A Supplementary Workbook to Formalize Information Organization in Chemical Engineering

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Abstract

The main goal of this course is to teach Introduction to Chemical Engineering (CHE 317) to the freshmen/sophomores about energy and mass balances to understand various chemical processes. Our approach is to teach the different implications of the following principle:

Accumulation=Input-Output + Generation – Consumption.

Two of the main challenges that students have in mastering this concept are the generation of consistent nomenclature and the organization of all the variables that they are asked to use to keep track of mass, composition, concentrations, enthalpy, internal energy, state phases, and number of processing units (e.g. reactor, separator, distillation columns, etc.). To address this, I instituted: **(1) use of one consistent nomenclature system, (2) use of extensive tables to track every component in our system. I would like to incorporate these methods into a formal supplementary workbook for the course.**

Objectives

Our overarching goal is to institute a systematic approach that the students can consistently use in their problem solving method for the Introduction to Chemical Engineering-Material and Energy Balance course.

The objective of this project is to develop a formal workbook aid that would include multiple templates for various tables used in the course and a template for our ChemE dictionary. I expect that these workbooks will:

1. Allow students to have templates of this tables before class to save lecture time.
2. Allow students to keep all their tables bounded and organized in a logical way so that the differences and similarities in the types of problems are easier to appreciate.
3. Allow students a chance to practice more at home.

Developmental History of Innovation

The various tables and dictionary have been tested through various worksheets and special classes devoted to it. Different versions of the material has been created and is under current improvement. Students have been surveyed and interview personal to obtain additional feedback.

Learning Activities and Materials

(1) A dynamic **"My First Chemical Engineering Dictionary"**: for students to continually fill out during the semester, updating it with new terms and concepts that they were continuously learning. This was modeled after the Larousse Dictionary, where they had to define the concept, use it in a sentence, and associate it with a visual image that meant something to them.

(2) Use of specialized accounting tables to track every component in our systems. While we started with a simple table that kept track of all processing units by the end of the course we had a library of specialized tables for every type of problem we encountered: (1) non-reactive tables, (2) multi-unit tables, (3) reactive tables, (4) atomic tables, and (5) energy-mass tables.

Our common Accounting table

Let X_S^L = composition of component **L** in stream **S** (mass of **L**/total mass)

Let $\dot{m}_S$ - TOTAL mass flow rate in stream **S** (mass/time)

Let $\dot{n}_S$ - TOTAL **mole** flow rate in stream **S** (moles/time)

Let $\dot{v}_S$ - TOTAL **volumetric** flow rate in stream **S** (moles/time)

	Total/Overall	Component **A**	Comp **B**………	Comp **L**
Streams ---→ (1………S) INPUT (+) OUTPUT (-)		**Fraction A x total**	**Fraction B x total**	**Fraction K x total**
1 + or -	$\dot{m}_1$ $\dot{n}_1$ $\dot{v}_1$	X_1^A $\dot{m}_1$	X_1^B $\dot{m}_1$	$(1-X_1^A-X_1^B-..)$ $\dot{m}_1$
2 + or -	$\dot{m}_2$, $\dot{n}_2$ $\dot{v}_2$	X_2^A $\dot{m}_2$	X_2^B $\dot{m}_2$	$(1-X_2^A-X_2^B-..)$ $\dot{m}_2$
3 + or -	$\dot{m}_3$, $\dot{n}_3$, $\dot{v}_3$	X_3^A $\dot{m}_3$	X_3^B $\dot{m}_3$	$(1-X_3^A-X_3^B-..)$ $\dot{m}_3$
4 + or -	$\dot{m}4$, $\dot{n}_4$, $\dot{v}_4$	X_4^A $\dot{m}_4$	X_4^B $\dot{m}_4$	$(1-X_4^A-X_4^B-..)$ $\dot{m}_4$
. + or -	.			
. + or -	.			
S + or -	$\dot{m}_s$ or $\dot{n}_s$	X_S^A $\dot{m}_S$	X_S^B $\dot{m}_S$	$(1-X_S^A-X_S^B)$ $\dot{m}_S$

NOTE: **FOR EACH STREAM**, YOU MUST ACCOUNT FOR: (1)- ALL YOUR **TOTAL** MASS/MOLES **AND**(2)- FOR THE MASS (MOLES) OF **EACH COMPONENT**

Execution

Positives;

(1)Students cited in their course evaluations that "tables were very helpful to develop a system for the course"

(2) ~81% of students "agree" or "strongly agree" in their midcourse evaluations that the tables and dictionary "helped [them] organize information for problem solving."

Challenges:

(1)Student resistance to such formalized method, specially students who are repeating the course or dropped (from another professor's course).

(2) How to organize this workbook (i.e. order in which material is presented and information included).

Major Issues to Resolve

(1)Chronological organization of the workbook in a way that there's a natural build-up in complexity and logic.

(2) Material that explains the purpose and best use for each table (i.e. specific example problems) in ways that students can appreciate the general themes between the problems that the tables could be used for.

(3) Integration of the developed workbook material with real-life problems and situations(e.g. examples of bank accounts, dynamic city populations, cooking recipes).

(4) How to execute effective use of this material: student evaluation. Ways by which the workbook can be used to offer feedback to the students on their organizational and problem solving skills. Should the workbook also include an evaluation section? Would the workbook be turned in with their homework? How often should their book be looked at and how can it be integrated with homework?

(5) How to stress the value of these exercised so that it is not seen as extra work.

Discussion

I am currently researching the use of similar materials in other areas of engineering education and hope to expand on this knowledge during the FOEE Workshop. It will be very valuable to learn from others who have formally tried similar ideas what worked well and what could have been done better to polish this concept for my class. By the time of the workshop, I would have implemented the idea for the first time at least once and will have a better sense of the working and non-working aspects of this formalization strategy.. **Since we teach various sections of this course here at UT, perhaps this can also be the beginning of introducing new material to the other sections of this same course.**

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