Dynamic Simulation of Depropanizer

Objectives

- To introduce basic concepts in dynamic simulation in HYSYS such as pressure-flow specification, control system, integrator, and strip chart
- To illustrate different modelling requirements in dynamic vs. steady-state
- To highlight different strategies to model the unit operations i.e. low vs. high fidelity
- To highlight various modelling assumptions, simplifications, and limitations
- To introduce some of best practices to build robust, fit-for-purpose dynamic simulation models

Activities

Lesson 0:

- Build steady state model
- Perform simple steady-state analyses using Spreadsheet and Case Studies

Lesson 1:

- Convert steady state case to dynamic model
- Setup integrator and add strip charts
- Introduce disturbances and monitor the control response

Lesson 2:

- Convert depropanizer column steady state case (pre-built model) to dynamic
- Merge with the model built in Lesson 1

Lesson 3:

- Incorporate pump curves to increase the modelling fidelity
- Use pump speed control instead of control valve to control separator level

Lesson 4:

- Investigate overpressure protection system at the separator
- Automate scenarios using Event Scheduler

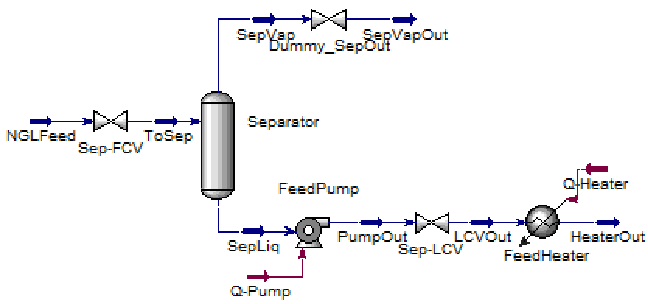
Solution Files

Lesson	HYSYS file	HYSYS Ver.
0	Lesson0-SS.hsc Lesson0-Exercise1.hsc	9.0
1	Lesson1-SS.hsc Lesson1-Dyn.hsc Lesson1-Exercise1-start.hsc Lesson1-Exercise1-end.hsc Lesson1-Exercise2-start.hsc Lesson1-Exercise2-end.hsc	8.8
2	Lesson1-Dyn.hfl (***template from Lesson 1***) Lesson2-SS.hsc (***starter case***) Lesson2-Dyn.hsc Lesson2-Exercise1-start.hsc Lesson2-Exercise1-end.hsc Lesson2-Exercise2-start.hsc Lesson2-Exercise2-end.hsc	8.8
3	Lesson3-Exercise1.hsc Lesson3-Exercise2.hsc	8.8
4	Lesson4-Dyn.hsc Lesson4-Exercise1-start.hsc Lesson4-Exercise1-end.hsc	9.0

Lesson 0: Build steady state model

Introduction

In this section, we will be building a small process section upstream of the depropanizer. This model contains the equipment to condition the NGL feed to the required operating pressure and temperature, before it is routed to the depropanizer column. The heat and material balance for this steady state case is shown below.



Material Streams									
		NGLFeed	ToSep	SepLiq	SepVap	SepVapOut	PumpOut	LCVOut	HeaterOut
Vapour Fraction		0.0000	0.0878	0.0000	1.0000	1.0000	0.0000	0.0000	0.0000
Temperature	C	15.00	4.018	4.018	4.018	3.828	5.185	5.260	50.00
Pressure	kPa	600.0	250.0	250.0	250.0	240.0	2150	1950	1900
Molar Flow	kgmole/h	984.7	984.7	898.3	86.49	86.49	898.3	898.3	898.3
Mass Flow	kg/h	6.000e+004	6.000e+004	5.603e+004	3971	3971	5.603e+004	5.603e+004	5.603e+004
Liquid Volume Flow	m3/h	102.7	102.7	94.92	7.739	7.739	94.92	94.92	94.92
Heat Flow	kJ/h	-1.518e+008	-1.518e+008	-1.424e+008	-9.455e+006	-9.455e+006	-1.421e+008	-1.421e+008	-1.362e+008

Add fluid package

Create a new HYSYS case and save as "***Lesson0-SS.hsc***" in your working folder.

1. We are now in Properties environment. Add a new component list (***Component Lists>Add>HYSYS***).

2. Add the following components:

Component	Type	Group
Ethane	Pure Component	
Propane	Pure Component	
i-Butane	Pure Component	
n-Butane	Pure Component	
i-Pentane	Pure Component	
n-Pentane	Pure Component	
n-Hexane	Pure Component	

3. Select Peng-Robinson fluid package (***Fluid Packages>Add>HYSYS>Peng-Robinson***).

Select unit of measurements and dynamic options

1. Enter the Simulation environment. Set the units to be used in this session to SI (***Home>Units***).
2. We are going to disable the dynamic assistant for this session by unchecking this option: ***File>Options>Simulation>Dynamics Assistant>Perform Checks when Switching to Dynamics or Starting the Integrator***

Build steady state case

Invoke the Model Palatte if it is not already open (***View>Model Pallate***). Build steady state case using the specifications in the following table. The typical navigation required for this session are given below. Don't forget to periodically save the case!

1. Add new stream/equipment
   - Open View tab and select ***Model Pallate***. Drag and drop selected object into the flowsheet area
2. Material stream
   - To specify pressure/temperature/composition: Double click object and go to ***Worksheets***
3. Valve
   - To specify delta P/Cv: Double click object and go to ***Rating/Sizing***
4. Heater
   - To add associated energy stream: Double click object and go to ***Design>Connections>Energy***
   - To specify pressure drop: Double click object and go to ***Design>Parameters***
5. Pump
   - To add associated energy stream: Double click object and go to ***Design>Connections>Energy***
   - To specify pressure increase: Double click object and go to ***Design>Parameters***

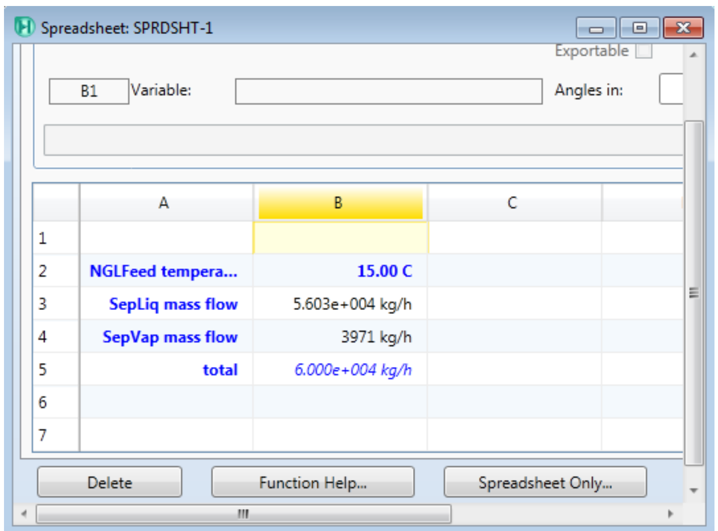
Object name	Specifications
NGLFeed	• Temperature: 15 ^{o}C • Pressure: 600 kPa • Mass flow: 60,000 kg/h (can just type 6e4) • Composition: Mole Fractions Ethane: 0.0100 Propane: 0.4300 i-Butane: 0.0700 n-Butane: 0.1200 i-Pentane: 0.0500 n-Pentane: 0.0400 n-Hexane: 0.2800
Sep-FCV	• Delta P: 350 kPa
Separator	• None
Dummy_SepOut	• Delta P: 10 kPa
FeedPump	• Energy stream: Q-Pump • Adiabatic efficiency: 75 kPa • Delta P: 1900 kPa
Sep-LCV	• Delta P: 200 kPa
FeedHeater	• Delta P: 50 kPa
HeaterOut	• Energy stream: Q-Heater • Temperature: 50 ^{o}C

Exercise 1

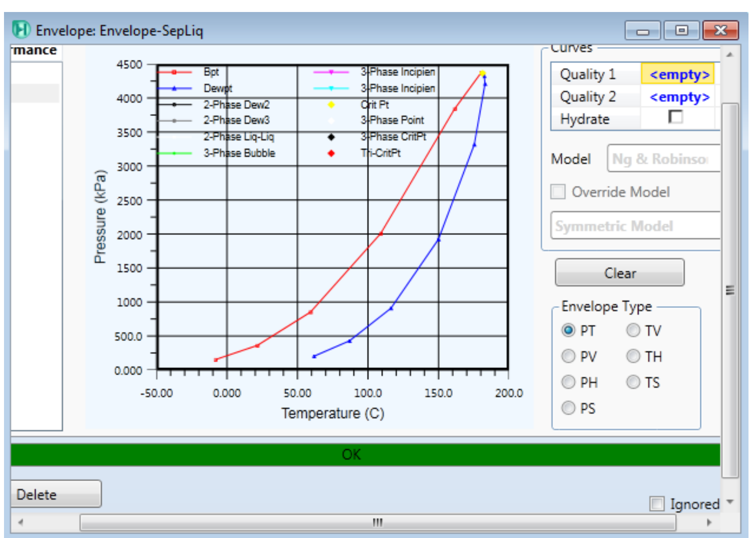
1. Add a spreadsheet (***View>Model Pallate>Common>Spreadsheet***). Copy and paste the following variables into the spreadsheet:

- Temperature from NGLFeed stream
- Mass flow from SepLiq stream
- Mass flow from SepVap stream

Then, compute the total mass flows in the spreadsheet (e.g. below; in cell B5 type "=B3+B4")

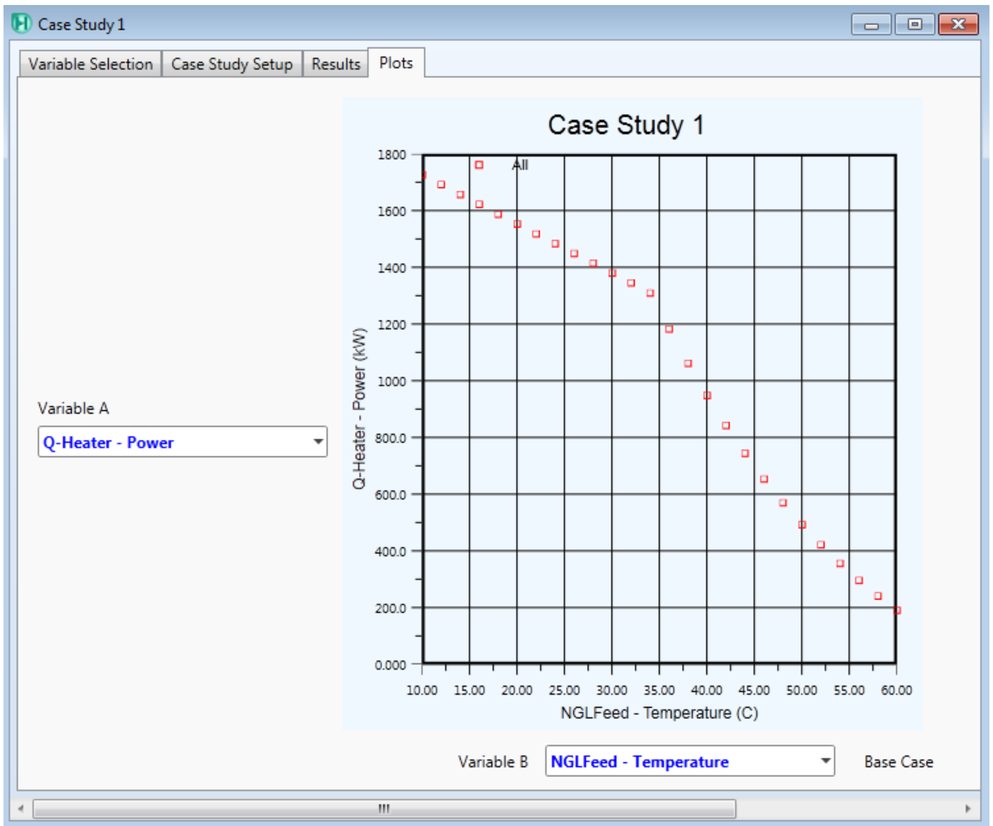


2. Add a phase envelope for SepLiq stream. To do this, double click the stream and go to ***Attachments>Analysis>Create>Envelope>Add>Performance>Plots***



3. Use Case Studies feature to change the NGLFeed temperature from 10^{o}C to 12^{o}C, 14^{o}C, ……. , 58^{o}C, 60^{o}C and monitor the following variables:

- Mass flow of SepLiq
- Mass flow of SepVap
- Power of Q-Heater



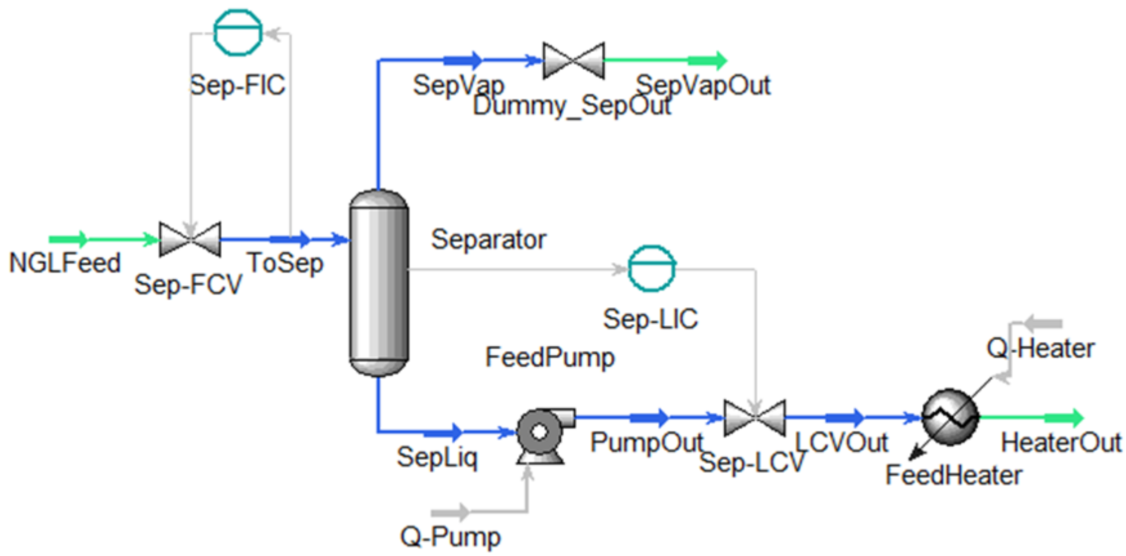
Questions

1. In the spreadsheet, change the NGLFeed temperature from 15^{o}C to 30^{o}C. Explain any changes observed in the mass flow and phase envelope of the SepLiq stream.
2. Export the results from the Case Studies into Excel and plot all the graphs.

Lesson 1: Migrate to dynamic model

Introduction

We will now use the previous steady state case and convert it to dynamic mode.



Prepare for dynamic mode

1. Save the previous steady state case as "**Lesson1-SS.hsc**". Then, save it as "**Lesson1-Dyn.hsc**"
2. Size the control valves Sep-FCV and Sep-LCV by clicking Size Valve in ***Rating>Sizing***. This will calculate and assign the valves' Cv using the current flow conditions at 50% opening.
3. Dummy_SepOut valve is just a fake valve used to introduce pressure-flow equation around the separator. Hence simple conductance k is used (instead of the rigorous Cv value) and set to be a large value to minimise pressure drop. To do this, in ***Rating>Sizing>Sizing Methods***, change the sizing method to "Simple resistance equation". Set conductance k=10,000.
4. Other changes to be made in the Dynamics tab for each equipment/streams (including the ones above) are summarised below:

Strea/Equipment	Dynamic specifications
NGLFeed	• Activate pressure spec (=600 kPa), deactivate spec mass flow spec
Sep-FCV	• Cv: 96.18 USGPM (calculated using "Size Valve")
Separator	• Vessel volume: 10 m^3

Dummy_SepOut	• Conductance (k): 10, 000
FeedPump	• Efficiency: 75 kPa • Delta P: 1900 kPa
Sep-LCV	• Cv: 117 USGPM (calculated using "Size Valve")
FeedHeater	• Select outlet temperature specification (***Dynamics>Specs>Model Details>Product Temp Spec***) and specify the product temperature to 50 ^{0}C • Activate flow conductance specification (***Dynamics>Specs>Dynamic Specifications>Overall k*****).** Its value should already be calculated as 321.3.
HeaterOut and SepVapOut	• Activate pressure spec (HeaterOut=1900 kPa, SepVapOut=240 kPa)

Add PID controllers

Add Sep-FIC and Sep-LIC controllers (***View>Model Pallate>Dynamics>PID Controller***) with the following parameters:

Controller	Information
Sep-FIC	• Connection: PV: ToSep mass flow, OP: Sep-FCV actuator desired position • Action: Reverse • PV range: 0 kg/h to 150,000 kg/h • Tuning: Kc=0.2, Ti=0.2 min • Mode: Manual
Sep-LIC	• Connection: PV: Separator Liquid Percent Level, OP: Sep-LCV Actuator Desired Position • Action: Direct • PV range: 0% to 100% • Tuning: Kc=1, Ti=3 min • Mode: Manual

Change PFD colour scheme

Change the colour scheme in the drop-down menu in ***Flowsheet/Modify>Conditional Formatting*** to “Dynamic P/F Specs”. Note the change in colour for the boundary streams.

Enter dynamic mode

1. Open the integrator (***Dynamics>Integrator or Ctrl+I***). Set the step size to 0.5 sec.
2. Activate the Dynamic Mode (***Dynamics>Dynamic Simulation>Dynamics Mode***).
3. Run the model (***Dynamics>Run***). Check that it is running fine by monitoring the integrator.
4. Stop the integrator and save the case.

NOTE: This is a rather tricky step – sometimes the dynamic initialisation may fail. If this happens: (a) try to go back to steady state mode, (b) make sure it runs OK in steady state mode (you have to re-activate the steady state solver in Home tab), and (c) re-enter dynamic mode.

Change controller mode from Manual to Auto

1. Change Sep-LIC controller mode to Auto, with SP=50%. Run the case, and wait until the separator level stabilises.
2. Change Sep-FIC controller mode to Auto, with SP=60,000 kg/h. Run the case, and wait until the flow stabilises.
3. Stop the integrator and save the case.

Add a strip chart

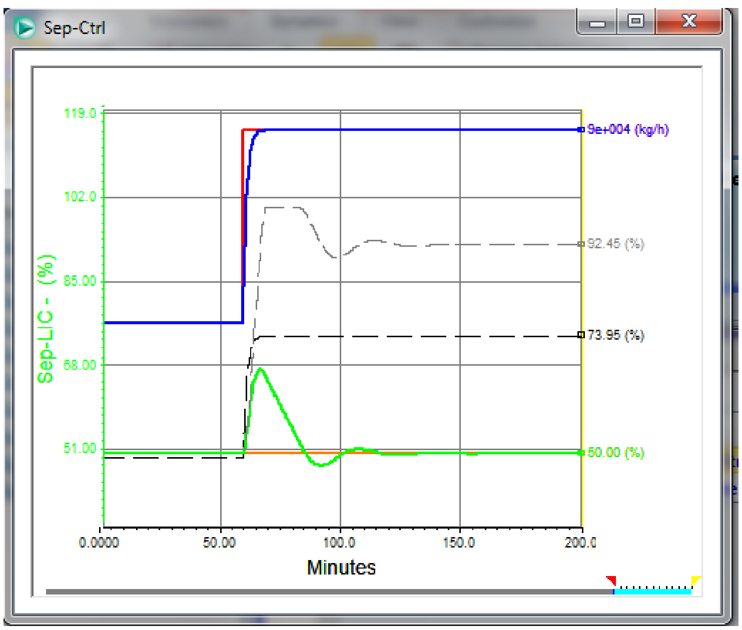
1. Add a new strip chart (***Dynamics>Tools>Strip Charts>Add***). Change its properties as following:
   - Name: Sep-Ctrl
   - Logger size: 10000
   - Sample interval: 1 sec
2. Click Edit, and add the following Sep-FIC and Sep-LIC variables: SP, PV and OP.
3. Click Display. Run the case and check that the strip chart is displaying the variables we’ve added.
4. Save the case.

Exercise 1

1. Open "**Lesson1-Dyn.hsc**". Run the case and make sure it already reaches its steady state conditions. One way to check this is to look at PV – at steady state, PV=SP. Then, save it as "**Lesson1-Exercise1-start.hsc**".
2. Run the case and change the feed mass flow by changing the Sep-FIC set point from 60,000 kg/h to 90,000 kg/h. Wait until the system to stabilise.
3. Save the case as "**Lesson1-Exercise1-end.hsc**"

Questions:

1. What is the maximum level deviation from its set point? How long does it take until the set point is recovered?
2. Look at the opening of Sep-LCV. Is there any issue with this? (Hint: check what is the typical controllability range of control valves)

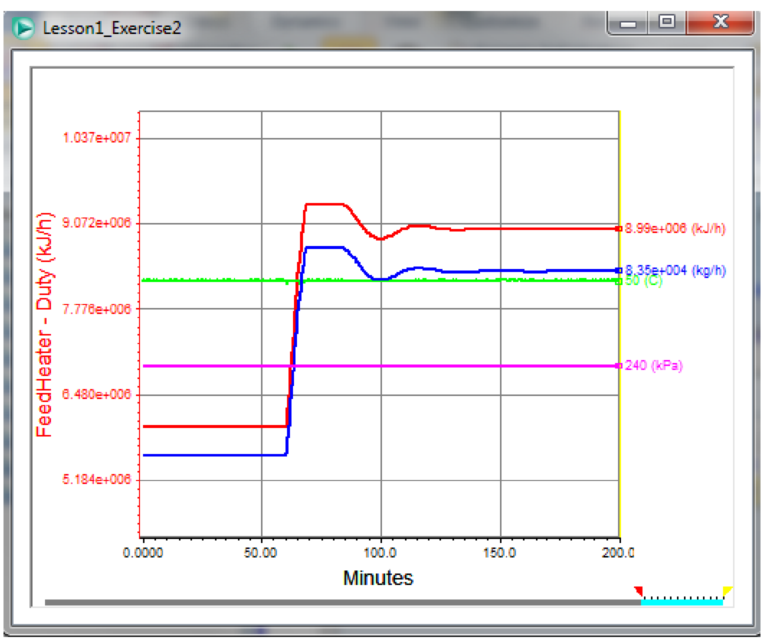


Exercise 2

1. Open "**Lesson1-Dyn.hsc**".
2. Add a new strip chart with the following variables:
   - Object: FeedHeater, Variable: Duty
   - Object: HeaterOut, Variable: Temperature, mass flow
   - Object: Separator, Variable: Vessel pressure
3. Save it as "**Lesson1-Exercise2-start.hsc**"
4. Run the case. Repeat the disturbance introduced in Exercise 1 i.e. change the feed mass flow by changing the Sep-FIC set point from 60,000 kg/h to 90,000 kg/h. Wait until the system to stabilise.
5. Save it as "**Lesson1-Exercise2-end.hsc**"

Questions:

1. How does the separator pressure look like?
2. How does the heater outlet temperature look like?
3. Why the heater duty follows exactly the same dynamic response as the flow through the heater?
4. Are these modelling assumptions/strategies valid? If not, what else can be done to improve the model?

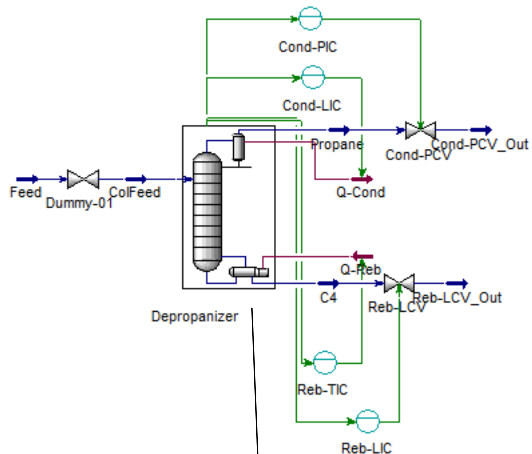


Lesson 2: Merge two simulation cases into one

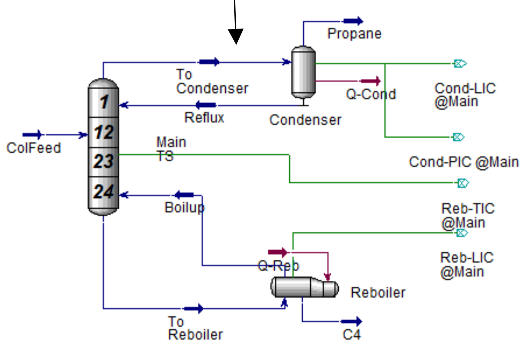
Introduction

In this section, we will convert a depropanizer column steady state model to dynamic using a feature in HYSYS called Dynamics Assistant. More advanced operations such as importing/exporting PFDs will also be explored.

The steady state model is shown below:



Material Streams							
		Feed	Propane	C4	Cond-PCV_Out	Reb-LCV_Out	ColFeed
Vapour Fraction		0.0000	1.0000	0.0000	1.0000	0.2227	0.0000
Temperature	C	50.00	52.23	158.9	47.28	144.4	50.00
Pressure	kPa	1900	1890	1910	1600	1400	1900
Molar Flow	kgmole/h	826.3	378.1	448.2	378.1	448.2	826.3
Mass Flow	kg/h	5.000e+004	1.625e+004	3.375e+004	1.625e+004	3.375e+004	5.000e+004
Liquid Volume Flow	m3/h	86.27	33.08	53.19	33.08	53.19	86.27
Heat Flow	kJ/h	-1.225e+008	-3.897e+007	-6.844e+007	-3.897e+007	-6.844e+007	-1.225e+008



Material Streams								
		Reflux	To Condenser	Boilup	To Reboiler	Propane	C4	ColFeed
Vapour Fraction		0.0000	1.0000	1.0000	0.0000	1.0000	0.0000	0.0000
Temperature	C	52.23	56.26	158.9	144.2	52.23	158.9	50.00
Pressure	kPa	1890	1890	1910	1910	1890	1910	1900
Molar Flow	kgmole/h	756.1	1134	1344	1792	378.1	448.2	826.3
Mass Flow	kg/h	3.376e+004	5.001e+004	9.398e+004	1.277e+005	1.625e+004	3.375e+004	5.000e+004
Liquid Volume Flow	m3/h	66.86	99.94	152.0	205.2	33.08	53.19	86.27
Heat Flow	kJ/h	-8.935e+007	-1.186e+008	-1.758e+008	-2.690e+008	-3.897e+007	-6.844e+007	-1.225e+008

In this steady state model, most of the dynamic specifications have been defined, except for some of the parameters that were intentionally left out for this lesson – this will be fixed before we proceed into dynamic mode.

General setup

1. Open "**Lesson2_SS.hsc**".
2. Enter the Simulation environment. Set the units to be used in this session to SI (***Home>Units***).
3. We are going to disable the dynamic assistant for this session by unchecking this option: ***File>Options>Simulation>Dynamics Assistant>Perform Checks when Switching to Dynamics or Starting the Integrator***
4. Change the colour scheme in the drop-down menu in ***Flowsheet/Modify>Conditional Formatting*** to "Dynamic P/F Specs".

Check dynamic specification requirement using Dynamics Assistant

The model is currently in steady state mode and is not ready to be run in dynamic. Dynamics Assistant can help what specifications need to be made, although not all of them should be followed. *This feature should be used with care since it may override whatever values you have specified in the model.*

1. Activate the Dynamics Assistant (***Dynamics>Dynamic Simulation>Dynamics Assistant***). You will get the following message:

	Make changes
Disable stream flow specifications	✓
Enable stream pressure specifications	✓
Valves not sized	✓
Enable internal stream flow specifications	✓
Tray section pressure profile needs attention	✓

One can double each item and the specific stream/equipment that needs attention will be shown. For example, double-clicking "Disable stream flow specifications" will open the following:

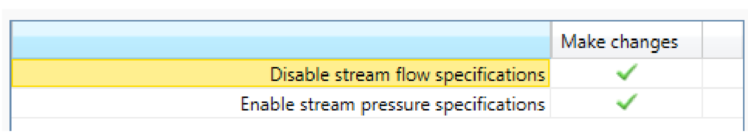
Remove flow specifications in these streams:

No.	Name	OK
0	Feed	☑

2. To address all the issues flagged by Dynamics Assistant, do the following changes:

Dynamics Assistant message	Action required
Disable stream flow specifications	We are going to ignore this message. Instead, deactivate pressure spec in “Feed” stream.
Enable stream pressure specifications	Activate pressure spec in “Cond-PCV_Out” and “Reb-LCV_Out” streams.
Valves not sized	In “Dummy-01” valve, select “Simple resistance equation” and specify k value as 10,000. (Note: Just click OK if there is a pop-up message “Unable to size valve….”)
Enable internal stream flow specifications	Activate molar flow spec in “Reflux” stream. To do this: • Double-click “Depropanizer” column and click “Column Environment…” located at the bottom of the window • Once you are in the column environment, double-click “Reflux” stream. The molar flow spec is located in the Dynamic tab
Tray section pressure profile needs attention	Set tray diameter to 3 metres (***Depropanizer>Rating>Towers>Diameter***)

Invoke Dynamics Assistant again. Verify that all the issues have been resolved, except for the following, which we will ignore:



Enter dynamic mode

1. Open the Integrator. Maintain the step size at 0.5 sec. Go to “Execution” tab and change “Composition and Flash Calculations” to 3.

2. Switch to dynamic mode. Open the strip charts. Run the case.

3. Note that all the controllers have been already set to Auto. Wait until the system stabilises to the following conditions:

Controllers	Set points
Reb-LIC	50%
Reb-TIC	135°C
Cond-PIC	1900 kPa
Cond-LIC	50%

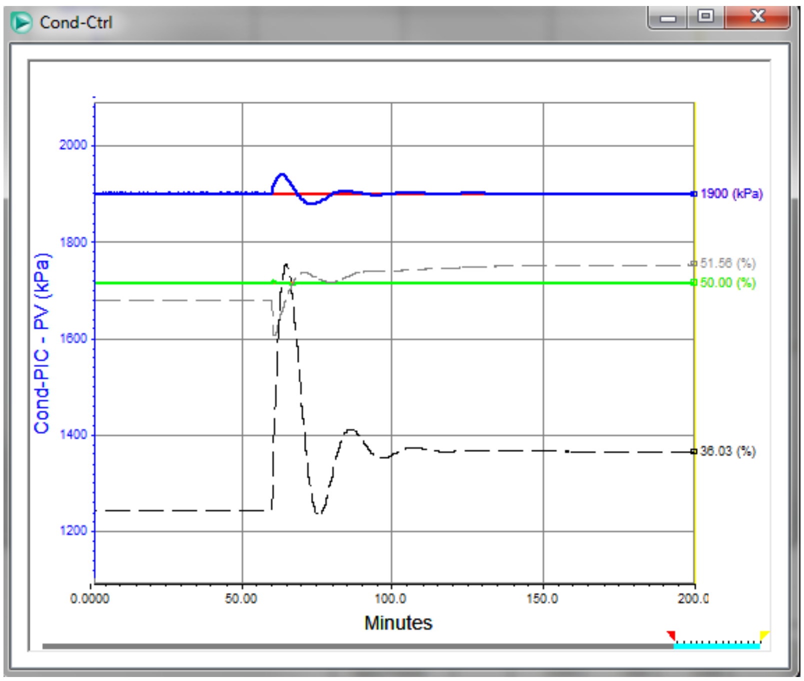
4. Save the case as “**Lesson2_Dyn.hsc**”.

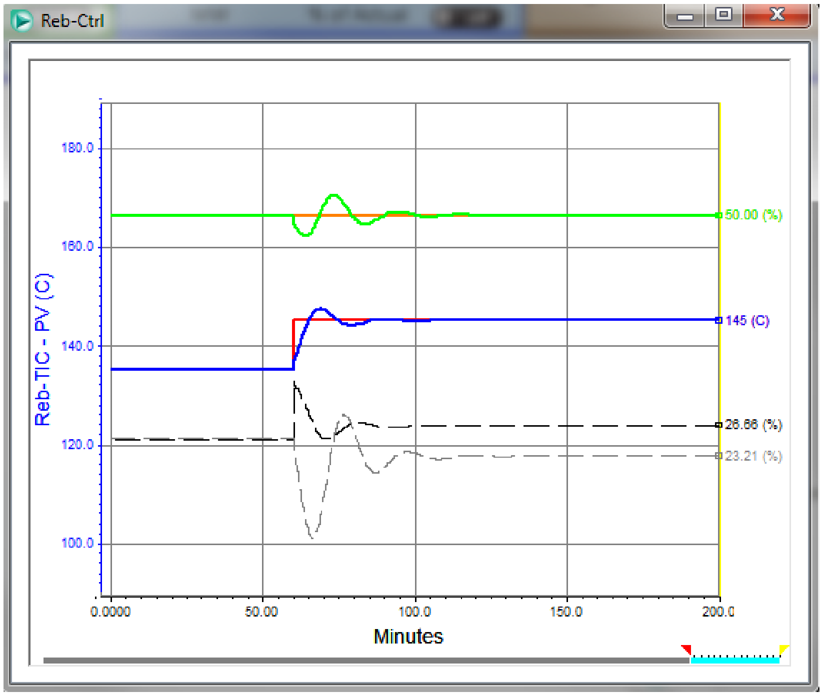
<u>Exercise 1</u>

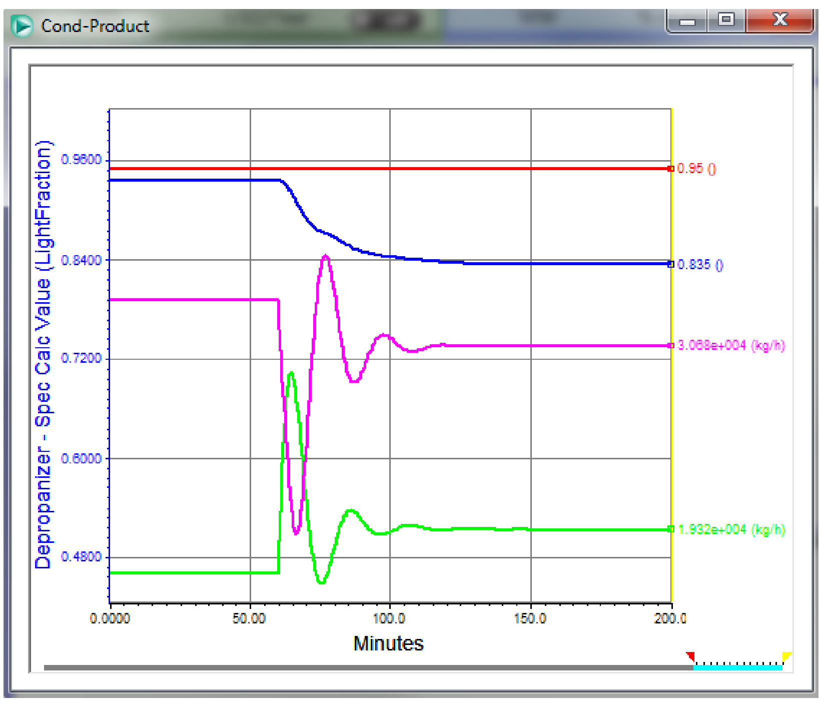
1. Open “**Lesson2-Dyn.hsc**”. Save it as “**Lesson2-Exercise1-start.hsc**”.
2. Change the Reb-TIC controller SP from 135°C to 145°C
3. Save the case as “**Lesson2-Exercise1-end.hsc**”

<u>Questions</u>

1. What is the effect of changing the reboiler temperature on the light components (ethane, methane) at the condenser gas outlet? How long does it take for the system to stabilise to a new steady state condition?
2. Explain the effects of changing the reboiler temperature on the other controllers?




Reb-Ctrl
180.0
160.0
140.0
120.0
100.0
Reb-TIC - PV (C)
50.00 (%)
145 (C)
26.66 (%)
23.21 (%)
0.0000
50.00
100.0
150.0
200.0
Minutes


Cond-Product
0.9600
0.8400
0.7200
0.6000
0.4800
Depropanizer - Spec Calc Value (LightFraction)
0.95 ()
0.835 ()
3.068e+004 (kg/h)
1.932e+004 (kg/h)
0.0000
50.00
100.0
150.0
200.0
Minutes

Exercise 2

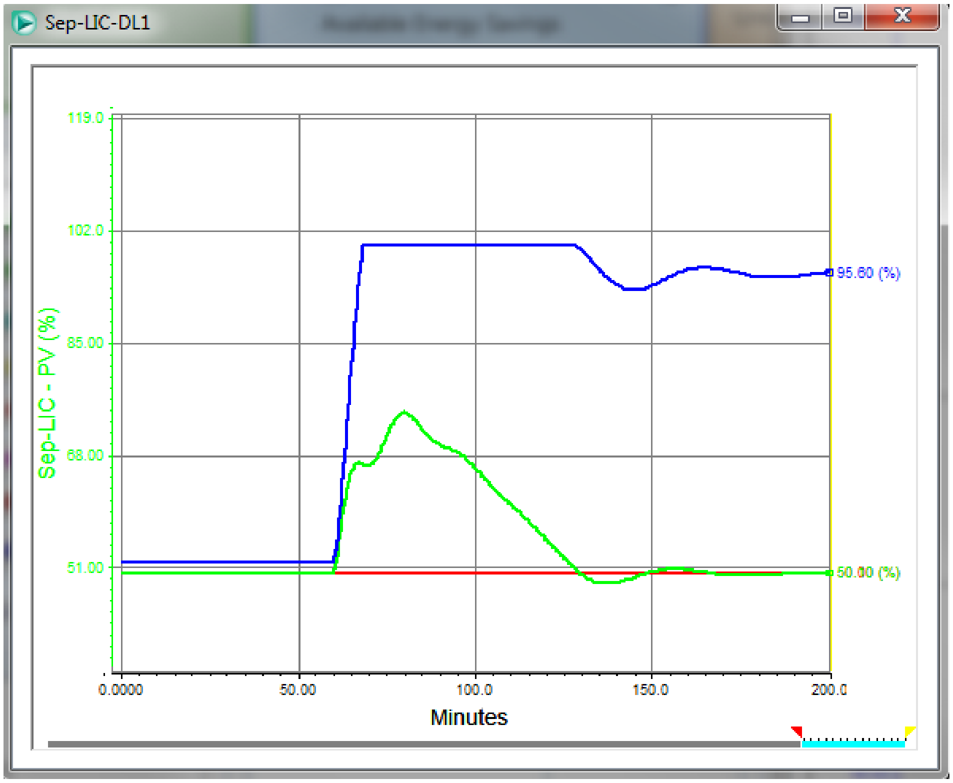
1. Open "**Lesson2-Dyn.hsc**".
2. Right-click in the PFD area, and select "Import from File". Browse and select the supplied template "Lesson1-Dyn.hfl". This template contains the dynamic model from Lesson 1.

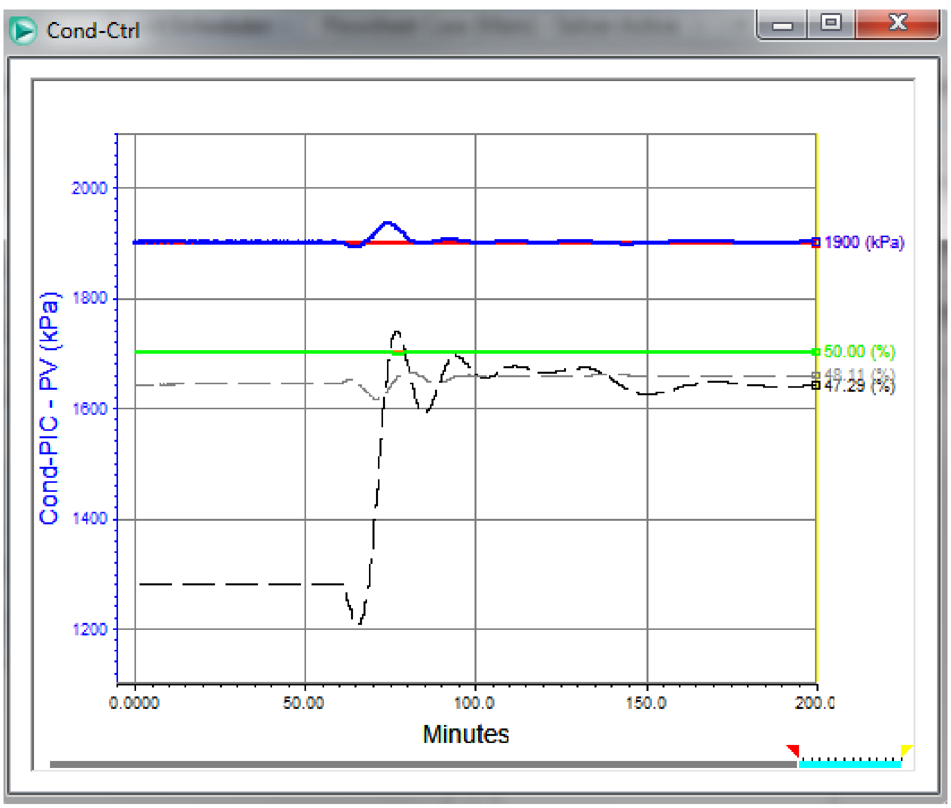
NOTE: sometimes the dynamic initialisation may fail when importing templates. If this happens, try closing the case and repeat steps 1 and 2.

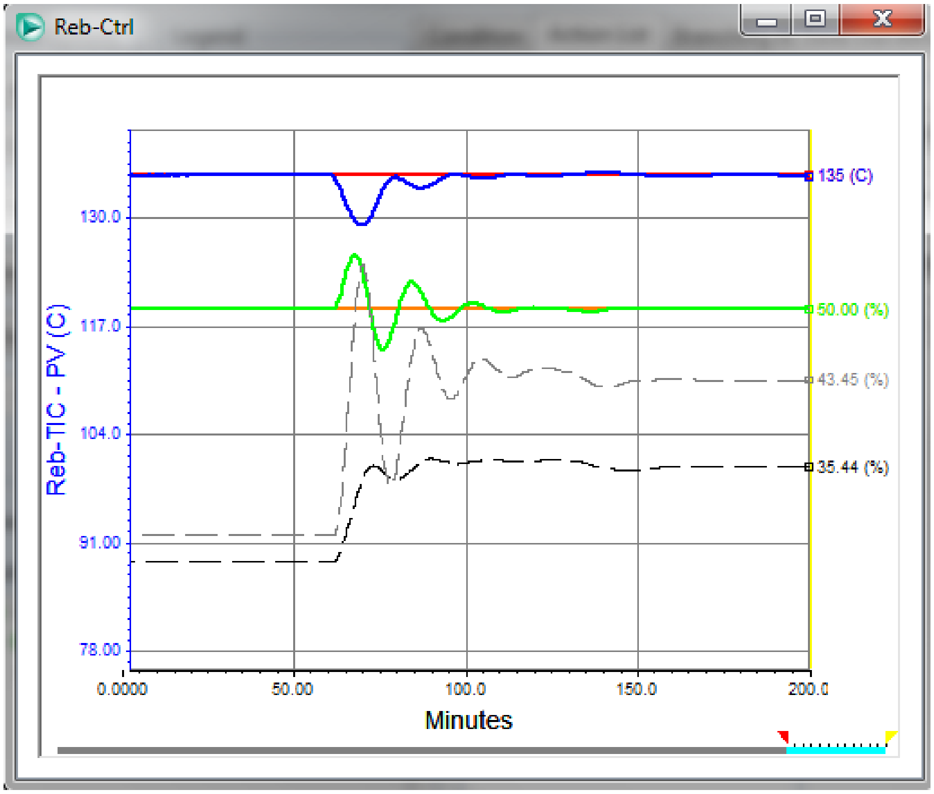
3. Merge the separate sections into one. To do this:
    - Delete "Feed" stream upstream of "Dummy-01" valve.
    - Connect "HeaterOut" stream to "Dummy-01" valve.
    - De-activate the pressure spec in "HeaterOut" stream.
4. Run the case and wait until it stabilises.
5. Add new strip charts to monitor Sep-FIC and Sep-LIC controllers.
6. Save the case as "**Lesson2-Exercise2-start.hsc**".
7. Introduce similar disturbance made in Exercise 1 of Lesson 1 i.e. change the Sep-FIC set point from 60,000 kg/h to 90,000 kg/h. Save the case as "**Lesson2-Exercise2-end.hsc**".

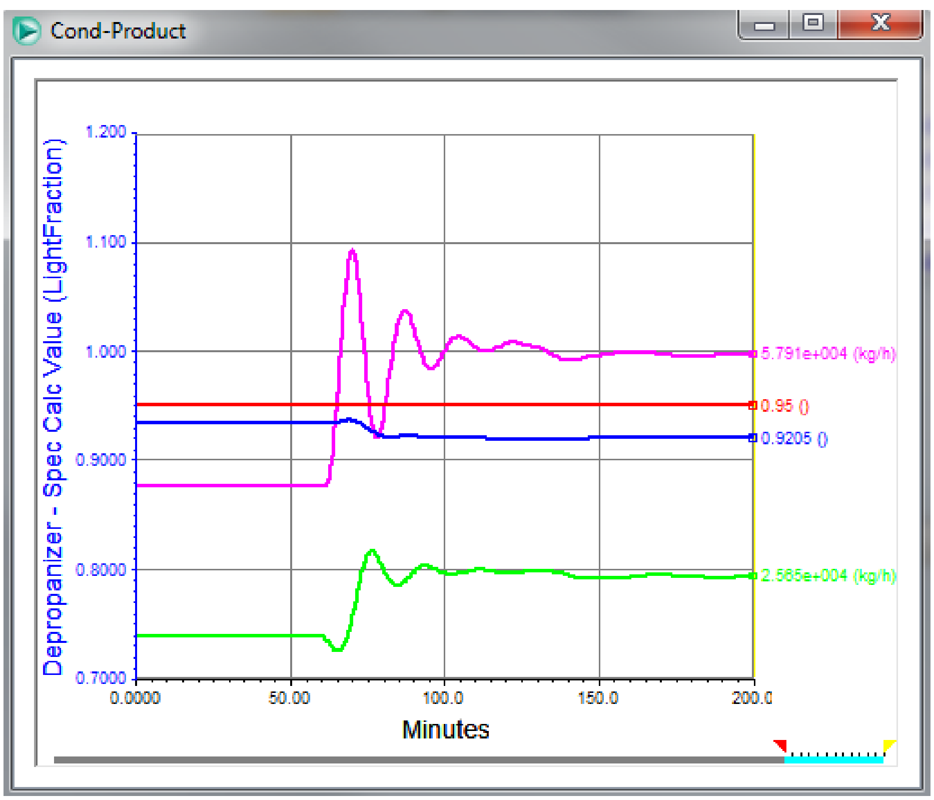
Questions

1. What are the main differences observed in Sep-LIC controller, compared to Exercise 1 in Lesson 1?


Sep-LIC-DL1
119.0
102.0
85.00
68.00
51.00
Sep-LIC - PV (%)
95.60 (%)
50.00 (%)
0.0000
50.00
100.0
150.0
200.0
Minutes


Cond-Ctrl
2000
1800
1600
1400
1200
Cond-PIC - PV (kPa)
1900 (kPa)
50.00 (%)
48.11 (%)
47.29 (%)
0.0000
50.00
100.0
150.0
200.0
Minutes


Reb-Ctrl
Reb-TIC - PV (C)
130.0
117.0
104.0
91.00
78.00
0.0000
50.00
100.0
150.0
200.0
Minutes
135 (C)
50.00 (%)
43.45 (%)
35.44 (%)


Cond-Product
Depropanizer - Spec Calc Value (LightFraction)
1.200
1.100
1.000
0.9000
0.8000
0.7000
0.0000
50.00
100.0
150.0
200.0
Minutes
5.791e+004 (kg/h)
0.95 ()
0.9205 ()
2.565e+004 (kg/h)

Lesson 3: Adding more details into the model

Introduction

In the previous lessons, most of the equipment were modelled at a quite low fidelity level and most of the dynamic parameters were left at their default values. For example:

- **Control valves**: Only Cv was model. No details on how fast the valve can travel to open or close were specified. By default, HYSYS assumes instantaneous actuator travel time.
- **Heater**: Ideal temperature control was assumed i.e. the heater is capable to keep the outlet temperature at 50 °C without any deviation or delay, regardless the inlet flow and temperature profiles.
- **Pump**: Fixed pressure increase and efficiency were assumed.

While this is fine to get the dynamic model up and running, it may not be sufficient to properly predict the system response. In reality, we may need to include more information or change the modelling strategy, depending on what we are trying to achieve from the model.

In this lesson, we will assume the pump is of centrifugal type and add head vs. flow curves to give it a more realistic behaviour. These curves are usually supplied by pump vendor/manufacturer, but in this case we will use built-in feature in HYSYS to generate them.

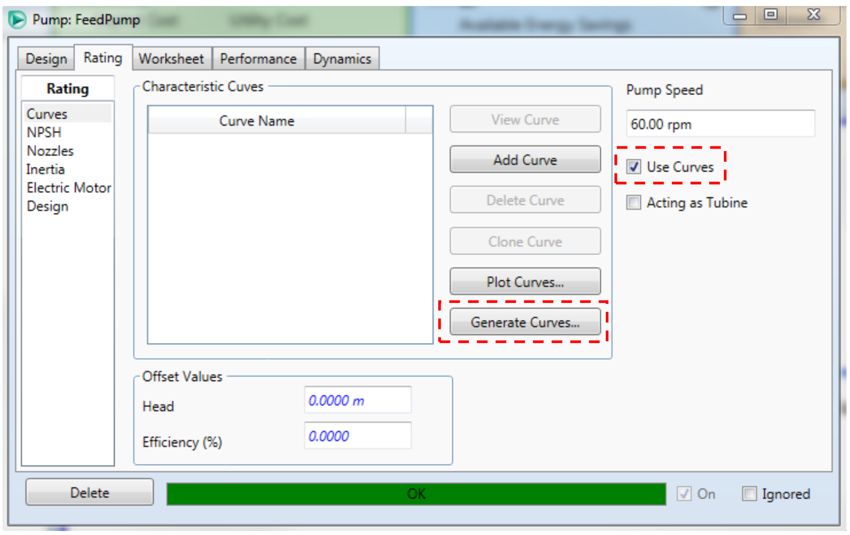
In Exercise 1, we will model the pump as a fixed-speed machine, and observe its behaviour.

Then, in Exercise 2, we will model it as variable speed pump and use it to control the separator level.

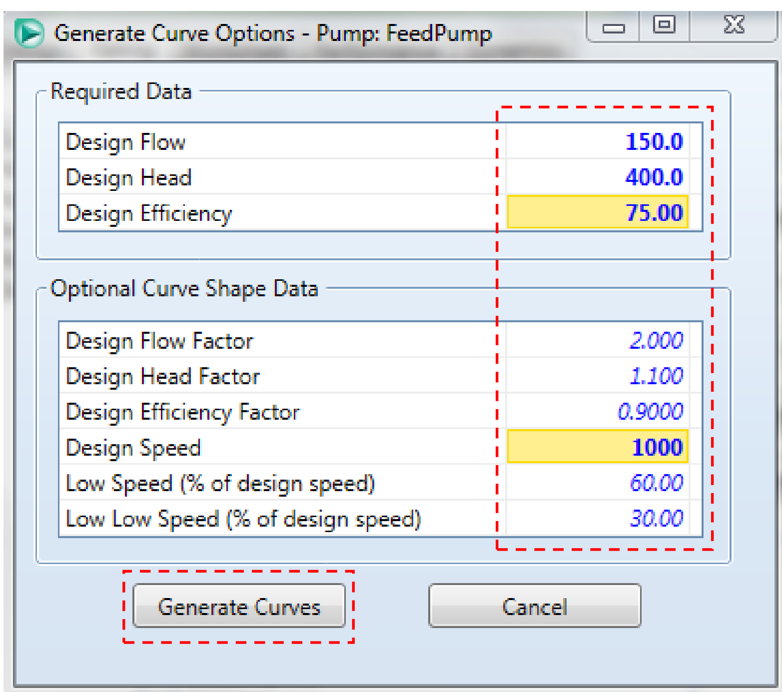
Exercise 1

1. Open "**Lesson2-Exercise2-start.hsc**". This should be the combined modelled built in Lesson 2. Save the case as "**Lesson3-Exercise1.hsc**"

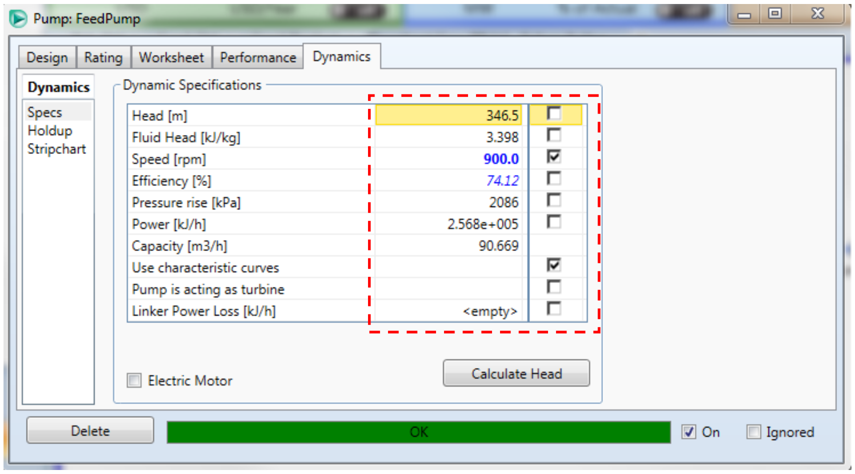
2. Activate "Use Curves" and click "Generate Curves".



3. In the pop-up box, specify design flow=150 m3/h, head=400 m, efficiency=75% and speed=1000 rpm. The click "Generate Curves"



4. Activate only “Use characteristic curve” and “Speed”. Specify speed to 900 rpm.

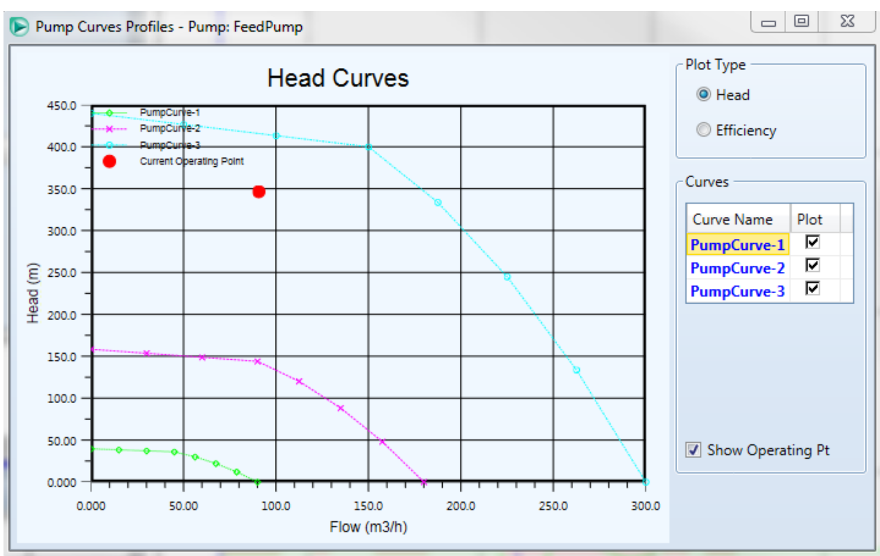


5. Run the case until it stabilise. Save the case.

Questions

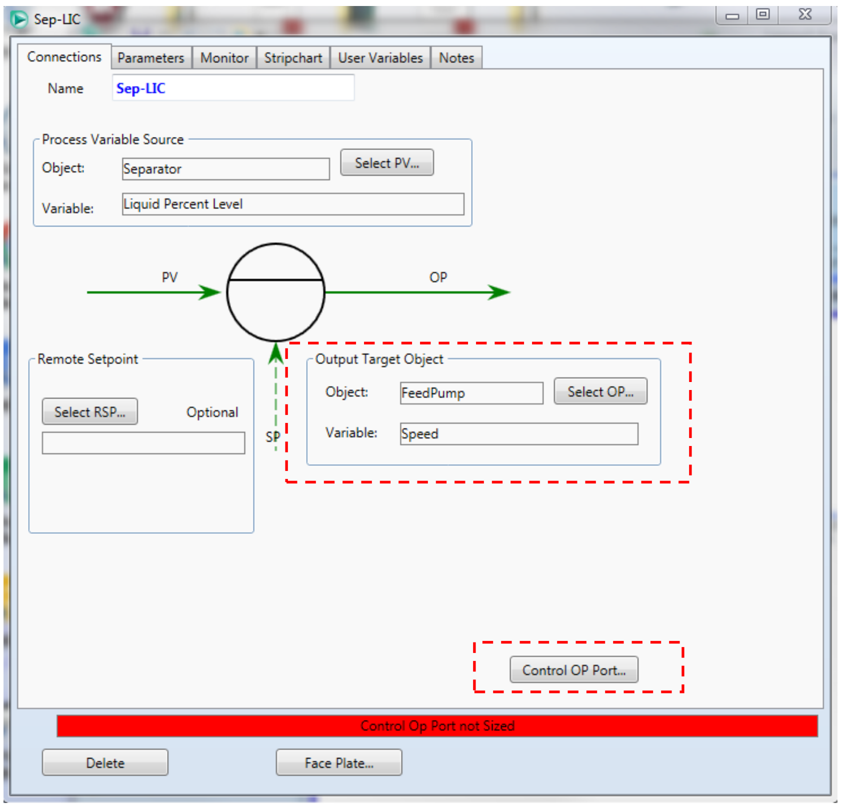
1. What is the opening of Sep-LCV? Is it the same as the previous model? If not, why? (Hint: check the pressure differences across pump and Sep-LCV).

2. Repeat Exercise 1 in Lesson 1 using this current model and compare the results with previous runs. Also monitor the pump operating trajectory in ***Rating>Curves>Plot Curves***.

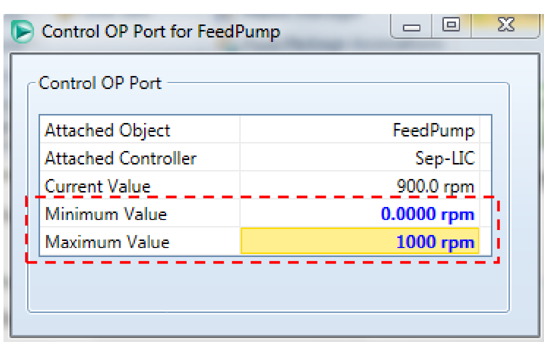


Exercise 2

1. Open "**Lesson3-Exercise1.hsc**". Save it as "**Lesson3-Exercise2.hsc**".
2. Change the output target object in Sep-LIC to "FeedPump" speed. Then click "Control OP Port":



3. In the pop-up box, set minimum and maximum values as 0 rpm and 1000 rpm, respectively.



4. Set the valve opening of Sep-LCV to 100%.
5. Put Sep-LIC on Auto (it was automatically set Manual when we changed its output target object).

6. Run the case until it stabilise. Save the case.

Questions

1. What is the advantage of using variable speed pump to control the separator level as opposed to using Sep-LCV? (Hint: check the pump duty before and after using speed control).

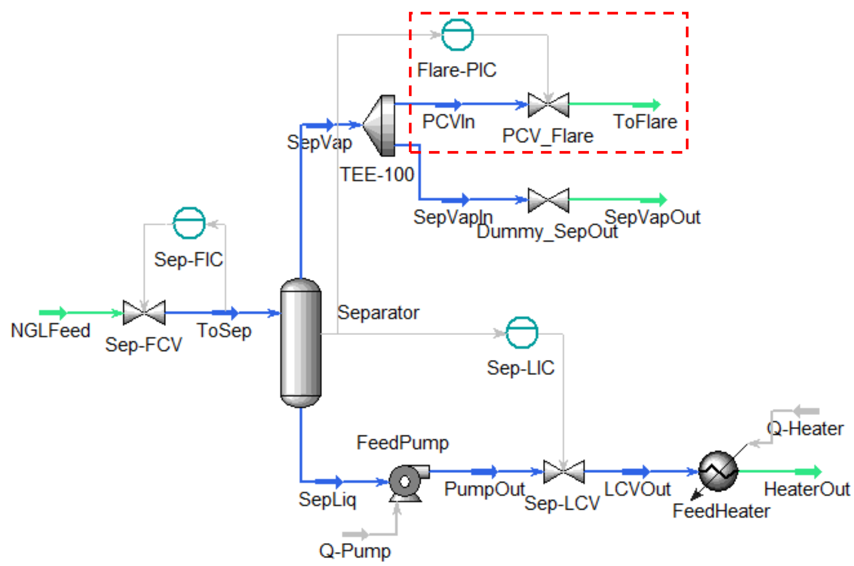
2. Repeat Exercise 1 in Lesson 1 using this current model and compare the results with previous runs. Also monitor the pump operating trajectory in ***Rating>Curves>Plot Curves***. You may also want to add a new strip chart to monitor the pump speed.

3. In this case, what is the assumption made when we "talk" directly to pump speed? How can we add another layer of details so that the pump accelerates and decelerates more realistically?

Lesson 4: Automation using Event Scheduler

Introduction

In this lesson, we will investigate how a control valve can be used to protect the separator from overpressure by re-routing the gas to the flare system. This valve (PCV_Flare) has been added into "**Lesson4-Dyn.hsc**".

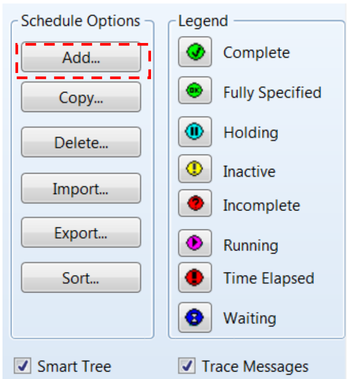


As per previous lessons, the separator is operating at 240 kPa. The flare valve is set to open only when the pressure exceeds 280 kPa. This means in normal operating scenario, the valve is closed and no flow is vented to flare.

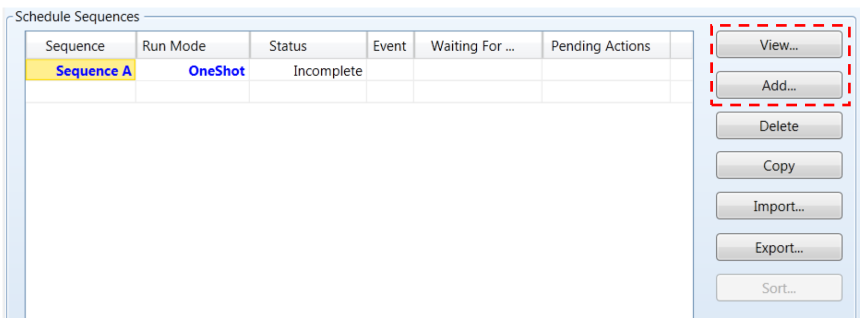
We will implement a potential upset scenario by automatically closing the Dummy_SepOut valve at a specified time using Event Scheduler. This will cause the separator pressure to increase, and we will see whether the PCV_Flare valve is capable to protect the separator from overpressure.

Set up the Event Scheduler

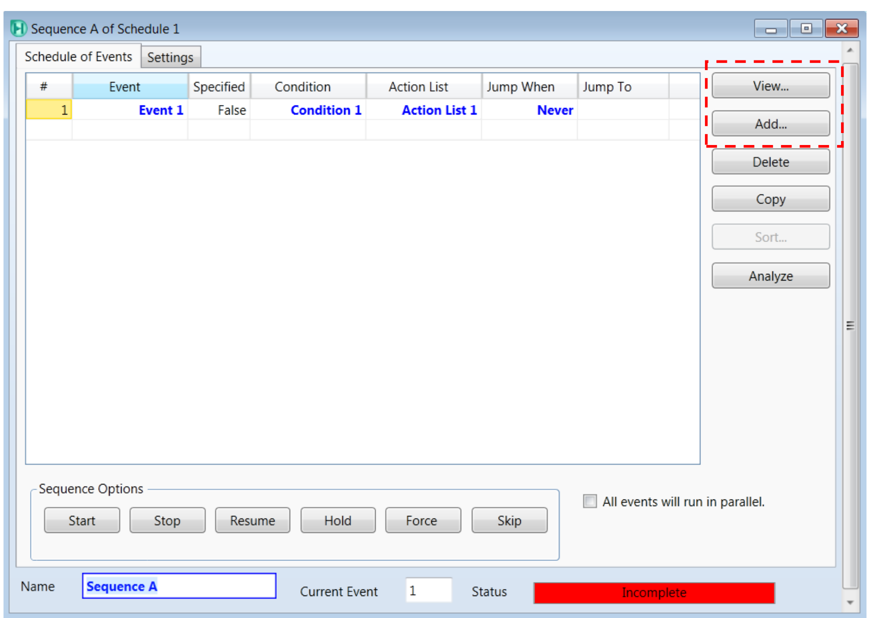
1. Open the starter case "**Lesson4-Dyn.hsc**". Open the Event Scheduler ("Ctrl+E"), and add a new schedule.



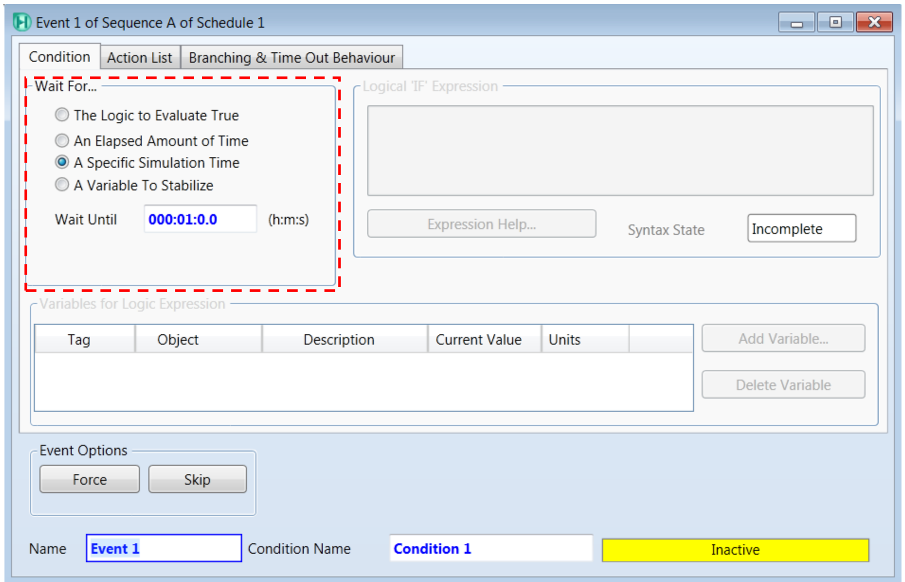
2. Add a sequence, and then view it.



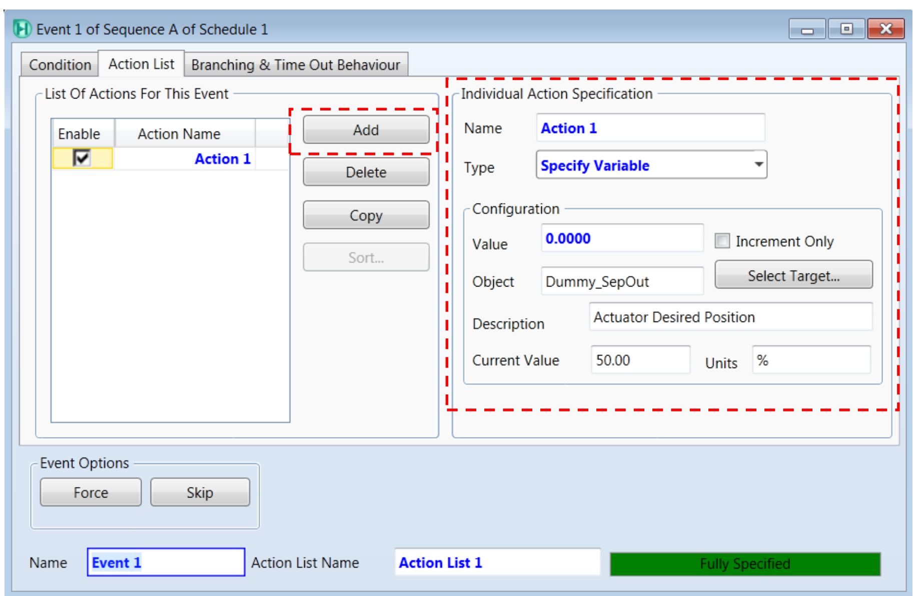
3. Add an event, and then view it.



4. In the condition tab, select "A Specific Simulation Time", and set "Wait Until" to 1 min.



5. In the "Action List" tab, add a new action, and use "Select Target" to close Dummy_SepOut valve as shown below.

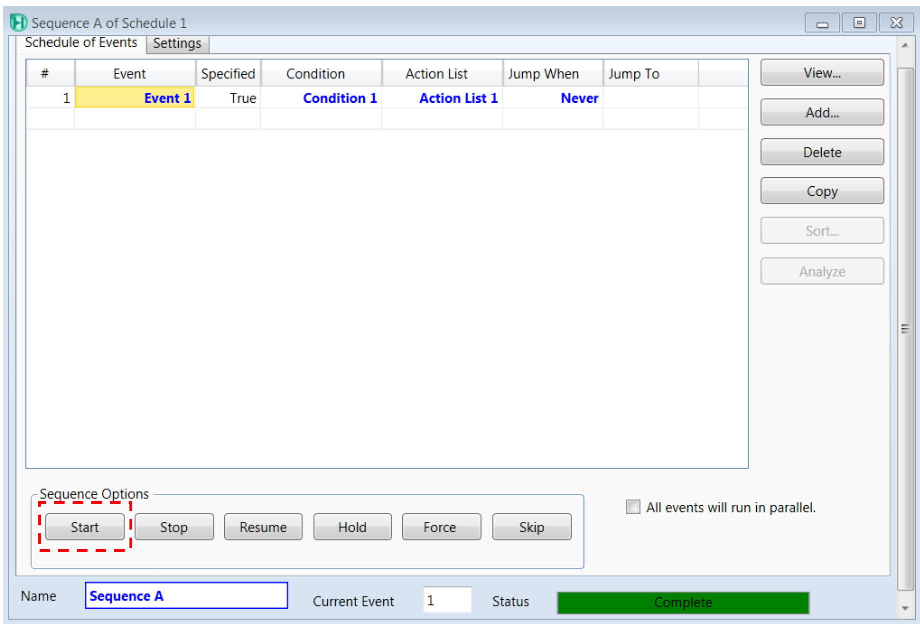


Exercise 1

1. Once you've added the Event Scheduler, save the case as "**Lesson4-Exercise1-start.hsc**". In the Integrator, set the following values

- Current time = 0 min
- End time = 30 min

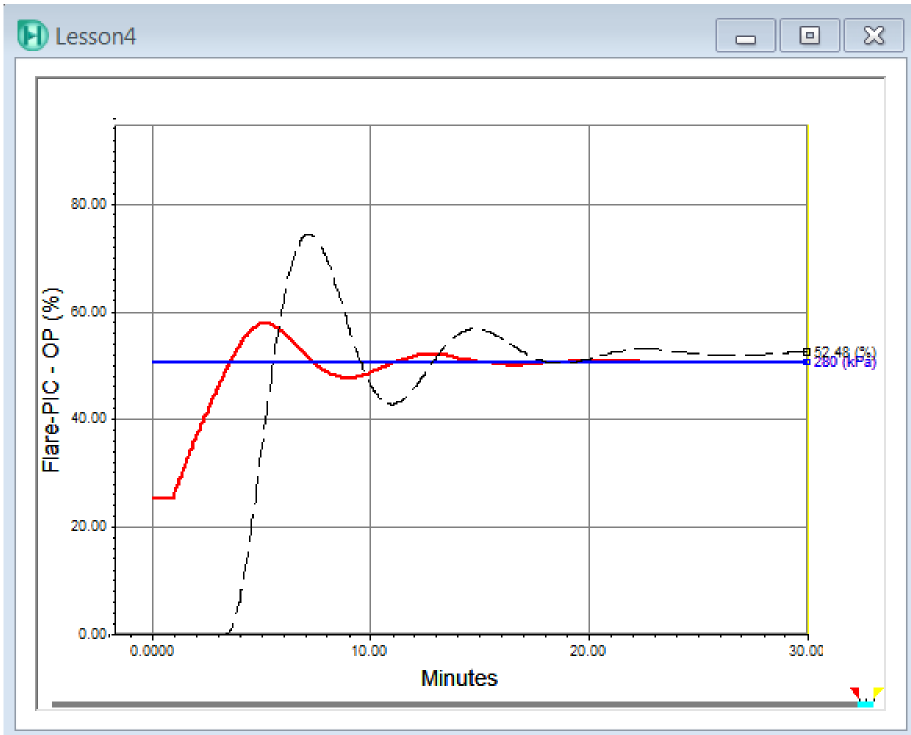
Then start the sequence, and run the simulation.



Once the run is finished, save the case as "**Lesson4-Exercise1-end.hsc**"

Questions

1. At what pressure, the PCV_Flare valve starts to open?
2. What is the maximum pressure expected at the separator if PCV_Flare fails to open?
3. What is the last layer of protection that should be installed to protect the separator from overpressure in the event of PCV_Flare fails to open? Should this be included in the model as well?


Lesson4
Flare-PIC - OP (%)
80.00
60.00
40.00
20.00
0.00
0.0000
10.00
20.00
30.00
Minutes
52.48 (%)
280 (kPa)