Plantwide Control Course

Lecture 1: Introduction

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Chemical Process Operation

Key Production Objectives

Safety
Stability
Economics
- Production rate
- Product quality
- Product Specs

Production objectives can vary due to changes in the market or unavoidable disturbances during operation like
- Ambient conditions
- Raw material quality
- Sensor noise
- Equipment characteristics

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Chemical Process Operation

- Interconnected units
- Material and energy recycle
- Manipulating a process stream disturbs the connected unit(s)

Key control system design questions:

- What process variables (CVs) should be controlled? We will study self-optimizing in detail
- What manipulation handles (MVs) to use, pairing
- Degree of tightness of control
Course Objectives

- To be able to choose right controlled variables to control
- Right pairing
- Design plant-wide control structure for complete chemical plan
Example: Post-combustion CO2 Capture Plant


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Example: Post-combustion CO2 Capture Plant

Flue Gas from Power Plant

Absorber

Cooler

To Stack

Water Make up

V-7

V-8

V-9

Pump 1

Pump 2

Surge Tank

Amine Makeup

Stripper

Reboiler

Rich/Lean Exchanger

CO2

Condenser

V-2

V-3

V-4

V-5

V-6

V-10

Cooling Water in

Cooling Water out

Cooling Water in

Cooling Water out

Steam

Condensate

n=1

n=15

n=20

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Example: Post-combustion CO2 Capture Plant

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Performance of the proposed control structure in region I alternative 1 in pairings

- Flowrate of fluegas: disturbance
  - 5%
  - 10%
  - 15%
  - 20%
  - 25%
  +25%

- Temperature of tray no. 16 in the stripper, y33
  - Time (min)
  - C
  - 90
  - 95
  - 100
  - 105
  - 110
  - 115
  - 120

- Reboiler duty, u2
  - Time (min)
  - KW
  - 1050
  - 1100
  - 1150
  - 1200
  - 1250
  - 1300

- V-8 to set recycle lean amine flowrate, u1
  - Time (min)
  - Valve opening%
  - 0
  - 50
  - 60
  - 70
  - 80
  - 90
  - 100

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Modified alternative 2
Modified alternative 2: Move the throughput manipulator

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Performance of the modified alt.2

(a) Flowrate of flues: disturbance

(b) Reboiler duty, u2

(c) Temperature of tray no.16 in the stripper, y2

(d) Duty of Pump 1

(e) V-8 to set recycle lean amine flowrate, u1

(f) CO2 recovery in absorber, y1

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Course Organization

• Systematic Plantwide Control Procedure of Skogestad
  \(\triangleright\) Top-down analysis including of Self-optimizing
  \(\triangleright\) Bottom-up including of controls of:
  \(\triangleright\) Distillation systems
  \(\triangleright\) Reactors
  \(\triangleright\) Heat exchangers
  \(\triangleright\) Miscellaneous systems

• Plantwide procedure of Nitin Kaistha, maximization throughput
• Plantwide procedure of William Luyben
• Examples and issues

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