



**Introduction
to
Aspen Plus Basics
version 10.2**

, Ph. D.

Course Agenda – day 1

Introduction - General Simulation Concepts

The User Interface - Graphical Flowsheet Definition

Basic Input - Getting Around the Graphical User Interface

Unit Operation Models - Overview of Available Unit Operations

Separator – Two-phase & Three-phase Flash Calculation

DSTWU – Determination of N_{\min} and R_{\min}

DISTIL – Preliminary Separation Approximation

RadFrac - Multistage Separation Model

Course Agenda – day 1

Heat Exchangers - Heaters and Heat Exchangers

Pressure Changers - Pumps, Compressors, Pipes and Valves

Reactor Models - Overview of Available Reactor Types

Full-Scale Plant Modeling Workshop : *Additional*

Simulate a Methanol Plant

Simulate a PX Plant

Simulate a CDU

Introduction

Objective:

Introduce general flowsheet simulation concepts and Aspen Plus features

Introduction

- What is flowsheet simulation?
 - Use of a computer program to quantitatively model the characteristic equations of a chemical process
- Uses underlying physical relationships
 - Mass balance
 - Equilibrium relationships
 - Summation of Compositions
 - Enthalpy Balance
 - **Rate correlations (reaction and mass/heat transfer)**
- Predicts
 - Stream flowrates, compositions and physical properties
 - Operating conditions
 - Equipment sizing

가?

- (Chemical Process Simulator)

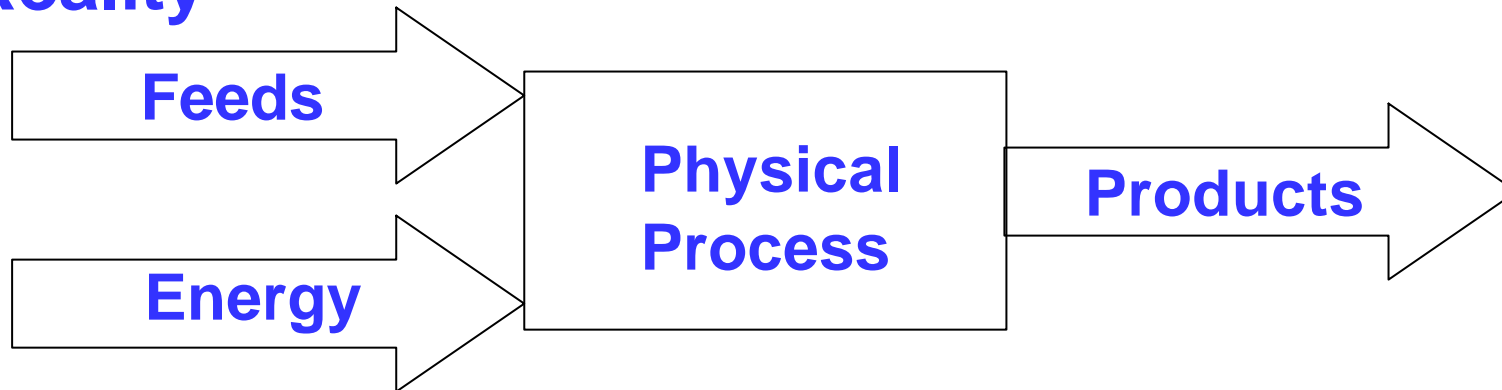
Computer Hardware

Software . - 1988

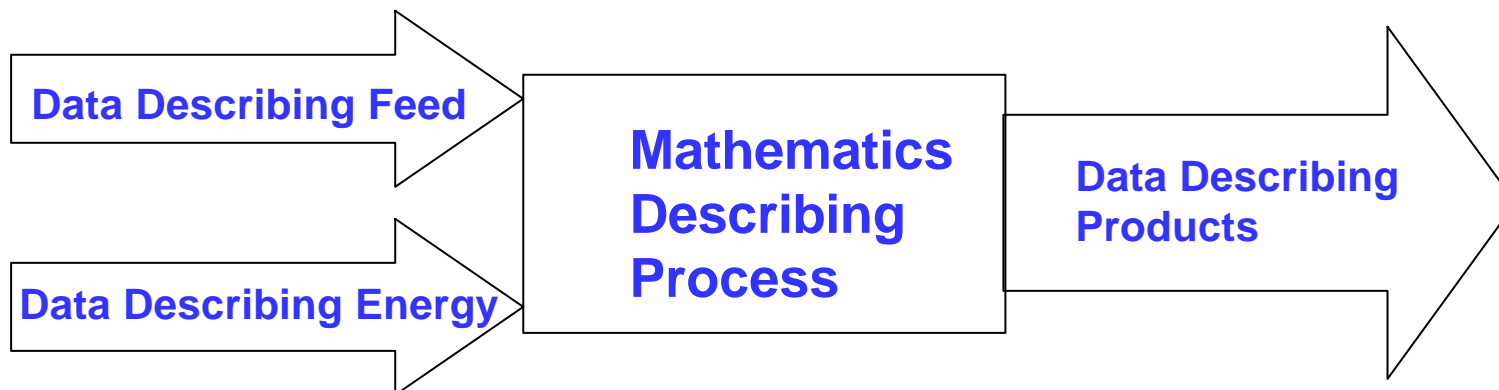
Henry Jo

Process Simulation

Reality



Mathematics



(Purposes for Simulation?)



New Plant Design



()

Existing Plant Revamp (Expansion)



Existing Plant Operations



Engineer Training

Advantages of Simulation

- Reduces plant design time
 - Allows designer to quickly test various plant configurations
- Helps improve current process
 - Answers “what if” questions
 - Determines optimal process conditions within given constraints
 - Assists in locating the constraining parts of a process (debottlenecking)

Advantages of Simulation

- Faster Calculations - More solutions
- Accurate Results
- Standardization
 - Pure Components : 1,550
 - Binary Database : 10,000 VLE & 3,000 LLE
 - Thermodynamic Methods over 60 Models
- Solution of Recycle Processes
- **Less Costly than Pilot Plant Tests !!**

(I)

Faster Calculations

- The equilibrium flash separator is the simplest equilibrium-stage process with which the designer must deal. Despite the fact that only one stage is involved, the calculation of the compositions and the relative amount of the vapor and liquid phases at any given pressure and temperature usually involves a tedious trial-and-error solution.

Buford D. Smith, 1963

(II)

Standardization

- Pure Component Database

1,550 가

(Commonly Used Components > 100)

- Binary Database

10,000

$(100) \times (100 - 1) / 2 = 4950$ BIP's

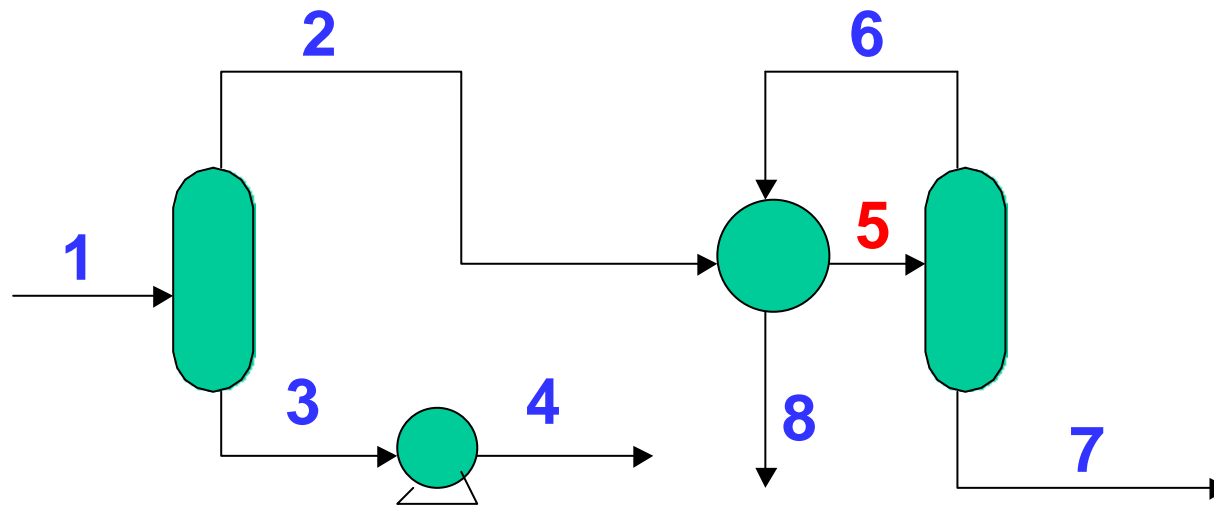
- Thermodynamic Option

60

EOS Model, LACT Model, Special Package !

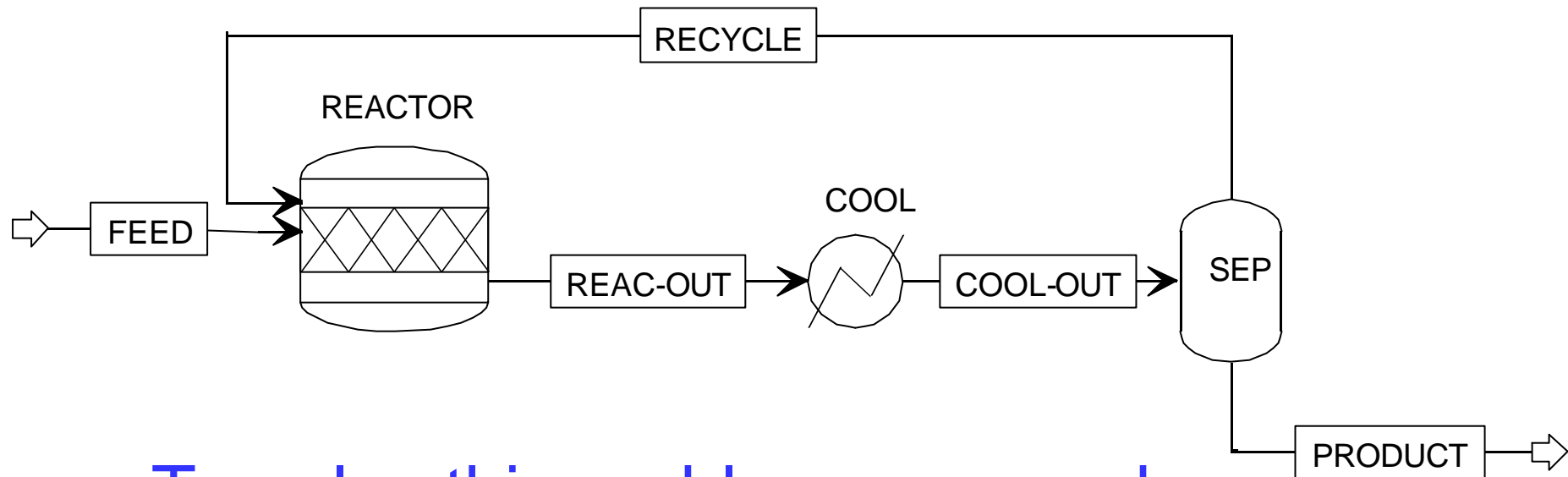
(III) Solution of Recycle Process

- Sequential-Modular Approach



General Simulation Problem

What is the composition of stream PRODUCT?



- To solve this problem, we need:
 - Material balances
 - Energy balances

Approaches to Flowsheet Simulation

- **Sequential Modular**
 - Aspen Plus is a sequential modular simulation program.
 - Each unit operation block is solved in a certain sequence.
- **Equation Oriented**
 - Aspen Custom Modeler (formerly SPEEDUP) is an equation oriented simulation program.
 - All equations are solved simultaneously.
- **Combination**
 - Aspen Dynamics (formerly DynaPLUS) uses the Aspen Plus sequential modular approach to initialize the steady state simulation and the Aspen Custom Modeler (formerly SPEEDUP) equation oriented approach to solve the dynamic simulation.

Aspen Plus Basics

- The best way to learn Aspen Plus concepts is by using Aspen Plus. This session leads you through an example Aspen Plus simulation to explain how to open a file, enter data, run a simulation and examine results.
- It will allow one and half hour for this session.

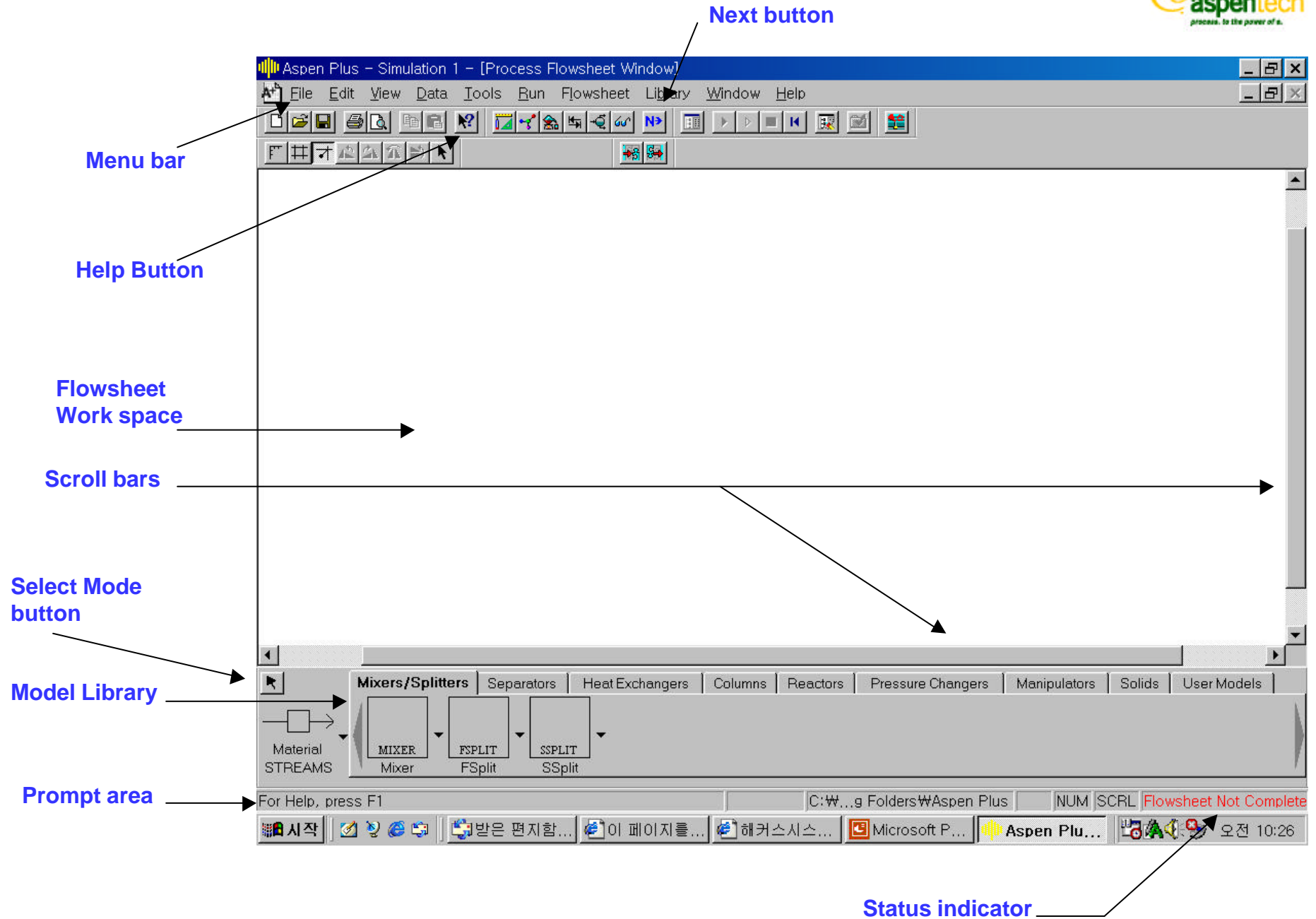
The User Interface

Objective:

Become comfortable and familiar with the Aspen Plus graphical user interface

Aspen Plus References:

- *User Guide*, Chapter 1, The User Interface
- *User Guide*, Chapter 2, Creating a Simulation Model
- *User Guide*, Chapter 4, Defining the Flowsheet



Opening a File

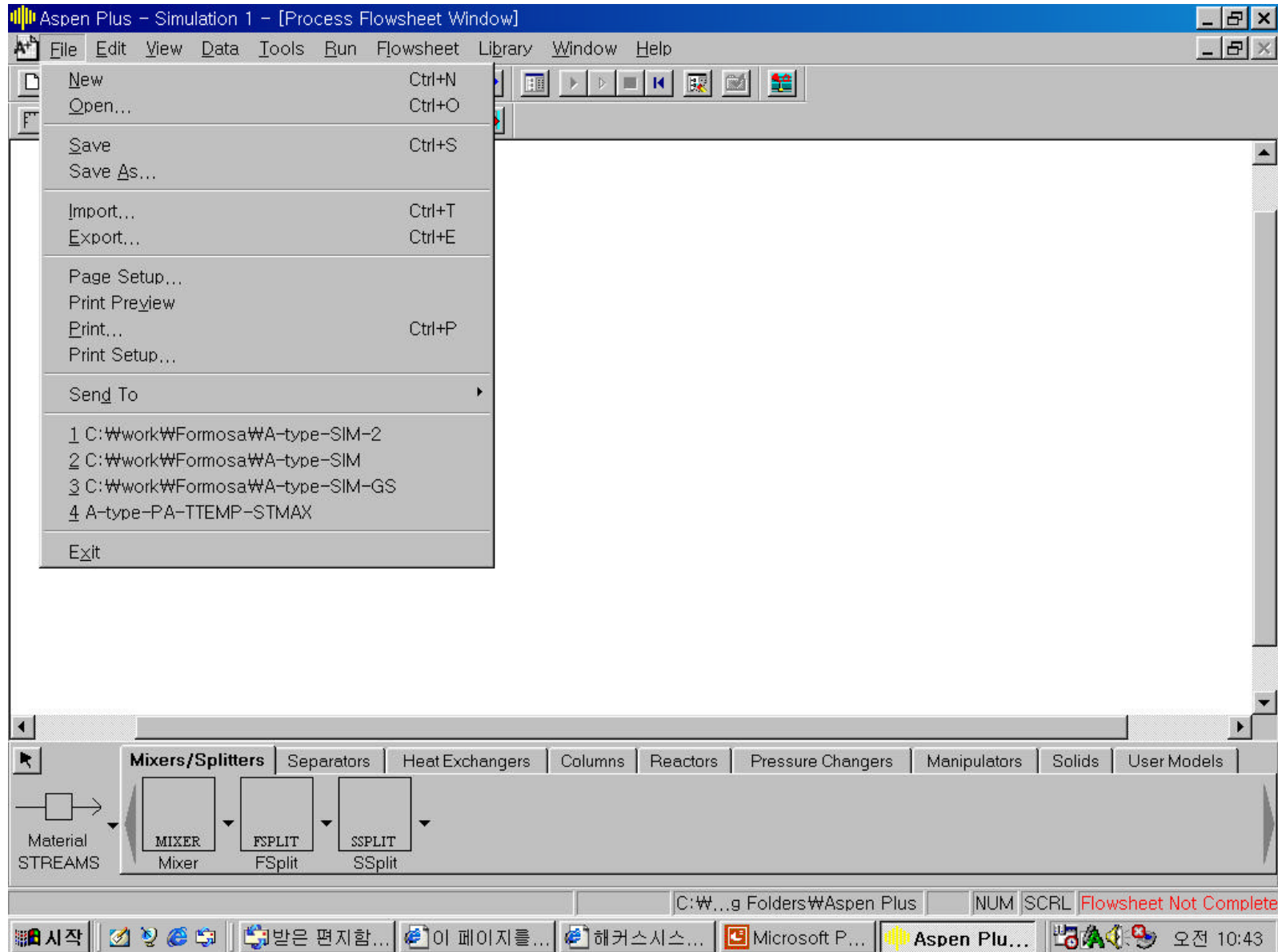
You can open a file for an Aspen Plus simulation by either:

- Double-clicking the file from Windows Explorer
- Selecting the open command from the File menu in Aspen Plus


In this session, you will use the open command on the File menu.

- To display the File menu, click File on the menu bar.

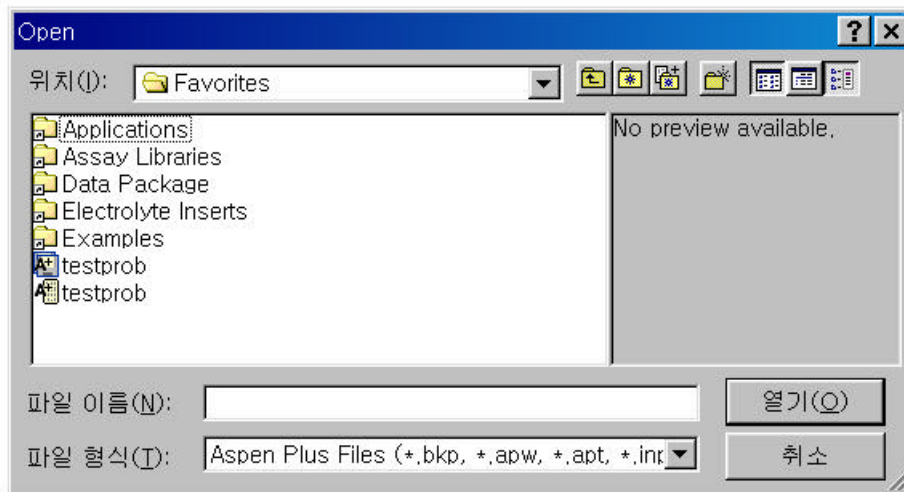
Aspen Plus displays the File menu:



- From the File menu, select Open.

The Open dialog box appears. Your default working directory is displayed in the Look In box. You can navigate to the folder containing a file by using the Look In box or the Look In Favorite button, .

- Click the Look in Favorite button.



Aspen Plus modeling Procedures

1. Define the process flowsheet modeled and the purpose of the model.
(Setup Specifications Global) (Title Card in PRO/II)
2. Select the units of measurement for input data and output.
3. Specify what chemical components will be present in the streams of the flowsheet.
(Components Specifications Global) (Component Data in PRO/II)
4. Specify the methods and models to be used for calculating physical properties.
(Property Specifications Global) (Thermodynamic Data in PRO/II)
5. Define the feed streams to the process.
(Stream Specifications Global) (Stream Data in PRO/II)
6. Convert the process flowsheet into unit operating blocks and choose an appropriate model for each block.
(Block Specifications Global) (Unit Operations Data in PRO/II)
7. Specify the performance of each unit operating block to represent the design and operating conditions of the process.
(Design Specifications Global) (Specifications in PRO/II)

Basic Input

The minimum required inputs (in addition to the graphical flowsheet) to run a simulation are:

- | | |
|--------------|----------------------|
| - Setup | Title |
| - Components | Component Data |
| - Properties | Thermodynamic Data |
| - Streams | Stream Data |
| - Blocks | Unit Operations Data |

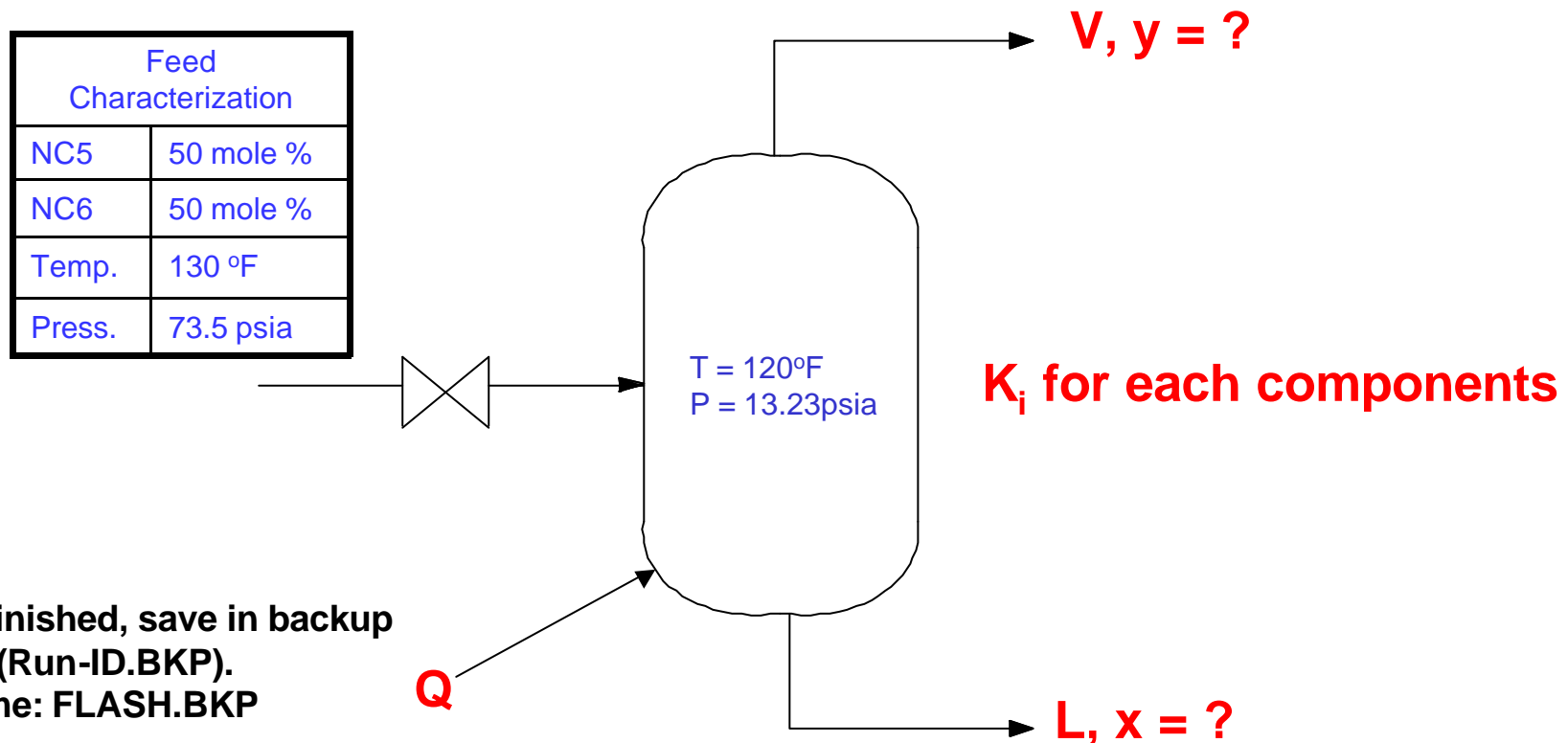
Using the Mouse

- Left button click - Select object/field
- Right button click - Bring up menu for selected object/field, or inlet/outlet
- Double left click - Open Data Browser object sheet

Reference: Aspen Plus User Guide, Chapter 1, The User Interface

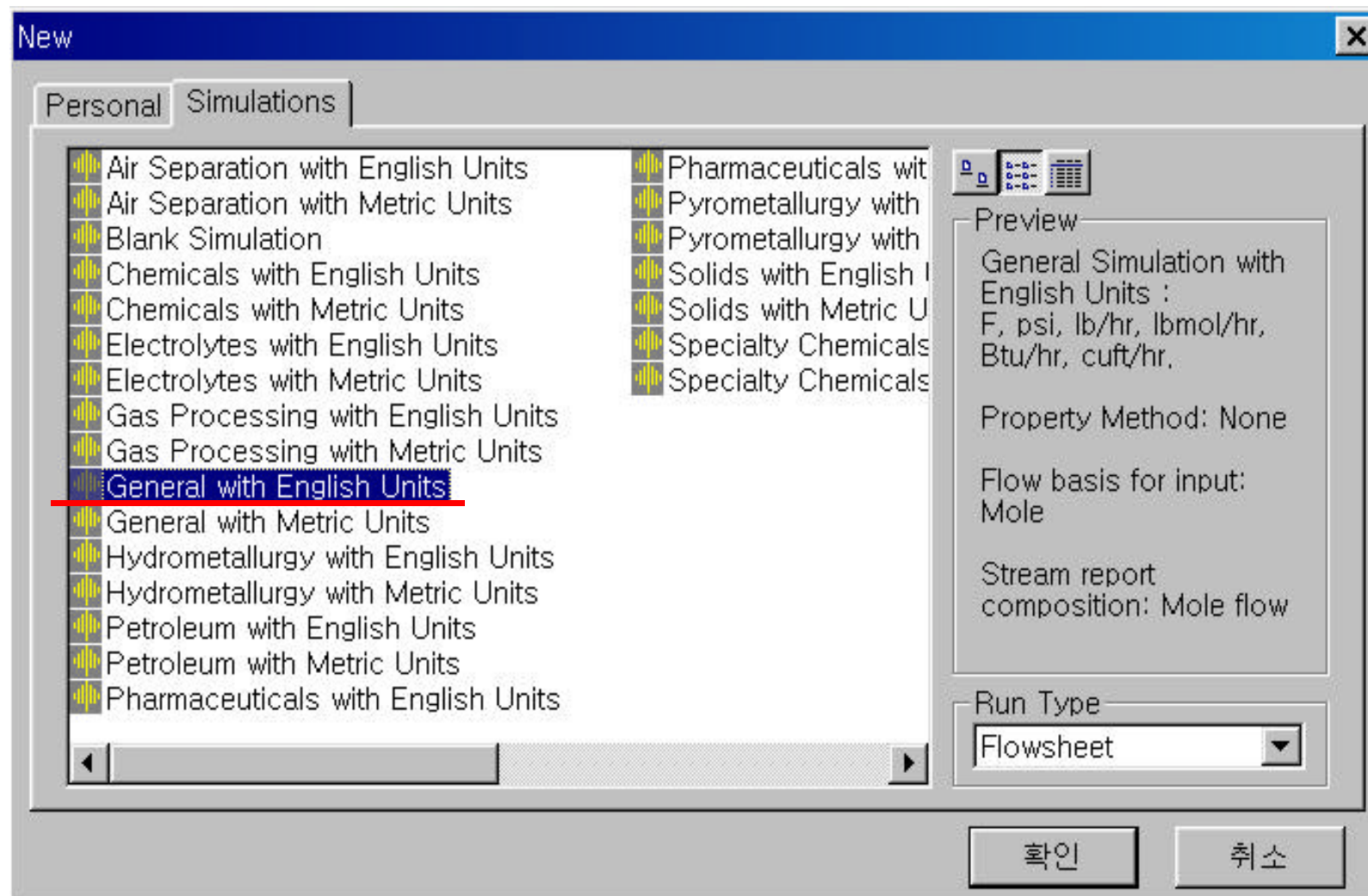
Ex 1 : Two-phase Flash

- An equimolar stream of *n*-pentane and *n*-hexane, at 130°F and 73.5 psia, is fed a flash vessel, where it is flashed to 13.23 psia with vapor liquid products in equilibrium at 120°F.
- Use ideal Raoult's law for the simulation of this system.



When finished, save in backup format (Run-ID.BKP).
Filename: FLASH.BKP

Start with the General with English Units Template



Choose the appropriate icons for the block

- To place a block on the flowsheet:
 1. Click on a model category tab in the Model Library.
 2. Select a unit operation model. Click the drop-down arrow to select an icon for the model.
 3. Click on the model and drag it to the flowsheet where you want to place the block, then release the mouse button.

Choose the appropriate icons for the block



- To place a stream on the flowsheet:
 1. Click on the stream icon in the Model Library.
 2. If you want to select a different stream type (Material, Heat or Work), click the down arrow next to the icon and choose a different type.
 3. Click a highlighted port to make the connection.
 4. Repeat step 3 to connect the other end of the stream.
 5. To place one end of the stream as either a process flowsheet or product, click a blank part of the Process Flowsheet window.
 6. Click the right mouse button on stop creating streams.

Graphic Flowsheet operations

- To display an input for a Block or a Stream in the Data Browser:
 1. Double click the left mouse on the object of interest.
- To rename, Delete, Change the icon, provide input or view results for a block or stream:
 1. Select object (Block or Stream) by clicking on it with the left mouse button.
 2. Click the right mouse while the pointer is over the selected object icon to bring up the menu for that object.
 3. Choose appropriate menu item.

Automatic Naming of Streams and Blocks

- Stream and block names can be automatically assigned by Aspen Plus or entered by the user when the object is created.
- Stream and block names can be displayed or hidden.
- To modify the naming options:
 - Select Options from the Tools menu.
 - Click the flowsheet tab.
 - Check or uncheck the naming options desired.

Setup

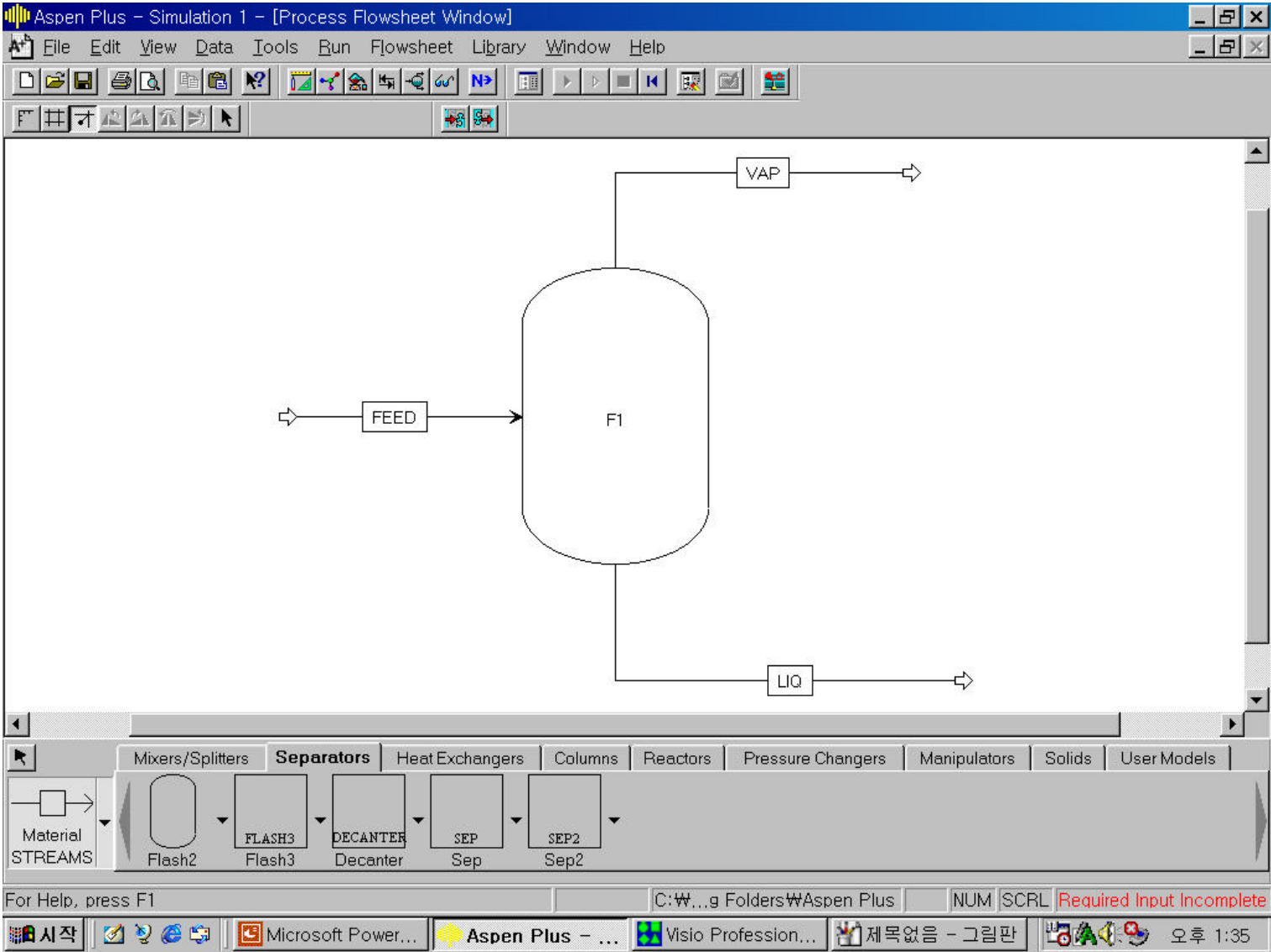


Most of the commonly used Setup information is entered on the *Setup Specifications Global* sheet:

- Flowsheet title to be used on reports
- Run type
- Input and output units
- Valid phases (e.g. vapor-liquid or vapor-liquid-liquid)
- Ambient pressure

Stream report options are located on the *Setup Report Options Stream* sheet.

Step 1 : general process information (Setup Specifications)



Step 1 : general process information (Setup Specifications) *continued*

Aspen Plus - Simulation 1 - [Setup Specifications - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Specifications

- Setup
 - Specifications
 - Simulation Options
 - Stream Class
 - Substreams
 - Units Sets
 - Report Options
- Components
- Properties
- Streams
- Blocks
- Reactions
- Convergence
- Flowsheeting Options
- Model Analysis Tools
- Results Summary

Global | Description | Accounting | Diagnostics

Title: **NC5-NC6 Flash**

Units of measurement

Input data: ENG

Output results: ENG

Global settings

Run type: Flowsheet

Input mode: Steady-State

Stream class: CONVEN

Flow basis: Mole

Ambient: 14.69595 psi

Ambient temp.: 50 F

Valid phases:

Use free water calculations

Text to appear on each page of the report file. See Help.

Input Complete

Mixers/Splitters | **Separators** | Heat Exchangers | Columns | Reactors | Pressure Changers | Manipulators | Solids | User Models

Material STREAMS

Flash2

FLASH3 Flash3

DECANTER Decanter

SEP Sep








SEP2 Sep2

Two-outlet flash, Models flash drums, evaporators, and so forth, u

C:\W...g Folders\WAspen Plus NUM SCRL Required Input Incomplete

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Status Indicators

Symbol	Status
	Input for the form is incomplete
	Input for the form is complete
	No input for the form has been entered. It is optional.
	Results for the form exist.
	Results for the form exist, but there were calculation errors.
	Results for the form exist, but there were calculation warnings.
	Results for the form exist, but input has changed since the results were generated.

Setup Run Types

Run Type	
Flowsheet	<p>Standard Aspen Plus flowsheet run including sensitivity studies and optimization.</p> <p>Flowsheet runs can contain property estimation, assay data analysis, and/or property analysis calculations.</p>
Assay Data Analysis	<p>A standalone Assay Data Analysis and pseudocomponent generation run</p> <p>Use Assay Data Analysis to analyze assay data when you do not want to perform a flowsheet simulation in the same run.</p>
Data Regression	<p>A standalone Data Regression run</p> <p>Use Data Regression to fit physical property model parameters required by ASPEN PLUS to measured pure component, VLE, LLE, and other mixture data. Data Regression can contain property estimation and property analysis calculations. ASPEN PLUS cannot perform data regression in a Flowsheet run.</p>
PROPERTIES PLUS	<p>PROPERTIES PLUS setup run</p> <p>Use PROPERTIES PLUS to prepare a property package for use with Aspen Custom Modeler (formerly SPEEDUP) or Aspen Pinch (formerly ADVENT), with third-party commercial engineering programs, or with your company's in-house programs. You must be licensed to use PROPERTIES PLUS.</p>
Property Analysis	<p>A standalone Property Analysis run</p> <p>Use Property Analysis to generate property tables, PT-envelopes, residue curve maps, and other property reports when you do not want to perform a flowsheet simulation in the same run.</p> <p>Property Analysis can contain property estimation and assay data analysis calculations.</p>
Property Estimation	<p>Standalone Property Constant Estimation run</p> <p>Use Property Estimation to estimate property parameters when you do not want to perform a flowsheet simulation in the same run.</p>

Setup Units



- Units in Aspen Plus can be defined at 3 different levels:
 1. Global Level (“Input Data” & “Output Results” fields on the *Setup Specifications Global* sheet)
 2. Object level (“Units” field in the top of any input form of an object such as a block or stream)
 3. Field Level
- Users can create their own units sets using the *Setup Units Sets* Object Manager. Units can be copied from an existing set and then modified.

Components



- Use the *Components Specifications* form to specify all the components required for the simulation.
- If available, physical property parameters for each component are retrieved from databanks.
- Pure component databanks contain parameters such as molecular weight, critical properties, etc. The databank search order is specified on the Databanks sheet.
- The Find button can be used to search for components.
- The Electrolyte Wizard can be used to set up an electrolyte simulation.

Step 2 : chemical species (Component Specifications Form)

Aspen Plus - Simulation 1 - [Components Specifications - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Specifications

ENG

Selection Petroleum Nonconventional Databanks

Define components

Component ID	Type	Component name	Formula
NC5	Conventional	N-PENTANE	C5H12-1
NC6	Conventional	N-HEXANE	C6H14-1

Find Elec Wizard User Defined Reorder

Component ID. If data are to be retrieved from databanks, enter either Component Name or Formula. See Help.

Input Complete

Mixers/Splitters **Separators** Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS

Flash2 FLASH3 Flash3 DECANTER Decanter SEP Sep SEP2 Sep2

For Help, press F1 C:\W...g Folders\WAspen Plus NUM SCRL Required Input Incomplete

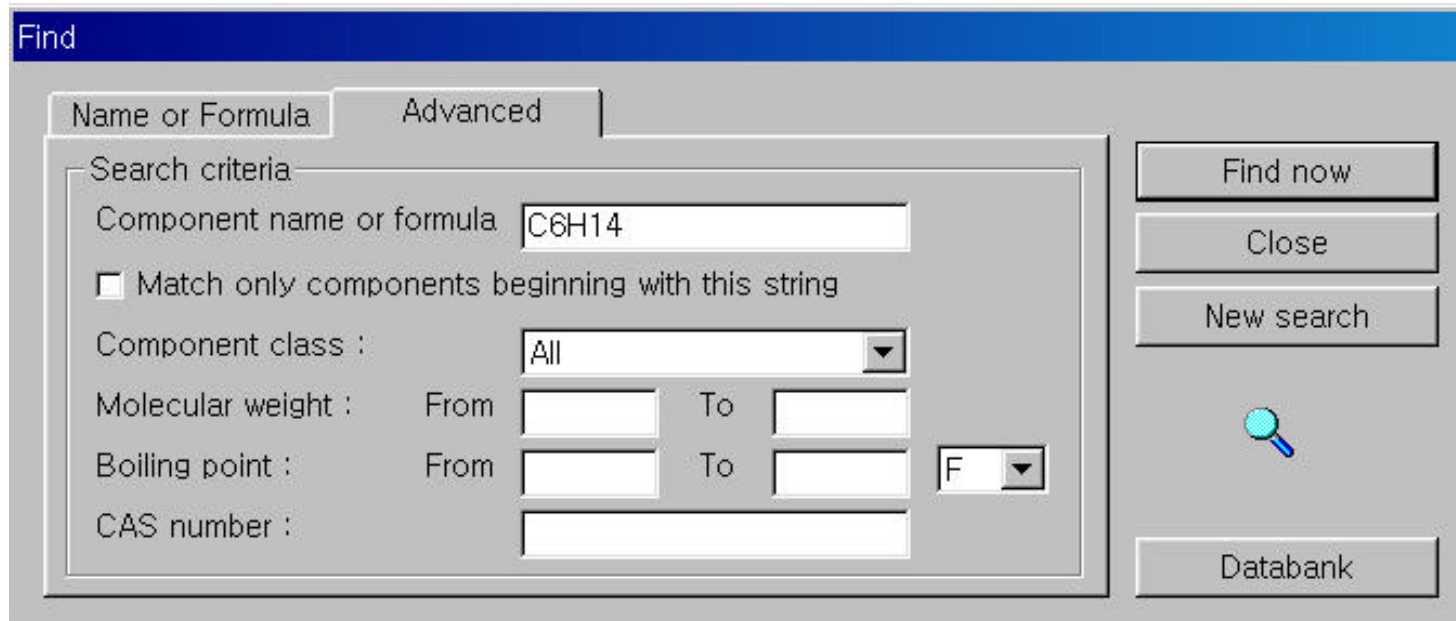
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Entering Components



- The Component ID is used to identify the component in simulation inputs and results.
- Each Component ID can be associated with a databank component as either:
 - Formula: Chemical formula of component (e.g., C₆H₆)
(Note that a suffix is added to formulas when there are isomers, e.g. C₂H₆O-2)
 - Component Name: Full name of component (e.g., BENZENE)
- Databank components can be searched for using the Find button.
 - Search using component name, formula, component class, molecular weight, boiling point, or CAS number.
 - All components containing specified items will be listed.

Find



The screenshot shows the 'Find' dialog box with the 'Name or Formula' tab selected. The search criteria are as follows:

- Component name or formula:
- Match only components beginning with this string
- Component class: (dropdown)
- Molecular weight: From To
- Boiling point: From To (Unit: (dropdown))
- CAS number:

Buttons on the right side of the dialog include: Find now, Close, New search, a magnifying glass icon, and Databank.

- Find performs an AND search when more than one criterion is specified.

Pure Component Databanks

Databank	Contents	Use
PURE10	Data from the Design Institute for Physical Property Data (DIPPR) and AspenTech	Primary component databank in Aspen Plus
AQUEOUS	Pure component parameters for ionic and molecular species in aqueous solution	Simulations containing electrolytes
SOLIDS	Pure component parameters for strong electrolytes, salts, and other solids	Simulations containing electrolytes and solids
INORGANIC	Thermochemical properties for inorganic components in vapor, liquid and solid states	Solids, electrolytes, and metallurgy applications
PURE93	Data from the Design Institute for Physical Property Data (DIPPR) and AspenTech delivered with Aspen Plus 9.3	For upward compatibility
PURE856	Data from the Design Institute for Physical Property Data (DIPPR) and AspenTech delivered with Aspen Plus 8.5-6	For upward compatibility

Parameters missing from the first selected databanks will be searched for in subsequent selected databanks.

Properties

- Use the *Properties Specifications* form to specify the physical property methods to be used in the simulation.
- Property methods are a collection of models and methods used to describe pure component and mixture behavior.
- Choosing the right physical properties is critical for obtaining reliable simulation results.
- Selecting a Process Type will narrow the number of methods available.

Step 3 : physical property (Property Specifications Global Form)

Aspen Plus - Simulation 1 - [Properties Specifications - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Specifications

- Substreams
- Units Sets
- Report Options
- Components
 - Specifications
 - Assay/Blend
 - Petro Characterization
 - Pseudocomponents
 - Attr-Comps
 - Henry Comps
 - UNIFAC Groups
 - Comp-Groups
 - Comp-Lists
- Properties
 - Specifications**
 - Property Methods
 - Estimation
 - Molecular Structure
 - Parameters
 - Data
 - Analysis
 - Prop-Sets
 - Advanced
- Streams

Global Flowsheet Sections Referenced

Property methods & models

Process type: ALL

Property method: IDEAL

Base method: IDEAL

Henry components:

Modify property models

Vapor EOS: ESIG

Data set: 1

Liquid gamma: GMIDL

Data set: 1

Liquid enthalpy: HLMX82

Liquid volume: VLMX01

Paynting correction

Heat of mixing

Petroleum calculation options

Free-water method: STEAM-TA

Water solubility: 3

Electrolyte calculation options

Chemistry ID:

Use true-components

Ideal property method. Uses both Raoult's law and Henry's law.

Input Complete

Mixers/Splitters **Separators** Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS

Flash2 FLASH3 Flash3

Decanter DECANTER Decanter

Sep SEP Sep

Sep2 SEP2 Sep2

For Help, press F1

C:\W...g Folders\W\Aspen Plus NUM SCRL Required Input Incomplete

시작 Microsoft Power... Aspen Plus - ... Visio Professiona... 오후 2:05

Streams



- Use *Stream Input* forms to specify the feed stream conditions and composition.
- To specify stream conditions enter two of the following:
 - Temperature
 - Pressure
 - Vapor Fraction
- To specify stream composition enter either:
 - Total stream flow and component fractions
 - Individual component flows
- Specifications for streams that are not feeds to the flowsheet (i.e. recycle streams) are used as estimates.

Step 4 : stream variables (Stream Specifications form)

Aspen Plus - Simulation 1 - [Stream FEED (MATERIAL) - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

FEED ENG All

Specifications Flash Options PSD Component Attr.

Substream name: MIXED

State variables

Temperature: 130 F

Pressure: 73.5 psi

Total flow: Mole 1 lbmol/hr

Solvent:

Composition

Mole-Frac

Component	Value
NC5	0.5
NC6	0.5

Total: 1

Lets you type the component flow, fraction or concentration. See Help.

Input Complete

Mixers/Splitters **Separators** Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS Flash2 FLASH3 DECANter SEP Sep2

For Help, press F1 C:\W...g Folders\WAspen Plus NUM SCRL Required Input Incomplete

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Blocks

- Each *Block Input* or *Block Setup* form specifies operating conditions and equipment specifications for the unit operation model.
- Some unit operation models require additional specification forms
- All unit operation models have optional information forms (e.g. *BlockOptions* form).

Step 5 : equipment parameters (Block [Flash2] Specifications Form)

Aspen Plus - Simulation 1 - [Block F1 (Flash2) Input - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Input

ENG

Specifications Flash Options Entrainment

Flash specifications

Temperature 120 F

Pressure 13.23 psi

Valid phases

Vapor-Liquid

Lets you type the pressure. Absolute units: outlet pressure if value > 0; pressure drop if value <= 0. Gauge units: outlet pressure for all values. See Help.

Input Complete

Mixers/Splitters **Separators** Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS

Flash2 FLASH3 Decanter Sep Sep2

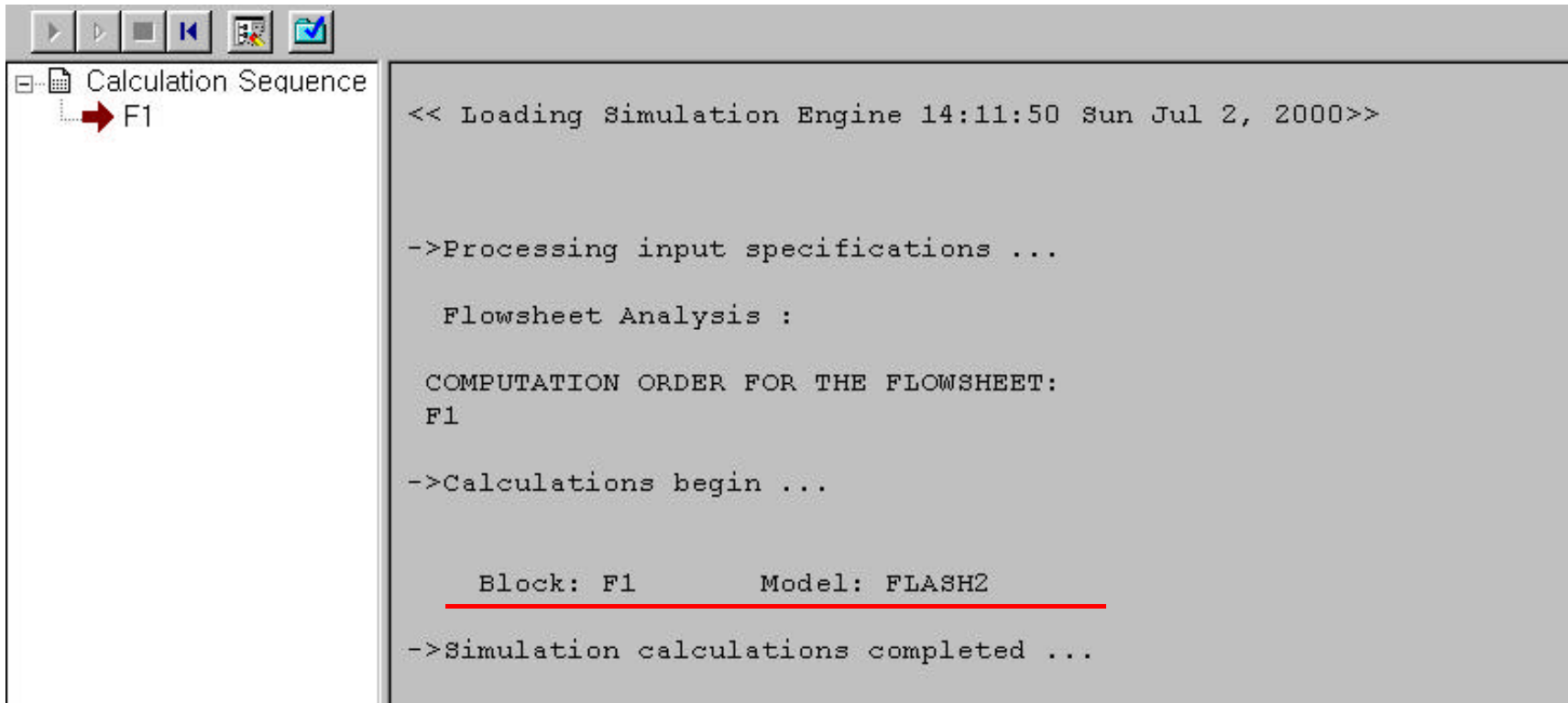
For Help, press F1

C:\W...g Folders\WAspen Plus NUM SCRL Required Input Complete

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Starting the Run

- Select *Control Panel* from the *View* menu or press the Next button to be prompted.
 - The simulation can be executed when all required forms are complete.
 - The Next button will take you to any incomplete forms.



The screenshot shows the Aspen Plus simulation engine output window. The left pane displays the 'Calculation Sequence' tree with 'F1' selected. The main window shows the following text output:

```
<< Loading Simulation Engine 14:11:50 Sun Jul 2, 2000>>

->Processing input specifications ...

Flowsheet Analysis :

COMPUTATION ORDER FOR THE FLOWSHEET:
F1






->Calculations begin ...

  Block: F1      Model: FLASH2
  -----
->Simulation calculations completed ...
```


Control Panel

The Control Panel consists of:

- A message window showing the progress of the simulation by displaying the most recent messages from the calculations
- A status area showing the hierarchy and order of simulation blocks and convergence loops executed
- A toolbar which you can use to control the simulation

Run		Start or continue calculations
Step		Step through the flowsheet one block at a time
Stop		Pause simulation calculations
Reinitialize		Purge simulation results
Results		Check simulation results

Reviewing Results



- **History file or Control Panel Messages**
 - Contains any generated errors or warnings
 - Select *History* or *Control Panel* on the *View* menu to display the History file or the Control Panel
- **Stream Results**
 - Contains stream conditions and compositions
 - For all streams (*/Data/Results Summary/Streams*)
 - For individual streams (bring up the stream folder in the Data Browser and select the *Results* form)
- **Block Results**
 - Contains calculated block operating conditions (bring up the block folder in the Data Browser and select the *Results* form)

Examine result 1 : Aspen Plus Output

Aspen Plus - Simulation 1 - [Block F1 (Flash2) - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Streams: FEED, LIQ, VAP; Blocks: F1; Results: Results, Stream Results; Results Summary

Summary | Balance | Phase Equilibrium

Block results summary

Outlet temperature:	120	F
Outlet pressure:	13.23	psi
Vapor fraction:	0.43922009	
Heat duty:	4567.19816	Btu/hr
Net duty:	4567.19816	Btu/hr
1st liquid / Total liquid:	1	

Results Available

Mixers/Splitters | **Separators** | Heat Exchangers | Columns | Reactors | Pressure Changers | Manipulators | Solids | User Models

Material STREAMS: Flash2, FLASH3 Flash3, DECANTER Decanter, SEP Sep, SEP2 Sep2

For Help, press F1 | C:\W...g Folders\WAspen Plus | NUM | SCRL | Results Available

시작 | Microsoft P... | Aspen Plu... | Visio Profes... | 받은 편지함... | 오후 2:32

Examine results : Aspen Plus Output - *continued*

Aspen Plus - Simulation 1 - [Block F1 (Flash2) - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Streams

- FEED
- LIQ
- VAP

Blocks

- F1
 - Results
 - Stream Results
- Results Summary

Summary Balance **Phase Equilibrium**

Vapor-liquid equilibrium results

Component	F	X	Y	K
NC5	0.5	0.38409737	0.64798018	1.68702064
NC6	0.5	0.61590263	0.35201982	0.57155108

Mixers/Splitters Separators Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS

Flash2 FLASH3 DECANTER SEP SEP2

For Help, press F1

C:\W...g Folders\W\Aspen Plus NUM SCRL [Results Available](#)

시작 Microsoft P... Aspen Plu... Visio Profes... 오후 2:40

Examine results : Aspen Plus Output - *continued*

Aspen Plus - Simulation 1 - [Block F1 (Flash2) Stream Results - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Stream Results

- Streams
 - FEED
 - LIQ
 - VAP
- Blocks
 - F1
 - Results
 - Stream Results**
- Results Summary

Material Heat Vol.% Curves Wt.% Curves Petro. Curves Poly. Curves

Display: Streams Format: FULL Stream Table

	FEED	VAP	LIQ	
Substream: MIXED				
Mole Flow lbmol/hr				
NC5	.5000000	.2846059	.2153941	
NC6	.5000000	.1546142	.3453858	
Total Flow lbmol/hr	1.0000000	.4392201	.5607799	
Total Flow lb/hr	79.16372	33.85861	45.30511	
Total Flow cuft/hr	2.059465	206.5189	1.156715	

Mixers/Splitters **Separators** Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS Flash2 FLASH3 Flash3 Decanter SEP Sep SEP2 Sep2

For Help, press F1 C:\w...g Folders\Aspen Plus NUM SCRL Results Available

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Unit Operation Models

- ***Objective:***

Review major types of unit operation models

- ***Aspen Plus References:***

- *User Guide, Chapter 10, Unit Operation Models*
- *Unit Operation Models Reference Manual*

Unit Operation Model Types



- Mixers/Splitters
- Separators
- Heat Exchangers
- Columns
- Reactors
- Pressure Changers
- Manipulators
- Solids
- User Models

Mixers/Splitters

Model	Description	Purpose	Use
Mixer	Stream mixer	Combine multiple streams into one stream	Mixing tees, stream mixing operations, adding heat streams, adding work streams
FSplit	Stream splitter	Split stream flows	Stream splitters, bleed valves
SSplit	Substream splitter	Split substream flows	Solid stream splitters, bleed valves

Separators

Model	Description	Purpose	Use
Flash2	Two-outlet flash	Determine thermal and phase conditions	Flashes, evaporators, knockout drums, single stage separators
Flash3	Three-outlet flash	Determine thermal and phase conditions	Decanters, single stage separators with two liquid phases
Decanter	Liquid-liquid decanter	Determine thermal and phase conditions	Decanters, single stage separators with two liquid phases and no vapor phase
Sep	Multi-outlet component separator	Separate inlet stream components into any number of outlet streams	Component separation operations such as distillation and absorption, when the details of the separation are unknown or unimportant
Sep2	Two-outlet component separator	Separate inlet stream components into two outlet streams	Component separation operations such as distillation and absorption, when the details of the separation are unknown or unimportant

Heat Exchangers

Model	Description	Purpose	Use
Heater	Heater or cooler	Determines thermal and phase conditions	Heaters, coolers, valves. Pumps and compressors when work-related results are not needed.
HeatX	Two-stream heat exchanger	Exchange heat between two streams	Two-stream heat exchangers. Rating shell and tube heat exchangers when geometry is known.
MHeatX	Multistream heat exchanger	Exchange heat between any number of streams	Multiple hot and cold stream heat exchangers. Two-stream heat exchangers. LNG exchangers.
Hetran*	Interface to B-JAC Hetran program	Design and simulate shell and tube heat exchangers	Shell and tube heat exchangers with a wide variety of configurations.
Aerotran*	Interface to B-JAC Aerotran program	Design and simulate air-cooled heat exchangers	Air-cooled heat exchangers with a wide variety of configurations. Model economizers and the convection section of fired heaters.

Columns - Shortcut

Model	Description	Purpose	Use
DSTWU	Shortcut distillation design	Determine minimum RR, minimum stages, and either actual RR or actual stages by Winn-Underwood-Gilliland method.	Columns with one feed and two product streams
Distl	Shortcut distillation rating	Determine separation based on RR, stages, and D:F ratio using Edmister method.	Columns with one feed and two product streams
SCFrac	Shortcut distillation for petroleum fractionation	Determine product composition and flow, stages per section, duty using fractionation indices.	Complex columns, such as crude units and vacuum towers

Columns - Rigorous

Model	Description	Purpose	Use
RadFrac	Rigorous fractionation	Rigorous rating and design for single columns	Distillation, absorbers, strippers, extractive and azeotropic distillation, reactive distillation
MultiFrac	Rigorous fractionation for complex columns	Rigorous rating and design for multiple columns of any complexity	Heat integrated columns, air separators, absorber/stripper combinations, ethylene primary fractionator/quench tower combinations, petroleum refining
PetroFrac	Petroleum refining fractionation	Rigorous rating and design for petroleum refining applications	Preflash tower, atmospheric crude unit, vacuum unit, catalytic cracker or coker fractionator, vacuum lube fractionator, ethylene fractionator and quench towers
BatchFrac**	Rigorous batch distillation	Rigorous rating calculations for single batch columns	Ordinary azeotropic batch distillation, 3-phase, and reactive batch distillation
RateFrac*	Rate-based distillation	Rigorous rating and design for single and multiple columns. Based on nonequilibrium calculations	Distillation columns, absorbers, strippers, reactive systems, heat integrated units, petroleum applications
Extract	Liquid-liquid extraction	Rigorous rating for liquid-liquid extraction columns	Liquid-liquid extraction

* Requires separate license and + Input language only in version 10.0

Reactors

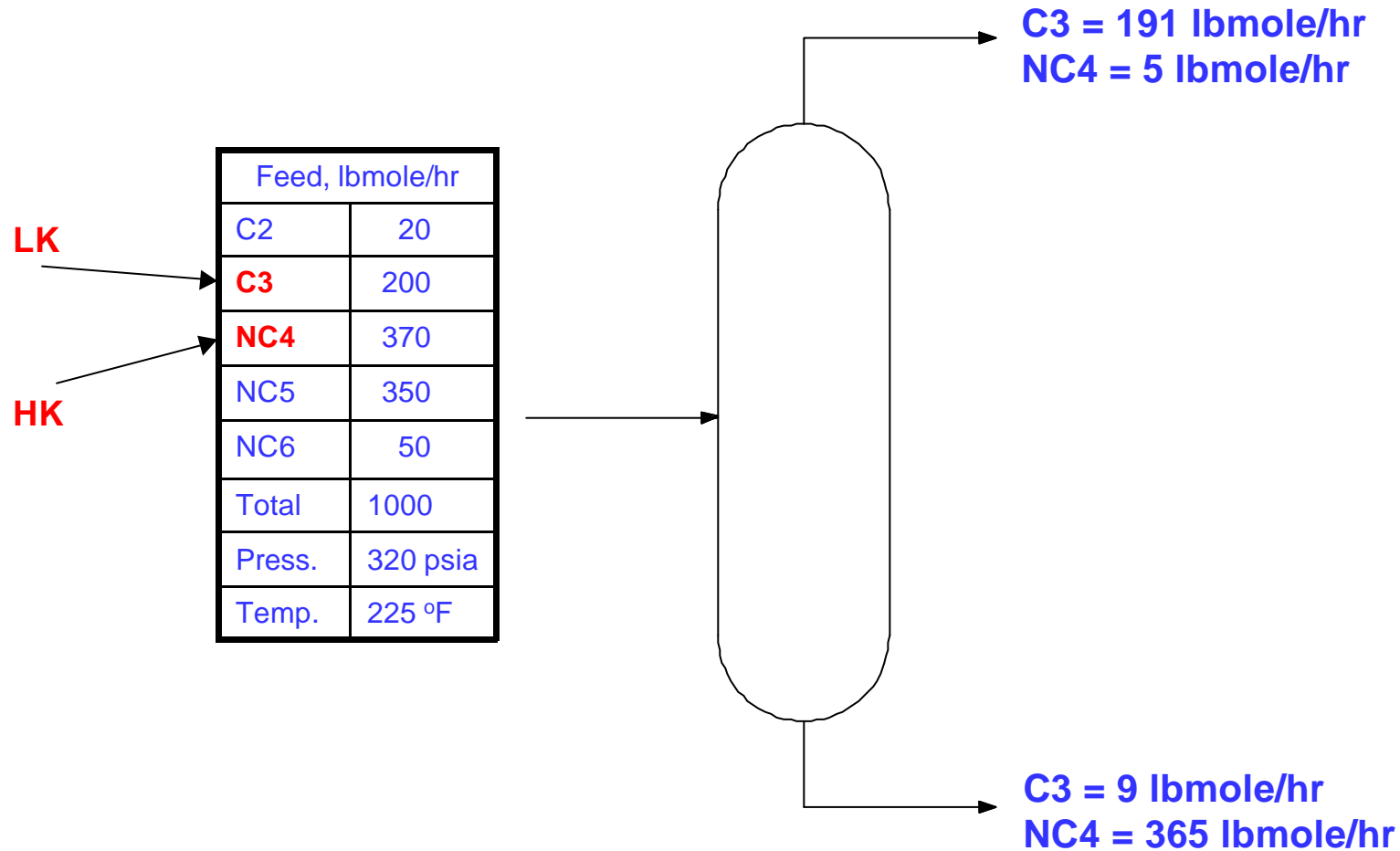
Model	Description	Purpose	Use
RStoic	Stoichiometric reactor	Stoichiometric reactor with specified reaction extent or conversion	Reactors where the kinetics are unknown or unimportant but stoichiometry and extent are known
RYield	Yield reactor	Reactor with specified yield	Reactors where the stoichiometry and kinetics are unknown or unimportant but yield distribution is known
REquil	Equilibrium reactor	Chemical and phase equilibrium by stoichiometric calculations	Single- and two-phase chemical equilibrium and simultaneous phase equilibrium
RGibbs	Equilibrium reactor	Chemical and phase equilibrium by Gibbs energy minimization	Chemical and/or simultaneous phase and chemical equilibrium. Includes solid phase equilibrium.
RCSTR	Continuous stirred tank reactor	Continuous stirred tank reactor	One, two, or three-phase stirred tank reactors with kinetics reactions in the vapor or liquid
RPlug	Plug flow reactor	Plug flow reactor	One, two, or three-phase plug flow reactors with kinetic reactions in any phase. Plug flow reactions with external coolant.
RBatch	Batch reactor	Batch or semi-batch reactor	Batch and semi-batch reactors where the reaction kinetics are known

Pressure Changers

Model	Description	Purpose	Use
Pump	Pump or hydraulic turbine	Change stream pressure when the pressure, power requirement or performance curve is known	Pumps and hydraulic turbines
Compr	Compressor or turbine	Change stream pressure when the pressure, power requirement or performance curve is known	Polytropic compressors, polytropic positive displacement compressors, isentropic compressors, isentropic turbines.
MCompr	Multi-stage compressor or turbine	Change stream pressure across multiple stages with intercoolers. Allows for liquid knockout streams from intercoolers	Multistage polytropic compressors, polytropic positive compressors, isentropic compressors, isentropic turbines.
Valve	Control valve	Determine pressure drop or valve coefficient (CV)	Multi-phase, adiabatic flow in ball, globe and butterfly valves
Pipe	Single-segment pipe	Determine pressure drop and heat transfer in single-segment pipe or annular space	Multi-phase, one dimensional, steady-state and fully developed pipeline flow with fittings
Pipeline	Multi-segment pipe	Determine pressure drop and heat transfer in multi-segment pipe or annular space	Multi-phase, one dimensional, steady-state and fully developed pipeline flow

Ex 2 : Hydrocarbon Distillation

- For the simulation of a depropanizer that involves five normal paraffins: ethane through *n*-hexane.

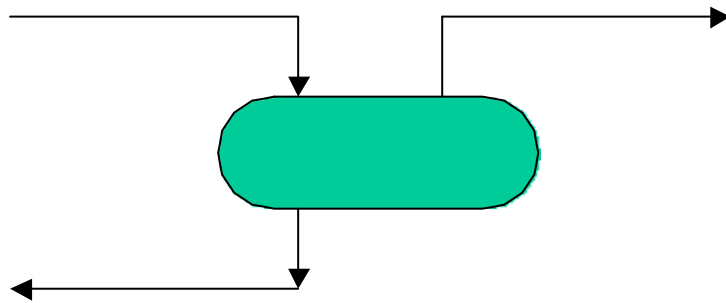


Depropanizer New Design

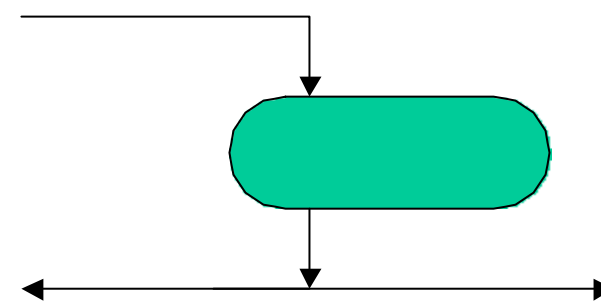
1. Determine the number of tray to obtain:
 - a) C3 recovery at overhead : 99.5 %
 - b) NC4 recovery at overhead : 1.35 %
2. Determine the column pressure, based on a dew point condenser temperature of 130°F.
3. Use RK-Soave (SRK in PRO/II) method for VLE calculation.
4. Find an actual reflux ratio which minimizes the summation of total utility consumptions (*operating costs*) and theoretical number of stages (*capital costs*).

How we can determine the condenser type? or How we can determine the column pressure?

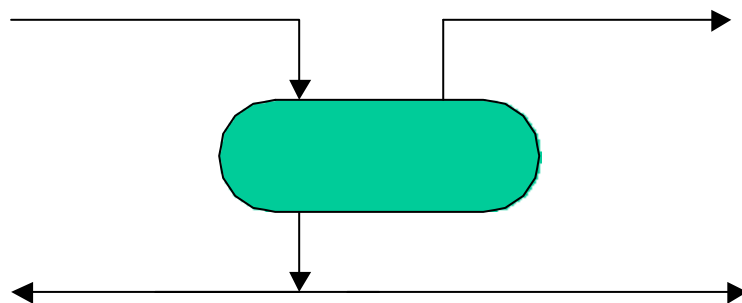
A. Partial



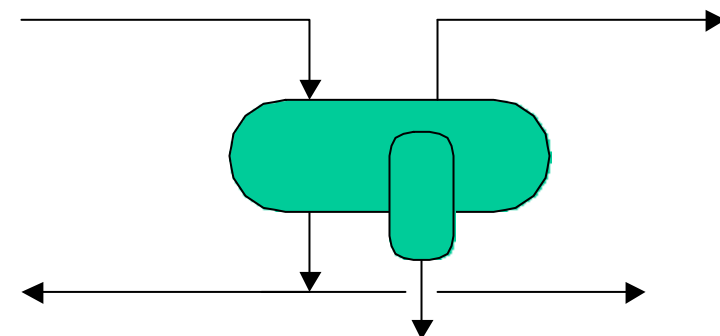
B. Bubble or sub-cooled



C. Mixed



D. Mixed with decanter



It depends on the refrigerant available and overhead compositions to be assumed.

- **Overhead molar flow rate (assume)**
 $C2 = 30, C3 = 191, NC4 = 5$
- **Normalize ! (Component mole %)**
 $C2 = 13.27, C3 = 84.51, NC4 = 2.22$
- **First, we have to determine the dew point pressure !**

Component	Mole %
C2	13.27
C3	84.51
NC4	2.22
Temperature (°F)	130.00
Dew P at 130 °F	?

Dew P Calculation (General Process Information)



The screenshot displays the Aspen Plus software interface for a Dew P Calculation. The window title is "Aspen Plus - DewP - [Setup - Data Browser]". The menu bar includes File, Edit, View, Data, Tools, Run, Plot, Library, Window, and Help. The toolbar contains various icons for file operations and simulation control.

The main window is divided into a left-hand tree view and a right-hand configuration panel. The tree view shows the "Setup" folder expanded, with sub-items like Specifications, Simulation Options, Stream Class, Substreams, Units Sets, Report Options, Components, Properties, Streams, Blocks, BUBBLE, Input, Hcurves, Dynamic, Block Options, Reactions, Convergence, Flowsheeting Options, and Model Analysis Tools. The "Input" sub-item under BUBBLE is selected.

The configuration panel is titled "Global" and contains the following settings:

- Title: Dew Pressure Calculation for the Condenser Pressure
- Units of measurement:
 - Input data: ENG
 - Output results: ENG
- Global settings:
 - Run type: Flowsheet
 - Input mode: Steady-State
 - Stream class: CONVEN
 - Flow basis: Mole
 - Ambient: 14.69595 psi
 - Ambient temp.: 50 F
 - Valid phases: (empty dropdown)
 - Use free water calculations

Below the configuration panel, there is a text field for "Text to appear on each page of the report file. See Help." and a status bar indicating "Input Complete".

The bottom of the interface features a toolbar with tabs for "Mixers/Splitters", "Separators", "Heat Exchangers", "Columns", "Reactors", "Pressure Changers", "Manipulators", "Solids", and "User Models". The "Separators" tab is active, showing icons for "Flash2", "Flash3", "Decanter", "Sep", and "Sep2".

The Windows taskbar at the bottom shows the system tray with the time "오후 6:08" and several open applications including Visio Pro, a Korean document, an Aspen Plus introduction, and a monitor window.

Dew P Calculation (Component Specification)



Aspen Plus - Simulation 1 - [Components Specifications - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Specifications

ENG

Selection Petroleum Nonconventional Databanks

Define components

Component ID	Type	Component name	Formula
C2	Conventional	ETHANE	C2H6
C3	Conventional	PROPANE	C3H8
NC4	Conventional	N-BUTANE	C4H10-1

Find ElecWizard User Defined Reorder

Component ID. If data are to be retrieved from databanks, enter either Component Name or Formula. See Help.

Input Complete

Mixers/Splitters Separators Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS

Flash2 FLASH3 Flash3

Decanter DECANTER Decanter

Sep SEP Sep

Sep2 SEP2 Sep2

For Help, press F1

C:\W...g Folders\WAspen Plus NUM SCRL Required Input Incomplete

시작 Visio Pro... 받은 편... 아스펜소개 MON-1 Aspen ... 오후 5:45

Dew P Calculation (Physical Property Specification)



The screenshot displays the Aspen Plus software interface for a simulation titled "Simulation 1 - [Properties Specifications - Data Browser]". The main window is divided into several sections:

- Specifications Panel (Left):** A tree view showing the simulation structure. The "Specifications" folder is expanded, and the "Global" sub-section is selected.
- Global Properties (Main):** This section is divided into three tabs: "Global" (selected), "Flowsheet Sections", and "Referenced".
 - Property methods & models:** Includes dropdowns for "Process type" (set to ALL), "Base method" (set to RK-SOAVE), and "Henry components".
 - Petroleum calculation options:** Includes dropdowns for "Free-water method" (set to STEAM-TA) and "Water solubility" (set to 3).
 - Electrolyte calculation options:** Includes a "Chemistry ID" dropdown and a checked checkbox for "Use true-components".
 - Property method:** A dropdown menu set to RK-SOAVE.
 - Modify property models:** A group of checkboxes and dropdowns for "EOS" (set to ESRKSTD), "Data set", "Liquid gamma", "Data set", "Liquid enthalpy" (set to HLMX107), and "Liquid volume" (set to VLMX20). There are also checkboxes for "Poynting correction" and "Heat of mixing".
- Equation of State:** A text box at the bottom of the Global tab indicating "Redlich-Kwong-Soave equation of state."

Below the specifications panel, there is a "Streams" section with a tree view. At the bottom of the interface, there is a "Process Flow Diagram" toolbar with icons for "Mixers/Splitters", "Separators", "Heat Exchangers", "Columns", "Reactors", "Pressure Changers", "Manipulators", "Solids", and "User Models". The "Separators" section is active, showing icons for "Flash2", "Flash3", "Decanter", "Sep", and "Sep2".

The status bar at the bottom of the window displays "For Help, press F1", the current directory "C:\W...g Folders\WAspen Plus", and a red warning message "Required Input Incomplete". The Windows taskbar at the very bottom shows the system tray with the time "오후 5:46" and several application icons including Visio Pro, a text editor, and the Aspen Plus application.

Dew P Calculation (Feed Stream Specification)



Aspen Plus - Simulation 1 - [Stream 1 (MATERIAL) - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

1 ENG

Specifications Flash Options PSD Component Attr.

Substream name: **MIXED**

State variables

Temperature: 130 F

Vapor fraction: 0

Total flow: Mole, 1 lbmol/hr

Solvent:

Composition

Mole-Frac

Component	Value
C2	0.1327
C3	0.8451
NC4	0.0222

Total: 1

Lets you type the component flow, fraction or concentration. See Help.

Input Complete

Mixers/Splitters **Separators** Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS

Flash2 FLASH3 Flash3 Decanter SEP Sep SEP2 Sep2

For Help, press F1

C:\W...g Folders\WAspen Plus NUM SCRL Required Input Incomplete

시작 Visio Pro... 받은 편... 아스펜소개 MON-1 Aspen ... 오후 5:47

Dew P Calculation (Performance Specification)



The screenshot displays the Aspen Plus software interface for a simulation. The main window is titled "Aspen Plus - Simulation 1 - [Block BUBBLE (Flash2) Input - Data Browser]". The interface includes a menu bar (File, Edit, View, Data, Tools, Run, Plot, Library, Window, Help), a toolbar with various icons, and a tree view on the left showing the simulation hierarchy. The tree view is expanded to show the "Input" section for the "BUBBLE" block, with "Input" selected. The main panel shows the "Specifications" tab for the "Flash Options" section. The "Flash specifications" section includes a "Temperature" field set to 130 F and a "Vapor fraction" field set to 0. The "Valid phases" section is set to "Vapor-Liquid". A note at the bottom of the specifications panel reads: "Lets you type the molar vapor fraction. 0.0 for bubble point, 1.0 for dew point. For subcooled liquid or superheated vapor use temperature and pressure specifications. See Help." Below the specifications panel, there is a "Material STREAMS" section with a "Flash2" icon. The bottom of the window shows a taskbar with various applications open, including Visio Pro, and a system tray with the time "오후 5:49".

Aspen Plus - Simulation 1 - [Block BUBBLE (Flash2) Input - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Input

Specifications Flash Options Entrainment

Flash specifications

Temperature 130 F

Vapor fraction 0

Valid phases

Vapor-Liquid

Lets you type the molar vapor fraction. 0.0 for bubble point, 1.0 for dew point. For subcooled liquid or superheated vapor use temperature and pressure specifications. See Help.

Input Complete

Mixers/Splitters Separators Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS

Flash2 FLASH3 FLASH3 Flash3

DECANTER DECANTER Decanter

SEP SEP Sep

SEP2 SEP2 Sep2

For Help, press F1

C:\W...g Folders\WAspen Plus NUM SCRL Required Input Incomplete

시작 Visio Pro... 받은 편... 아스펜소개 MON-1 Aspen ... 오후 5:49

Examine Results



Aspen Plus - Simulation 1 - [Block BUBBLE (Flash2) Results - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Results

- Streams
- Blocks
 - BUBBLE
 - Results
 - Stream Results
 - Results Summary

Summary | Balance | Phase Equilibrium

Block results summary

Outlet temperature:	130	F
Outlet pressure:	298.736269	psi
Vapor fraction:	1	
Heat duty:	4852.54609	Btu/hr
Net duty:	4852.54609	Btu/hr
1st liquid / Total liquid:		

Mixers/Splitters | **Separators** | Heat Exchangers | Columns | Reactors | Pressure Changers | Manipulators | Solids | User Models

Material STREAMS

Flash2 | FLASH3 Flash3 | DECANTER Decanter | SEP Sep | SEP2 Sep2

For Help, press F1

C:\W...g Folders\WAspen Plus NUM SCRL Results Available

시작 | Visio Pro... | 받은 편... | 아스펜소개 | MON-1 | Aspen ... | 오후 5:57

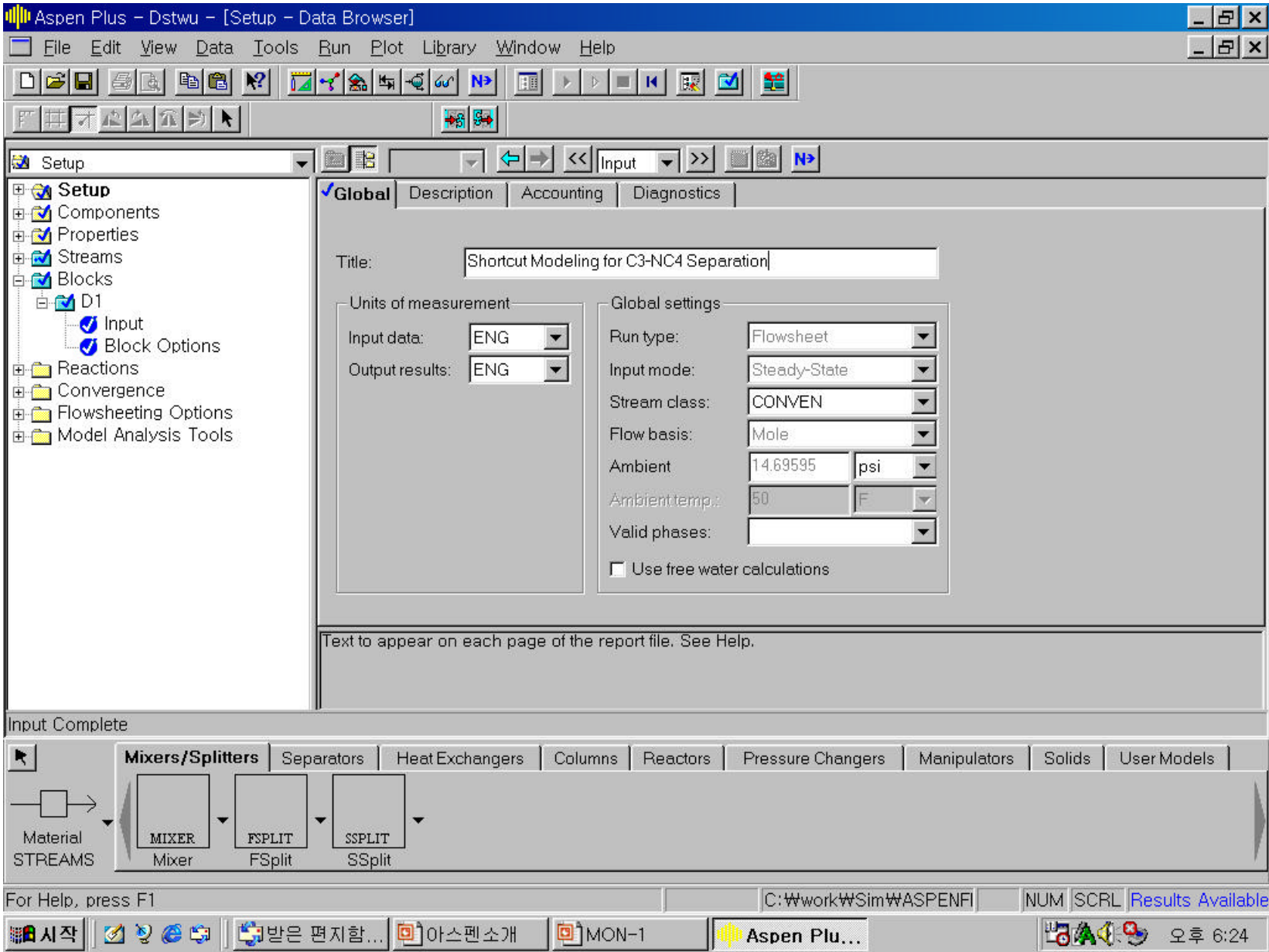
Dew Pressure Calculation Results

- Condenser type = partial condenser
- Condenser operating temperature = 130°F
- Condenser Pressure = 299 psia
- Condenser pressure drop = 4 psia (assumed)
- Column pressure drop = 5 psia (assumed)

DSTWU modeling

- Partial condenser is utilized.
- RR = -1.75 (' - ' means a multiple of minimum reflux ratio.)

DSTWU modeling



The screenshot displays the Aspen Plus software interface, specifically the 'Setup - Data Browser' window. The window title is 'Aspen Plus - Dstwu - [Setup - Data Browser]'. The menu bar includes File, Edit, View, Data, Tools, Run, Plot, Library, Window, and Help. The toolbar contains various icons for file operations and simulation control.

The main area is divided into a left-hand tree view and a right-hand configuration panel. The tree view shows the following structure:

- Setup
 - Components
 - Properties
 - Streams
 - Blocks
 - D1
 - Input
 - Block Options
 - Reactions
 - Convergence
 - Flowsheeting Options
 - Model Analysis Tools

The right-hand panel is titled 'Global' and contains the following settings:

- Title: Shortcut Modeling for C3-NC4 Separation
- Units of measurement:
 - Input data: ENG
 - Output results: ENG
- Global settings:
 - Run type: Flowsheet
 - Input mode: Steady-State
 - Stream class: CONVEN
 - Flow basis: Mole
 - Ambient: 14.69595 psi
 - Ambient temp.: 50 F
 - Valid phases: (empty)
 - Use free water calculations

At the bottom of the window, there is a 'Mixer/Splitters' section with a 'Material STREAMS' input and three options: MIXER (Mixer), FSPLIT (FSplit), and SSPLIT (SSplit). The status bar at the bottom shows 'For Help, press F1', the current directory 'C:\work\Sim\ASPENFI', and the time '오후 6:24'.

DSTWU modeling

Aspen Plus - Dstwu - [Components Specifications - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Specifications ENG Input

Selection Petroleum Nonconventional Databanks

Define components

Component ID	Type	Component name	Formula
C2	Conventional	ETHANE	C2H6
C3	Conventional	PROPANE	C3H8
NC4	Conventional	N-BUTANE	C4H10-1
NC5	Conventional	N-PENTANE	C5H12-1
NC6	Conventional	N-HEXANE	C6H14-1
*			

Find Elec Wizard User Defined Reorder

Component ID. If data are to be retrieved from databanks, enter either Component Name or Formula. See Help.

Mixers/Splitters Separators Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS MIXER FSPLIT SSPLIT Mixer FSplit SSplit

For Help, press F1 C:\work\Sim\WASPENFI NUM SCRL Input Changed

시작 받은 편지함... 아스펜 소개 MON-1 Aspen Plu... 오후 6:25

DSTWU modeling

Aspen Plus - Dstwu - [Properties Specifications - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Specifications

- Setup
 - Components
 - Specifications
 - Assay/Blend
 - Petro Characterization
 - Pseudocomponents
 - Attr-Comps
 - Henry Comps
 - UNIFAC Groups
 - Comp-Groups
 - Comp-Lists
 - Properties
 - Specifications**
 - Property Methods
 - Estimation
 - Molecular Structure
 - Parameters
 - Data
 - Analysis
 - Prop-Sets
 - Advanced
 - Streams
 - Blocks
 - D1

Global | Flowsheet Sections | Referenced

Property methods & models

Process type: ALL

Base method: RK-SOAVE

Henry components:

Property method: RK-SOAVE

Modify property models

EOS: ESRKSTD

Data set: 1

Liquid gamma_t:

Data set:

Liquid enthalpy: HLMX107

Liquid volume: VLMX20

Poynting correction

Heat of mixing

Petroleum calculation options

Free-water method: STEAM-TA

Water solubility: 3

Electrolyte calculation options

Chemistry ID:

Use true-components

All process types.

Mixers/Splitters | Separators | Heat Exchangers | Columns | Reactors | Pressure Changers | Manipulators | Solids | User Models

Material STREAMS

MIXER Mixer

FSPLIT FSplit

SSPLIT SSplit

For Help, press F1

C:\work\Sim\WASPENFI NUM SCRL Input Changed

시작 | 받은 편지함... | 아스펜 소개 | MON-1 | Aspen Plu... | 오후 6:25

DSTWU modeling

Aspen Plus - Dstwu - [Stream FEED (MATERIAL) - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

FEED ENG Input

Specifications Flash Options PSD Component Attr.

Substream name:

State variables:

Temperature:

Pressure:

Total flow:

Solvent:

Composition:

Mole-Flow

Component	Value
C2	30
C3	200
NC4	370
NC5	350
NC6	50

Total:

Lets you select the substream name.

Input Changed, Unreconciled.

Mixers/Splitters Separators Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS

MIXER Mixer FSPLIT FSplit SSPLIT SSplit

For Help, press F1

C:\work\Sim\ASPENFI NUM SCRL Input Changed

시작 받은 편지함... 아스펜 소개 MON-1 Aspen Plu... 오후 6:26

DSTWU modeling

Aspen Plus - Dstwu - [Block D1 (DSTWU) - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

D1 ENG Input

- UNIFAC Groups
 - Comp-Groups
 - Comp-Lists
 - Properties
 - Specifications
 - Property Methods
 - Estimation
 - Molecular Structure
 - Parameters
 - Data
 - Analysis
 - Prop-Sets
 - Advanced
 - Streams
 - BOT
 - DIS
 - FEED
 - Input
 - Blocks
 - D1
 - Input
 - Block Options
 - Reactions
 - Convergence

Specifications | Calculation Options | Convergence

Column specifications:

- Number of stages:
- Reflux ratio:

Pressure:

- Condenser: psi
- Reboiler: psi

Key component recoveries:

Light key:

- Comp:
- Recov:

Heavy key:

- Comp:
- Recov:

Condenser specifications:

- Total condenser
- Partial condenser with all vapor distillate
- Partial condenser with vapor and liquid distillate

Distillate vapor fraction:

Molar reflux ratio:

Input Changed

Mixers/Splitters | Separators | Heat Exchangers | Columns | Reactors | Pressure Changers | Manipulators | Solids | User Models

Material STREAMS

- MIXER Mixer
- FSPLIT FSplit
- SSPLIT SSplit

For Help, press F1

C:\work\Sim\ASPENFI NUM SCRL Input Changed

시작 | 받은 편지함... | 아스펜 소개 | MON-1 | Aspen Plu... | 오후 6:27

DSTWU modeling Results

Aspen Plus - Dstwu - [Block D1 (DSTWU) - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

D1

- Streams
 - BOT
 - DIS
 - FEED
 - Results
- Blocks
 - D1
 - Results
 - Stream Results
- Results Summary

Summary | Balance | **Reflux Ratio Profile**

Results

Minimum reflux ratio:	3.20841414	
Actual reflux ratio:	5.61472475	
Minimum number of stages:	10.9105896	
Number of actual stages:	15.8273677	
Feed stage:	8.71554575	
Number of actual stages above feed:	7.71554575	
Reboiler heating required:	9398579	Btu/hr
Condenser cooling required:	6682894.25	Btu/hr
Distillate temperature:	130.012782	F
Bottom temperature:	282.721306	F

Mixers/Splitters | Separators | Heat Exchangers | Columns | Reactors | Pressure Changers | Manipulators | Solids | User Models

Material STREAMS

- MIXER Mixer
- FSPLIT FSplit
- SSPLIT SSplit

For Help, press F1

C:\work\Sim\WASPENFI NUM SCRL Input Changed

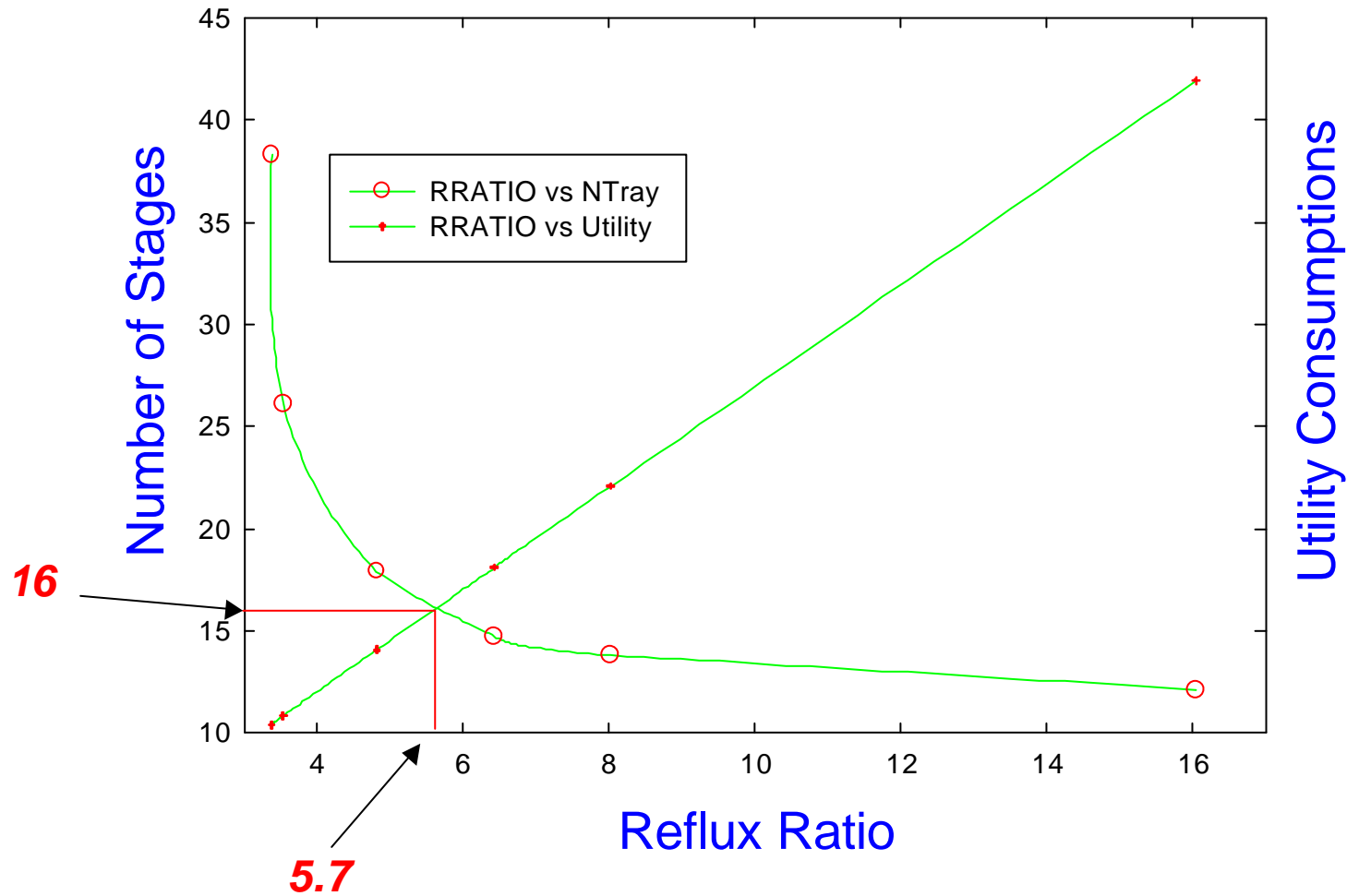
시작 | 받은 편지함... | 아스펜 소개 | MON-1 | Aspen Plu... | 오후 6:35

DSTWU modeling Case Study

R/R _{min}	Number of Tray	Reflux Ratio	Feed Tray	Condenser Duty	Reboiler Duty	Utility
1.00	Infinite	3.21	-	-	-	-
1.05	38.3	3.37	19.7	3.82	6.54	10.36
1.10	26.1	3.53	13.7	4.06	6.77	10.83
1.50	17.9	4.81	9.7	5.67	8.39	14.06
2.00	14.7	6.42	8.0	7.69	10.40	18.09
2.50	13.8	8.02	7.7	9.67	12.39	22.06
5.00	12.1	16.04	6.9	19.60	22.32	41.92
Infinite	10.9	Infinite	-	-	-	-

- Minimum Reflux Ratio = 3.21
- Minimum Number of Stages = 10.9

Reflux Ratio vs. # of Stages & Utility Consumptions



Shortcut Modeling Results using **DSTWU**

- File Name = DSTWU-F.bkp
- Optimum Reflux Ratio = 5.7
- Optimum Number of Stages = 16
- Feed Tray Location = 9
- Partial Condenser Temperature = 130 °F
- Overhead Condenser Heat Duty = 6.79 MM Btu/Hr
- Bottom Reboiler Heat Duty = 9.61 MM Btu/Hr
- C3 Recovery at Overhead Product = 95.5 %
- NC4 Recovery at Overhead Product = 1.34 %

Shortcut Modeling using **DISTIL**

- File Name = DISTIL.bkp
- Modeling using 'DISTIL' is an intermediate step between DSTWU and RadFrac
- DSTWU :
 - N_{min} , R_{min} ,
 - Ratio, R/R_{min}
 - R_{opt} , N_{opt} , $FTRAY_{opt}$
- DISTIL tells us a preliminary modeling results such as condenser, reboiler heat duties, condenser temperature & material balances prior to performing rigorous modeling.

DISTIL (simulation flowshhet)



The screenshot displays the Aspen Plus software interface for configuring a DISTIL block. The window title is "Aspen Plus - Distil - [Block D1 (DISTIL) - Data Browser]". The menu bar includes File, Edit, View, Data, Tools, Run, Plot, Library, Window, and Help. The toolbar contains various icons for file operations and simulation control.

The left sidebar shows a tree view of the process configuration:

- Setup
- Components
- Properties
- Streams
- Blocks
 - D1
 - Input
 - Dynamic
 - Block Options
 - Reactions
 - Convergence
 - Flowsheeting Options
 - Model Analysis Tools

The main panel is divided into two tabs: "Specifications" (selected) and "Convergence".

Specifications Tab:

- Column specifications:**
 - Number of stages: 16
 - Feed stage: 9
 - Reflux ratio: 5.7
 - Distillate to feed mole: 0.226
 - Condenser type: Partial
- Pressure specifications:**
 - Condenser pressure: 299 psi
 - Reboiler pressure: 308 psi

Below the specifications, a text box reads: "Number of theoretical stages, including condenser and reboiler."

The bottom toolbar shows a "Material STREAMS" section with icons for "MIXER Mixer", "FSPLIT FSplit", and "SSPLIT SSplit". Other tabs in the toolbar include Separators, Heat Exchangers, Columns, Reactors, Pressure Changers, Manipulators, Solids, and User Models.

The status bar at the bottom indicates "For Help, press F1", the current file path "C:\work\Sim\ASPENFI", and the number of results "NUM". A "Results Available" button is also present. The Windows taskbar at the very bottom shows the system clock as "오전 11:20".

Comparison between 'DSTWU' and 'DISTIL'

	DSTWU	DISTIL
Reflux Ratio	5.7	5.7
Number of Tray	16	16
Feed Tray Location	9	9
Condenser Temperature	130 °F	134 °F
Condenser Heat Duty	-6.79	-6.94
Reboiler Heat Duty	9.06	9.63
C3 Recovery at Top	95.5 %	93.0 %
NC4 Recovery at Top	1.34 %	2.7 %

RadFrac

- ***Objective:***

Discuss the minimum input required for the RadFrac fractionation model, and the use of design specifications and stage efficiencies

- ***Aspen Plus References:***

Unit Operation Models Reference Manual, Chapter 4, Columns

RadFrac: Rigorous Multistage Separation

- Vapor-Liquid or Vapor-Liquid-Liquid phase simulation of:
 - Ordinary distillation
 - Absorption, reboiled absorption
 - Stripping, reboiled stripping
 - Azeotropic distillation
 - Reactive distillation
- Configuration options:
 - Any number of feeds
 - Any number of side draws
 - Total liquid draw off and pumparounds
 - Any number of heaters
 - Any number of decanters

RadFrac Setup Configuration Sheet

<input checked="" type="checkbox"/> Configuration	<input checked="" type="checkbox"/> Streams	<input checked="" type="checkbox"/> Pressure	<input checked="" type="checkbox"/> Condenser	Reboiler	3-Phase
Setup options					
Number of stages:	9				
Condenser:	Total				
Reboiler:	Kettle				
Valid phases:	Vapor-Liquid				
Convergence:	Standard				
Operating specifications					
Reflux ratio	Mole	1			
Distillate to feed ratio		0.5			
Free water reflux ratio:					Feed basis

- Specify:
 - Number of stages
 - Condenser and reboiler configuration
 - Two column operating specifications
 - Valid phases
 - Convergence

RadFrac Setup Streams Sheet

Configuration
 Streams
 Pressure
 Condenser
 Reboiler
 3-Phase

Feed streams

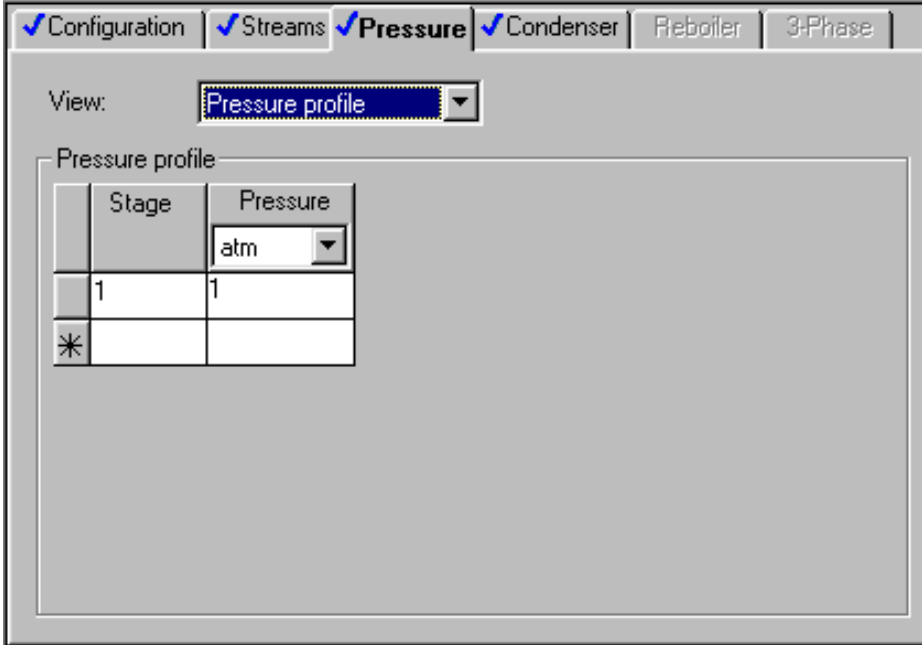
Name	Stage	Convention
FEED	6	Above-Stage

Product streams

Name	Stage	Phase	Basis	Flow
OVHD	1	Liquid	Mole	
BTMS	9	Liquid	Mole	

- Specify:
 - Feed stage location
 - Feed stream convention (see Help)
- ABOVE-STAGE:**
- Vapor from feed goes to stage above feed stage
 - Liquid goes to feed stage
- ON-STAGE:**
- Vapor & Liquid from feed go to specified feed stage

RadFrac Setup Pressure Sheet



View:

Pressure profile

	Stage	Pressure
	1	1
*		

- Specify one of:
 - Column pressure profile
 - Top/Bottom pressure
 - Section pressure drop

RadFrac



Aspen Plus - Simulation 1 - [Setup Specifications - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Specifications

- Setup
 - Specifications
 - Simulation Options
 - Stream Class
 - Substreams
 - Units Sets
 - Report Options
- Components
- Properties
- Streams
- Blocks
- Reactions
- Convergence
- Flowsheeting Options
- Model Analysis Tools
- Results Summary

Global | Description | Accounting | Diagnostics

Title: Rigorous Distillation for C3-NC4 Separation

Units of measurement

Input data: ENG
Output results: ENG

Global settings

Run type: Flowsheet
Input mode: Steady-State
Stream class: CONVEN
Flow basis: Mole
Ambient: 14.69595 psi
Ambient temp.: 50 F
Valid phases:
 Use free water calculations

Text to appear on each page of the report file. See Help.

Input Complete

Mixers/Splitters | Separators | Heat Exchangers | **Columns** | Reactors | Pressure Changers | Manipulators | Solids | User Models

Material STREAMS

DSTWU | DISTL | RadFrac | EXTRACT | MULTIFRAC | SCFRAC | PETROFRAC | RATEFRAC | BATCHFRAC

For Help, press F1 | C:\W...g Folders\WAspen Plus | NUM | SCRL | Required Input Incomplete

시작 | 아스펜 소개 | MON-1 | SigmaPI... | 받은 편... | Aspen ... | 오후 8:43

RadFrac



Aspen Plus - Simulation 1 - [Components Specifications - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Specifications ENG Selection Petroleum Nonconventional Databanks

Define components

Component ID	Type	Component name	Formula
C2	Conventional	ETHANE	C2H6
C3	Conventional	PROPANE	C3H8
NC4	Conventional	N-BUTANE	C4H10-1
NC5	Conventional	N-PENTANE	C5H12-1
NC6	Conventional	N-HEXANE	C6H14-1

Find ElecWizard User Defined Reorder

Component ID. If data are to be retrieved from databanks, enter either Component Name or Formula. See Help.

Input Complete

Mixers/Splitters Separators Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS DSTWU DISTL RadFrac EXTRACT MULTIFRAC SCFRAC PETROFRAC RATEFRAC BATCHFRAC

For Help, press F1 C:\W...g Folders\WAspen Plus NUM SCRL Required Input Incomplete

시작 아스펜 소개 MON-1 SigmaPI... 받은 편... Aspen ... 오후 8:46

RadFrac



Aspen Plus - Simulation 1 - [Properties Specifications - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

Specifications

- Substreams
- Units Sets
- Report Options
- Components
 - Specifications
 - Assay/Blend
 - Petro Characterization
 - Pseudocomponents
 - Attr-Comps
 - Henry Comps
 - UNIFAC Groups
 - Comp-Groups
 - Comp-Lists
- Properties
 - Specifications**
 - Property Methods
 - Estimation
 - Molecular Structure
 - Parameters
 - Data
 - Analysis
 - Prop-Sets
 - Advanced
- Streams

Global | Flowsheet Sections | Referenced

Property methods & models

Process type: ALL
Base method: RK-SOAVE
Henry components:

Petroleum calculation options

Free-water method: STEAM-TA
Water solubility: 3

Electrolyte calculation options

Chemistry ID:

Use true-components

Property method: RK-SOAVE

Modify property models

EOS: ESRKSTD
Data set:
Liquid gamma:
Data set:
Liquid enthalpy: HLMX107
Liquid volume: VLMX20

Poynting correction
 Heat of mixing

Redlich-Kwong-Soave equation of state.

Input Complete

Mixers/Splitters | Separators | Heat Exchangers | **Columns** | Reactors | Pressure Changers | Manipulators | Solids | User Models

Material STREAMS

DSTWU | DISTL | RadFrac | EXTRACT | MULTIFRAC | SCFRAC | PETROFRAC | RATEFRAC | BATCHFRAC

For Help, press F1 | C:\W...g Folders\WAspen Plus | NUM | SCRL | Required Input Incomplete

시작 | 아스펜 소개 | MON-1 | SigmaPI... | 받은 편... | Aspen ... | 오후 8:47

RadFrac



Aspen Plus - Simulation 1 - [Stream 1 (MATERIAL) - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

1 ENG All

Specifications Flash Options PSD Component Attr.

Substream name: MIXED

State variables:

Temperature: 225 F

Pressure: 320 psi

Total flow: 1000 lbmol/hr (Mole)

Solvent:

Composition:

Component	Value
C2	30
C3	200
NC4	370
NC5	350
NC6	50

Total: 1000

Lets you type the component flow, fraction or concentration. See Help.

Input Complete

Mixers/Splitters Separators Heat Exchangers **Columns** Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS

DSTWU DISTL RadFrac EXTRACT MULTIFRAC SCFRAC PETROFRAC RATEFRAC BATCHFRAC

For Help, press F1 C:\W...g Folders\WAspen Plus NUM SCRL Required Input Incomplete

시작 아스펜 소개 MON-1 SigmaPI... 받은 편... Aspen ... 오후 8:48

RadFrac



Aspen Plus - C3-c4-r - [Block B1 (RadFrac) - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

B1 ENG Input

- Configuration
- Streams
- Pressure
- Condenser
- Reboiler
- 3-Phase

Setup options

Number of stages: 16

Condenser: Partial-Vapor

Reboiler: Kettle

Valid phases: Vapor-Liquid

Convergence: Standard

Operating specifications

Reflux ratio: Mole 5.7

Distillate to feed ratio: 0.226

Free water reflux ratio: Feed basis

Number of stages, including condenser and reboiler.

Mixers/Splitters Separators Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS MIXER FSPLIT SSPLIT

For Help, press F1 C:\work\대림산업 NUM Input Changed

시작 받은 편지함 - O... Microsoft Power... Aspen Plus - ... 오후 1:00

RadFrac



Aspen Plus - C3-c4-r - [Block B1 (RadFrac) - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

B1 ENG Input

- Configuration
- Streams**
- Pressure
- Condenser
- Reboiler
- 3-Phase

Feed streams

Name	Stage	Convention
1	9	Above-Stage

Product streams

Name	Stage	Phase	Basis	Flow	Units	Flow ratio	Feed s
2	1	Vapor	Mole		lbmol/hr		Feed
3	16	Liquid	Mole		lbmol/hr		Feed

Feed stage number.

Mixers/Splitters Separators Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS

- MIXER Mixer
- FSPLIT FSplit
- SSPLIT SSplit

For Help, press F1

C:\work\대림산업 NUM Input Changed

시작 받은 편지함 - O... Microsoft Power... Aspen Plus - ... 오후 1:00

RadFrac



Aspen Plus - C3-c4-r - [Block B1 (RadFrac) - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

B1

- Configuration
- Streams
- Pressure**
- Condenser
- Reboiler
- 3-Phase

View: Top / Bottom

Top stage / Condenser pressure

Stage 1 / Condenser pressure: 299 psi

Stage 2 pressure (optional)

Stage 2 pressure: 303 psi

Condenser pressure drop: psi

Pressure drop for rest of column (optional)

Stage pressure drop: psi

Column pressure drop: 5 psi

Mixers/Splitters Separators Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS

MIXER Mixer FSPLIT FSplit SSPLIT SSplit

For Help, press F1

C:\work\대림산업 NUM Input Changed

시작 받은 편지함 - O... Microsoft Power... Aspen Plus - ... 오후 1:01

Comparison between ' DSTWU' , ' DISTIL' , and ' RadFrac1'

	DSTWU	DISTIL	RadFrac1
Reflux Ratio	5.7	5.7	5.7
Number of Tray	16	16	16
Feed Tray Location	9	9	9
Condenser Temperature	130 °F	134 °F	135.3 °F
Condenser Heat Duty	-6.79	-6.94	-7.11
Reboiler Heat Duty	9.06	9.63	9.79
C3 Recovery at Top	95.5 %	93.0 %	92.0 %
NC4 Recovery at Top	1.34 %	2.7 %	3.22 %

RadFrac (Design Spec 1)



The screenshot displays the Aspen Plus software interface for configuring a RadFrac design specification. The window title is "Aspen Plus - C3-c4-r2 - [Block B1 (RadFrac) Design Specs 1 - Data Browser]". The menu bar includes File, Edit, View, Data, Tools, Run, Plot, Library, Window, and Help. The toolbar contains various icons for file operations and simulation control.

The left sidebar shows a tree view of the process design:

- Streams
- Blocks
 - B1
 - Design Specs
 - 1 (selected)
 - 2
 - Vary
 - Results Summary
 - Profiles
 - Stream Results
 - Results Summary

The main area shows the configuration for Design Specification 1:

- Design specification Type: Mole recovery
- Specification Target: 0.955

Below the configuration, a description reads: "Recovery, on a mole basis, of a group of components in a set of product streams."

At the bottom, the "Results Available" section shows "16 Stages" and "0 Pumparound(s)". The "Mixers/Splitters" tab is active, displaying icons for Mixer (MIXER), FSplit (FSPLIT), and SSplit (SSPLIT).

The Windows taskbar at the bottom shows the system clock at 1:16 PM and several open applications, including Microsoft Power...

RadFrac (Design Spec 1)



The screenshot displays the Aspen Plus software interface for configuring a RadFrac distillation column. The main window is titled "Aspen Plus - C3-c4-r2 - [Block B1 (RadFrac) Design Specs 1 - Data Browser]". The interface includes a menu bar (File, Edit, View, Data, Tools, Run, Plot, Library, Window, Help), a toolbar with various icons, and a tree view on the left showing the project structure: Streams, Blocks, B1, Design Specs (1, 2), Vary, Results Summary, Profiles, Stream Results, and Results Summary.

The main panel is divided into several tabs: Specifications, Components, Feed/Product Streams, Options, and Results. The "Components" tab is active, showing two lists of components:

- Components:**
 - Available components: C2, NC4, NC5, NC6
 - Selected components: C3
- Base components:**
 - Available components: C2, C3, NC4, NC5, NC6
 - Selected components: (empty)

Below the component lists, the chemical formula C2H6 and the name "ETHANE" are displayed. At the bottom of the window, there is a "Mixers/Splitters" section with icons for MIXER, FSPLIT, and SSPLIT. The status bar at the very bottom shows "For Help, press F1", the current directory "C:\work\대림산업", the variable "NUM", and the text "Results Available". The Windows taskbar at the bottom indicates the time is "오후 1:16".

RadFrac (Design Spec 1)



Aspen Plus - C3-c4-r2 - [Block B1 (RadFrac) Design Specs 1 - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

1 ENG Results

- Streams
- Blocks
 - B1
 - Design Specs
 - 1
 - 2
 - Vary
 - Results Summary
 - Profiles
 - Stream Results
 - Results Summary

Specifications Components **Feed/Product Streams** Options Results

Product streams

Available streams	Selected streams
3	2

Feed streams as base streams

Available streams	Selected streams
	1

Product streams to include in the specification.

Mixers/Splitters Separators Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS

- MIXER Mixer
- FSPLIT FSplit
- SSPLIT SSplit

For Help, press F1

C:\work\대림산업 NUM Results Available

시작 받은 편지함 - O... Microsoft Power... Aspen Plus - ... 오후 1:17

RadFrac (Variable 1)



The screenshot displays the Aspen Plus Data Browser window for a RadFrac column. The interface includes a menu bar (File, Edit, View, Data, Tools, Run, Plot, Library, Window, Help), a toolbar, and a tree view on the left showing the process hierarchy: Streams, Blocks, B1, Design Specs (1, 2), Vary (1, 2), Results Summary, Profiles, and Stream Results. The main panel is titled 'Specifications' and shows the following configuration for Variable 1:

- Adjusted variable:** Type: **Reflux ratio**
- Upper and lower bounds:** Lower bound: 3.5, Upper bound: 10
- Optional:** Maximum step size: (empty field)

Below the specifications, a text box provides a definition: "Reflux ratio (liquid reflux/distillate) which excludes free water for all cases except when Valid Phases=Vapor-Liquid-FreeWaterAnyStage (Setup Configuration sheet)."

At the bottom of the window, the status bar shows "Results Available" and "16 Stages 0 Pumparound(s)". A component palette is visible, with "Mixers/Splitters" selected, showing options for MIXER (Mixer), FSPLIT (FSplit), and SSPLIT (SSplit).

The Windows taskbar at the bottom shows the system clock at 1:18 PM and the active window is "Aspen Plus - ...".

RadFrac (Design Spec 2)



Aspen Plus - C3-c4-r2 - [Block B1 (RadFrac) Design Specs 2 - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

2 ENG Results

- Streams
- Blocks
 - B1
 - Design Specs
 - 1
 - 2
 - Vary
 - 1
 - 2
 - Results Summary
 - Profiles
 - Stream Results
 - Results Summary

Specifications Components Feed/Product Streams Options Results

Design specification
Type: Mole recovery

Specification
Target: 0.0134

Recovery, on a mole basis, of a group of components in a set of product streams.

Results Available 16 Stages 0 Pumparound(s)

Mixers/Splitters Separators Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS MIXER Mixer FSPLIT FSplit SSPLIT SSplit

For Help, press F1 C:\work\대림산업 NUM Results Available

시작 받은 편지함 - O... Microsoft Power... Aspen Plus - ... 오후 1:19

RadFrac (Design Spec 2)



The screenshot displays the Aspen Plus software interface for configuring a RadFrac distillation column. The window title is "Aspen Plus - C3-c4-r2 - [Block B1 (RadFrac) Design Specs 2 - Data Browser]". The menu bar includes File, Edit, View, Data, Tools, Run, Plot, Library, Window, and Help. The toolbar contains various icons for file operations and simulation control.

The main window is divided into several sections:

- Left Panel (Tree View):** Shows a hierarchical structure of the design. Under "Blocks", "B1" is expanded to show "Design Specs" (with sub-items 1 and 2), "Vary" (with sub-items 1 and 2), "Results Summary", "Profiles", and "Stream Results".
- Top Panel (Tabs):** Includes "Specifications", "Components", "Feed/Product Streams", "Options", and "Results". The "Components" tab is currently active.
- Components Section:** Contains two lists of components with transfer buttons. The top list, "Components", has "Available components" (C2, C3, NC5, NC6) and "Selected components" (NC4). The bottom list, "Base components", has "Available components" (C2, C3, NC4, NC5, NC6) and an empty "Selected components" list.
- Bottom Panel (Equipment Selection):** Features a "Material STREAMS" icon and a row of equipment selection buttons: "MIXER Mixer", "FSPLIT FSplit", and "SSPLIT SSplit".

At the bottom of the window, a status bar shows "For Help, press F1", the current directory "C:\work\대림산업", the variable "NUM", and the text "Results Available". The Windows taskbar at the very bottom shows the system tray with the time "오후 1:19" and several application icons, including "시작", "받은 편지함", "Microsoft Power...", and "Aspen Plus - ...".

RadFrac (Design Spec 2)



Aspen Plus - C3-c4-r2 - [Block B1 (RadFrac) Design Specs 2 - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

2 ENG Results

- Streams
- Blocks
 - B1
 - Design Specs
 - 1
 - 2
 - Vary
 - 1
 - 2
 - Results Summary
 - Profiles
 - Stream Results
 - Results Summary

Specifications Components **Feed/Product Streams** Options Results

Product streams

Available streams: 3
Selected streams: 2

Feed streams as base streams

Available streams:
Selected streams: 1

Product streams to include in the specification.

Mixers/Splitters Separators Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS MIXER Mixer FSPLIT FSplit SSPLIT SSplit

For Help, press F1 C:\work\대림산업 NUM Results Available

시작 받은 편지함 - O... Microsoft Power... Aspen Plus - ... 오후 1:20

RadFrac (Variable 2)



Aspen Plus - C3-c4-r2 - [Block B1 (RadFrac) Vary 2 - Data Browser]

File Edit View Data Tools Run Plot Library Window Help

2 ENG Results

- Streams
- Blocks
 - B1
 - Design Specs
 - 1
 - 2
 - Vary
 - 1
 - 2
 - Results Summary
 - Profiles
 - Stream Results
 - Results Summary

Specifications Components Results

Adjusted variable

Type: **Distillate to feed ratio**

Upper and lower bounds

Lower bound: 0.2

Upper bound: 0.4

Optional

Maximum step size:

Molar ratio of distillate flow rate to feed flow rate.

Results Available 16 Stages 0 Pumparound(s)

Mixers/Splitters Separators Heat Exchangers Columns Reactors Pressure Changers Manipulators Solids User Models

Material STREAMS

- MIXER Mixer
- FSPLIT FSplit
- SSPLIT SSplit

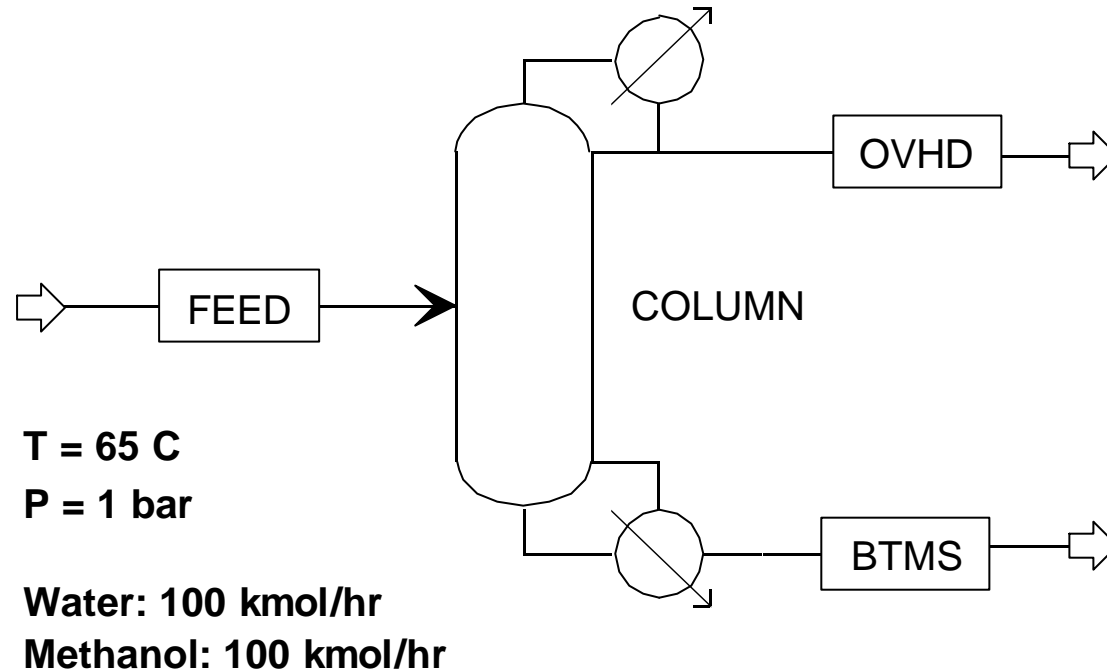
For Help, press F1 C:\work\대림산업 NUM Results Available

시작 받은 편지함 - O... Microsoft Power... Aspen Plus - ... 오후 1:20

Comparison between ' DSTWU' , ' DISTIL' , ' RadFrac1' & ;RadFrac2

	DSTWU	DISTIL	RadFrac1	RadFrac2
Reflux Ratio	5.7	5.7	5.7	9.14
Number of Tray	16	16	16	16
Feed Tray Location	9	9	9	9
Condenser Temperature	130 °F	134 °F	135.3 °F	130 °F
Condenser Heat Duty	-6.79	-6.94	-7.11	-10.95
Reboiler Heat Duty	9.06	9.63	9.79	13.67
C3 Recovery at Top	95.5 %	93.0 %	92.0 %	95.5 %
NC4 Recovery at Top	1.34 %	2.7 %	3.22 %	1.34 %

Methanol-Water RadFrac Column



RadFrac specifications

Total Condenser

Kettle Reboiler

9 Stages

Reflux Ratio = 1

Distillate to feed ratio = 0.5

Column pressure = 1 bar

Feed stage = 6

Use the NRTL-RK Property Method

Filename: RAD-EX.BKP

RadFrac Options



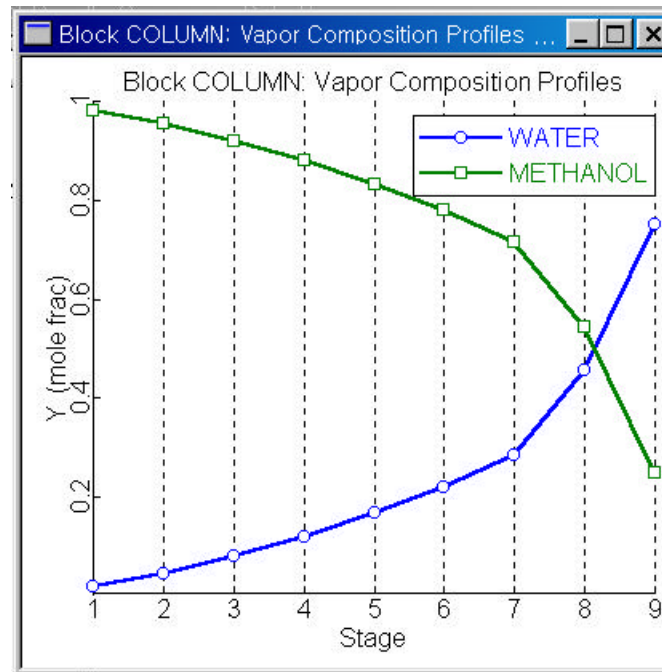
- To set up an absorber with no condenser or reboiler, set condenser and reboiler to none on the *RadFrac Setup Configuration* sheet.
- Either Vaporization or Murphree efficiencies on either a stage or component basis can be specified on the *RadFrac Efficiencies* form.
- Tray and packed column design and rating is possible.
- A Second liquid phase may be modeled if the user selects Vapor-liquid-liquid as Valid phases.
- Reboiler and condenser heat curves can be generated.

Plot Wizard

- Use Plot Wizard (on the Plot menu) to quickly generate plots of results of a simulation. You can use Plot Wizard for displaying results for the following operations:
 - Physical property analysis
 - Profiles for all separation models RadFrac, MultiFrac, PetroFrac and RateFrac
- Click the object of interest in the Data Browser to generate plots for that particular object.
- The wizard guides you in the basic operations for generating a plot.
- Click on the Next button to continue. Click on the Finish button to generate a plot with default settings.

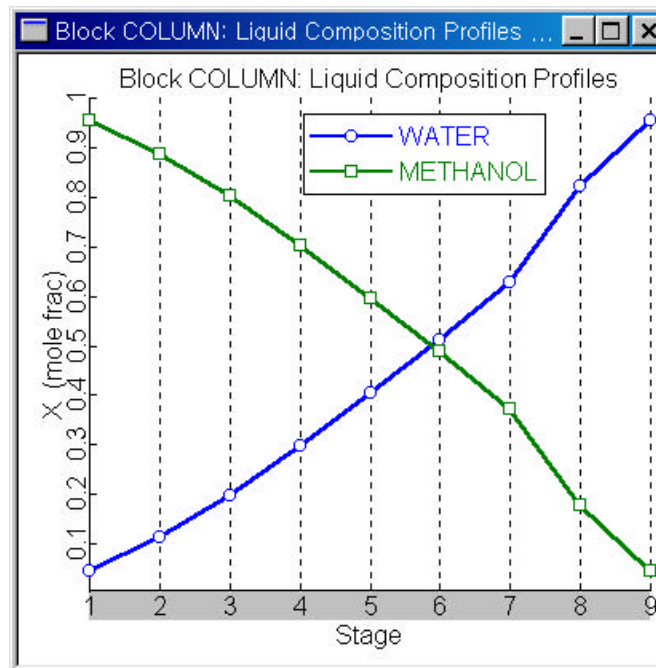
Plot Wizard Demonstration (1)

- Use the plot wizard on the column to create a plot of the *vapor phase compositions* throughout the column.



Plot Wizard Demonstration (2)

- Use the plot wizard on the column to create a plot of the *liquid phase compositions* throughout the column.



RadFrac DesignSpecs and Vary



- Design specifications can be specified and executed inside the RadFrac block using the *DesignSpecs* and *Vary* forms.
- One or more RadFrac inputs can be manipulated to achieve specifications on one or more RadFrac performance parameters.
- The number of specs should, in general, be equal to the number of varies.
- The DesignSpecs and Varys in a RadFrac are solved in a “Middle loop.” If you get an error message saying that the middle loop was not converged, check the DesignSpecs and Varys you have entered.

RadFrac Convergence Problems



If a RadFrac column fails to converge, doing one or more of the following could help:

1. Check that physical property issues (choice of Property Method, parameter availability, etc.) are properly selected.
2. Ensure that column operating conditions are feasible.
3. If the column err/tol is decreasing fairly consistently, increase the maximum iterations on the *RadFrac Convergence Basic* sheet.

RadFrac Convergence Problems

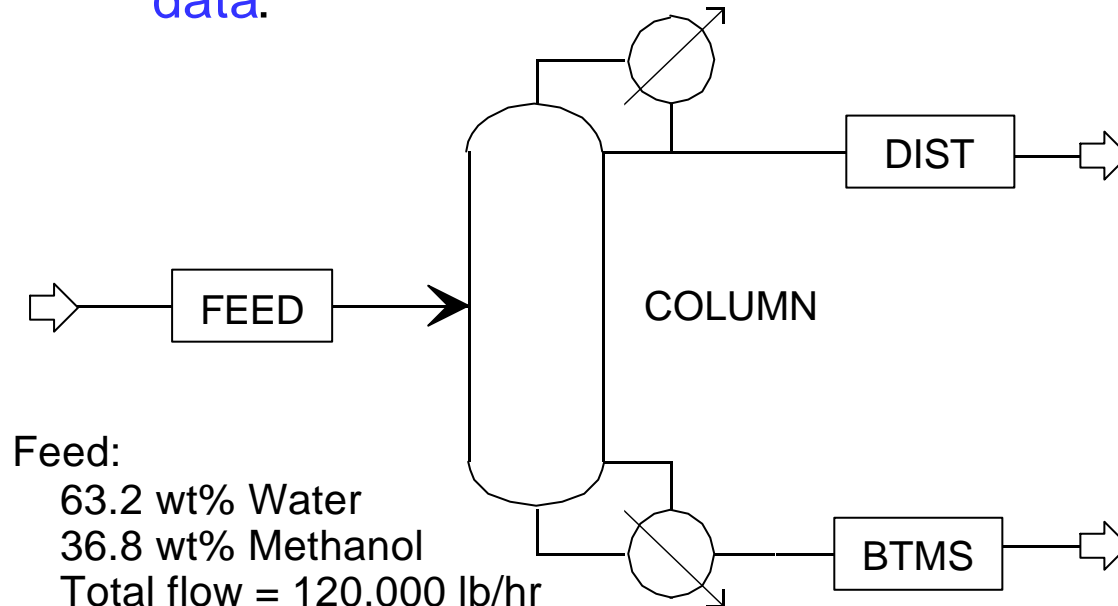
(Continued)

4. Provide temperature estimates for some stages in the column using the *RadFrac Estimates Temperature* sheet (useful for absorbers).
 5. Provide composition estimates for some stages in the column using the *RadFrac Estimates Liquid Composition* and *Vapor Composition* sheet (useful for highly non-ideal systems).
 6. Experiment with different convergence methods on the *RadFrac Setup Configuration* sheet.
- >> When a column does not converge, it is usually beneficial to Reinitialize after making changes.

RadFrac Workshop

Part A:

- Perform a rating calculation of a Methanol tower using the following data:



Feed:

63.2 wt% Water
36.8 wt% Methanol
Total flow = 120,000 lb/hr
Pressure 18 psia
Saturated liquid

Column specification:

38 trays (40 stages)
Feed tray = 23 (stage 24)
Total condenser
Top stage pressure = 16.1 psia
Pressure drop per stage = 0.1 psi
Distillate flowrate = 1245 lbmol/hr
Molar reflux ratio = 1.3

Use

- 1) Ideal Raoult's Law
- 2) NRTL Property Method
- 3) NRTL-RK Property Method
- 4) RK-Soave Property Method

Filename: RADFRAC.BKP

RadFrac Workshop

(Continued)

Part B:

- Set up design specifications within the column so the following two objectives are met:
 - 99.95 wt% methanol in the distillate
 - 99.90 wt% water in the bottoms
- To achieve these specifications, you can vary the distillate rate (800-1700 lbmol/hr) and the reflux ratio (0.8-2). Make sure stream compositions are reported as mass fractions before running the problem. Note the condenser and reboiler duties:

Condenser Duty : _____

Reboiler Duty : _____

Heat Exchangers

- ***Objective:***

Introduce the unit operation models used for heat exchangers and heaters.

- ***Aspen Plus References:***

- *Unit Operation Models Reference Manual, Chapter 3, Heat Exchangers*

Heat Exchanger Blocks

- Heater - Heater or cooler
- HeatX - Two stream heat exchanger
- MHeatX - Multi-stream heat exchanger
- Hetran - Interface to B-JAC Hetran block
- Aerotran - Interface to B-JAC Aerotran block

Working with the Heater Model



The Heater block mixes multiple inlet streams to produce a single outlet stream at a specified thermodynamic state.

Heater can be used to represent:

- Heaters
- Coolers
- Valves
- Pumps (when work-related results are not needed)
- Compressors (when work-related results are not needed)

Heater can also be used to set the thermodynamic conditions of an outlet stream.

Heater Input Specifications



Allowed combinations:

- Pressure (or Pressure drop) and one of:
 - Outlet temperature
 - Heat duty or inlet heat stream
 - Vapor fraction
 - Temperature change
 - Degrees of sub-cooling or superheating
- Outlet Temperature or Temperature change and one of:
 - Pressure
 - Heat Duty
 - Vapor fraction

Heater Input Specifications *(Continued)*



For single phase use Pressure (drop) and one of:

- Outlet temperature
- Heat duty or inlet heat stream
- Temperature change

Vapor fraction of 1 means dew point condition,
0 means bubble point

Working with the HeatX Model

- HeatX can perform simplified or rigorous rating calculations.
- Simplified rating calculations (heat and material balance calculations) can be performed if exchanger geometry is unknown or unimportant.
- For rigorous heat transfer and pressure drop calculations, the heat exchanger geometry must be specified.

HeatX Workshop

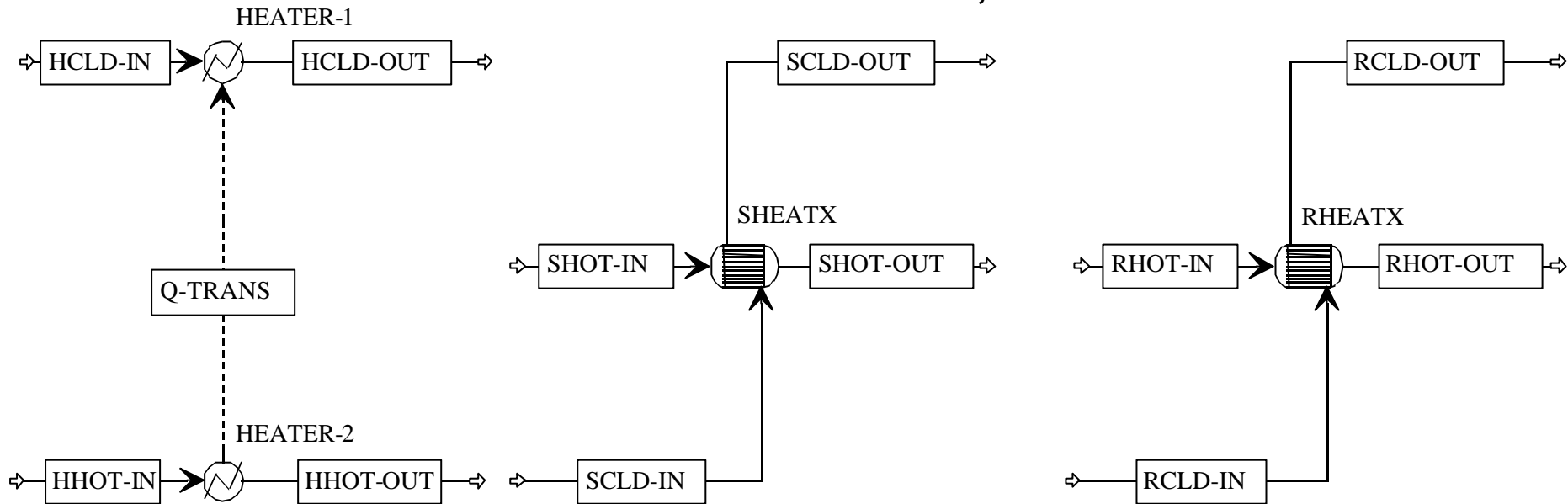


Objective: Compare the simulation of a heat exchanger that uses water to cool a hydrocarbon mixture using three methods: a shortcut HeatX, a rigorous HeatX and two Heaters connected with a Heat stream.

- **Hydrocarbon stream**
 - Temperature: 200 C
 - Pressure: 4 bar
 - Flowrate: 10000 kg/hr
 - Composition: 50 wt% benzene, 20% styrene, 20% ethylbenzene and 10% water
- **Cooling water**
 - Temperature: 20 C
 - Pressure: 10 bar
 - Flow rate: 60000 kg/hr
 - Composition: 100% water

HeatX Workshop *(Continued)*

When finished, save as filename: **HEATX.BKP**



Use the NRTL-RK Property Method for the hydrocarbon streams.

Specify that the valid phases for the hydrocarbon stream is Vapor-Liquid-Liquid.

Specify that the Steam Tables are used to calculate the properties for the cooling water streams on the Block BlockOptions Properties sheet.

Start with the General with Metric Units Template.

HeatX Workshop *(Continued)*



- Shortcut HeatX simulation:
 - Hydrocarbon stream exit has a vapor fraction of 0
 - No pressure drop in either stream
- Two Heaters simulation:
 - Use the same specifications as the shortcut HeatX simulation
- Rigorous HeatX simulation:
 - Hydrocarbons in shell leave with a vapor fraction of 0
 - Shell diameter 1 m, 1 tube pass
 - 300 bare tubes, 3 m length, pitch 31 mm, 21 mm ID, 25 mm OD
 - All nozzles 100 mm
 - 5 baffles, 15% cut
 - Create heat curves containing all info required for thermal design.
 - Change the heat exchanger specification to Geometry and re-run.

Pressure Changers

Objective:

Introduce the unit operation models used to change pressure: pumps, compressors, and models for calculating pressure change through pipes and valves.

Aspen Plus References:

Unit Operation Models Reference Manual, Chapter 6,
Pressure Changers

Pressure Changer Blocks

- Pump - Pump
- Compr - Compressor or turbine
- MCompr - Multi-stage compressor or turbine
- Valve - Control valve or Pressure Let-down Valve
- Pipe - Single-segment pipe
- Pipeline - Multi-segment pipe

Reactor Models

Objective:

Introduce the various classes of reactor models available, and examine in some detail at least one reactor from each class

Aspen Plus References:

Unit Operation Models Reference Manual, Chapter 5, Reactors

Reactor Overview

