Aspen Plus® Videos for Chemical Engineering Undergraduates

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Paper 263b

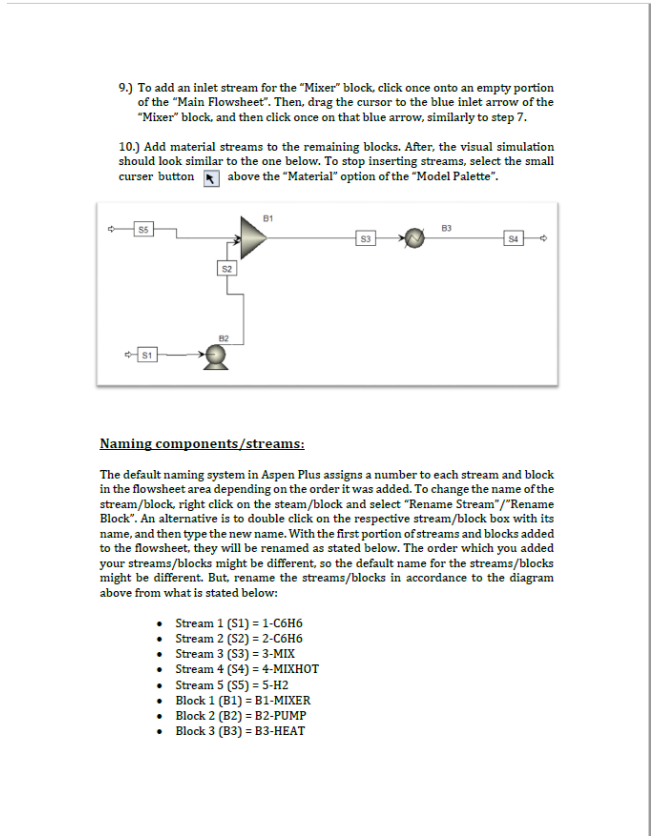
What & Why Aspen Plus®?

- Chemical process simulator
- Solve complex systems
  - Efficiently
  - User friendly
- Industry
  - Process engineering
  - Design

www.aspentech.com

Introducing Aspen Plus®

- Aspen Plus® in the C&PE curriculum
  - Lecture, design, laboratory courses
- Educational methods developed
  - Written handouts
  - Video modules
- How we apply them:
  - In-class lecture
  - Post video & handouts on **Blackboard®**



9.) To add an inlet stream for the "Mixer" block, click once onto an empty portion of the "Main Flowsheet". Then, drag the cursor to the blue inlet arrow of the "Mixer" block, and then click once on that blue arrow, similarly to step 7.

10.) Add material streams to the remaining blocks. After, the visual simulation should look similar to the one below. To stop inserting streams, select the small curser button above the "Material" option of the "Model Palette".

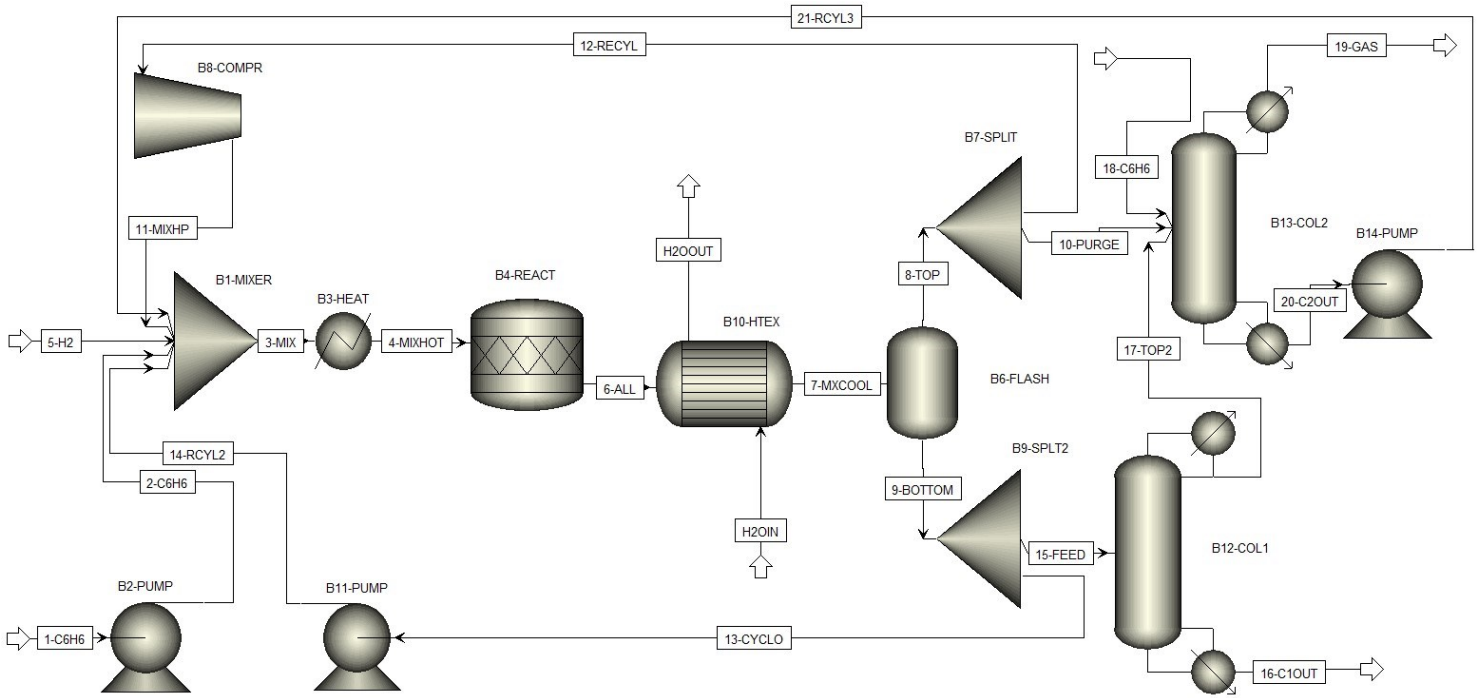
Naming components/streams:

The default naming system in Aspen Plus assigns a number to each stream and block in the flowsheet area depending on the order it was added. To change the name of the stream/block, right click on the steam/block and select "Rename Stream"/"Rename Block". An alternative is to double click on the respective stream/block box with its name, and then type the new name. With the first portion of streams and blocks added to the flowsheet, they will be renamed as stated below. The order which you added your streams/blocks might be different, so the default name for the streams/blocks might be different. But, rename the streams/blocks in accordance to the diagram above from what is stated below:

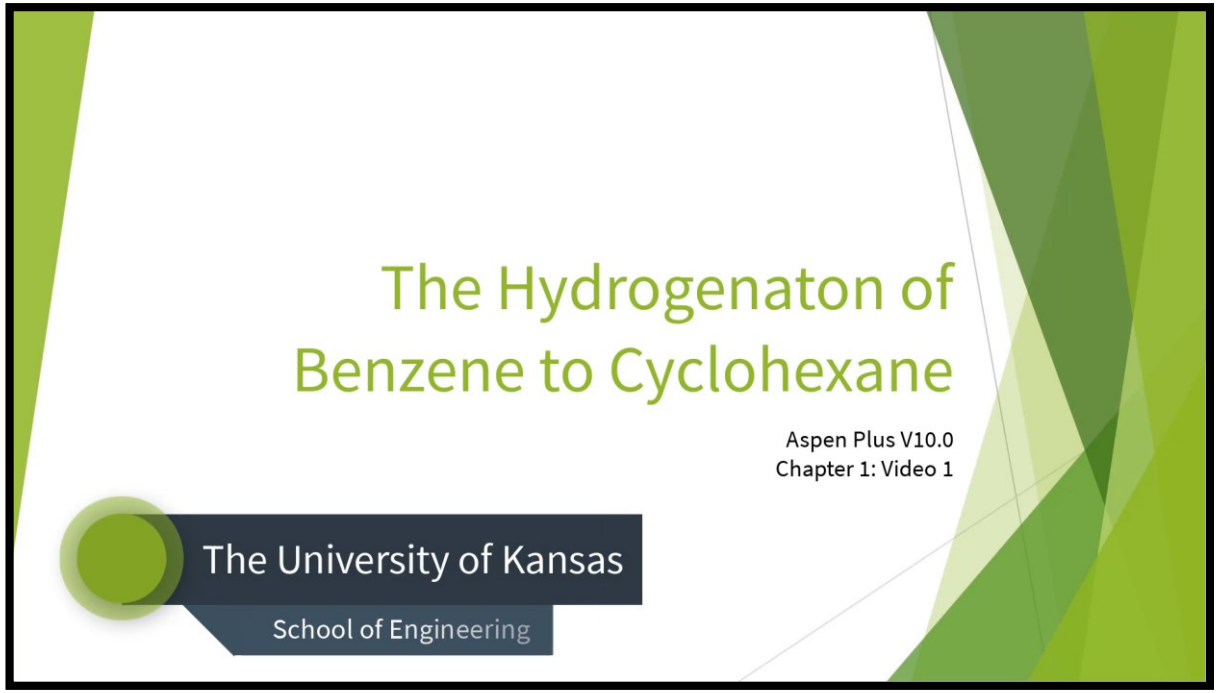
- Stream 1 (S1) = 1-C6H6
- Stream 2 (S2) = 2-C6H6
- Stream 3 (S3) = 3-MIX
- Stream 4 (S4) = 4-MIXHOT
- Stream 5 (S5) = 5-H2
- Block 1 (B1) = B1-MIXER
- Block 2 (B2) = B2-PUMP
- Block 3 (B3) = B3-HEAT

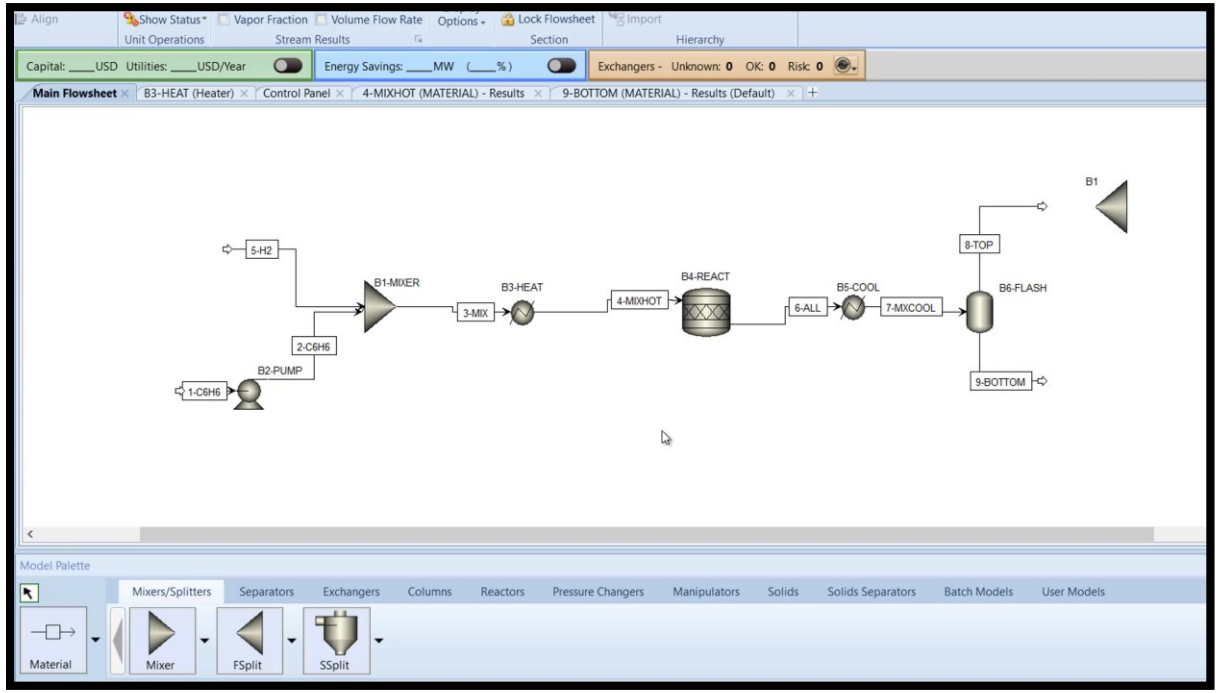
To Start: Material & Energy Balances

- MEB calculations
  - Control volume, temperature, pressure, enthalpy
- Unit operations
  - Reactors
  - Flash distillation
- ***Hydrogenation of Benzene to Cyclohexane***

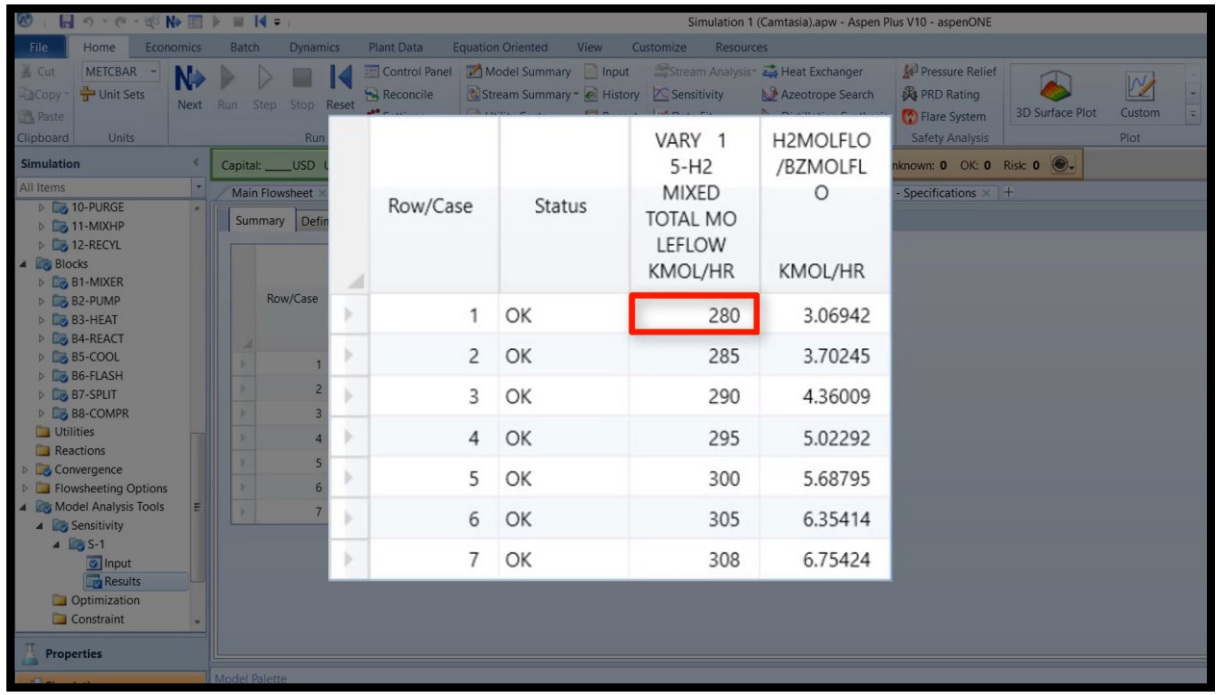


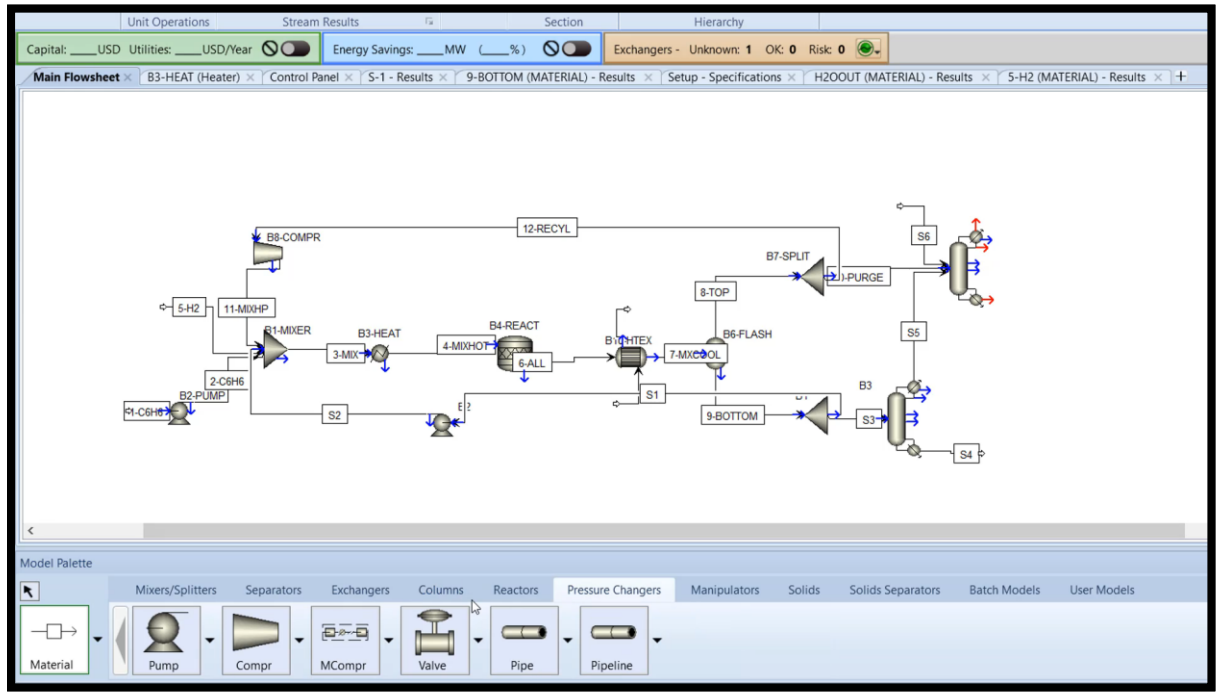
Videos


The Hydrogenaton of Benzene to Cyclohexane
Aspen Plus V10.0
Chapter 1: Video 1
The University of Kansas
School of Engineering


Main Flowsheet
B3-HEAT (Heater)
Control Panel
4-MIXHOT (MATERIAL) - Results
9-BOTTOM (MATERIAL) - Results (Default)
5-H2
2-C6H6
1-C6H6
B2-PUMP
B1-MIXER
3-MIX
B3-HEAT
4-MIXHOT
B4-REACT
6-ALL
B5-COOL
7-MXCOOL
B6-FLASH
8-TOP
B1
9-BOTTOM
Model Palette
Mixers/Splitters
Separators
Exchangers
Columns
Reactors
Pressure Changers
Manipulators
Solids
Solids Separators
Batch Models
User Models
Material
Mixer
FSplit
SSplit

Videos

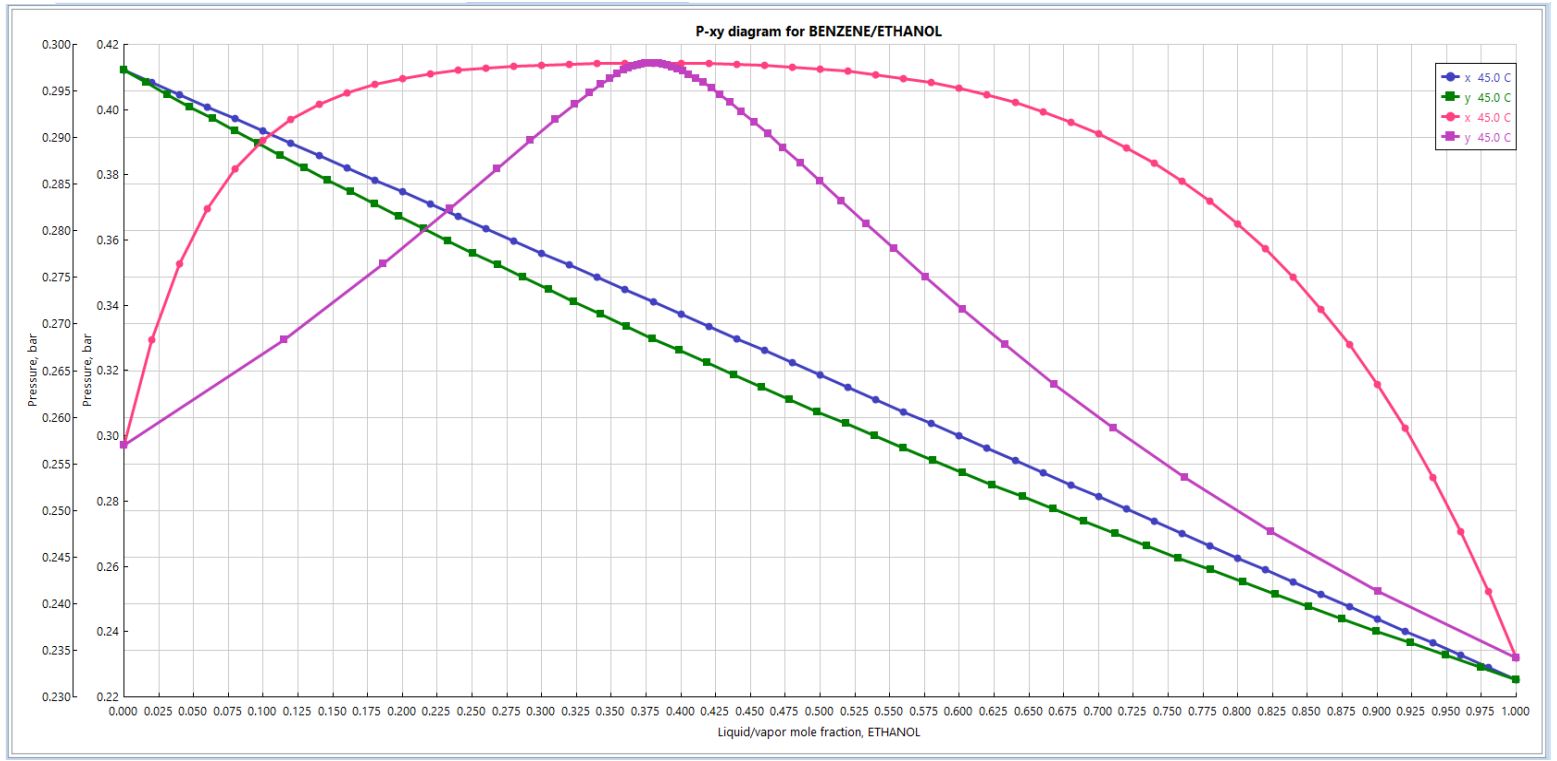




9-part video series

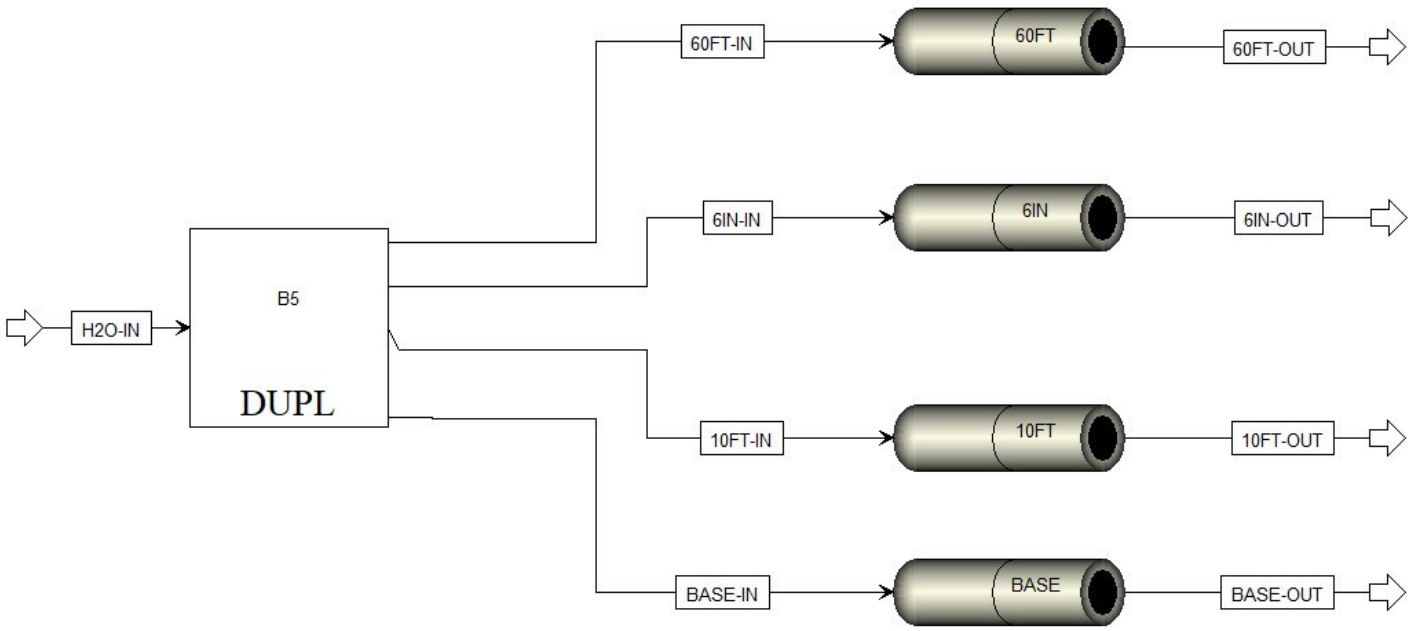
Chemical Engineering Thermodynamics II

- Multi-component interactions
- Fugacity expressions
- Equilibrium
  - Criteria
  - **VLE**
  - **Activity coefficients & different models**



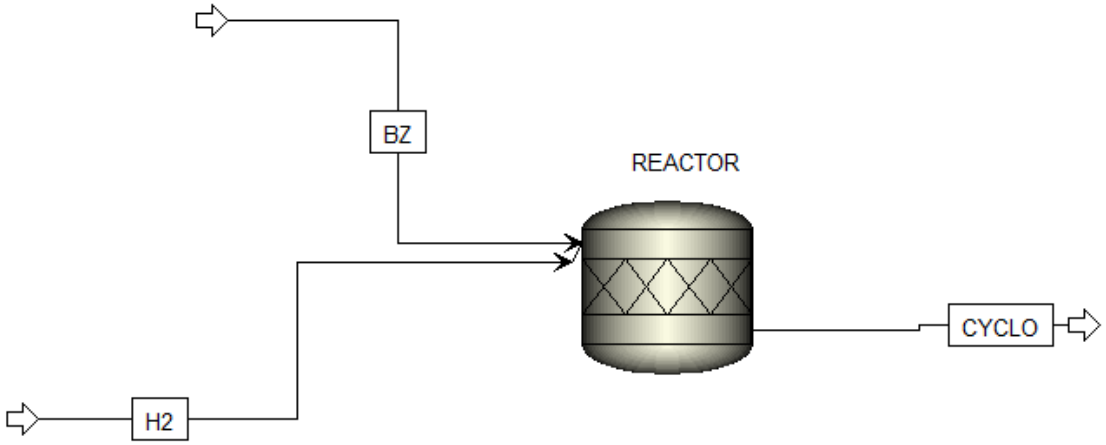
Momentum Transfer

- Navier-Stokes
- Bernoulli's Equation
  - Pipes
    - Reynolds number
    - Friction Factor
    - **Pressure drop**
  - Future: **Pumps**



Economic Appraisal

- Present worth of a project (Benzene to Cyclohexane) over time
  - **Build simulation** with input to determine output (sales)
  - Loan, interest, taxable income, depreciation
  - **Aspen Plus Economic Analyzer (APEA): Capital, operating, utility costs**
  - Is this project worth it?



Enabled by **Aspen Process Economic Analyzer (APEA)**

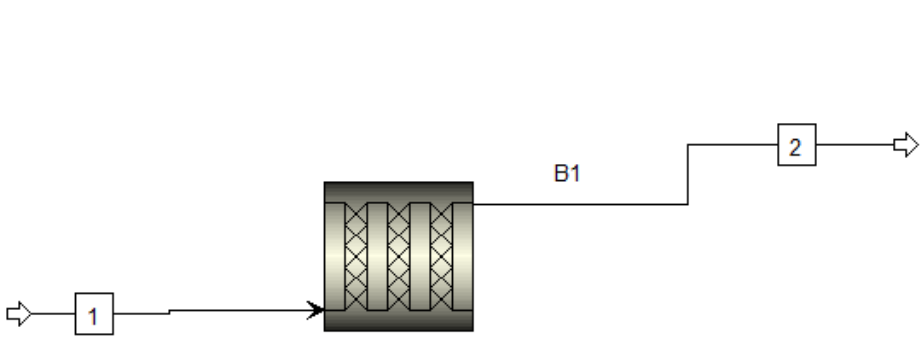
Template: <Default> | Save | Save as new | Reset | Paste | Send to Excel/ASW

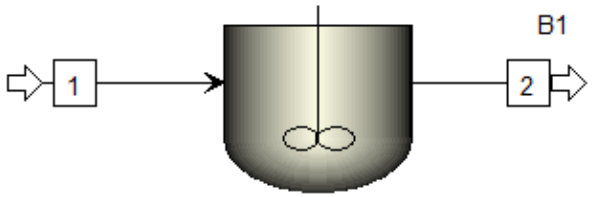
Summary | Utilities | Unit operation | Equipment | Agitated reactor

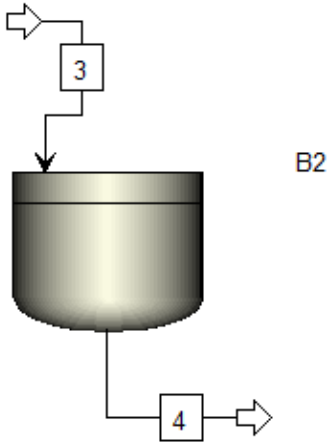
Total Capital Cost [USD]	1,958,570
Total Operating Cost [USD/Year]	1,303,330
Total Raw Materials Cost [USD/Year]	0
Total Product Sales [USD/Year]	0
Total Utilities Cost [USD/Year]	43,146.5
Desired Rate of Return [Percent/'Year]	20
P.O. Period [Year]	0
Equipment Cost [USD]	75,100
Total Installed Cost [USD]	215,400

Kinetics & Reactor Design

- Kinetic calculations
  - Rates, mechanisms, series/parallel reactions
- Reactors
  - **PFR, CSTR, Batch**
    - **Sizing, concentration & temperature profile**

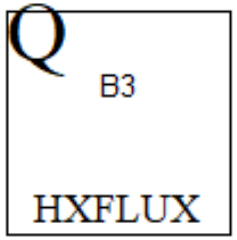


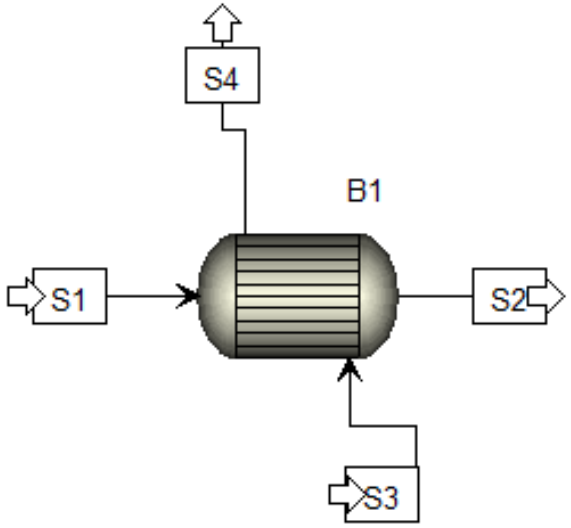




Heat & Mass Transfer

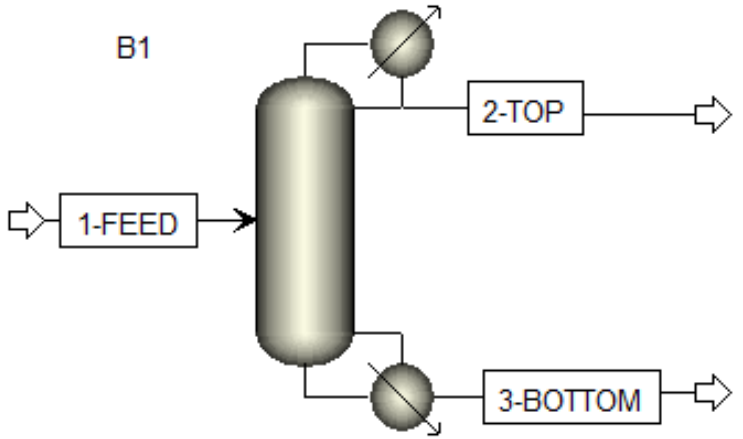
- Modes of heat & mass transfer
  - Fick's & Fourier's Law
- Unit operations
  - **Counter-current heat exchanger**
    - $\boldsymbol{Q = U \cdot A \cdot (Log\ mean\ temp.difference)}$
  - Future: **Packed column separation**





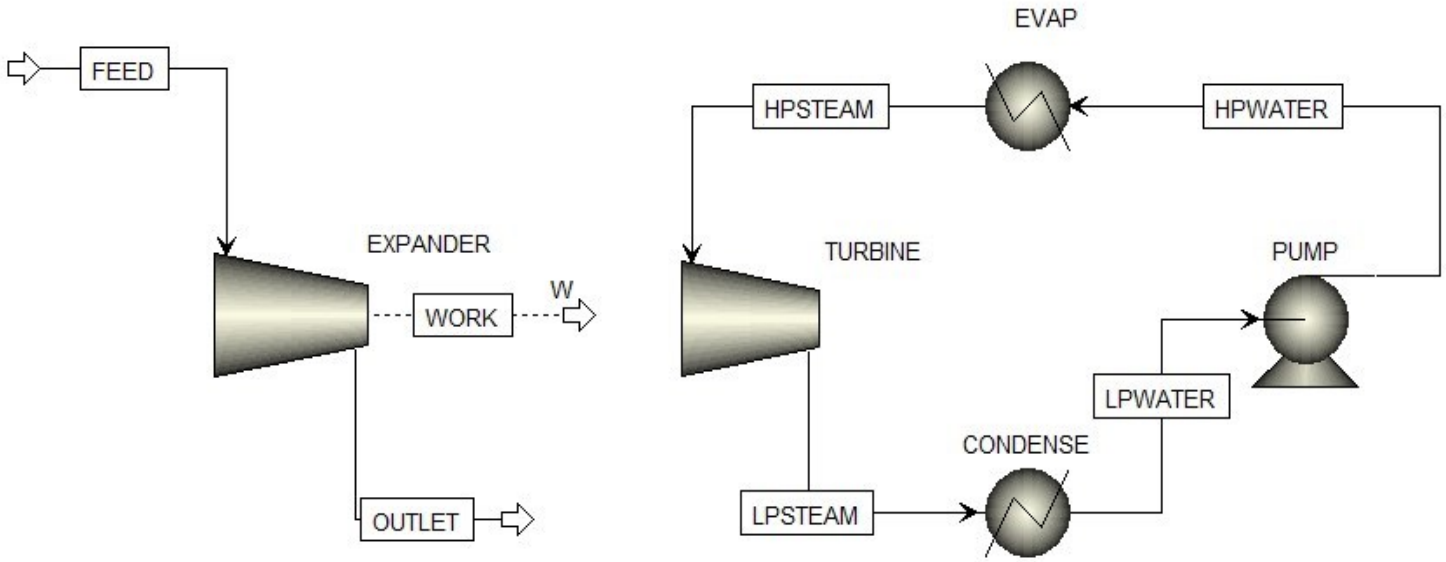
Introduction to Chemical Engineering

- New Freshman course
  - Biodiesel reaction – Lab section
    - Oil + CH_3ONa+ MeOH → $C_3H_8O_3$+ Biodiesel
    - Run a distillation ($C_3H_8O_3$, H_2O, MeOH)
    - Recovery of MeOH
  - In-class lecture: ASPEN
    - Simulate a distillation (MeOH, H_2O, C_6H_5OH)
    - Students given handouts to follow & fill in
    - Video posted on Blackboard®
  - Post-lab
    - Simulate distillation ($C_3H_8O_3$, H_2O, MeOH)
    - Do product streams match with lab results?
    - Survey



Chemical Engineering Thermodynamics I

- Conservation of energy
  - Entropy, heat, work
- Unit operations
  - Heat exchangers
  - **Compressors/Turbines**
- Cycles
  - Rankine Refrigeration and **Power Cycle**



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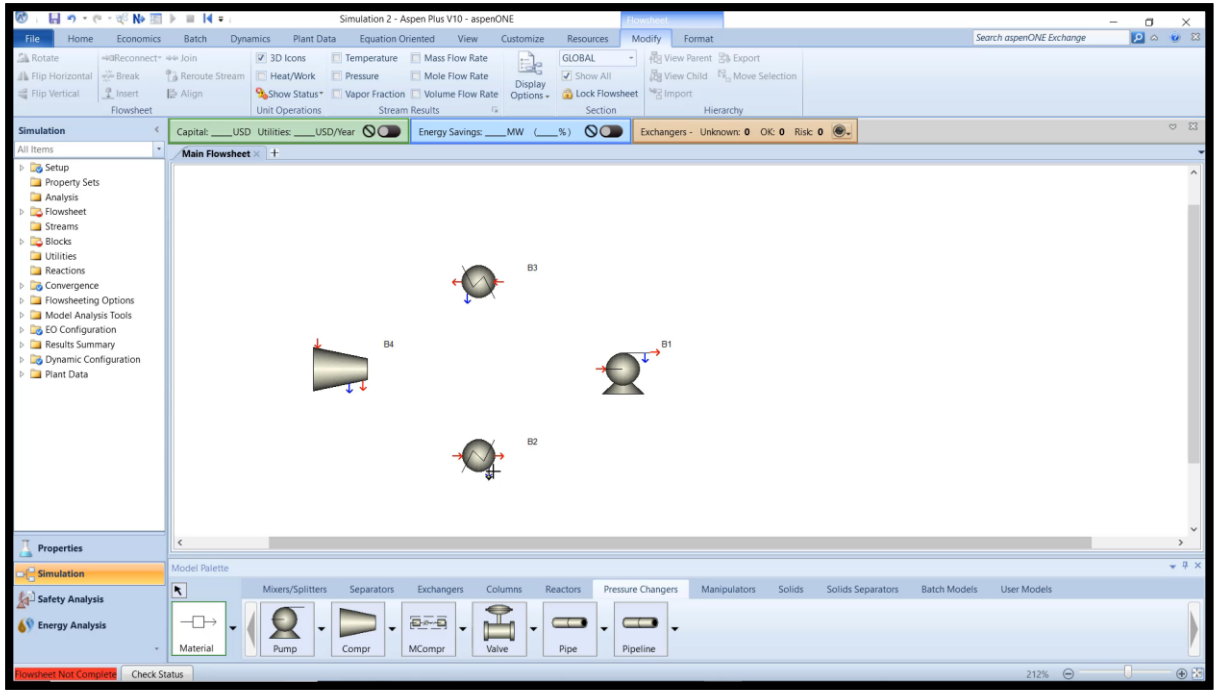
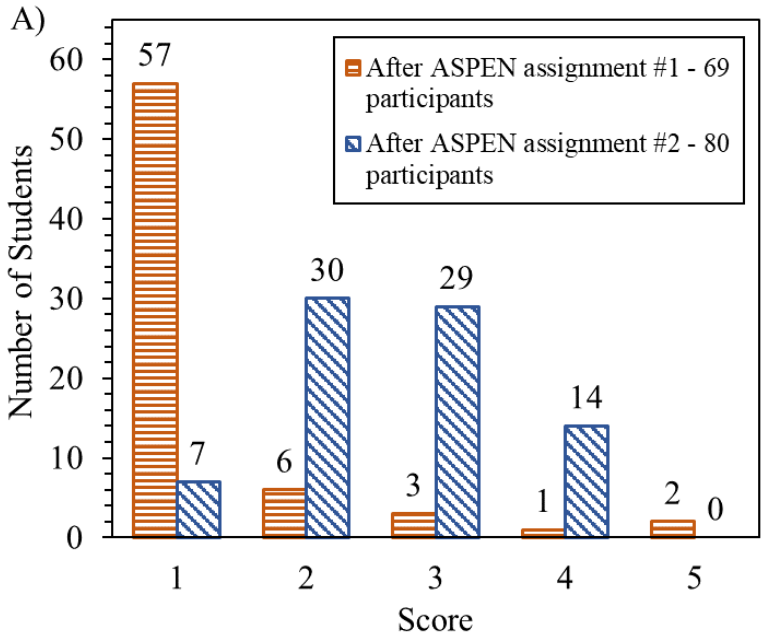

Simulation 2 - Aspen Plus V10 - aspenONE
Main Flowsheet
B1
B2
B3
B4
Material
Pump
Compr
MCompr
Valve
Pipe
Pipeline

Thermodynamics I: Class Introduction

- Structure
  - Adiabatic Turbine: Feb. 22 – March 1.
    1. In-class lecture (by hand & in Aspen)
    2. Assignment (by hand & in Aspen)
    3. Survey
  - Rankine Power Generation Cycle: March 29 – April 5.
    1. In-class lecture (graphically & in Aspen)
    2. Assignment (graphically & in Aspen)
    3. Survey

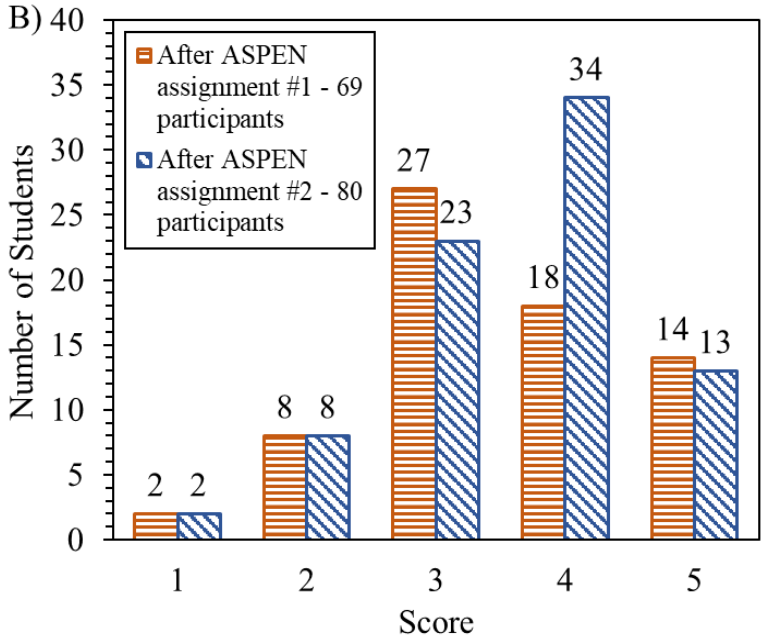
Student Feedback

- Thermo I class: 89 total students
- Assignment 1: Adiabatic Turbine
  - "How experienced were you in Aspen Plus® before C&PE 211?"
  - 1 (Not experienced) to 5 (experienced)
- Assignment 2: Rankine Power Cycle
  - "What do you believe your skill level in in using Aspen Plus® is?"
  - 1 (Not skilled) to 5 (skilled)



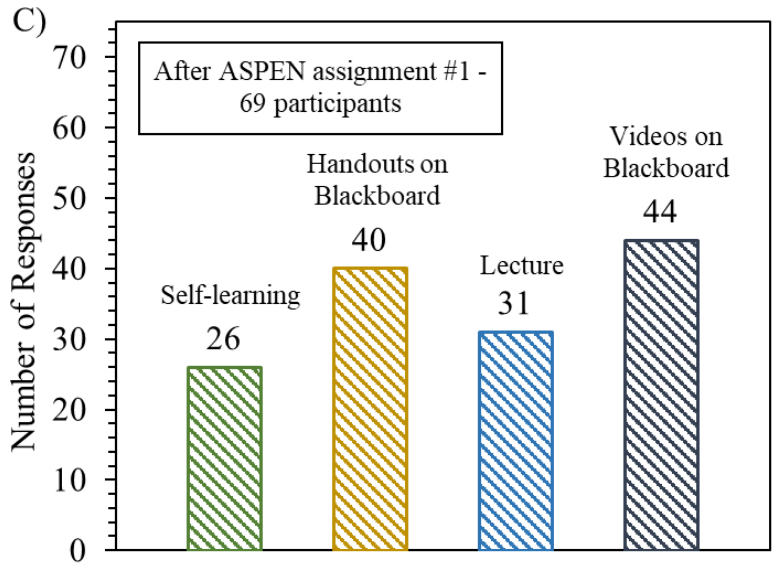
Student Feedback

- Thermo I class: 89 total students
- Assignment 1: Adiabatic Turbine
  - "How effective do you think the utilization of Aspen Plus® enhances classroom learning?"
  - 1 (Not effective) to 5 (effective)
- Assignment 2: Rankine Power Cycle
  - "How effective do you think the utilization of Aspen Plus® enhances classroom learning?"
  - 1 (Not effective) to 5 (effective)

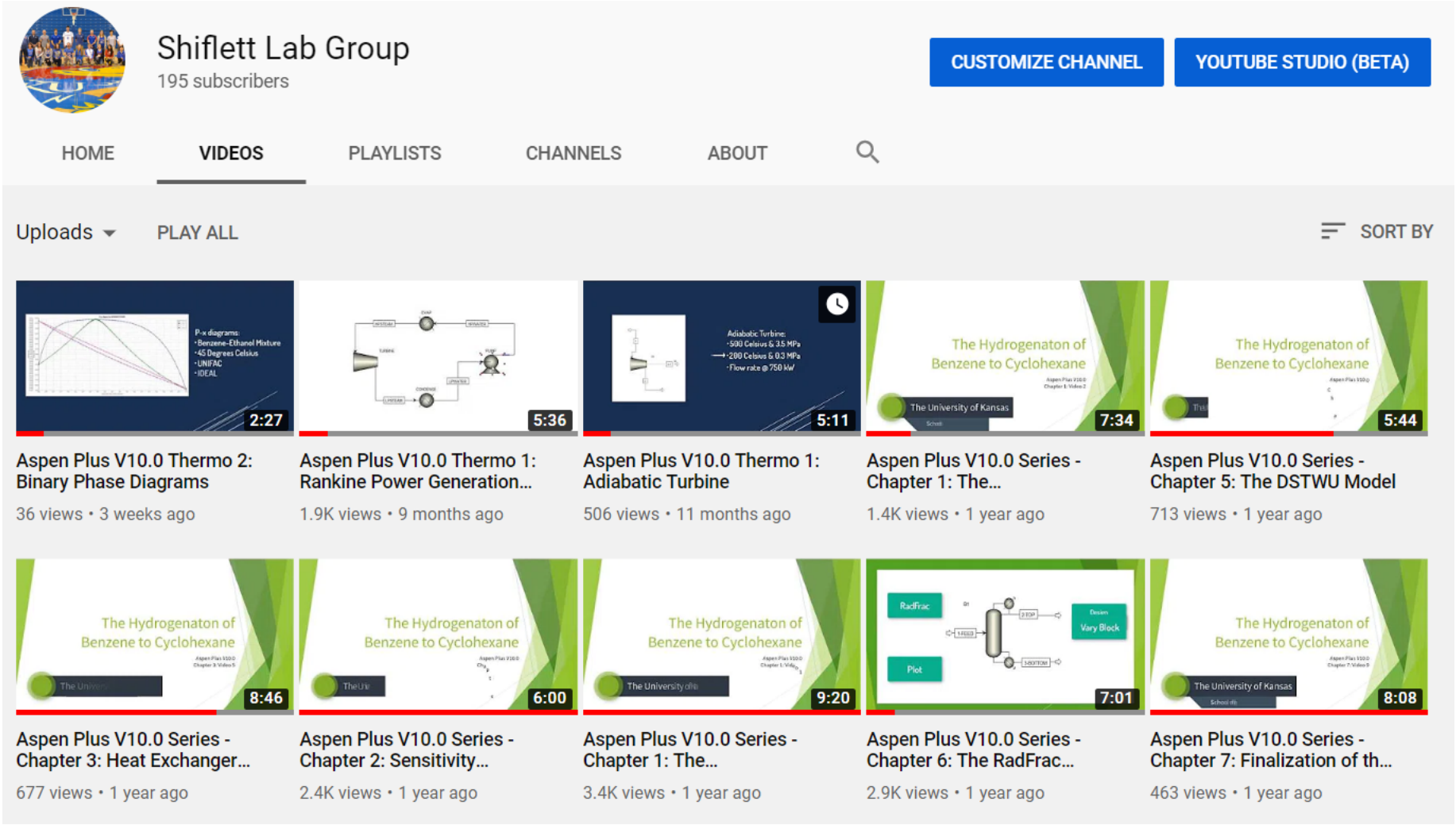


Student Feedback

- Thermo I class: 89 total students
- Assignment 1: Adiabatic Turbine
  - "Which format(s) were best to learn how to create Aspen Plus® simulations for Thermo 1? (You may select all that apply)?"



Video Library www.shiflettresearch.com



Future Work

- C&PE Courses
  - C&PE 111 Intro to Chemical Engineering ✓
  - C&PE 211 Material & Energy Balances ✓
  - C&PE 221 Chemical Engineering Thermo I ✓
  - C&PE 511 Momentum Transfer ✓
  - C&PE 512 Chemical Engineering Thermo II ✓
  - C&PE 522 Economic Appraisal ✓
  - C&PE 524 Kinetics & Reactor Design ✓
  - C&PE 525 Heat & Mass Transfer ✓
  - C&PE 611 Unit Operations C
  - C&PE 616 Chemical Engineering Lab I C
  - C&PE 615 Process Dynamics & Control C
  - C&PE 613 Design I
  - C&PE 626 Chemical Engineering Lab II

Concluding Remarks

- Students are interested in applying class content in Aspen Plus® and would like to see more in future courses
- Aspen Plus® videos are effective at teaching how to use the program
- Current YouTube channel has over 200 subscribers with over 16,000 total views and positive feedback
- Goal is to provide in-class lectures, handouts, and videos on Blackboard® & YouTube for all undergraduate chemical engineering classes at KU
- Plan to submit manuscript

Acknowledgments

Dr. Mark B. Shiflett

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