with variable speed pump Model : XPO-PCT/FLE	Flow / Level with pneumatic control valve Model : XPO-PCT/FL	Pressure / Temp./Flow Model : XPO-PCT/PTF	Coupled tank Model : XPO-PCT/ 3T	Shell Tube Heat Exchanger Model : XPO-STHE	PH/conductivity Model : ChemPCT
Controlled medium	Water	Water	Air for pressure /Flow, Water for temp. & air (air bubbler) for Cooling	Water	Water	Water
Storage tank material / capacity	1 No. 50 ltr, plastic/PVC.	1 No. 50 ltr, plastic/PVC.	1 No., 10 litre plexiglass tank for water	1 No. 50 ltr, plastic/PVC.	2 No. 50 ltr each, Hot Return sump & Cold Sump, plastic /PVC. 1 No. 5 liter, stainless steel tank with Header	1 No. 50 ltr, plastic/PVC.
Process tank capacity /material	Vertically mounted tank, 1 no. 20 liters, plexiglass (130 X 130 X 700) mm	Vertically mounted tank, 1 no. 20 ltr, plexiglass (130 X 130 X 700) mm	1 No. 5 liter, stainless steel tank with temp. pressure sensors attachment. Pressure relief valve (10 Bar)	3 Nos. of 10Ltr, plexiglass (130 x 130 x 350mm) tanks, coupled using manual valves	STHE : Shell - 100 x 800 mm, 1/4" NPT (F) socket 4, 2 drain socket, 4 baffles, 1 pass. Tube : 6 x 10 Nos. x 660 mm, 304SS. Weight <10kg	Reaction Vessel
Electronic sensor Type / Output / Range	<ul style="list-style-type: none"> Flow: turbine flow sensors 2 No. Level: WC pressure sensor 0 to 500mm, level measurement by bubbler method, O/P = 0 to 2.5V. Pressure supplied through small compressor & AFR 	<ul style="list-style-type: none"> Flow: turbine flow sensors 1 + 1 no. (Optionally 1No. Orifice plate with DP sensor, (0-5 PSI), O/P = 0 to 2.5V, 0-200LPH. Level: WC pressure sensor 0 to 500mm, level measurement by bubbler method, O/P = 0 to 2.5V (optionally capacitive sensor needs panel MIT2.) 	<ul style="list-style-type: none"> Pressure: piezo-resistive pressure sensor 0 to 30PSI, O/P = 0 to 2.5V Temp: PT100, O/P = 0 to 2.5V, ambient to 100°C Flow Turbine flow sensor 1No., O/P=0 to 2.5V, 0-150LPM 	<ul style="list-style-type: none"> 2 Nos. Level sensors WC pressure sensor 0 to 250mm, O/P 0 to 2.5V. 2nd sensor shared between two tanks using 6 way manifold block & 1/4" ball valve (2 Nos.) 	<ul style="list-style-type: none"> Temp: PT100, 4nos, encapsulated in SS tube (12mm length/3 dia), with 1/4" mate NPT plug with 3 wires flying leads 1mtr length and terminated on 5 pin DIN connector, O/P =0 to 2.5V ambient to 100°C Flow Turbine flow sensor 2No., O/P=0 to 2.5V, 0-100LPH 	<ul style="list-style-type: none"> PH sensor using combine glass electrode, for indicating pH between 0 to 14pH, & PID control between 3 to 6pH, with conditioning circuitry with PH transmitter /O/P 4 20mA. Conductivity sensor consisting of using dual plate glass electrode, conductivity cell, conductivity transmitter O/P 4 to 20mA.
Control Valve	Fraction HP universal motor operated variable speed pump driven from TAP (EMT9) panel, I/P 0 to 2.5V O/P 0 to 195Vdc, Pump Speed : 0-3000RPM	Pneumatically operated air to close, linear type, 1/2" size Diaphragm operated, CV = 0.4 with 1 to P. Converter I/P 4 to 20mA O/P 3 to 15 psi.	Pneumatically operated air to close, linear type, 1/2" size Diaphragm operated, C = 0.4 with 1 to P. Converter I/P 4 to 20mA O/P 3 to 15psi. TAP panel : SCR controlled full bridge (200Vdc) for 750 for temp. control. I/P 0 to 2.5Vdc.	2 Nos of variable speed motorized pump driven from EMT9 (2Nos.) or PEG6 Panel I/P 0 to 2.5V O/P 0 to 195VDC, Pump Speed = 0 to 4000 RPM.	2 nos Fraction HP universal motor operated variable speed pump driven from TAP (EMT9) panel, I/P 0 to 2.5V O/P 0 to 195Vdc, 0-3000RPM, TAP panel : SCR controlled full bridge (200Vdc) for 750W for temperature control. I/P - 0 to 2.5Vdc.	Pneumatically operated air to close, linear type, 1/2" size Diaphragm operated, CV = 0.4 with 1 to P. Converter I/P 4 to 20mA O/P 3 to 15 psi.
Rotameter	2 Nos., Acrylic body 1/2" size 0 to 200LPH	2 Nos., Acrylic body 1/2" size 0 to 200LPH	2 Nos., Acrylic body 1/4" size 0 to 50LPM	2 No. Acrylic body 1/2" size 0 to 200LPH	2 No. Acrylic body 1/2" size 0 to 100LPH	-
Generation & Distribution pump	1 No. 0.062KW, 1/12HP, 2800RPM, 1/2" outlet, 500 LPH. Head 9 meters, with brass impeller + 1no. AC motor pump (8 mtr head) for wild flow	1 No. 0.062KW, 1/12HP, 2800RPM, 1/2" outlet, 500 LPH. Head 9 meters, with brass impeller	230VAC 10W submersible water pump with 1/4" pvc pipe to fill in process vessel for temp. Control expt.	2 No. 0.06KW, 1/12 HP, 4000RPM 1/2" outlet, 500 LPH each, head 9 mtrs. with brass impeller.	2 No. 0.062KW, 1/12HP, 2800RPM, 1/2" outlet, 500 LPH. Head 9 mtrs, with brass impeller + 1No. AC motor pump (8 mtr head) for wild flow	1 No. 0.062KW, 1/12HP, 2800RPM, 1/2" outlet, 500 LPH. Head 9 mtrs, with brass impeller + 1No. AC motor pump (8 mtr head) for wild flow
Bourdon gauges	0 to 500mm of water column= 1No	4 Nos. (0 to 2 bars = 3 nos., 0 to 500mm of water column= 1No.)	2 Nos. 0 to 2 bars, 2Nos 0 to 10 bar 0-100°C gauge thermometer	0 to 300mm of water column= 2 No.	0-100°C gauge thermometer display hot water temp in boiler.	2 Nos. (0 to 2 bars)
Manual SS valves	1/2" size =4 nos., 1/4" size = 3 nos.	1/2" size =4 Nos., 1/4" size = 3 nos.	1/4" size = 7 Nos.	1/4" size = 2 nos. 1/2" size = 14 nos.	1/4" size = 6 nos. 1/2" size = 2. nos.	-
Piping material /size	Stainless steel 1/2" for water, 1/4" for air	Stainless steel 1/2" for water, 1/4" for air	Stainless steel , 1/4" for air	Stainless steel 1/4" size, Return bubbler & back pressure PU (6X4) only.	Stainless steel 1/4" size, Return piping using reinforced plastic	Stainless steel 1/2" size for water 1/4" for air
Air filter and regulators OR accessories	1 No. 0 to 1 bars, size 1/4"	2 Nos, 0 to 10 bars, size 1/4", Oil catcher (1/4" size max. pressure = 10 bars) 1 No.	3 Nos, 0 to 10 bars size 1/4" Oil catcher (1/4" size max. pressure = 10 bars)-1No.	2 nos. of Air regulator, 0 to 1 bar, size 1/4"	-----	1 Nos, 0 to 10 bars, size 1/4", Oil catcher (1/4" size max. pressure = 10 bars) 1No.
Air compressor	-	0 to 7 bars, 1/2 HP, 230VAC supply (optional) Tank Capacity : 110 Ltrs.	0 to 10 bars, 2 HP, 230VAC supply (optional) Tank Capacity : 110 Ltrs.	Compact Air Pump for Air/Bubbler x 2 Nos.	-----	2 Nos. 0 to 7 bars, 1/2 HP, 230VAC supply (optional)
Mech. Size/wt	1170(L) X 300 (W) X 990(H)mm /38kg.	1170(L) X 300 (W) X 990(H)mm /38kg.	1170(L) X 300 (W) X 990(H)mm /39kg.	1170(L) X 300 (W) X 990(H)mm /40kg.	1170(L) X 300 (W) X 990(H)mm /49kg.	1170(L) X 300 (W) X 990(H)mm /38kg.
Advance Control Expt. - Ratio - Cascade - Feedforward	Transfer function determination, Ziegler Nicholas PID tuning. Between 2 water flows Inner (fast) loop flow, outer (slow) loop level Water flow disturbance on level loop.	Transfer function determination, Ziegler Nicholas PID tuning. Between 2 water flows Inner (fast) loop flow, outer (slow) loop level Water flow disturbance on level loop.	Between 2 air flows Inner loop flow, Outer loop temp. Air flow on temp. loop.	<ul style="list-style-type: none"> Study of interactive & noninteractive systems. Experiments on - 1st order SISO, 2nd order SISO (interactive & non interactive), cascade control, Introduction of MIMO. 	<ul style="list-style-type: none"> 1) LMTD calculation for parallel flow & counter current flow Heat exchanger 2) Cascade: Between 2 temperatures 3) Feedforward: Water flow disturbance on temperature loop 	<ul style="list-style-type: none"> 1) Provision to change / disturb the pH in the reaction tank from 3 to 6pH. 2) Provision to change/Disturb the conductivity of the water in the REACTION tank from 200uS/cm to 500uS/cm & its PID control.
Additional Experiments	-----	1) Study of different control valves (equal %, quick opening) using SW based gain scheduler. 2) Study of V to I & I to P converters. 3) 10 segment gain scheduler & split phase control.	-----	-----	Characterization of HE	-----