# Training Simulator

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CAPE Forum 2005

# Outline

- What is the Training Simulator?
- What is the Virtual Plant?
- How to make a Virtual Plant?
- Example (Model Building – SSM, DSM, DSC – Calibration)
- Tools for Managing the Training
- Devices for Realizing Operator Actions
- Example (Living demonstration is possible during break time)
- Benefits of Training Simulator

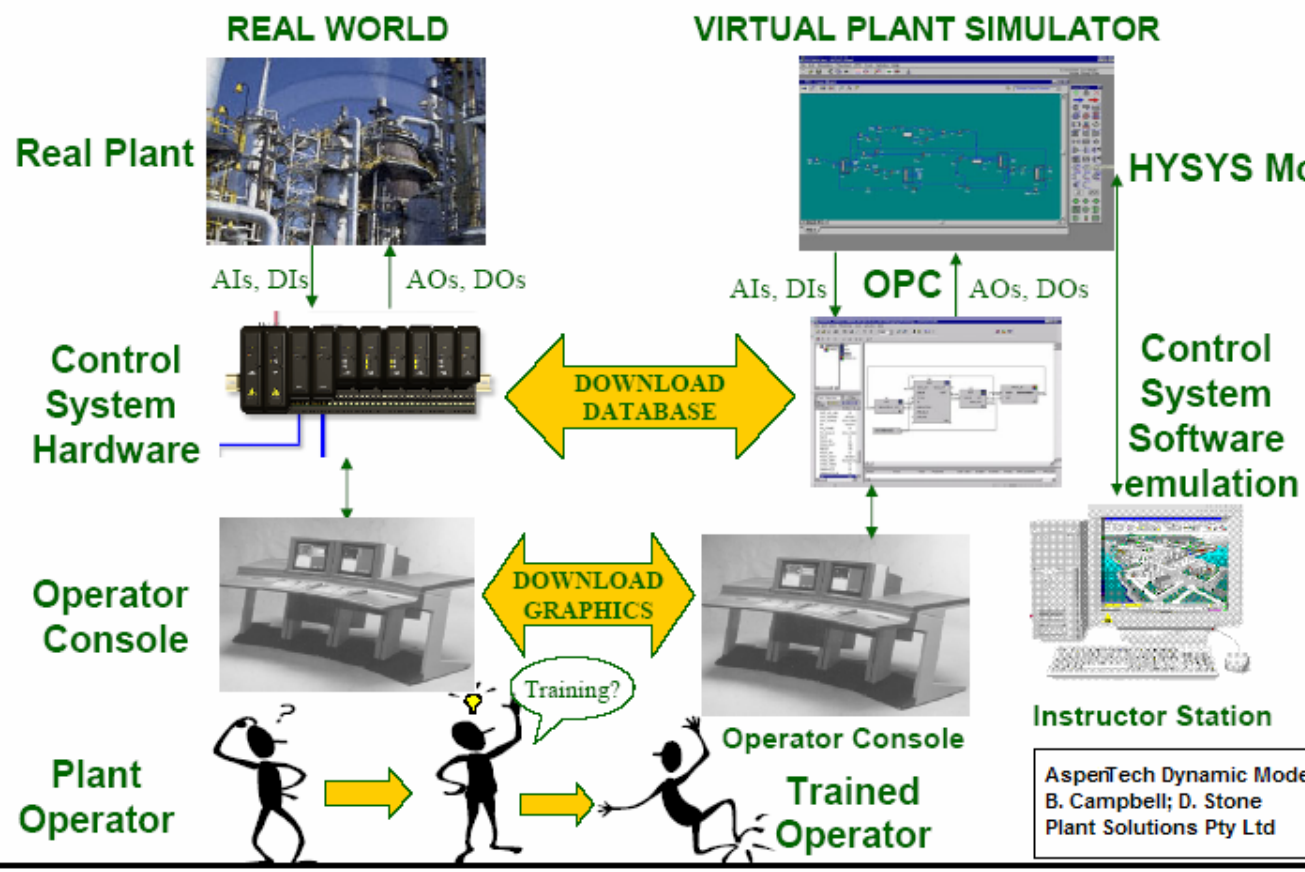
# What is the Training Simulator?

Integrated system of

| Hardware | Software | |
|---|---|---|
| **Simulation Computer** | **Application** | **Engine** |
| | Dynamic Process Model | Aspen, HYSYS, DynSim, Pro-II, CHEMCAD, ShadowPlant |
| **Instructor Interface** | Signal DB, Malfunctions | MMI or HMI, TS&O (MS-Acc.) Invensys, Toyo's TSS, … |
| **Operator Interface** | **Emulation** | |
| Must resemble the actual plant's interface (direct c.) | Professional Honeywell, Emerson Yokogawa, … | EXCEL, Special Solutions |

aspentech

## Virtual Plant Simulator & Operator Training

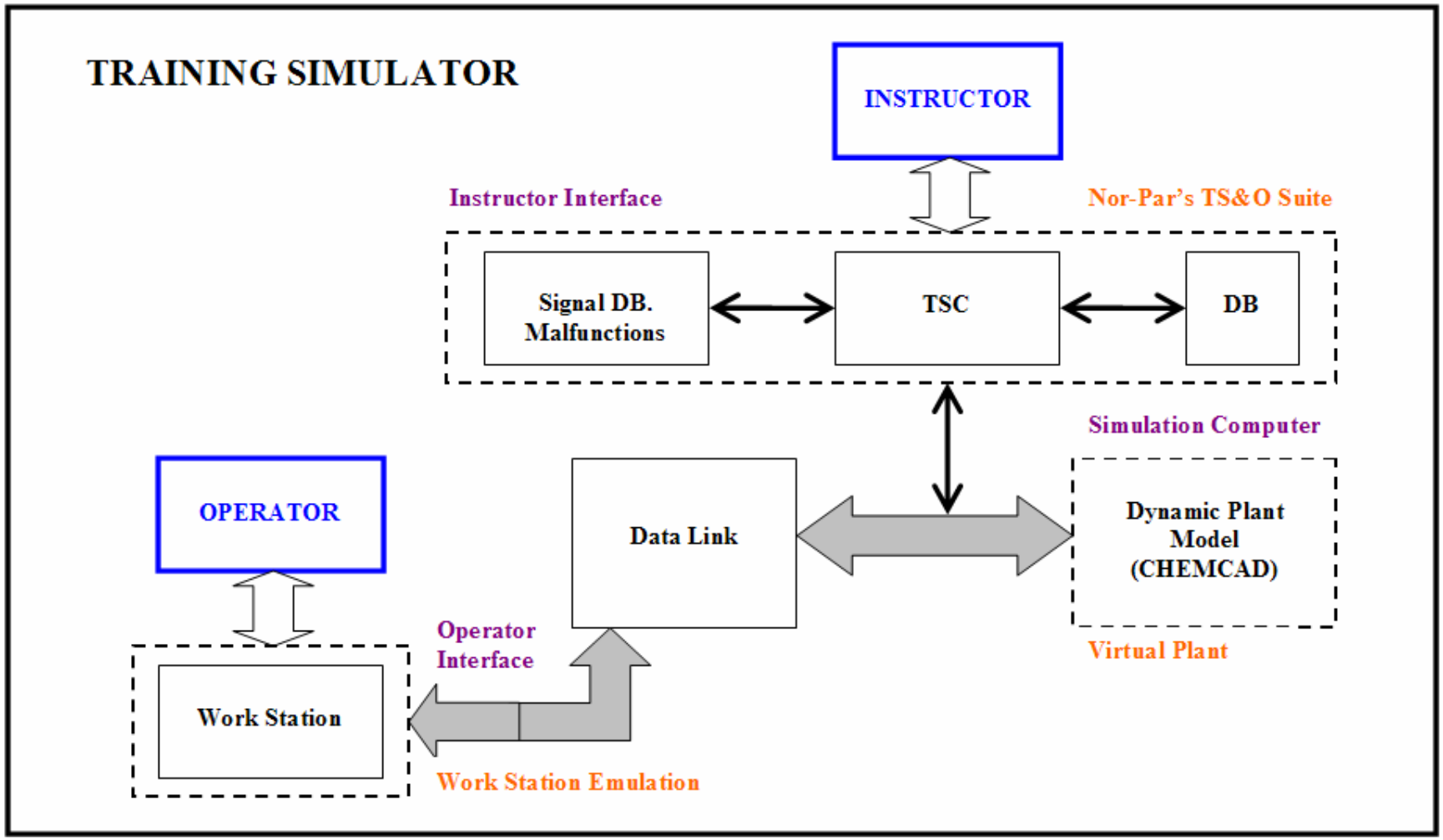



AspenTech Dynamic Modeling and Simulation, June 2004
B. Campbell; D. Stone
Plant Solutions Pty Ltd

Chemstations
CHEMCAD

Nor-Par a.s
TSO

Emulation


TRAINING SIMULATOR
INSTRUCTOR
Instructor Interface
Nor-Par's TS&O Suite
Signal DB.
Malfunctions
TSC
DB
Simulation Computer
OPERATOR
Data Link
Dynamic Plant
Model
(CHEMCAD)
Operator
Interface
Virtual Plant
Work Station
Work Station Emulation

# Training Simulator Modules at Nor-Par

- Virtual Plant → Complex dynamic model with CHEMCAD
- Instructor Interface → TS&O
- Operator Interface → Work Station Emulation (EXCEL)

- **Chemstations (Houston)**
  - **CHEMCAD (steady state process simulation)**
    - **CC-THERM** (rigorous heat exchanger calculation)
    - **CC-ReACS** (dynamic modeling of vessel reactor – batch / semi batch / continuous)
    - **CC-DCOLUMN** (dynamic modeling of distillation / absorption column, tray / packing)
    - Tools for data reconciliation, data mapping (EXCEL)
    - Technology for integration of user-specified algorithms (EXCEL / Visual Basic)
    - OPC compliant system
- **Nor-Par a.s (Oslo)**
  - Selling (CHEMCAD, Pipenet (Sunrise), TRIFLEX (PipeSolutions), …
  - Technical support, consulting work
  - Development (PLANT2CC family for online simulation, TS&O)
  - Engineering work (Applications)

# What is the Virtual Plant?

The Virtual Plant is complex dynamic model, which

- simulates the plant as closely as is technically and economically feasible
- can be driven to the plant operating limits
- safe in the knowledge that the predictions and results are a close reflection of reality
- has been built around the need for running the “plant” in normal and abnormal conditions and in start-up and shut-down situations

Blue copy of the plant.

# Model Building

(How to make Virtual Plant?)

1. Thermodynamics
2. Steady State Model (Simple / Detailed, Analysis)
3. Calibration (Parameters, Model development, Off-line)

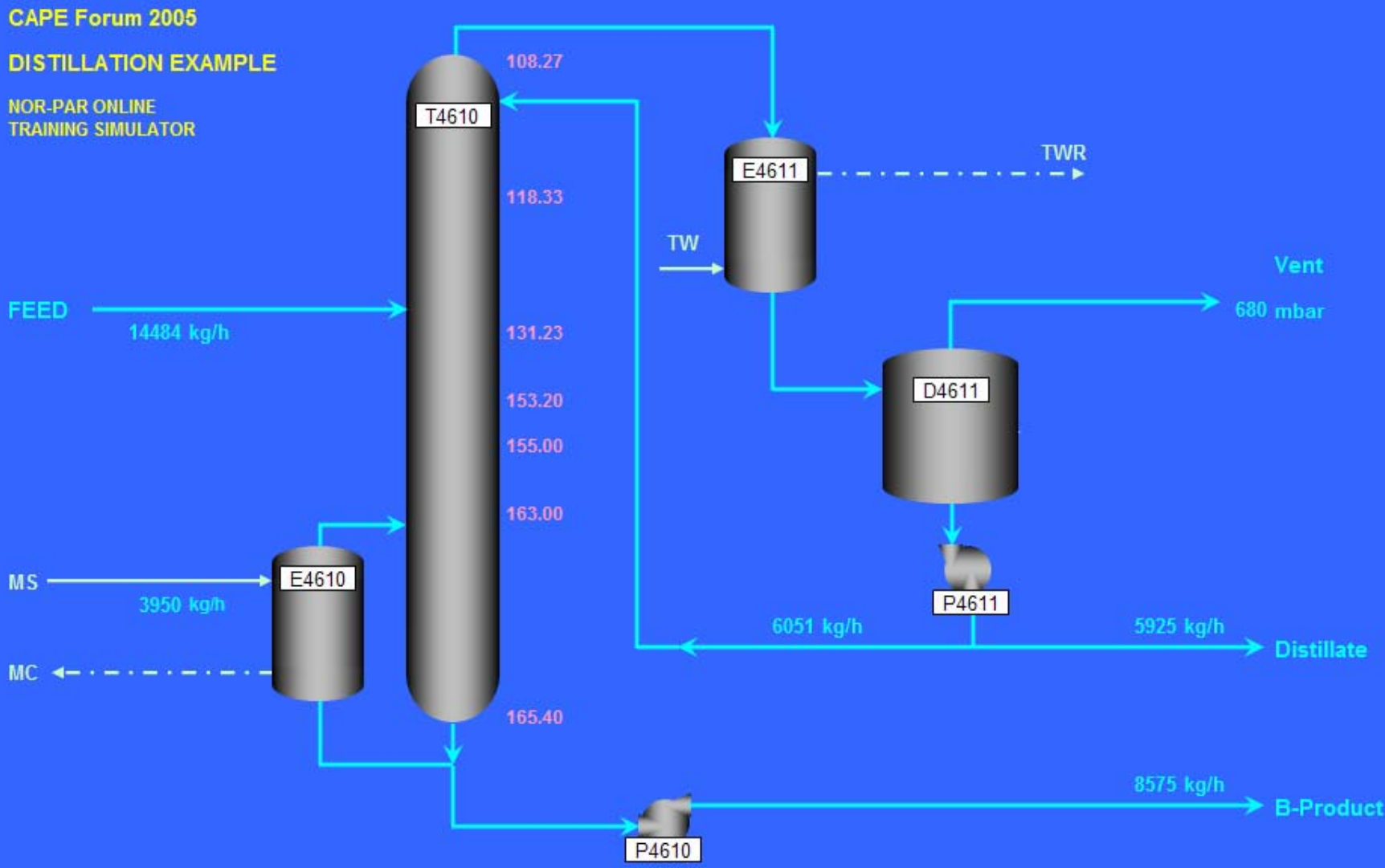
---------- All application ----------

1. Dynamic Model
2. Calibration (Dynamic analysis)

---------- For simulation & training ----------

1. Tuning (Control System)
2. Test runs

----------Training Simulator ----------


CAPE Forum 2005
DISTILLATION EXAMPLE
NOR-PAR ONLINE
TRAINING SIMULATOR
T4610
108.27
118.33
131.23
153.20
155.00
163.00
165.40
E4611
TWR
TW
Vent
680 mbar
FEED
14484 kg/h
D4611
MS
3950 kg/h
E4610
P4611
6051 kg/h
5925 kg/h
Distillate
MC
8575 kg/h
B-Product
P4610

# Model Building

(How to make Virtual Plant)

1. Thermodynamics
2. Steady State Model (Simple / Detailed, Analysis)
3. Calibration (Parameters, Model development, Off-line)

---------- AII application ----------

1. Dynamic Model
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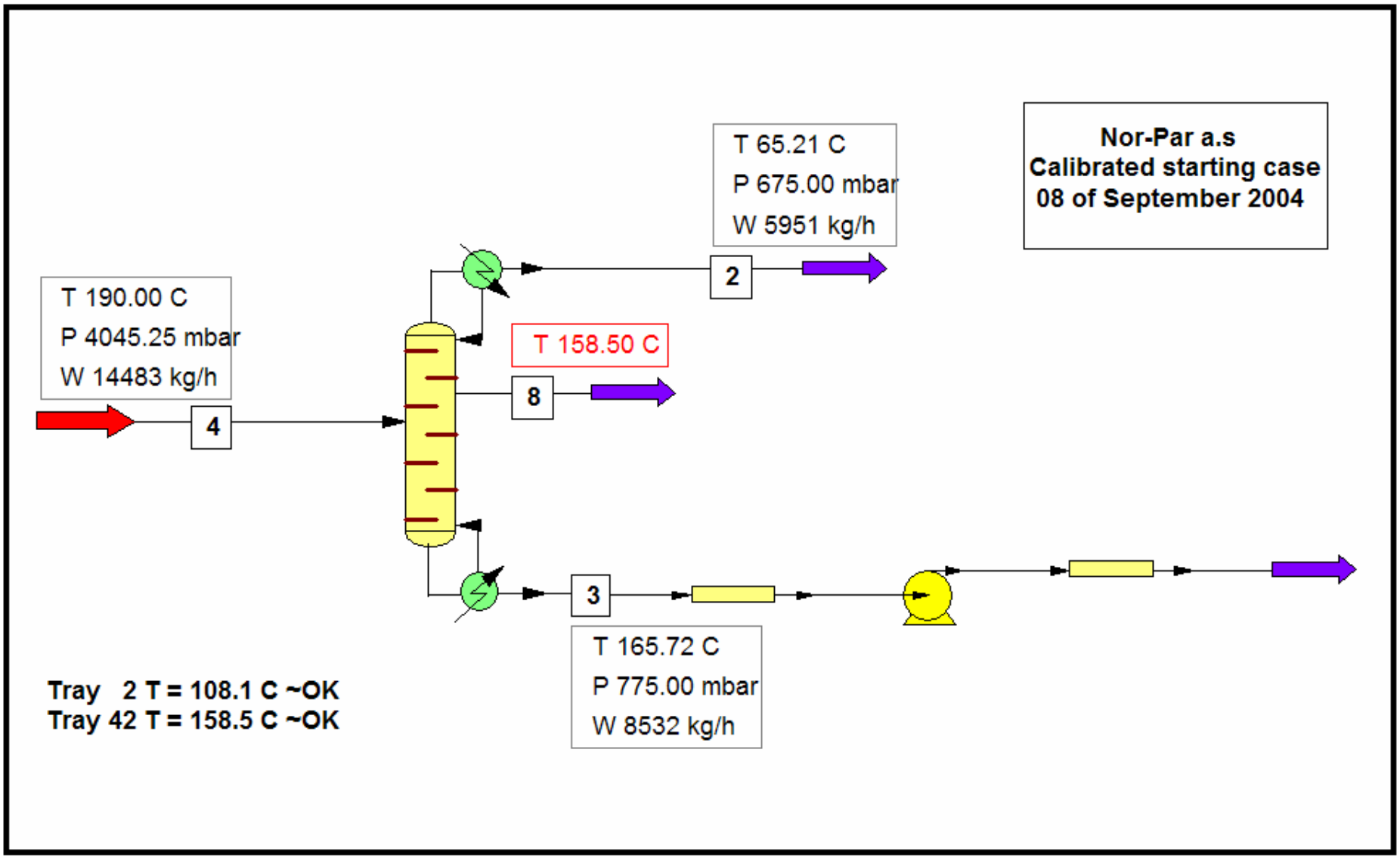
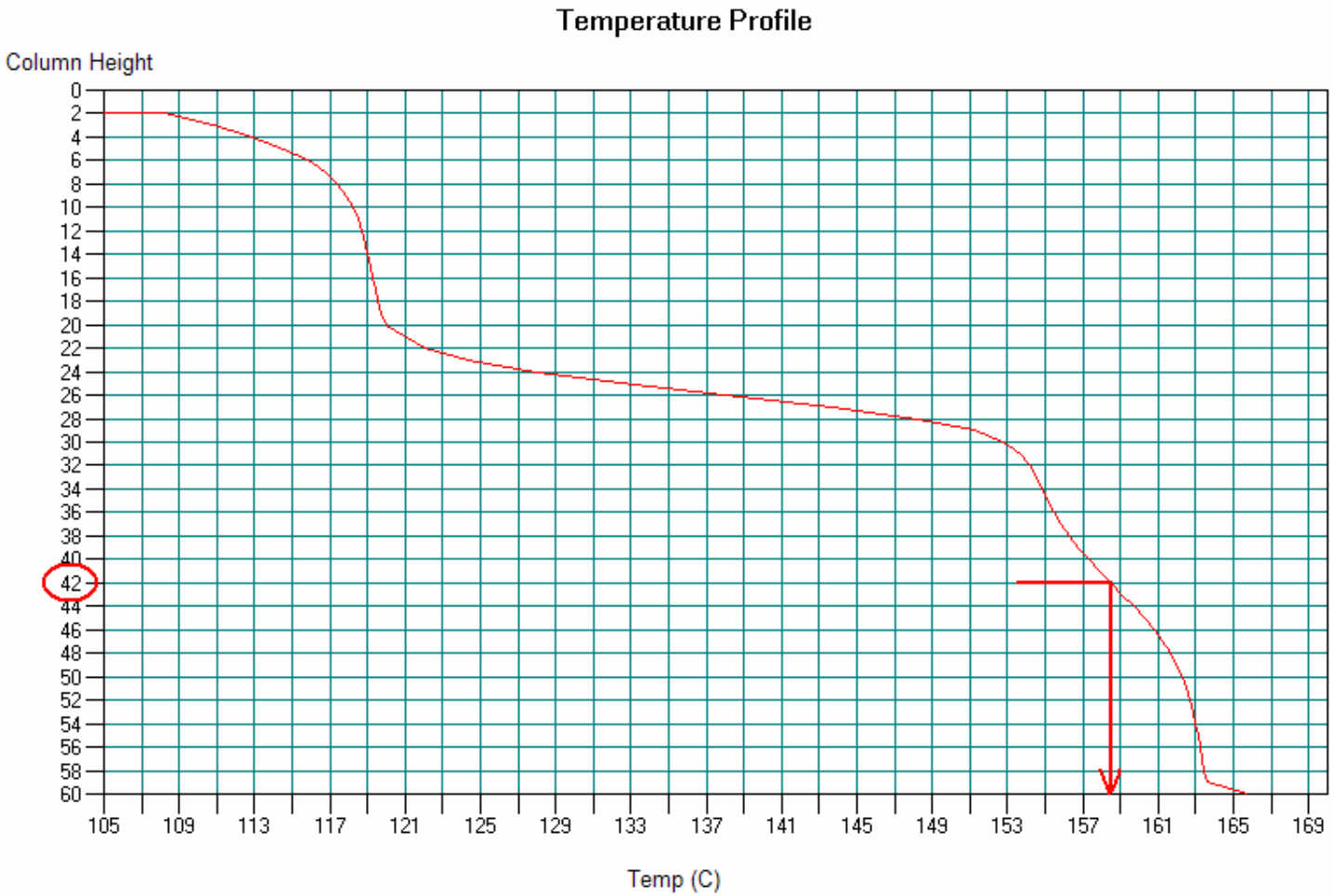
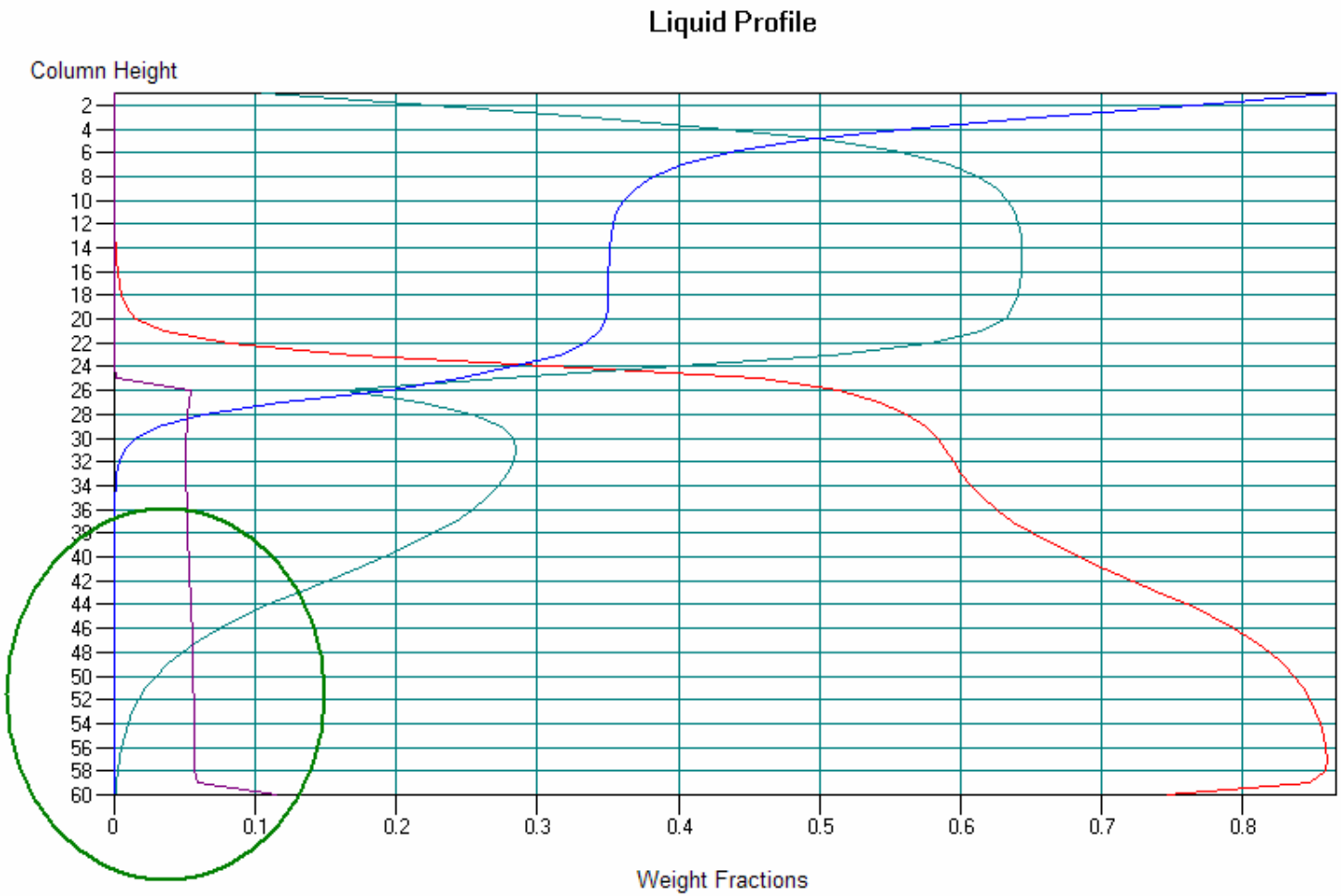
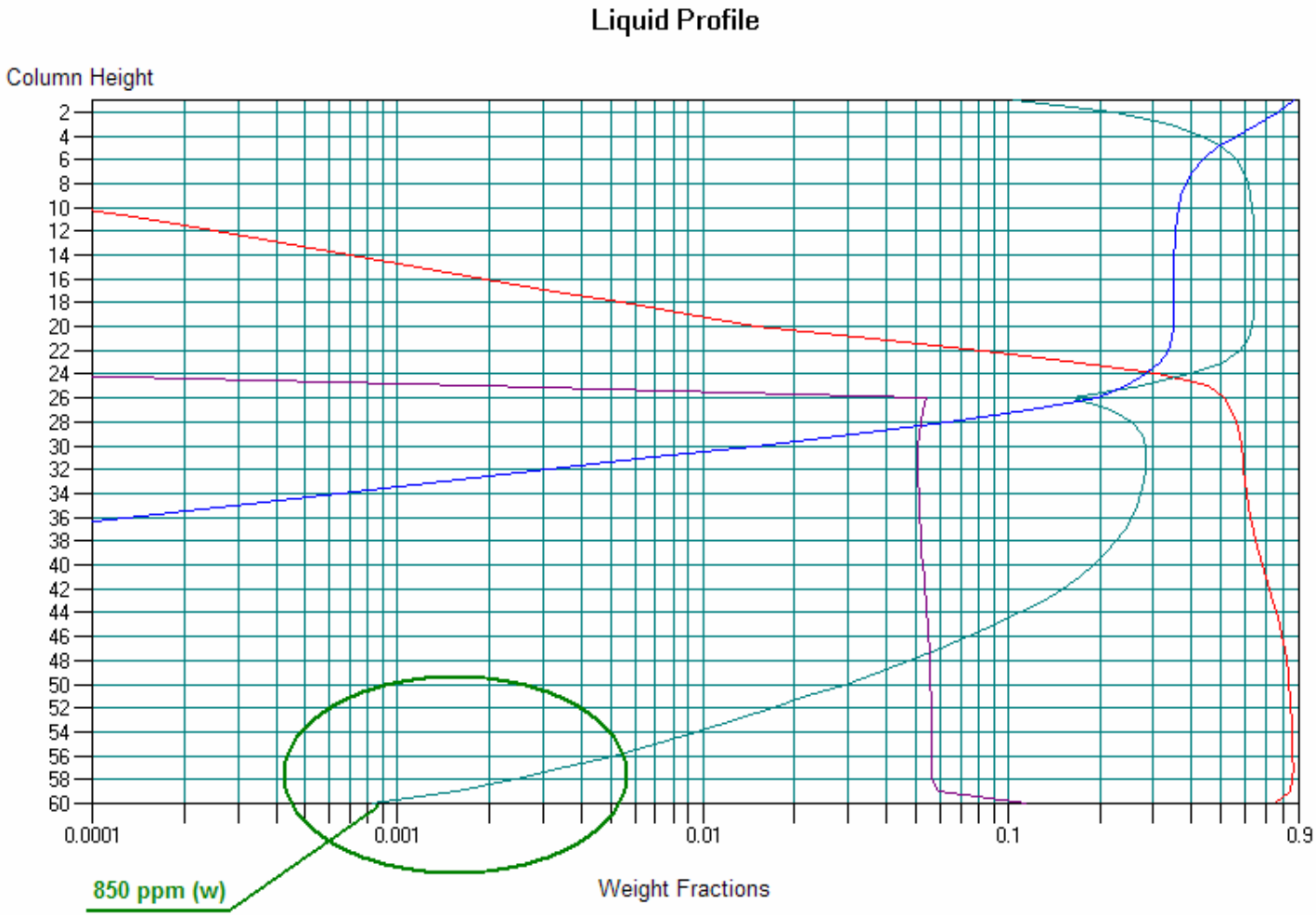
----------Training Simulator ----------


Nor-Par a.s
Calibrated starting case
08 of September 2004
T 65.21 C
P 675.00 mbar
W 5951 kg/h
2
T 190.00 C
P 4045.25 mbar
W 14483 kg/h
4
T 158.50 C
8
3
T 165.72 C
P 775.00 mbar
W 8532 kg/h
Tray 2 T = 108.1 C ~OK
Tray 42 T = 158.5 C ~OK


Temperature Profile
Column Height
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
105
109
113
117
121
125
129
133
137
141
145
149
153
157
161
165
169
Temp (C)


Liquid Profile
Column Height
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Weight Fractions

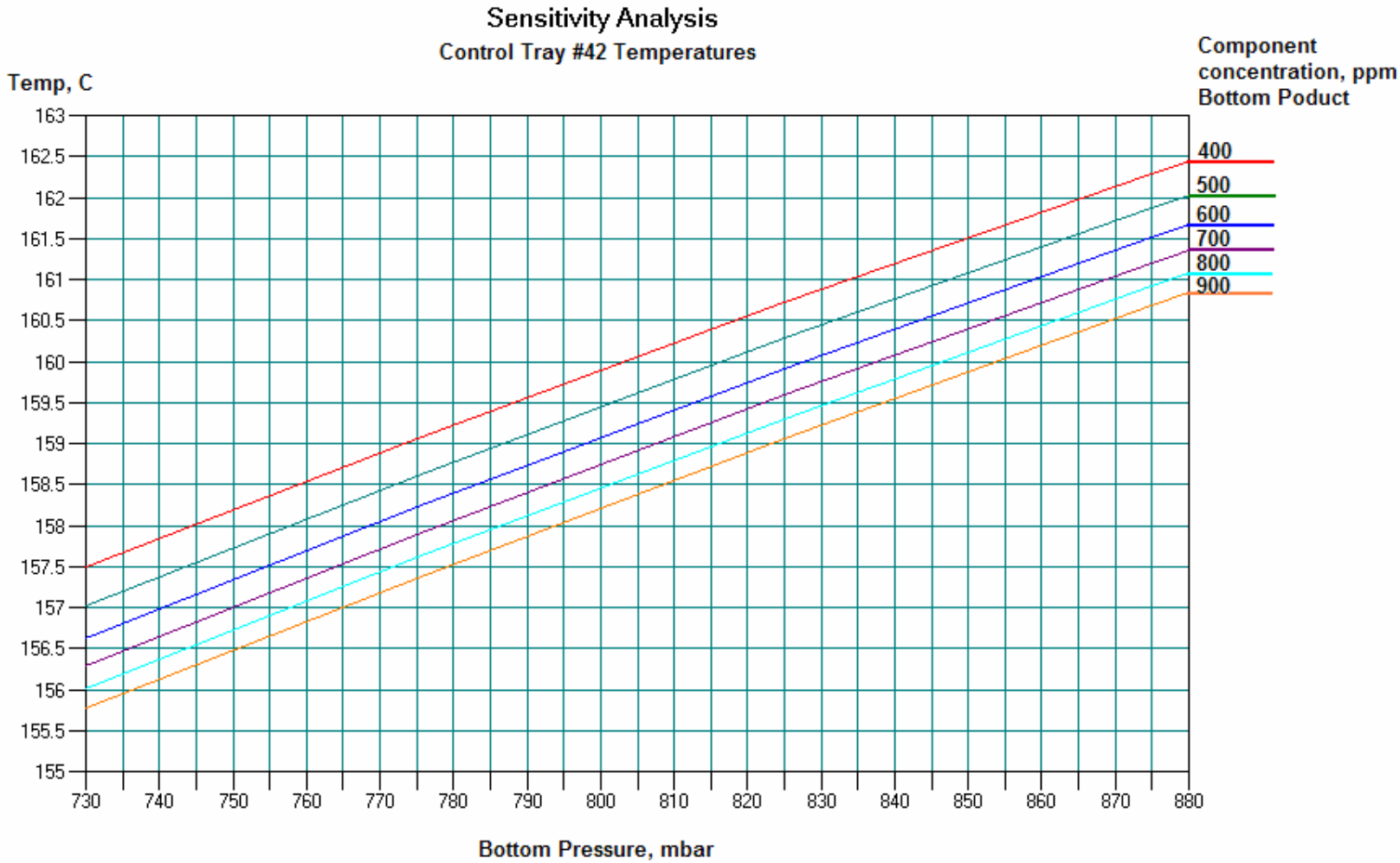

Liquid Profile
Column Height
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
0.0001
0.001
0.01
0.1
0.9
850 ppm (w)
Weight Fractions

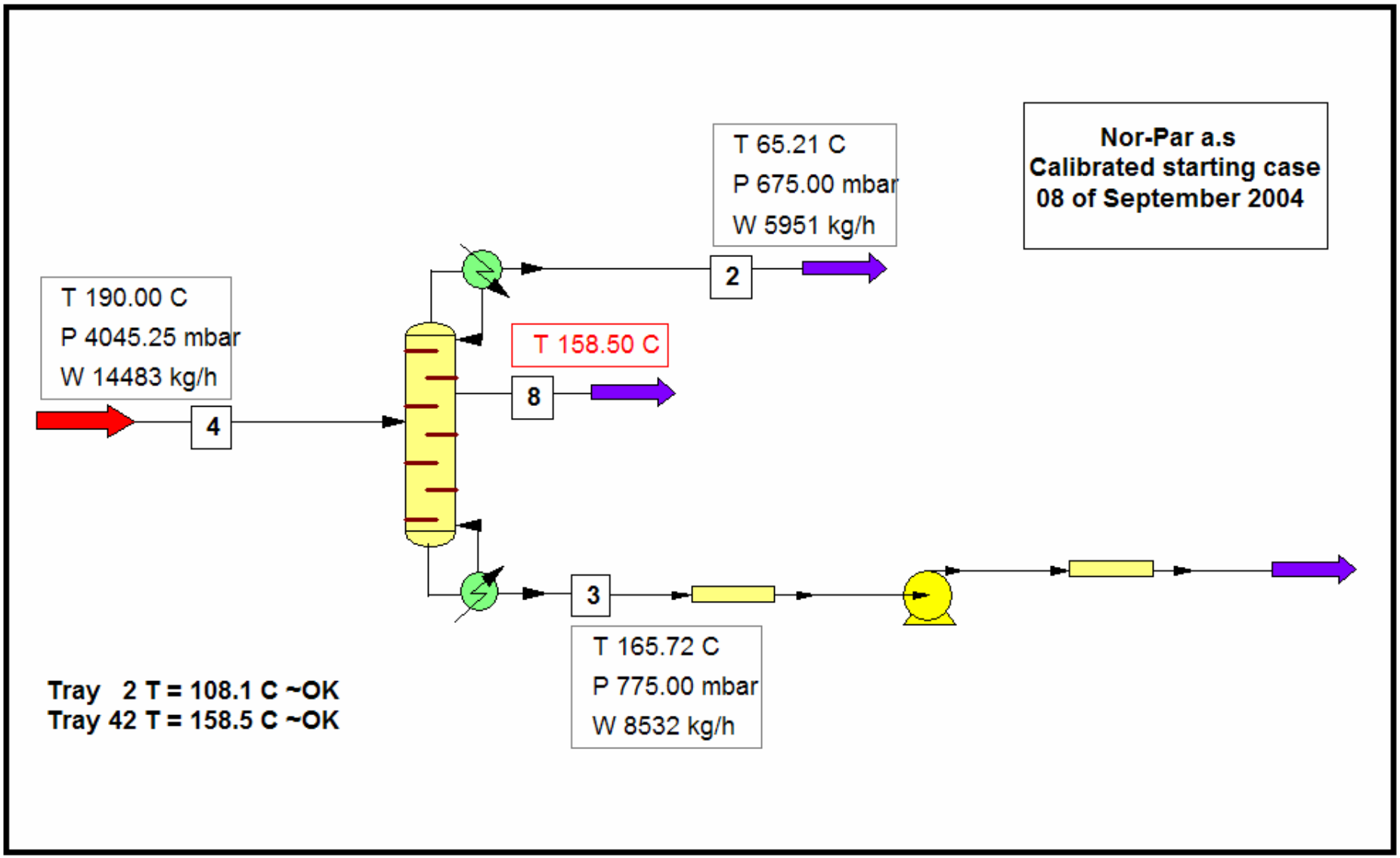
Packed Tower with Billet-Schultes Correlation
Mellapak, M, 250Y (Structured Packing)

| Stg | P Drop mbar | %Flood | Vap Load kg/(m2*sec) | Liq Load kg/(m2*sec) | Diam m | HTUov m |
|---|---|---|---|---|---|---|
| 2 | 0.427 | 58.27586 | 2.156 | 1.220 | 1.500 | 0.248 |
| 3 | 0.438 | 60.13105 | 2.203 | 1.268 | 1.500 | 0.229 |
| 4 | 0.446 | 61.56400 | 2.240 | 1.305 | 1.500 | 0.212 |
| 5 | 0.453 | 62.66986 | 2.270 | 1.335 | 1.500 | 0.201 |
| 6 | 0.457 | 63.44880 | 2.292 | 1.357 | 1.500 | 0.194 |
| 7 | 0.460 | 63.94577 | 2.308 | 1.372 | 1.500 | 0.189 |
| 8 | 0.461 | 64.23223 | 2.317 | 1.382 | 1.500 | 0.187 |
| 38 | 0.265 | 54.10086 | 1.710 | 3.051 | 1.500 | 0.229 |
| 39 | 0.261 | 53.61437 | 1.692 | 3.033 | 1.500 | 0.237 |
| 40 | 0.258 | 53.08282 | 1.673 | 3.014 | 1.500 | 0.246 |
| 41 | 0.254 | 52.52289 | 1.652 | 2.994 | 1.500 | 0.256 |
| 42 | 0.251 | 51.95192 | 1.632 | 2.973 | 1.500 | 0.267 |
| 43 | 0.247 | 51.39033 | 1.612 | 2.953 | 1.500 | 0.278 |
| 44 | 0.244 | 50.85733 | 1.592 | 2.934 | 1.500 | 0.289 |
| 54 | 0.228 | 48.22985 | 1.504 | 2.845 | 1.500 | 0.354 |
| 55 | 0.228 | 48.15547 | 1.502 | 2.843 | 1.500 | 0.356 |
| 56 | 0.227 | 48.09559 | 1.501 | 2.842 | 1.500 | 0.357 |
| 57 | 0.227 | 48.04998 | 1.500 | 2.841 | 1.500 | 0.358 |
| 58 | 0.227 | 48.02284 | 1.501 | 2.842 | 1.500 | 0.356 |
| 59 | 0.225 | 47.90974 | 1.503 | 2.845 | 1.500 | 0.343 |

Overall :

| | | | |
|---|---|---|---|
| Height | m | ..... | 16.500 |
| HETP | m | ..... | 0.284 |
| Pressure drop | mbar | ..... | 19.014 |


Sensitivity Analysis
Control Tray #42 Temperatures
Temp, C
163
162.5
162
161.5
161
160.5
160
159.5
159
158.5
158
157.5
157
156.5
156
155.5
155
730
740
750
760
770
780
790
800
810
820
830
840
850
860
870
880
Bottom Pressure, mbar
Component concentration, ppm Bottom Poduct
400
500
600
700
800
900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3
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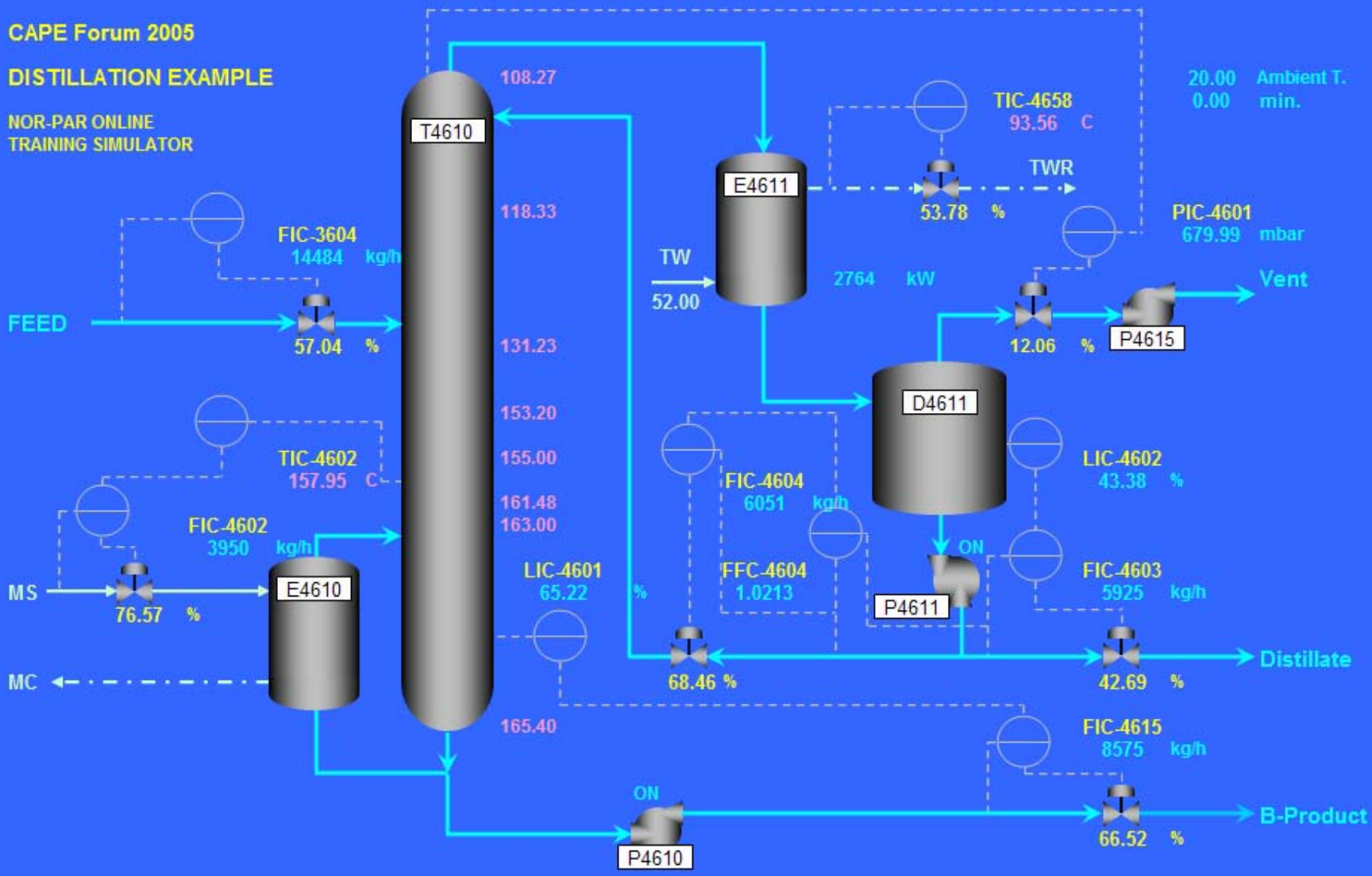
CAPE Forum 2005
DISTILLATION EXAMPLE
NOR-PAR ONLINE
TRAINING SIMULATOR
T4610
108.27
118.33
131.23
153.20
155.00
161.48
163.00
165.40
E4611
TIC-4658
93.56 C
TWR
53.78 %
20.00 Ambient T.
0.00 min.
PIC-4601
679.99 mbar
Vent
TW
52.00
2764 kW
12.06 %
P4615
FIC-3604
14484 kg/h
FEED
57.04 %
D4611
LIC-4602
43.38 %
TIC-4602
157.95 C
FIC-4604
6051 kg/h
FIC-4602
3950 kg/h
MS
76.57 %
E4610
MC
LIC-4601
65.22 %
FFC-4604
1.0213
ON
P4611
FIC-4603
5925 kg/h
68.46 %
42.69 %
Distillate
FIC-4615
8575 kg/h
ON
P4610
66.52 %
B-Product

# Model Building

(How to make Virtual Plant)

1. Thermodynamics
2. Steady State Model (Simple / Detailed, Analysis)
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---------- AII application ----------

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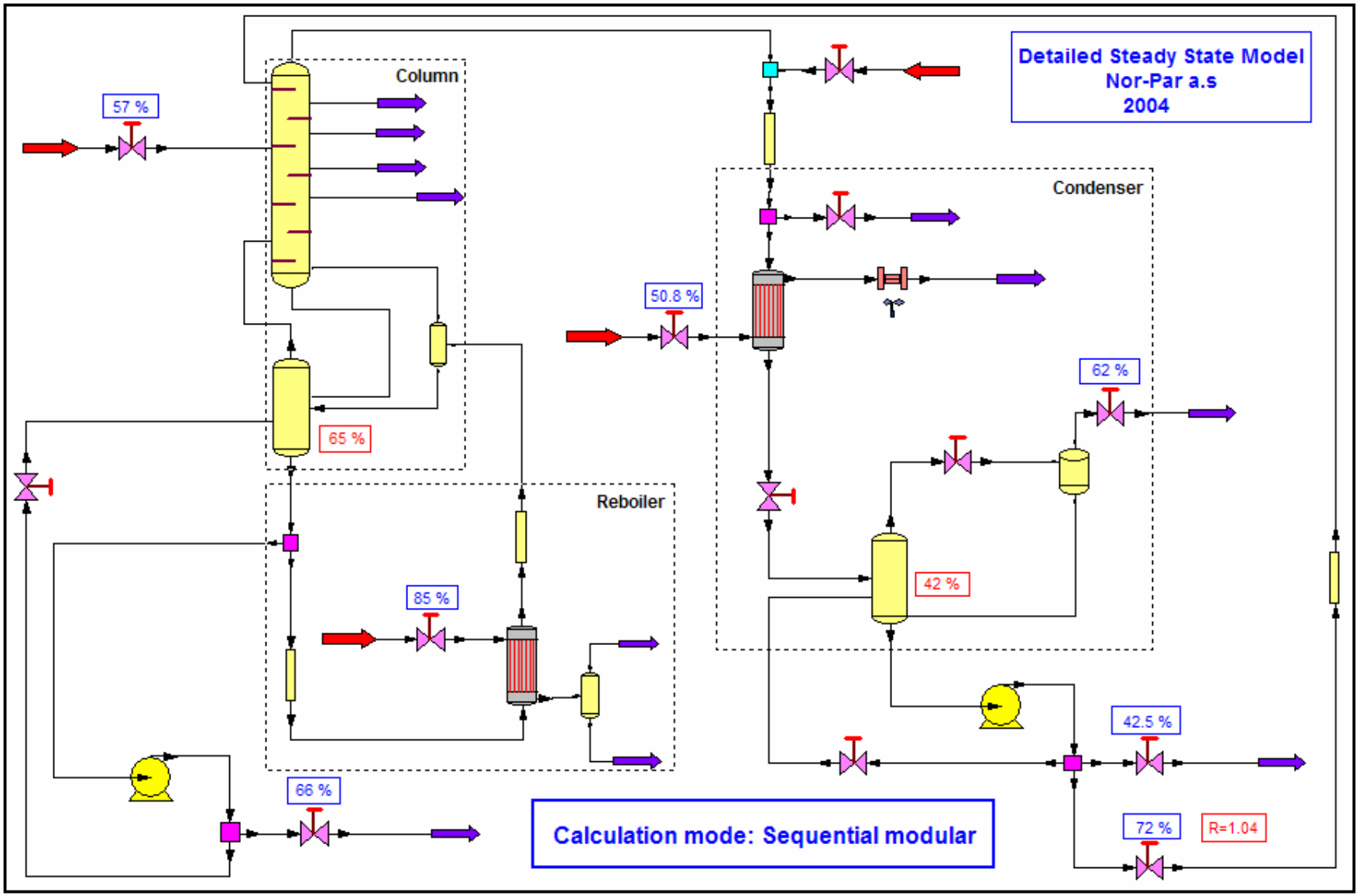
---------- For simulation & training ----------

1. Tuning (Control System)
2. Test runs

----------Training Simulator ----------


Detailed Steady State Model
Nor-Par a.s
2004
Column
Condenser
Reboiler
57 %
50.8 %
62 %
65 %
42 %
85 %
42.5 %
66 %
72 %
R=1.04
Calculation mode: Sequential modular

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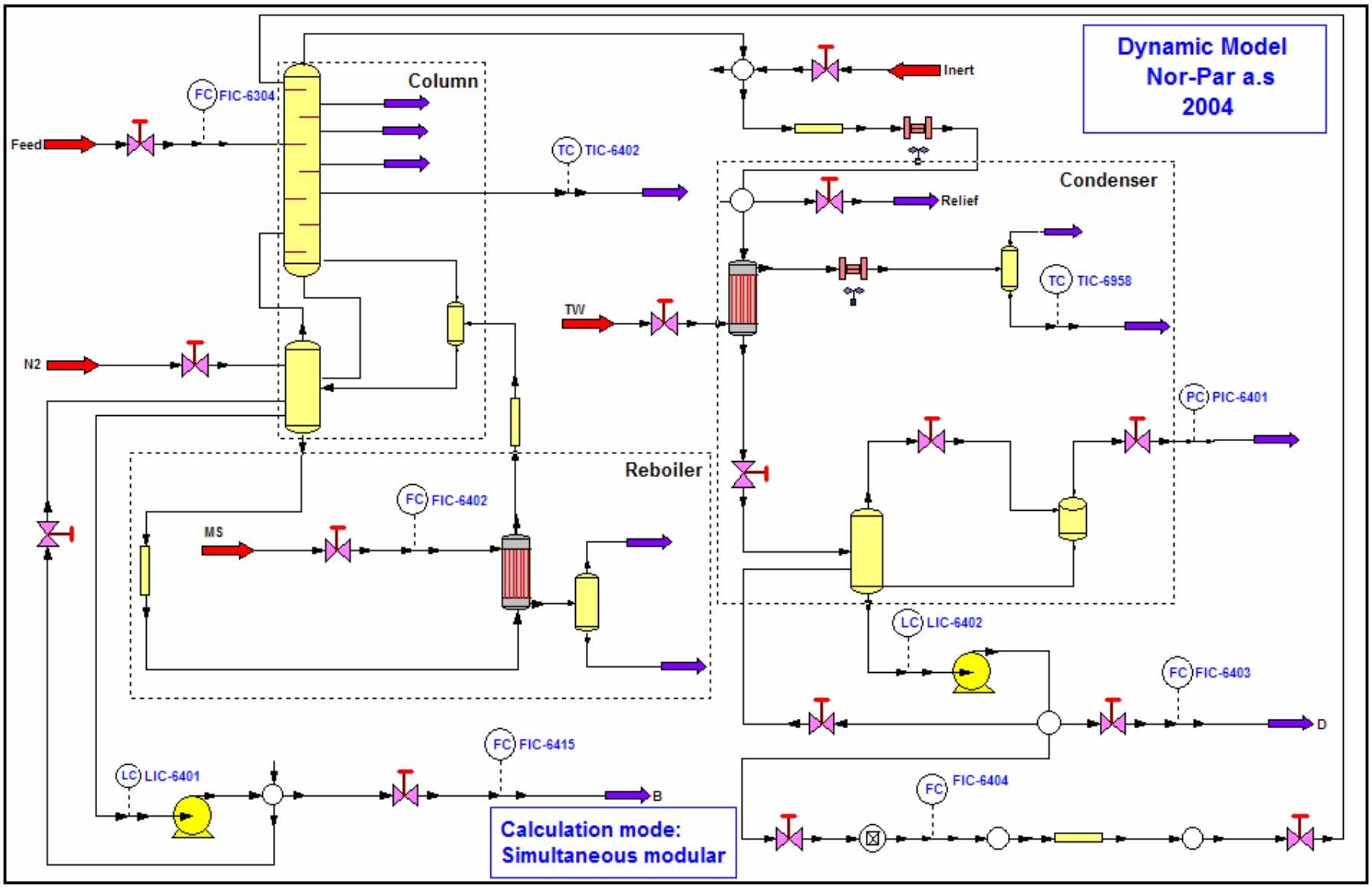
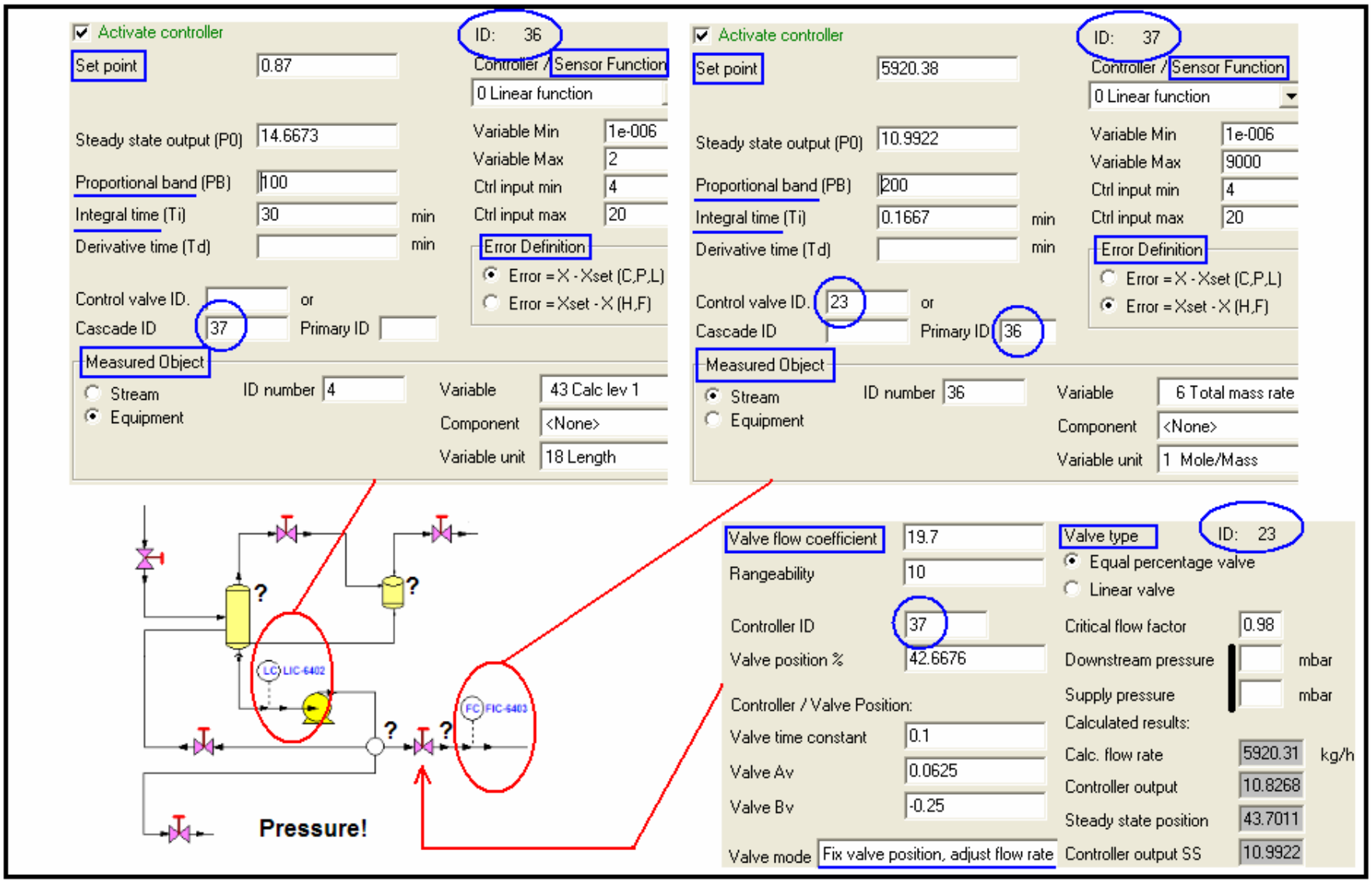
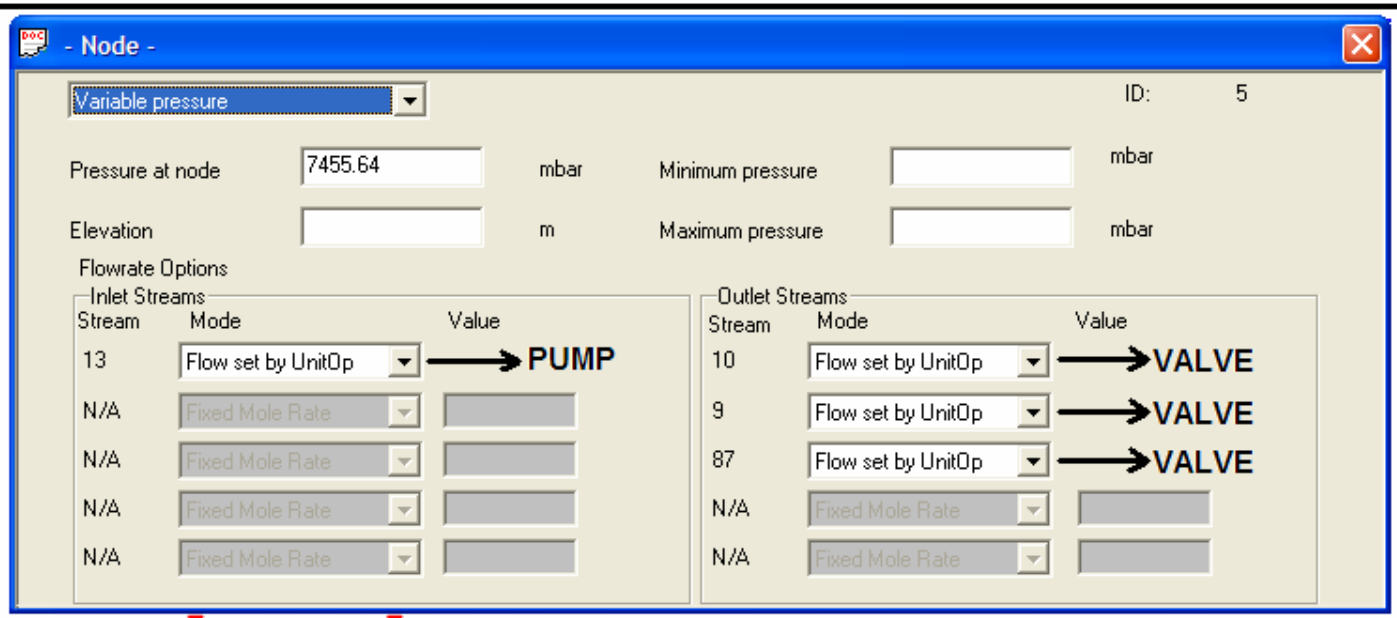
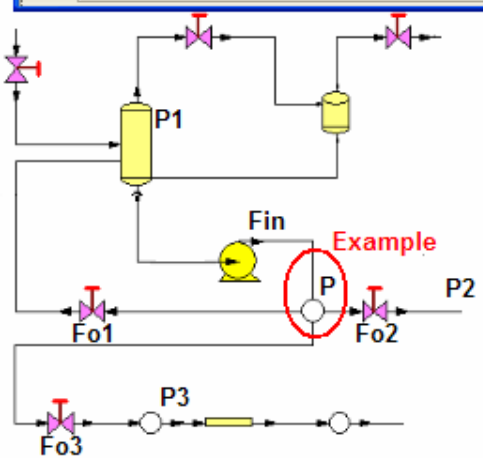

Dynamic Model
Nor-Par a.s
2004
Column
Condenser
Reboiler
Feed
FC FIC-6304
TC TIC-6402
Inert
Relief
TC TIC-6958
TW
N2
PC PIC-6401
MS
FC FIC-6402
LC LIC-6402
FC FIC-6403
D
FC FIC-6415
LC LIC-6401
B
FC FIC-6404
Calculation mode:
Simultaneous modular


Activate controller
ID: 36
Set point
0.87
Controller / Sensor Function
0 Linear function
Steady state output (P0)
14.6673
Variable Min
1e-006
Variable Max
2
Proportional band (PB)
100
Ctrl input min
4
Integral time (Ti)
30
min
Ctrl input max
20
Derivative time (Td)
min
Error Definition
Error = X - Xset (C,P,L)
Error = Xset - X (H,F)
Control valve ID.
or
Cascade ID
37
Primary ID
Measured Object
Stream
Equipment
ID number
4
Variable
43 Calc lev 1
Component
<None>
Variable unit
18 Length
Activate controller
ID: 37
Set point
5920.38
Controller / Sensor Function
0 Linear function
Steady state output (P0)
10.9922
Variable Min
1e-006
Variable Max
9000
Proportional band (PB)
200
Ctrl input min
4
Integral time (Ti)
0.1667
min
Ctrl input max
20
Derivative time (Td)
min
Error Definition
Error = X - Xset (C,P,L)
Error = Xset - X (H,F)
Control valve ID.
23
or
Cascade ID
Primary ID
36
Measured Object
Stream
Equipment
ID number
36
Variable
6 Total mass rate
Component
<None>
Variable unit
1 Mole/Mass
LC LIC-6402
FC FIC-6403
Pressure!
Valve flow coefficient
19.7
Valve type
ID: 23
Equal percentage valve
Linear valve
Rangeability
10
Controller ID
37
Critical flow factor
0.98
Valve position %
42.6676
Downstream pressure
mbar
Supply pressure
mbar
Controller / Valve Position:
Calculated results:
Valve time constant
0.1
Calc. flow rate
5920.31
kg/h
Valve Av
0.0625
Controller output
10.8268
Valve Bv
-0.25
Steady state position
43.7011
Valve mode
Fix valve position, adjust flow rate
Controller output SS
10.9922




**Calculated**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| P | Fin | Fo1 | Fo2 | Fo3 |

**Simultaneous modular technique**

Fin - (Fo1 + Fo2 + Fo3) = 0 (1)
Fin = f(PUMP, (P-P1)) (2)
Fo1= f(VALVE, (P-P1)) (3)
Fo2= f(VALVE, (P-P2)) (4)
Fo3= f(VALVE, (P-P3)) (5)

**... around next node +**
**dynamic vessels**
**column**

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(How to make Virtual Plant)

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---------- All application ----------

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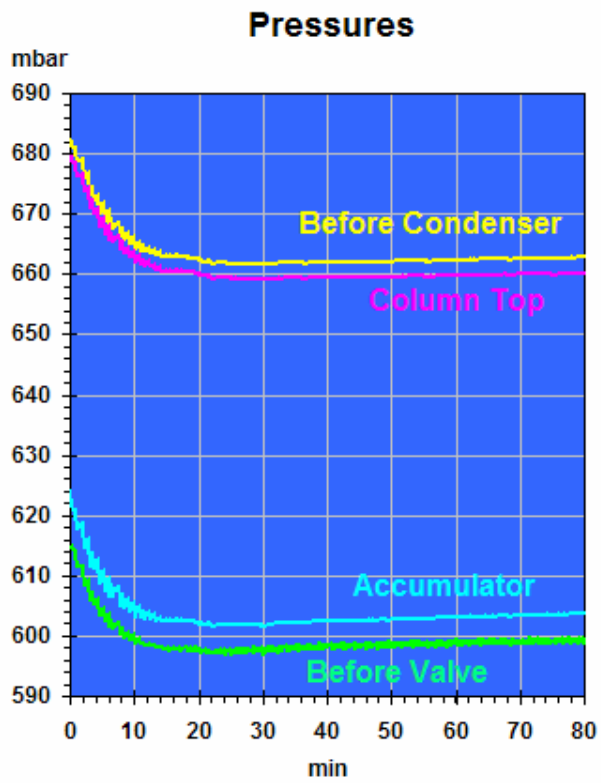
---------- For simulation & training ----------

1. Tuning (Control System)
2. Test runs

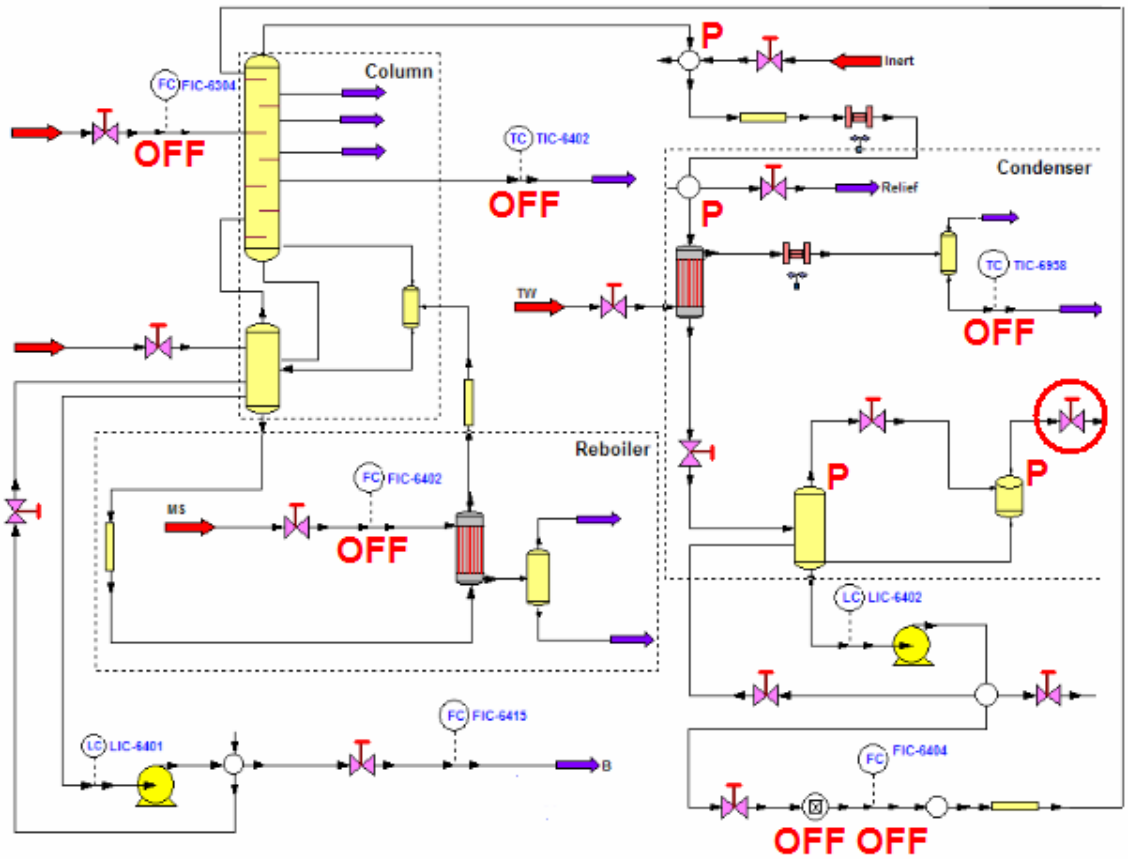
----------Training Simulator ----------

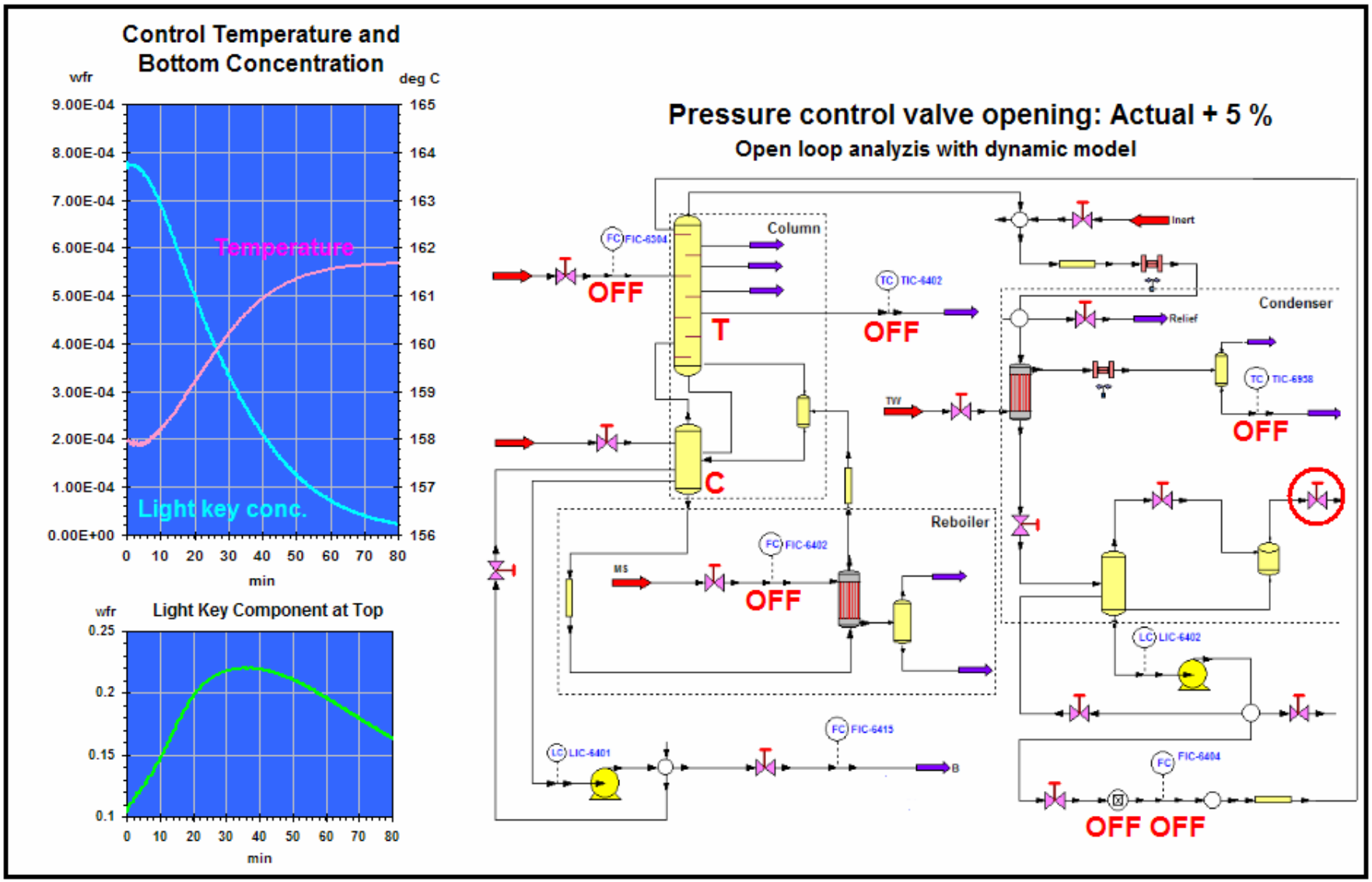


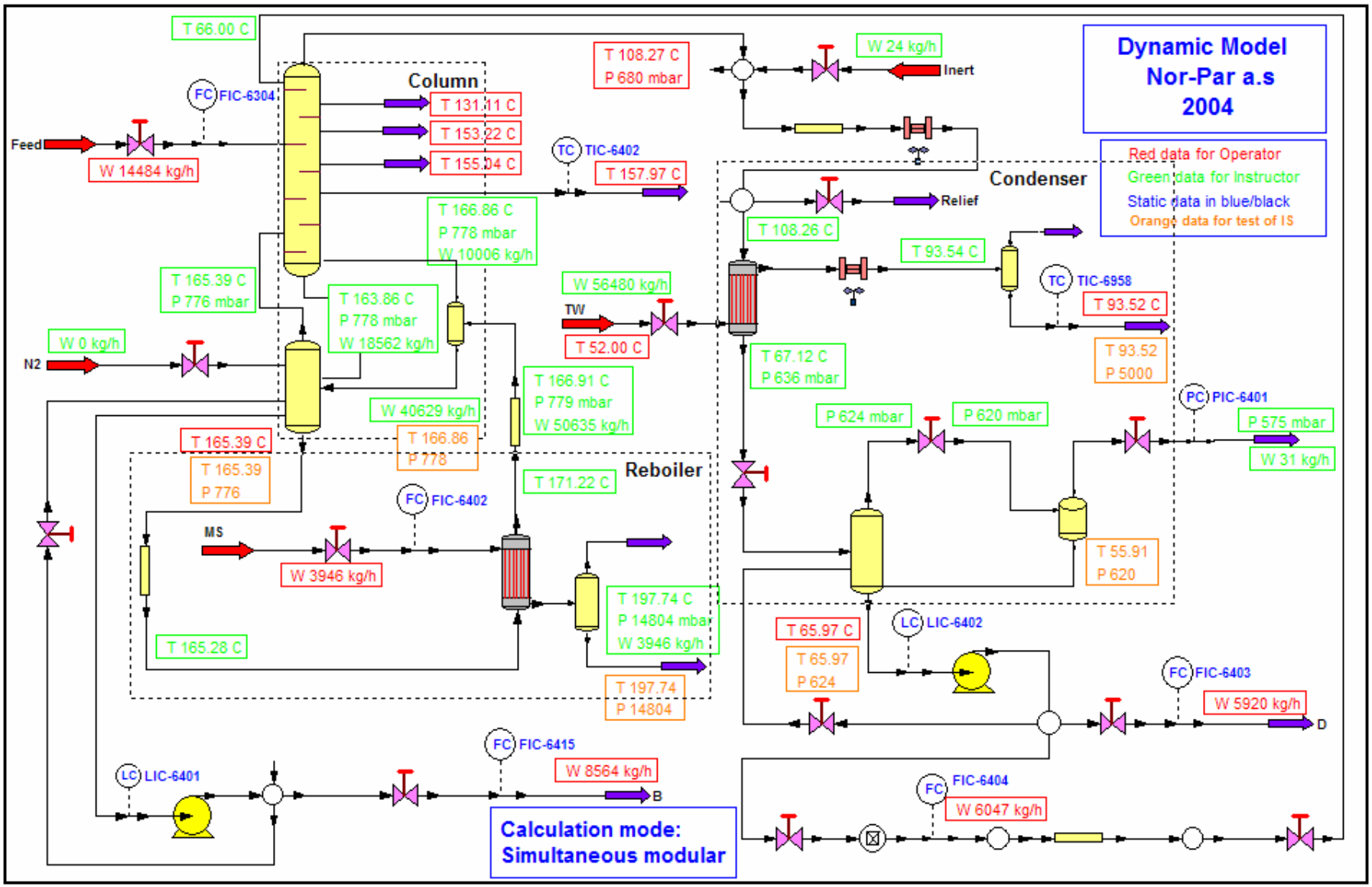

**Gain**
**Time constant(s)**
**Interactions!**

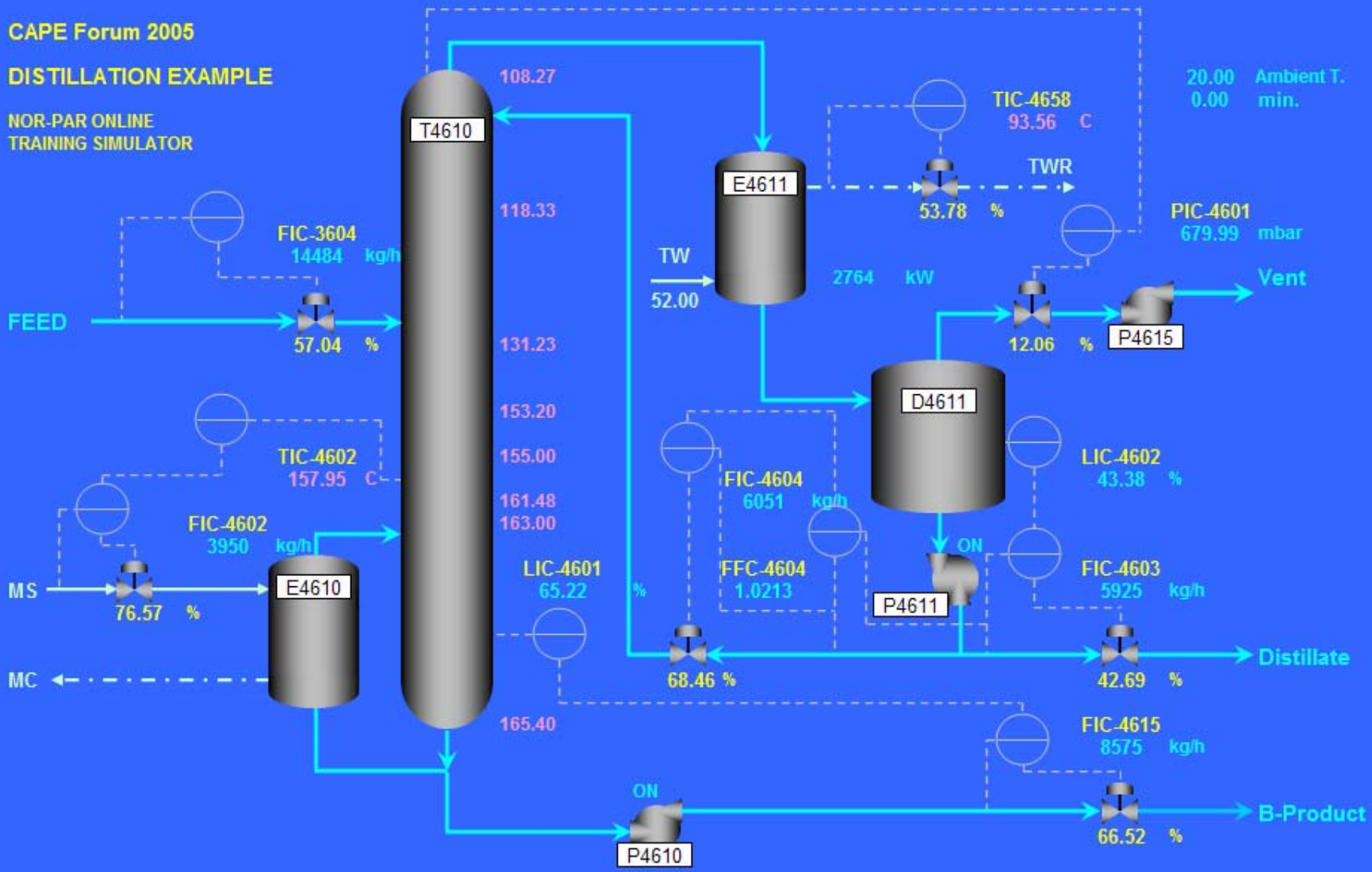
**Pressure control valve opening: Actual + 5 %**

**Open loop analyzis with dynamic model**




Control Temperature and Bottom Concentration
wfr
deg C
9.00E-04
8.00E-04
7.00E-04
6.00E-04
5.00E-04
4.00E-04
3.00E-04
2.00E-04
1.00E-04
0.00E+00
165
164
163
162
161
160
159
158
157
156
Temperature
Light key conc.
0 10 20 30 40 50 60 70 80
min
wfr
Light Key Component at Top
0.25
0.2
0.15
0.1
0 10 20 30 40 50 60 70 80
min
Pressure control valve opening: Actual + 5 %
Open loop analyzis with dynamic model
Column
FC FIC-6304
OFF
T
C
TC TIC-6402
OFF
Inert
Relief
Condenser
TC TIC-6938
OFF
TW
Reboiler
MS
FC FIC-6402
OFF
LC LIC-6402
FC FIC-6415
LC LIC-6401
B
FC FIC-6404
OFF OFF


Dynamic Model
Nor-Par a.s
2004
Red data for Operator
Green data for Instructor
Static data in blue/black
Orange data for test of IS
Column
Condenser
Reboiler
T 66.00 C
FC FIC-6304
Feed
W 14484 kg/h
T 131.11 C
T 153.22 C
T 155.04 C
TC TIC-6402
T 157.97 C
T 108.27 C
P 680 mbar
W 24 kg/h
Inert
Relief
T 108.26 C
T 166.86 C
P 778 mbar
W 10006 kg/h
T 165.39 C
P 776 mbar
T 163.86 C
P 778 mbar
W 18562 kg/h
W 56480 kg/h
TW
T 52.00 C
T 93.54 C
TC TIC-6958
T 93.52 C
T 93.52
P 5000
W 0 kg/h
N2
T 67.12 C
P 636 mbar
T 166.91 C
P 779 mbar
W 50635 kg/h
W 40629 kg/h
T 165.39 C
T 165.39
P 776
T 166.86
P 778
T 171.22 C
FC FIC-6402
MS
W 3946 kg/h
P 624 mbar
P 620 mbar
PC PIC-6401
P 575 mbar
W 31 kg/h
T 55.91
P 620
T 165.28 C
T 197.74 C
P 14804 mbar
W 3946 kg/h
T 197.74
P 14804
T 65.97 C
T 65.97
P 624
LC LIC-6402
FC FIC-6403
W 5920 kg/h
D
FC FIC-6415
W 8564 kg/h
B
LC LIC-6401
FC FIC-6404
W 6047 kg/h
Calculation mode:
Simultaneous modular


CAPE Forum 2005
DISTILLATION EXAMPLE
NOR-PAR ONLINE
TRAINING SIMULATOR
T4610
108.27
118.33
131.23
153.20
155.00
161.48
163.00
165.40
E4611
TIC-4658
93.56 C
TWR
53.78 %
20.00 Ambient T.
0.00 min.
PIC-4601
679.99 mbar
TW
52.00
2764 kW
Vent
12.06 %
P4615
FIC-3604
14484 kg/h
FEED
57.04 %
D4611
LIC-4602
43.38 %
TIC-4602
157.95 C
FIC-4604
6051 kg/h
FIC-4602
3950 kg/h
MS
76.57 %
E4610
LIC-4601
65.22 %
FFC-4604
1.0213
ON
P4611
FIC-4603
5925 kg/h
MC
68.46 %
42.69 %
Distillate
FIC-4615
8575 kg/h
ON
P4610
66.52 %
B-Product

# Training Simulator Main Modules

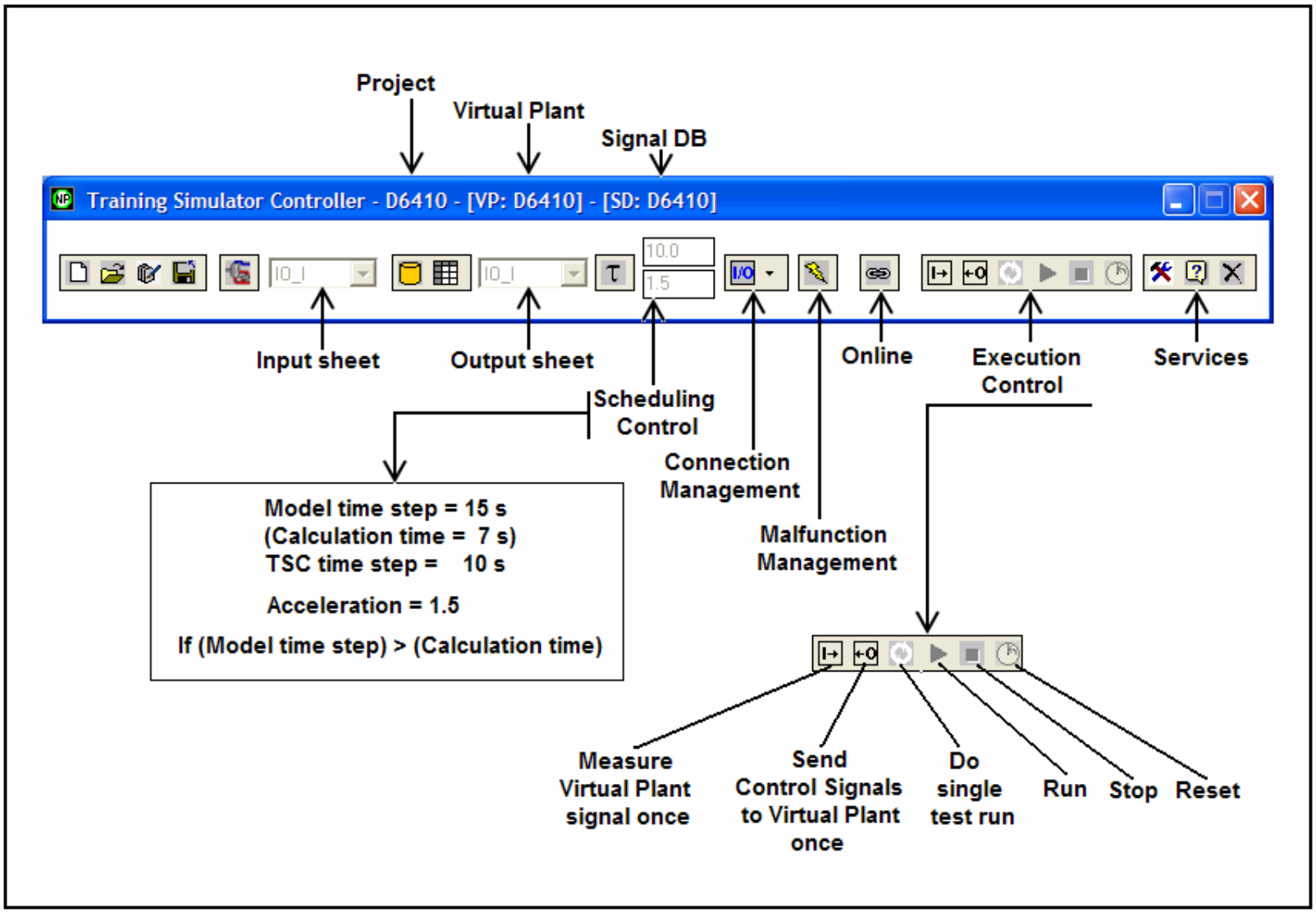
- Simulator Computer with Dynamic Model
  → Virtual Plant
- Instructor Interface
  → TS&O
- Operator Interface
  → Work Station Emulation

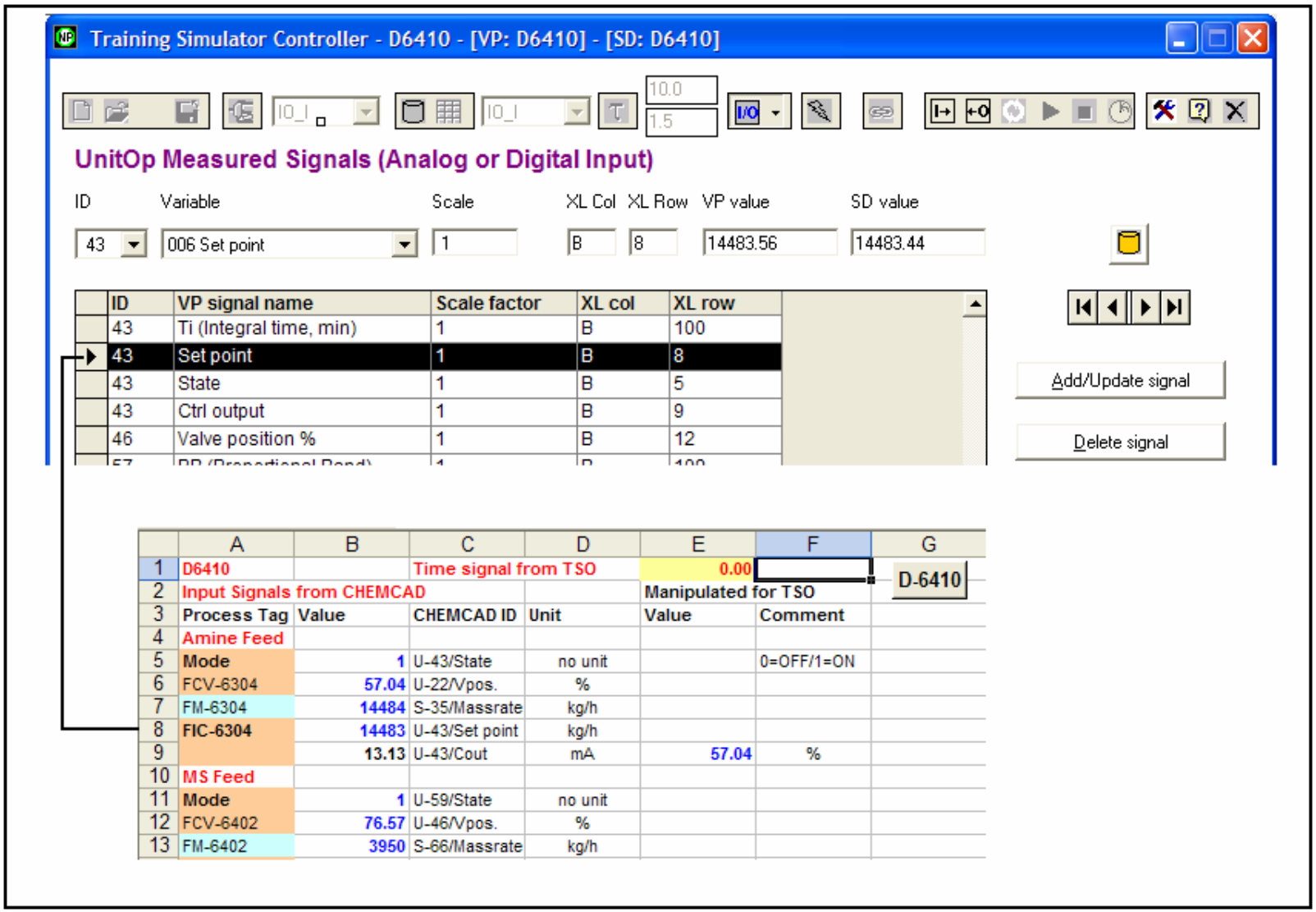
# Instructor Interface

- The Instructor Interface allows access to the simulator's special features, which do not exist at the Operator Interface.

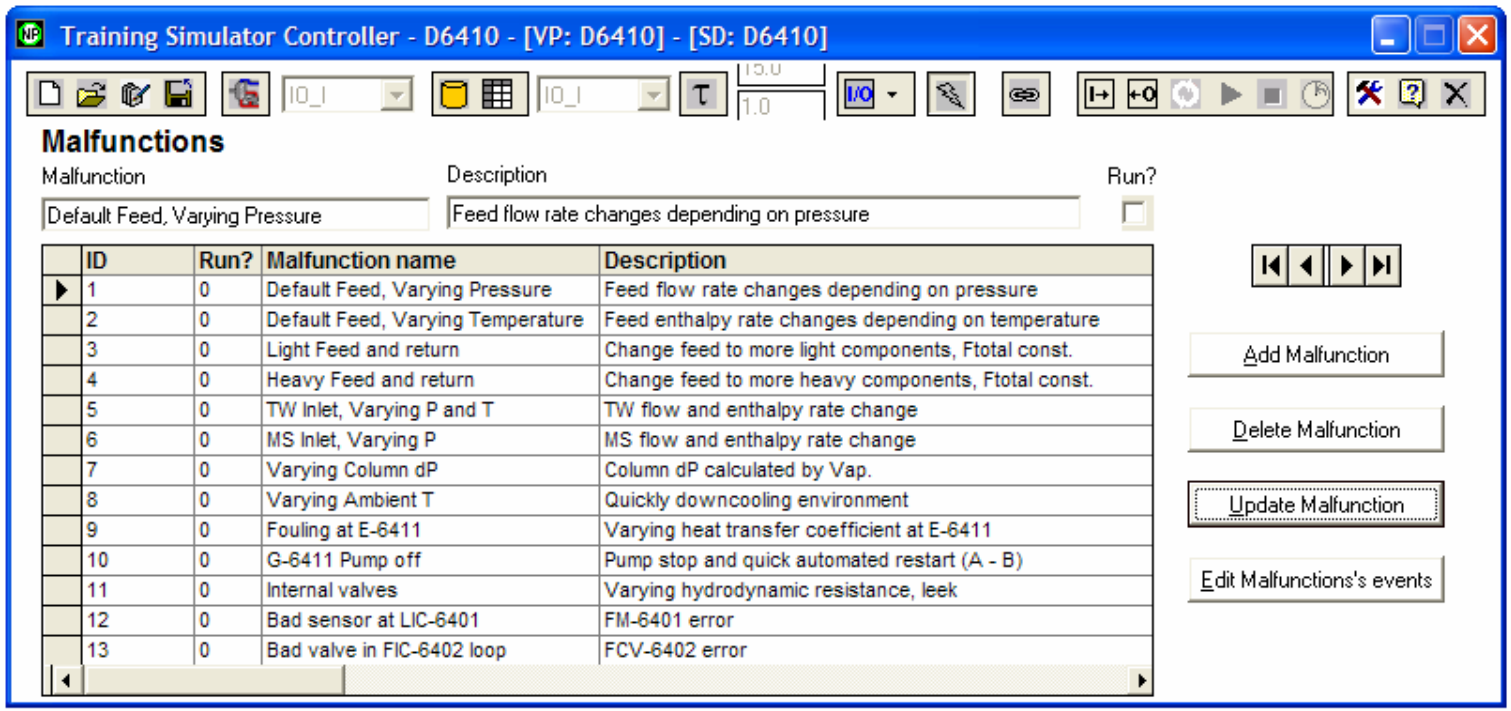
- These include:
  - RUN, FREEZE and RESUME execution of the process model and control system representation in a completely time synchronized manner
  - SAVE and RESTORE model states for future retrieval
  - EXECUTE the model FASTER or SLOWER than real time
  - Introduce malfunctions

- The Instructor Interface also lets the instructor
  - modify the connections between Virtual Plant and Operator Workstation
  - monitor the progress of the training session with lists and trends of process and control system variables (with CHEMCAD GUI)


Project
Virtual Plant
Signal DB
Training Simulator Controller - D6410 - [VP: D6410] - [SD: D6410]
10.0
1.5
Input sheet
Output sheet
Scheduling Control
Connection Management
Malfunction Management
Online
Execution Control
Services
Model time step = 15 s
(Calculation time = 7 s)
TSC time step = 10 s
Acceleration = 1.5
If (Model time step) > (Calculation time)
Measure Virtual Plant signal once
Send Control Signals to Virtual Plant once
Do single test run
Run
Stop
Reset


Training Simulator Controller - D6410 - [VP: D6410] - [SD: D6410]
UnitOp Measured Signals (Analog or Digital Input)
ID
Variable
Scale
XL Col
XL Row
VP value
SD value
43
006 Set point
1
B
8
14483.56
14483.44
ID
VP signal name
Scale factor
XL col
XL row
43
Ti (Integral time, min)
1
B
100
43
Set point
1
B
8
43
State
1
B
5
43
Ctrl output
1
B
9
46
Valve position %
1
B
12
Add/Update signal
Delete signal
D6410
Time signal from TSO
0.00
D-6410
Input Signals from CHEMCAD
Manipulated for TSO
Process Tag
Value
CHEMCAD ID
Unit
Value
Comment
Amine Feed
Mode
1
U-43/State
no unit
0=OFF/1=ON
FCV-6304
57.04
U-22/Vpos.
%
FM-6304
14484
S-35/Massrate
kg/h
FIC-6304
14483
U-43/Set point
kg/h
13.13
U-43/Cout
mA
57.04
%
MS Feed
Mode
1
U-59/State
no unit
FCV-6402
76.57
U-46/Vpos.
%
FM-6402
3950
S-66/Massrate
kg/h

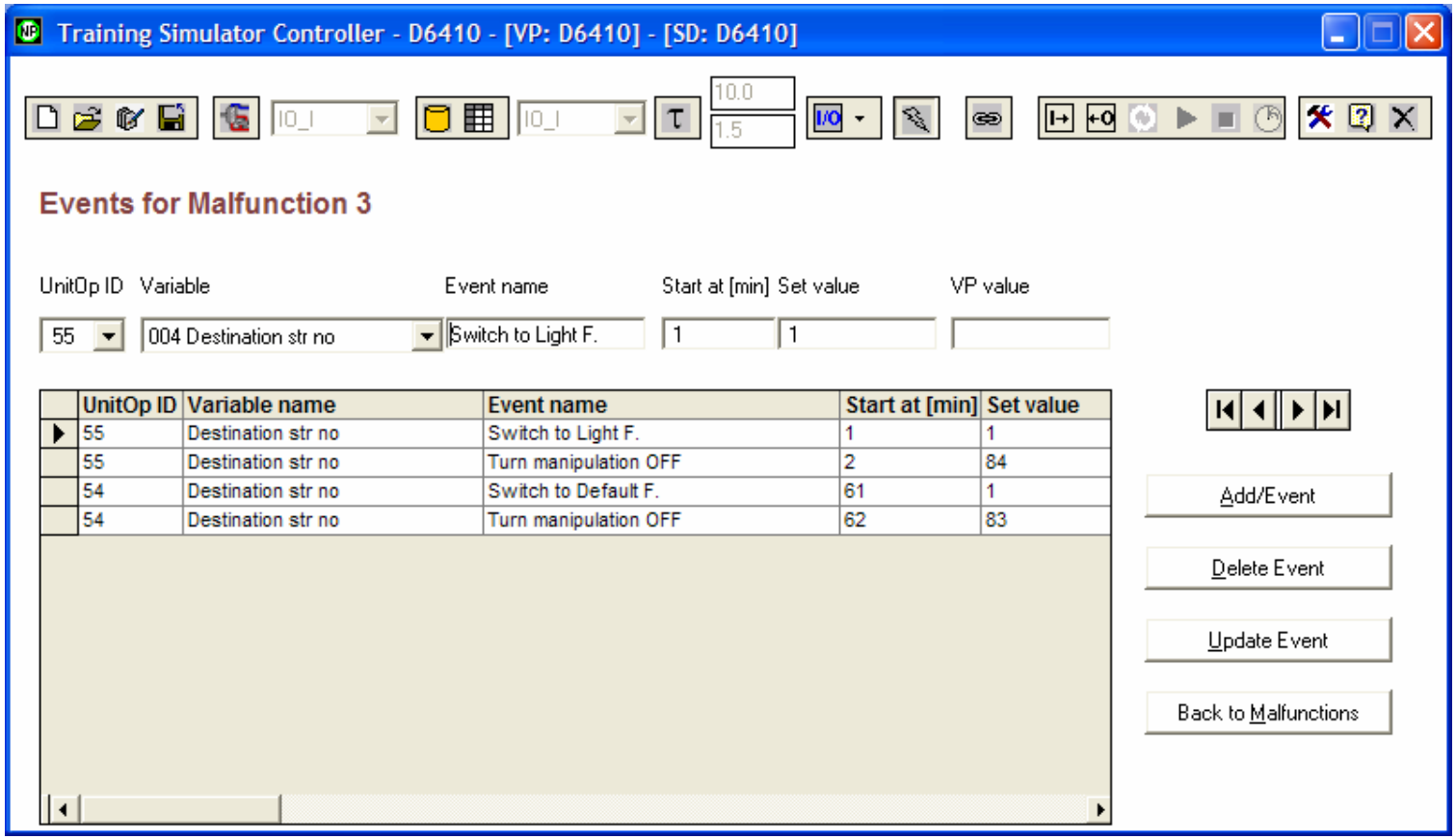
This is the list of malfunctions. In default case no malfunction is selected.




| | ID | Run? | Malfunction name | Description |
|---|---|---|---|---|
| ▶ | 1 | 0 | Default Feed, Varying Pressure | Feed flow rate changes depending on pressure |
| | 2 | 0 | Default Feed, Varying Temperature | Feed enthalpy rate changes depending on temperature |
| | 3 | 0 | Light Feed and return | Change feed to more light components, Ftotal const. |
| | 4 | 0 | Heavy Feed and return | Change feed to more heavy components, Ftotal const. |
| | 5 | 0 | TW Inlet, Varying P and T | TW flow and enthalpy rate change |
| | 6 | 0 | MS Inlet, Varying P | MS flow and enthalpy rate change |
| | 7 | 0 | Varying Column dP | Column dP calculated by Vap. |
| | 8 | 0 | Varying Ambient T | Quickly downcooling environment |
| | 9 | 0 | Fouling at E-6411 | Varying heat transfer coefficient at E-6411 |
| | 10 | 0 | G-6411 Pump off | Pump stop and quick automated restart (A - B) |
| | 11 | 0 | Internal valves | Varying hydrodynamic resistance, leek |
| | 12 | 0 | Bad sensor at LIC-6401 | FM-6401 error |
| | 13 | 0 | Bad valve in FIC-6402 loop | FCV-6402 error |

Example: How to select malfunction(s)? Select "Light Feed and return"
Click on row 3, click on Run? checkbox, Click on Update Malfunction
For more detailed description look at the "User Manual"!
You get

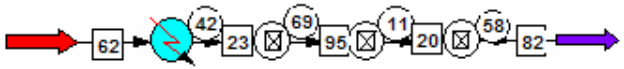
| | ID | Run? | Malfunction name | Description |
|---|---|---|---|---|
| ▶ | 1 | 0 | Default Feed, Varying Pressure | Feed flow rate changes depending on pressure |
| | 2 | 0 | Default Feed, Varying Temperature | Feed enthalpy rate changes depending on temperature |
| | 3 | 1 | Light Feed and return | Change feed to more light components, Ftotal const. |
| | 4 | 0 | Heavy Feed and return | Change feed to more heavy components, Ftotal const. |


Training Simulator Controller - D6410 - [VP: D6410] - [SD: D6410]
10.0
1.5
Events for Malfunction 3
UnitOp ID
Variable
Event name
Start at [min]
Set value
VP value
55
004 Destination str no
Switch to Light F.
1
1
UnitOp ID | Variable name | Event name | Start at [min] | Set value
55 | Destination str no | Switch to Light F. | 1 | 1
55 | Destination str no | Turn manipulation OFF | 2 | 84
54 | Destination str no | Switch to Default F. | 61 | 1
54 | Destination str no | Turn manipulation OFF | 62 | 83
Add/Event
Delete Event
Update Event
Back to Malfunctions

## Extensions for scenarios of Training Simulator

1. Change ambient temperature

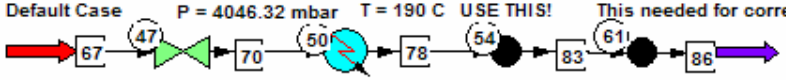
Default value 20 deg. C
Write new value into Unit_42/Tout_1
Ambient temperature used by Units 1,7,35



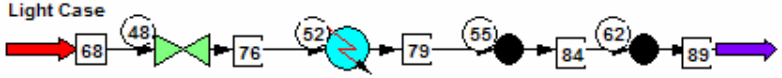

2. Chenge feed T/P/concentration

For feed selection write feed stream number (1)
into the "Destination ID" variable. This step needed always!
(Reset with SREF outlet stream ID)
Later use valve (Pout) and heat exchanger (Tout_1)
for manipulation of feed P & T.

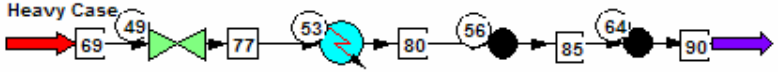
Default Case P = 4046.32 mbar T = 190 C USE THIS! This needed for correct balance




Light Case




Heavy Case

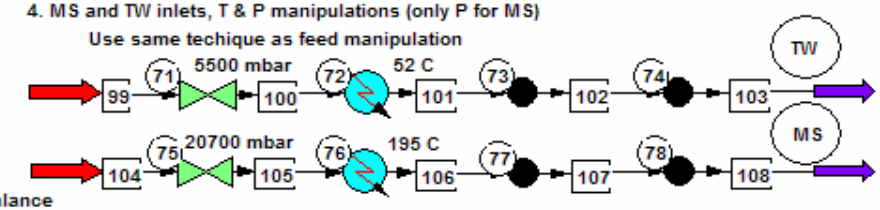



3. Manipulations on N2 (0 kg/h) and inert (small calculated) inlet

Simply modify the valve position
N2: Unit_15, actual value 5.95511e-007
Inert: Unit_26, actual value 20

4. MS and TW inlets, T & P manipulations (only P for MS)

Use same techique as feed manipulation

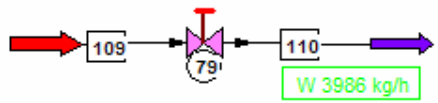



5. Simulation of bad sensor

Selected sensor specified in LIC-6401 (Unit 28)
Simply modify the "Measured Object ID" (actually 13)
Case A: Constant signal
to 27 (Unit_27 gives 1m / 50 % constant level)
Case B: Varying signal
to 4 (Unit_4 gives level controlled by LIC-6402)
In both cases Operator Screen should show the linked level! (IF !)

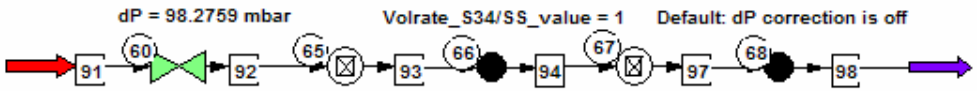
6. Simulation of bad valve

Delete controller ID from Unit_46
Set valve ID to 79 in Unit_59
Set controller ID to 59 in Unit_79
Operator screen should show the linked position (IF!)
and all actions directed to this linked valve.




7. Unit specific scenarios with unit parameters:
- fouling simulation with modified heat transfer coefficient
- pump with on/off
- internal hydrodynamic resistance with internal valve positions
- column delta P with FF mode of controller 67

dP = 98.2759 mbar Volrate_S34/SS_value = 1 Default: dP correction is off

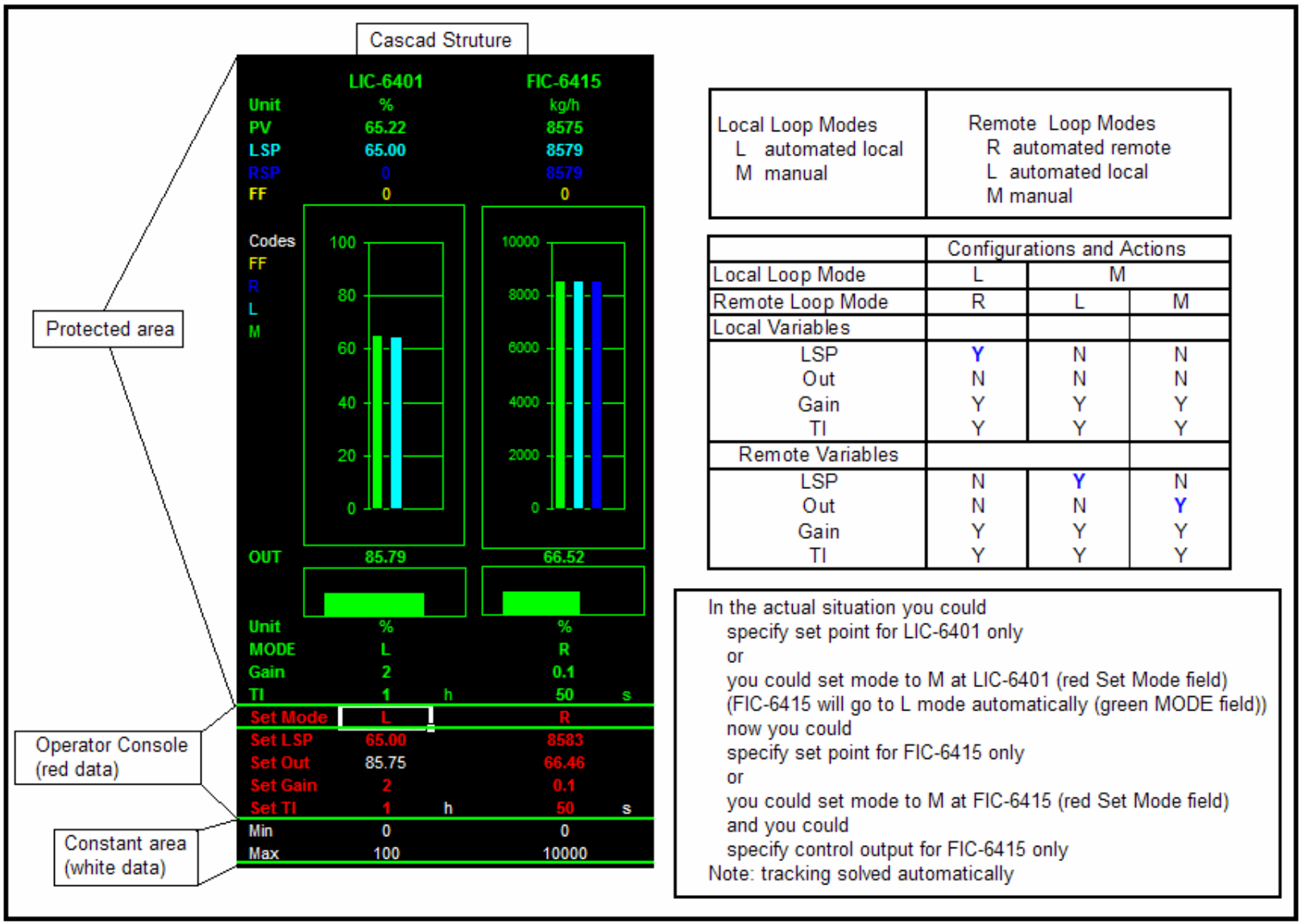



After sequence off - on - off we can work with the last dP or we can set it back to the default value.

**Runtime data refreshing OFF**
**Recording of history files OFF**

# Training Simulator Main Modules

- Simulator Computer with Dynamic Model
  → Virtual Plant
- Instructor Interface
  → TS&O
- Operator Interface
  → Work Station Emulation




| Local Loop Modes | Remote Loop Modes |
|---|---|
| L automated local<br>M manual | R automated remote<br>L automated local<br>M manual |

| | Configurations and Actions | | |
|---|---|---|---|
| Local Loop Mode | L | M | |
| Remote Loop Mode | R | L | M |
| Local Variables | | | |
| LSP | Y | N | N |
| Out | N | N | N |
| Gain | Y | Y | Y |
| TI | Y | Y | Y |
| Remote Variables | | | |
| LSP | N | Y | N |
| Out | N | N | Y |
| Gain | Y | Y | Y |
| TI | Y | Y | Y |

In the actual situation you could
specify set point for LIC-6401 only
or
you could set mode to M at LIC-6401 (red Set Mode field)
(FIC-6415 will go to L mode automatically (green MODE field))
now you could
specify set point for FIC-6415 only
or
you could set mode to M at FIC-6415 (red Set Mode field)
and you could
specify control output for FIC-6415 only
Note: tracking solved automatically

L25 =IF(PID_1!H30="R",PID_1!H9,(IF(PID_1!H30="L",PID_1!H34,PID_1!H7)))

| | A | B | C | D | E | F | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | Btm. Prod. | | | | | | Btm. Prod. | | | | | |
| 22 | Mode | 1 | U-33/State | no unit | | | Mode | 1 | U-33/State | no unit | 1 | by case |
| 23 | FCV-6415 | 66.52 | U-32/Vpos. | % | | | | | | | 14.64 | from % to mA |
| 24 | FM-6415 | 8575 | S-48/Massrate | kg/h | | | FIC-6415 | 14.64 | U-33/Cout | mA | 66.52 | Out by case |
| 25 | FIC-6415 | 8579 | U-33/Set point | kg/h | | | FIC-6415 | 8579 | U-33/Set point | kg/h | 8579 | SP by case |
| 26 | | 14.64 | U-33/Cout | mA | 66.52 | % | | | | | | |
| 27 | Btm. Level | | | | | | Btm. Level | | | | | |
| 28 | Mode | 1 | U-28/State | no unit | | | Mode | 1 | U-28/State | no unit | 1 | by case |
| 29 | LM-6401 | 1.30 | U-13/Calc. L1 | m | 65.22 | % | LIC-6401 | 17.73 | U-28/Cout | mA | 85.79 | from BP rate |
| 30 | LIC-6401 | 1.30 | U-28/Set point | m | 65.00 | % | LIC-6401 | 1.30 | U-28/Set point | m | 1.30 | from % to m |
| 31 | | 17.73 | U-28/Cout | mA | 85.79 | % | | | | % | 65.00 | SP by case |
| 32 | | | | | | | | | | | 17.73 | from % to mA |

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 5 | | | | LIC-6401 | | | | FIC-6415 | |
| 6 | | Unit | | % | | | | kg/h | |
| 7 | | PV | | 65.22 | | | | 8575 | |
| 8 | | LSP | | 65.00 | | | | 8579 | |
| 9 | | RSP | | 0 | | | | 8579 | |
| 10 | | FF | | 0 | | | | 0 | |
| 11 | | | | | | | | | |
| 25 | | | | | | | | | |
| 26 | | OUT | | 85.79 | | | | 66.52 | |
| 27 | | | | | | | | | |
| 28 | | | | | | | | | |
| 29 | | Unit | | % | | | | % | |
| 30 | | MODE | | L | | | | R | |
| 31 | | Gain | | 2 | | | | 0.1 | |
| 32 | | TI | | 1 | h | | | 50 | s |
| 33 | | Set Mode | | L | | | | R | |
| 34 | | Set LSP | | 65.00 | | | | 8583 | |
| 35 | | Set Out | | 85.75 | | | | 66.46 | |

| Local / Remote | L / R | M | |
|---|---|---|---|
| | | L | M |
| Local | | | |
| SP | OP | PV | PV |
| Out | PID | TR | TR |
| Remote | | | |
| SP | RSP | OP | PV |
| Out | PID | PID | OP |

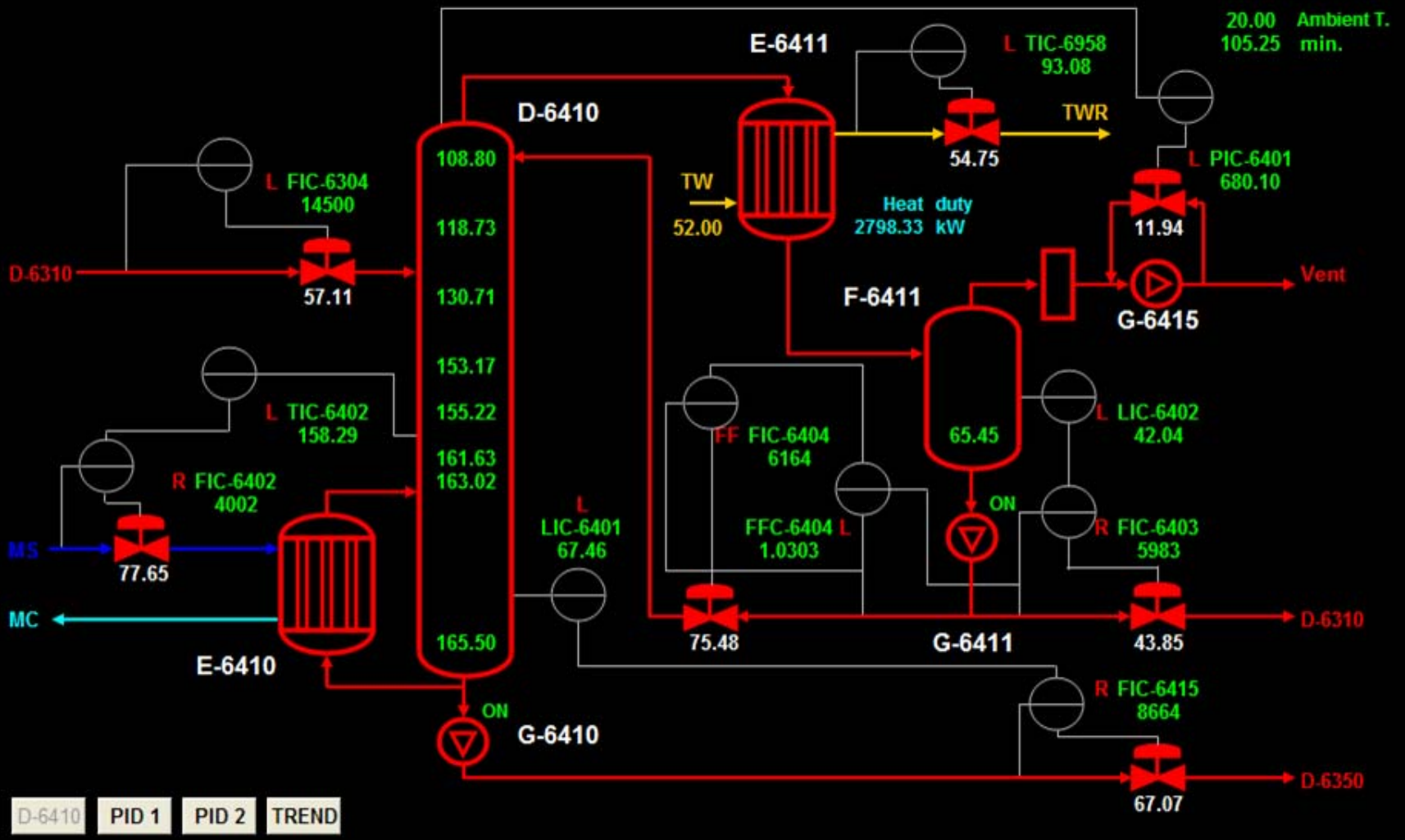
L32 =L29*0.16+4

L31 =IF(PID_1!D30="L",PID_1!D34,PID_1!D7)

L30 =(B122-B121)*(L31-B121)/100

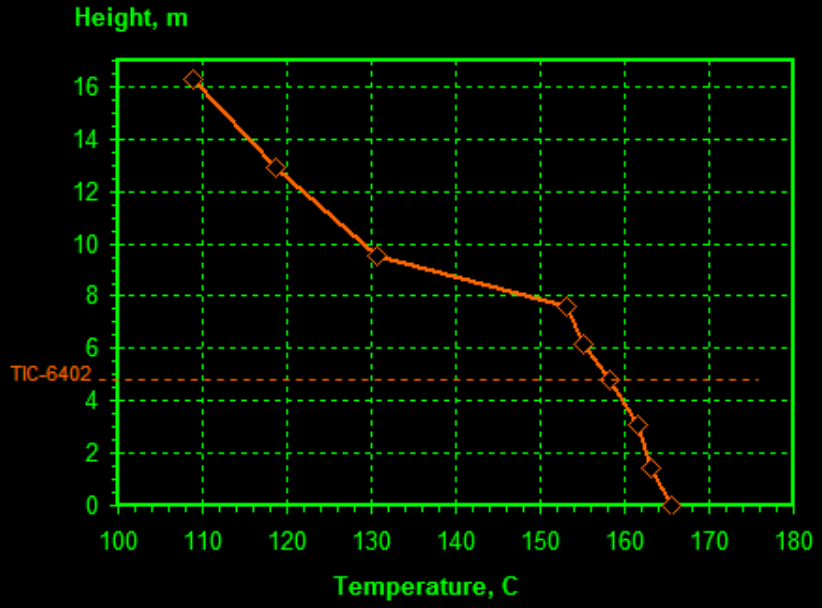
L29 =IF(PID_1!D33="M",PID_1!D35,PID_1!D26)

L28 =IF(PID_1!D33="M",0,1)

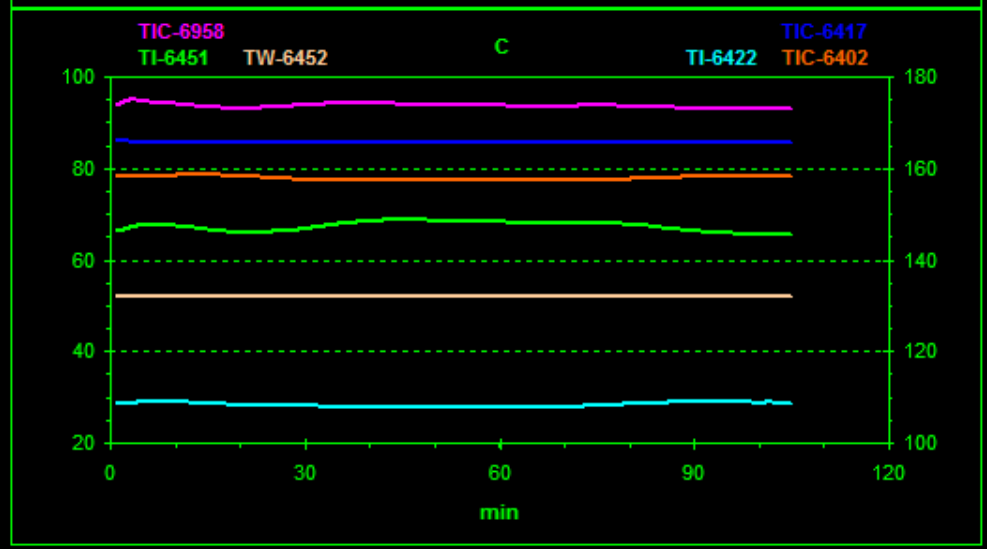

NOR-PAR ONLINE
TRAINING SIMULATOR
E-6411
L TIC-6958
93.08
20.00 Ambient T.
105.25 min.
D-6410
TWR
54.75
L PIC-6401
680.10
11.94
L FIC-6304
14500
TW
52.00
Heat duty
2798.33 kW
D-6310
57.11
108.80
118.73
130.71
153.17
155.22
161.63
163.02
165.50
F-6411
G-6415
Vent
L TIC-6402
158.29
R FIC-6402
4002
MS
77.65
MC
E-6410
L
LIC-6401
67.46
FF FIC-6404
6164
FFC-6404 L
1.0303
65.45
ON
L LIC-6402
42.04
R FIC-6403
5983
75.48
G-6411
43.85
D-6310
R FIC-6415
8664
ON
G-6410
67.07
D-6350
D-6410
PID 1
PID 2
TREND


LIC-6401 FIC-6415 TIC-6402 FIC-6402 LIC-6402 FIC-6403 FFC-6404 FIC-6404
Unit % kg/h grad C kg/h % kg/h ratio kg/h
PV 67.46 8664 158.29 4002 42.04 5983 1.0303 6164
LSP 65.00 8738 158.00 4001 45.00 5977 1.0100 6040
RSP 0 8738 0 4001 0 5977 0 0
FF 0 0 0 0 0 0 0 6042
Codes
FF
R
L
M
OUT 87.38 67.08 72.74 77.65 66.41 43.84 75.53 75.42
Unit % % % % % % % %
MODE L R L R L R L FF
Gain 2 0.15 10 0.1 1 0.5 0.15
TI 1 h 50 s 40 m 5 s 30 m 10 s 10 s
Set Mode L R L R L R L FF
Set LSP 65.00 8583 158.00 3948 45.00 5920 1.0100 6039
Set Out 86.64 66.46 72.77 76.46 66.47 42.67 77.05 68.69
Set Gain 2 0.15 10 0.1 1 0.5 0.15
Set TI 1 h 50 s 40 m 5 s 30 m 10 s 10 s
Min 0 0 0 0 0 0 0 0
Max 100 10000 200 5500 100 9000 2 8000
D-6410 PID 1 PID 2 TREND

## D-6410 Temperature Profile



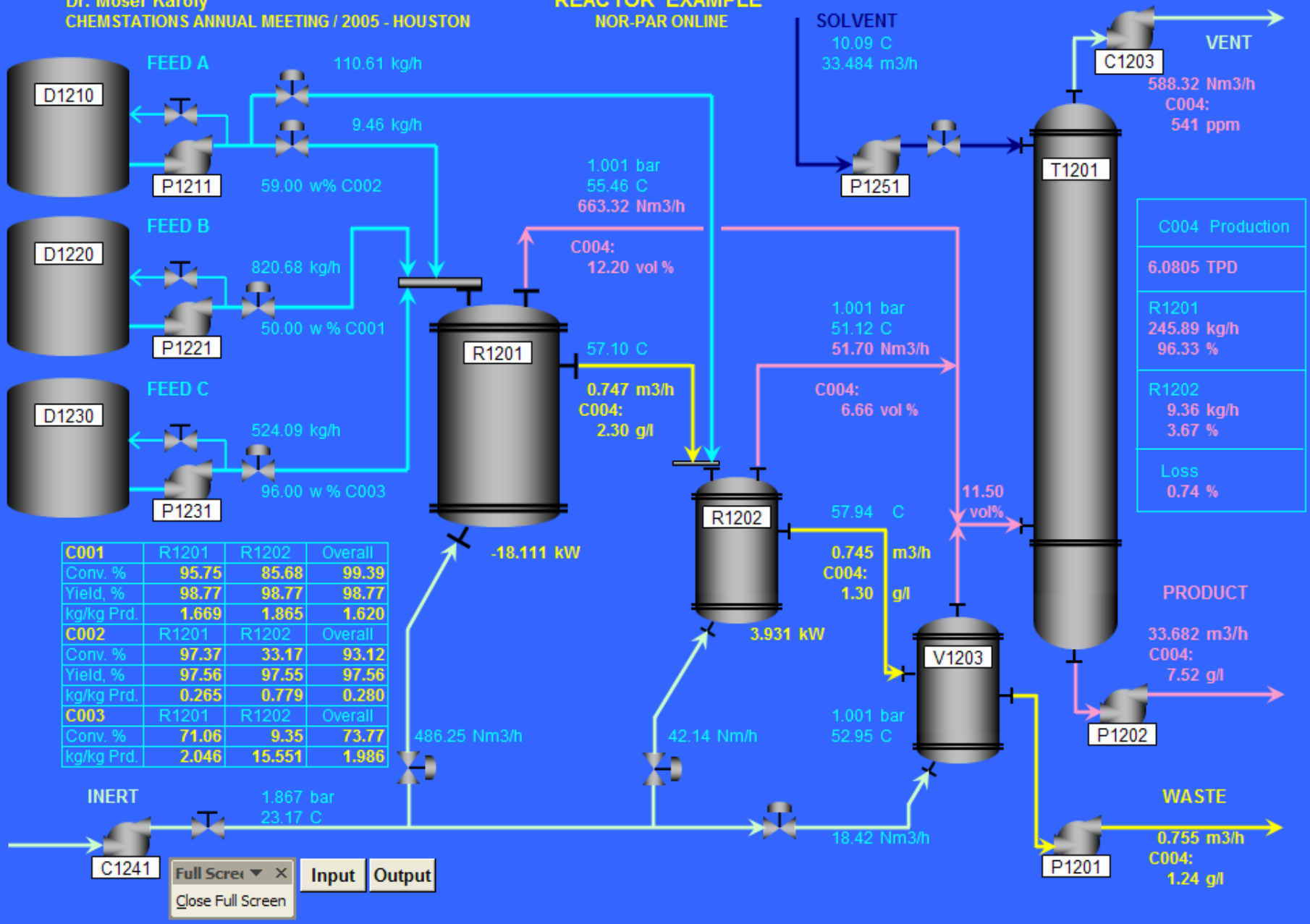

| T, C | H, m |
|---|---|
| 108.80 | 16.287 |
| 118.73 | 12.917 |
| 130.71 | 9.548 |
| 153.17 | 7.582 |
| 155.22 | 6.178 |
| 158.29 | 4.774 |
| 161.63 | 3.089 |
| 163.02 | 1.404 |
| 165.50 | 0.000 |

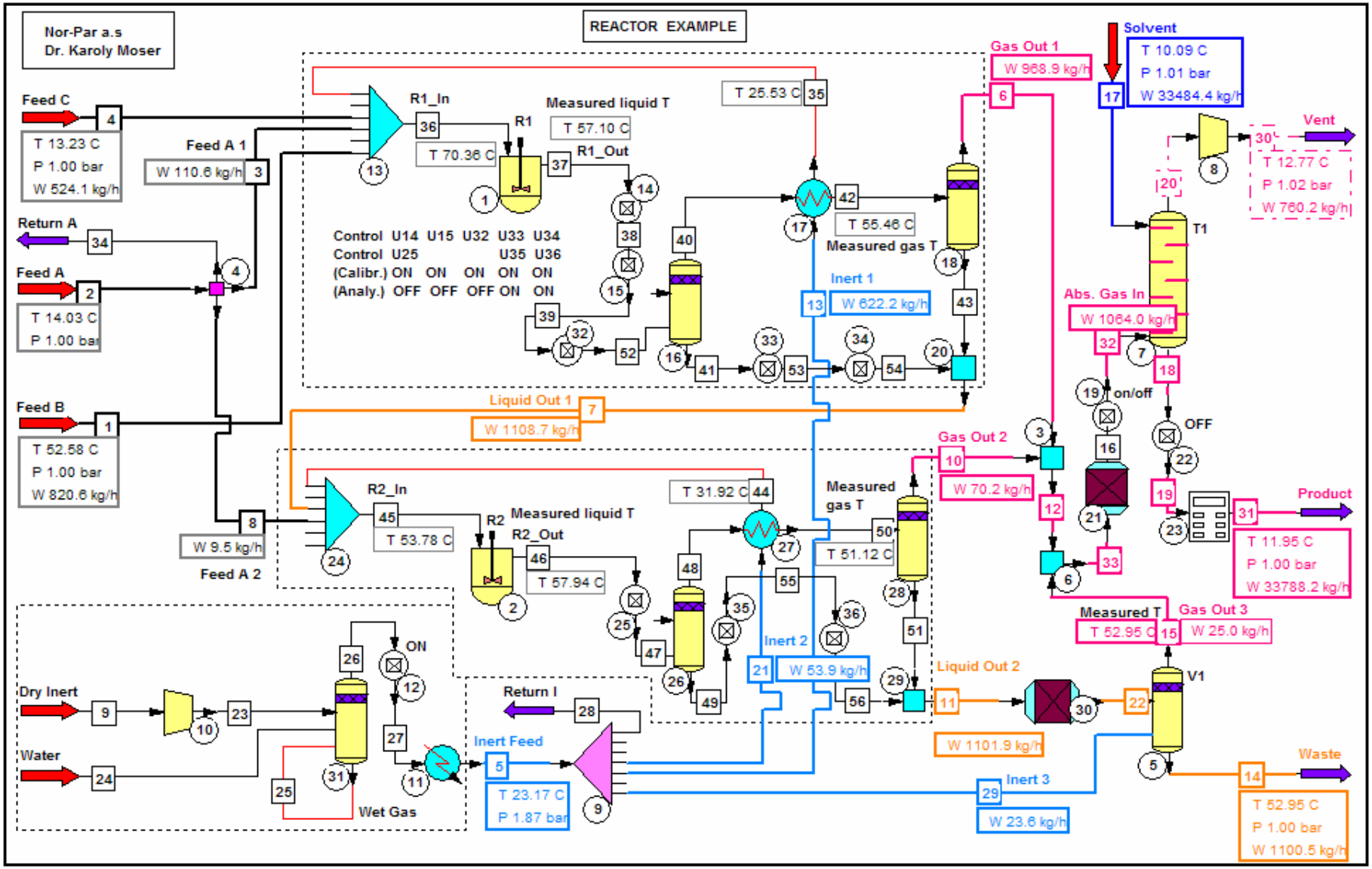




| Time | FIC-6304 | FIC-6404 | FIC-6403 | FIC-6415 | FIC-6402 | TIC-6402 | TIC-6958 | TI-6451 | TI-6422 | TIC-6417 | TW-6452 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 105.25 | 14500 | 6164 | 5983 | 8664 | 4002 | 158.29 | 93.08 | 65.45 | 108.80 | 165.50 | 52.00 |

D-6410 | PID 1 | PID 2 | TREND

# Thank You


Dr. Moser Karoly
CHEMSTATIONS ANNUAL MEETING / 2005 - HOUSTON
REACTOR EXAMPLE
NOR-PAR ONLINE
SOLVENT
10.09 C
33.484 m3/h
P1251
T1201
C1203
VENT
588.32 Nm3/h
C004:
541 ppm
FEED A
110.61 kg/h
D1210
9.46 kg/h
P1211
59.00 w% C002
FEED B
D1220
820.68 kg/h
P1221
50.00 w % C001
FEED C
D1230
524.09 kg/h
P1231
96.00 w % C003
1.001 bar
55.46 C
663.32 Nm3/h
C004:
12.20 vol %
R1201
57.10 C
0.747 m3/h
C004:
2.30 g/l
-18.111 kW
1.001 bar
51.12 C
51.70 Nm3/h
C004:
6.66 vol %
R1202
57.94 C
0.745 m3/h
C004:
1.30 g/l
3.931 kW
11.50
vol%
V1203
1.001 bar
52.95 C
C004 Production
6.0805 TPD
R1201
245.89 kg/h
96.33 %
R1202
9.36 kg/h
3.67 %
Loss
0.74 %
PRODUCT
33.682 m3/h
C004:
7.52 g/l
P1202
C001 | R1201 | R1202 | Overall
Conv. % | 95.75 | 85.68 | 99.39
Yield, % | 98.77 | 98.77 | 98.77
kg/kg Prd. | 1.669 | 1.865 | 1.620
C002 | R1201 | R1202 | Overall
Conv. % | 97.37 | 33.17 | 93.12
Yield, % | 97.56 | 97.55 | 97.56
kg/kg Prd. | 0.265 | 0.779 | 0.280
C003 | R1201 | R1202 | Overall
Conv. % | 71.06 | 9.35 | 73.77
kg/kg Prd. | 2.046 | 15.551 | 1.986
486.25 Nm3/h
42.14 Nm/h
INERT
1.867 bar
23.17 C
C1241
18.42 Nm3/h
WASTE
0.755 m3/h
C004:
1.24 g/l
P1201
Full Scre
Close Full Screen
Input
Output


Nor-Par a.s
Dr. Karoly Moser
REACTOR EXAMPLE
Feed C
T 13.23 C
P 1.00 bar
W 524.1 kg/h
Feed A 1
W 110.6 kg/h
Return A
Feed A
T 14.03 C
P 1.00 bar
Feed B
T 52.58 C
P 1.00 bar
W 820.6 kg/h
W 9.5 kg/h
Feed A 2
R1_In
R1
Measured liquid T
T 57.10 C
T 70.36 C
R1_Out
T 25.53 C
Control U14 U15 U32 U33 U34
Control U25 U35 U36
(Calibr.) ON ON ON ON ON
(Analy.) OFF OFF OFF ON ON
T 55.46 C
Measured gas T
Inert 1
W 622.2 kg/h
Liquid Out 1
W 1108.7 kg/h
R2_In
T 53.78 C
R2
Measured liquid T
R2_Out
T 57.94 C
T 31.92 C
Measured gas T
T 51.12 C
Inert 2
W 53.9 kg/h
Gas Out 1
W 968.9 kg/h
Gas Out 2
W 70.2 kg/h
Solvent
T 10.09 C
P 1.01 bar
W 33484.4 kg/h
Vent
T 12.77 C
P 1.02 bar
W 760.2 kg/h
T1
Abs. Gas In
W 1064.0 kg/h
on/off
OFF
Product
T 11.95 C
P 1.00 bar
W 33788.2 kg/h
Measured T
T 52.95 C
Gas Out 3
W 25.0 kg/h
V1
Liquid Out 2
W 1101.9 kg/h
Waste
T 52.95 C
P 1.00 bar
W 1100.5 kg/h
Dry Inert
Water
ON
Return I
Inert Feed
T 23.17 C
P 1.87 bar
Wet Gas
Inert 3
W 23.6 kg/h