Chemical Reaction Engineering 1 (Homogeneous Reactors) - Video course

COURSE OUTLINE

In simple terms, Chemical Engineering deals with the production of a variety of chemicals on large scale. Large scale production is associated with the engineering problems such as fluid flow, heat and mass transfer, mixing and all types of unit operations. These chemicals are produced through chemical reactions in a vessel called “Chemical Reactor”. Chemical Reactor is known as the heart of any chemical plant since the new chemicals are produced only in this vessel and the economics of the entire plant depends on the design of reactor. Chemical Reaction Engineering (CRE) deals with the design of Chemical Reactors to produce chemicals. The design of Chemical Reactors is based on a few simple and useful concepts. Though the concepts are simple, it is not easy for the students to develop a feeling for these concepts unless the teacher explains by giving different day to day examples with which the students are familiar with.

This is what I tried to do in these courses, one on homogeneous reactions (some call this as Chemical Reaction Engineering I) and heterogeneous reactions (some call this is as Chemical Reaction Engineering II).

After understanding the concepts, if we look at the subject of Chemical Reaction Engineering, it will be full of simple to complex mathematics. But, without understanding the concepts, the subject appears to be meaningless mathematical exercise and the student does not have “a feel for the design of the reactor”.

My experience at IIT Madras for the last 30+ years, unfortunately, is that, even most of the PG students who come for their Master’s and Doctorate degrees also do not have “the feel for the design of the reactor”. I find that this is due to lack of conceptual understanding of fundamentals of Chemical Reaction Engineering.

With this in mind, I tried to spend more time in explaining the concepts and physical understanding of the problems in CRE in terms of simple and familiar examples rather than spending a lot of time in solving a differential equation in the class. My belief is that once the student understands the concepts thoroughly, he/she develops a passion for the subject. Once the student is passionate about any subject, using mathematics or any tool to solve the problems is part of that unstoppable passion.

NP-TEL

NPTEL

http://nptel.ac.in

Chemical Engineering

Additional Reading:

1. Fogler, H.S., 1999, *Elements of Chemical Reaction Engineering*, 3rd Ed., Prentice-Hall, Englewood Cliffs.
2. Froment, G.B., and K.B. Bischoff, 1990, *Chemical Reactor Analysis and Design*, 2nd Ed., Wiley, New York.
3. C.G. Hill Jr., 1977, *An Introduction to Chemical Engineering Kinetics and Reactor Design*, John Wiley & Sons, New York.
4. Carberry, J.J., 1976, *Chemical and Catalytic Reaction Engineering*, McGraw-Hill, New York.
5. Smith, J.M., 1981, *Chemical Engineering Kinetics*, 3rd Ed., McGraw-Hill, New York.
6. Kunii, D & Levenspiel, O, *Fluidization Engineering*, 2nd Edn

As all of us know, it is impossible to cover all aspects of CRE even in these two courses and hence I tried to address some important general aspects, where these general aspects can be extended to specific cases. For example in heterogeneous reactions, gas-liquid reactions will be part of gas-liquid-solid reactions (slurry reactor) in simple analysis. I could not spend time on gas-liquid and liquid-liquid reactions, but the methodology used to analyze other reactions e.g. gas-solid reactions, can be easily extended to these reactions.
To try put the students on the right track for learning, I was telling in the lectures some morals, some anecdotes, stories etc., whenever there is an opportunity. These may please be taken in the right spirit since my intention was to make the students learn as much as possible. I think that I have given enough introductions to these courses and it is time for you to explore. I always enjoyed teaching/explaining CRE and I hope that you enjoy listening to CRE!!.

COURSE DETAIL

Lecture Number	Lecture Topic
1	Motivation & Introduction Part I
2	Motivation & Introduction Part II
3	What is Chemical Engg. Part I
4	What is Chemical Engg. Part II
5	What is Chemical Reaction Engg. Part I
6	What is Chemical Reaction Engg. Part II.
7	Homogeneous & Heterogeneous Reactions Part I
8	Homogeneous & Heterogeneous Reactions Part II
9	Basics of Kinetics and Contacting
10	Design of Batch reactors Part I
11	Design of Batch reactors Part II
12	Basics of Plug Flow Reactor Part I

Engineering, 2nd Edn. B&H, Boston.

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13	Basics of Plug Flow Reactor Part II
14	Design of Plug Flow Reactors Part I
15	Design of Plug Flow Reactors Part II
16	Basics of Mixed Flow Reactors
17	Design of Mixed Flow Reactors
18	Basics of Kinetics
19	Kinetics of Heterogeneous reactions Part I
20	Kinetics of Heterogeneous reactions Part II
21	Kinetics of Heterogeneous reactions Part III
22	Kinetics of Homogeneous reactions
23	Reaction rate for Homogeneous reactions
24	Gas Phase Homogeneous reactions
25	Contd. And later Reactor Design of PFR
26	Reactor Design for MFR and Combination of reactors.
27	PFR and MFR in series.
28	Unsteady state MFR and PFR
29	Recycle Reactors
30	Recycle Reactors (Autocatalytic reactions) Part I
31	Recycle Reactors (Autocatalytic reactions) Part II

32	Multiple Reactions Part I
33	Multiple Reactions Part II
34	Multiple Reactions Part III
35	Multiple Reactions Part IV
36	Multiple Reactions Part V
37	Multiple Reactions Part VI
38	Non-Isothermal Reactors Part I
39	Non-Isothermal Reactors Part II
40	Non-Isothermal Reactors (Graphical Design)
41	Non-Isothermal Reactors contd. & Adiabatic Reactors
42	Non-Isothermal Reactors (Graphical Design) Contd.
43	Non-Isothermal Batch Reactors
44	Non-isothermal Plug Flow Reactors Part I
45	Non-isothermal Plug Flow Reactors Part II
46	Adiabatic Plug Flow Reactors
47	Non-isothermal Mixed Flow Reactors
48	Non-isothermal Mixed Flow Reactors Contd. (Multiple steady states) Part I
49	Non-isothermal Mixed Flow Reactors Contd. (Multiple steady states) Part II
50	Non-Ideal Flow & Residence Time Distributions

	(RTD) basics Part I
51	Non-Ideal Flow & Residence Time Distributions (RTD) basics Part II
52	RTD for various reactors contd. Part I
53	RTD for various reactors contd. Part II
54	Diagnosing the ills of equipments & Various RTD Models
55	Dispersion Model
56	Dispersion with reaction Model and Tanks in Series Model
57	Multi-parameter model (MFR with dead space and bypass)
58	Direct use of RTD to predict conversion (Macro & Micro-fluid as well as Macro & Micro-mixing Concept) Part I
59	Direct use of RTD to predict conversion (Macro & Micro-fluid as well as Macro & Micro-mixing Concept) Part II
60	Direct use of RTD to predict conversion (Macro & Micro-fluid as well as Macro & Micro-mixing Concept) Part III

References:

O. Levenspiel, Chemical Reaction Engineering, 3rd Edn, Wiley & Sons (1999).