Shortcut Distillation

Spoken Tutorial Project
http://spoken-tutorial.org

National Mission on Education through ICT
http://sakshat.ac.in

Rahul, Neelesh, Kannan
IIT Bombay

28 May 2015

Learning Objectives

We will simulate a shortcut distillation column:

- **Minimum number of stages**
- **Minimum reflux ratio**
- **Optimal feed stage location**
- **Condenser and reboiler heat duty**

to achieve a particular product specification

System Requirements

- **DWSIM 3.4**
- **Any OS: Windows, Linux, Mac OS X or FOSSEE OS on ARM**

Prerequisites

To practice this tutorial you should know

- **How to add components to a flowsheet**
- **How to select thermodynamic packages**
- **How to add material streams and specify their properties**

Prerequisite tutorials are mentioned on our website, http://spoken-tutorial.org

Specifications

Components	Benzene, Toluene	
Feed	Flow rate	100 Kmol/h
	Mole fraction	$x_F = 0.4$
	Temperature	Saturated liquid
	Pressure	1 atm
Reflux ratio	2	
Product	Distillate	$x_D = 0.95$
	Bottoms	$x_B = 0.05$

All mole fractions x refer to benzene

Reference: W. Luyben, Distillation design and control using ASPEN simulation, John Wiley & Sons, Inc., Hoboken NJ, 2013

Our solution approach

- **Thermodynamics: Raoult's law**
- **Method: Fenske-Underwood-Gilliland**

Results

Parameter	Value
Min. reflux ratio	1.47
Min. no. of stages	7
Actual no. of stages	14
Optimal feed location	6

These values are in agreement with Prof. Bill Luyben's results

Summary

- We learnt how to specify a shortcut distillation column
- To specify key components, purities, and minimum reflux ratio
- To use custom units
- To calculate
  - minimum reflux ratio
  - optimal feed location and
  - total number of trays

Assignment 1: Verify Mass Balance

- **Verify if the total flow rate in Feed = sum of that in Bottoms and Distillate**
- **Repeat the above for overall flow**

Assignment 2: Verify Energy Balance

- **Verify if the energy content of Feed+ energy input through R-Duty = sum of energy content of Distillate and Bottoms, and energy removed by C-Duty**

Assignment 3: Purity vs. Energy

- **Repeat the simulation for different product purities**
- **Calculate the energy requirement for each simulation**
- **Can you interpret the results?**

Assignment 4: Repeat

- **Repeat this simulation with different thermodynamics**
- **Repeat this simulation with different feed conditions**
- **Try to reason your results**

About the Spoken Tutorial Project

- **Watch the video available at http://spoken-tutorial.org /What_is_a_Spoken_Tutorial**
- **It summarises the Spoken Tutorial project**

About the Spoken Tutorial Project

- Watch the video available at http://spoken-tutorial.org/What_is_a_Spoken_Tutorial
- It summarises the Spoken Tutorial project
- If you do not have good bandwidth, you can download and watch it

Spoken Tutorial Workshops

The Spoken Tutorial Project Team

- **Conducts workshops using spoken tutorials**
- **Gives certificates to those who pass an online test**
- **For more details, please write to contact@spoken-tutorial.org**

Forum to answer questions

- **Do you have questions in THIS Spoken Tutorial?**
- **Choose the minute and second where you have the question.**
- **Explain your question briefly.**
- **Someone from the FOSSEE team will answer them.**

Please visit http://forums.spoken-tutorial.org/

Textbook Companion Project

- **The FOSSEE team coordinates coding of solved examples of popular books**
- **We give honorarium and certificate to those who do this**

For more details, please visit this site:

http://dwsim.fossee.in/Textbook_Companion_Project

Lab Migration Project

- **The FOSSEE team helps migrate commercial simulator labs to DWSIM**
- **We give honorarium and certificates to those who do this**

For more details, please visit this site:

http://dwsim.fossee.in/lab-migration-project

Acknowledgements

- **Spoken Tutorial and FOSSEE are funded by the National Mission on Education through ICT, MHRD, Government of India**
- **More information on this mission is available at**

  http://spoken-tutorial.org/NMEICT-Intro

Thanks!

http://dwsim.inforside.com.br/