

Specialization project

Project title

Analysis and optimization of control structures for distillation processes

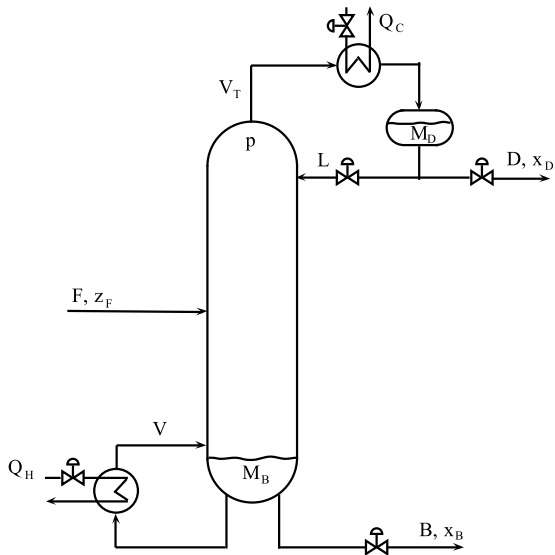
Student

Nina Helene Omdahl

Supervisor

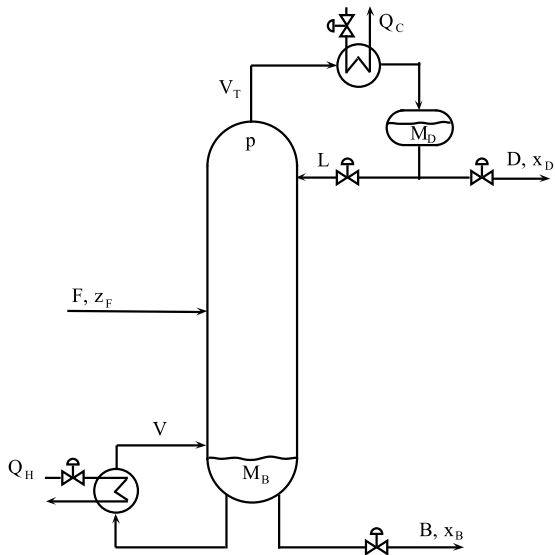
Krister Forsman

Distillation process



Distillation process

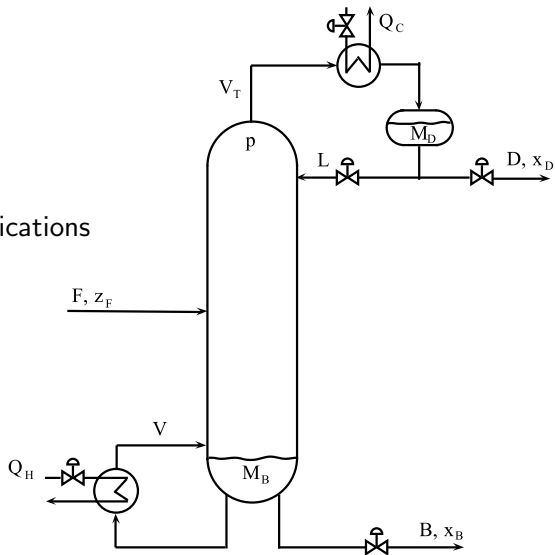
Control objectives:



Distillation process

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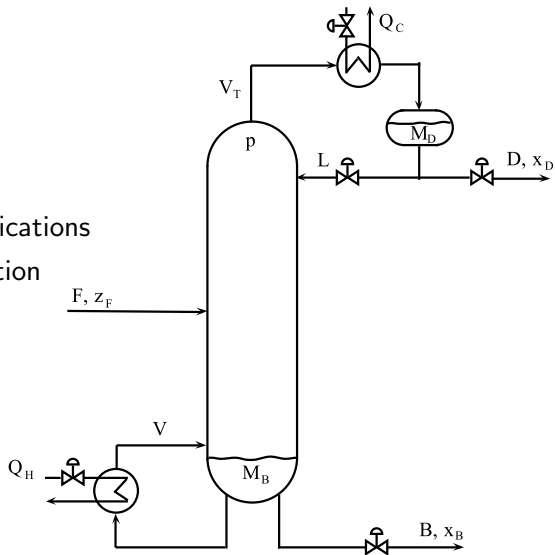
- ▶ Meet product specifications



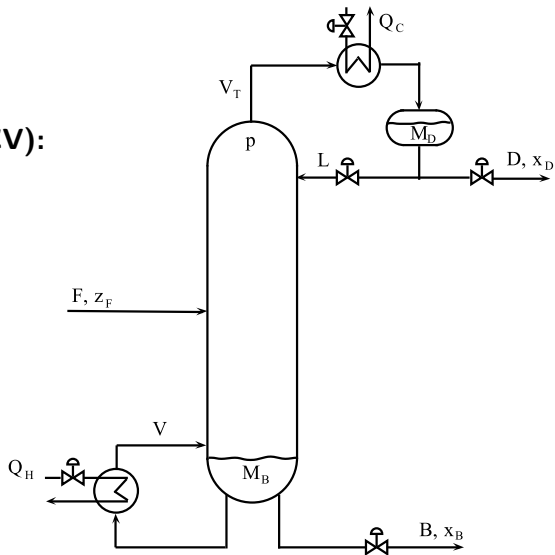
Distillation process

Control objectives:

- ▶ Meet product specifications
- ▶ Ensure stable operation



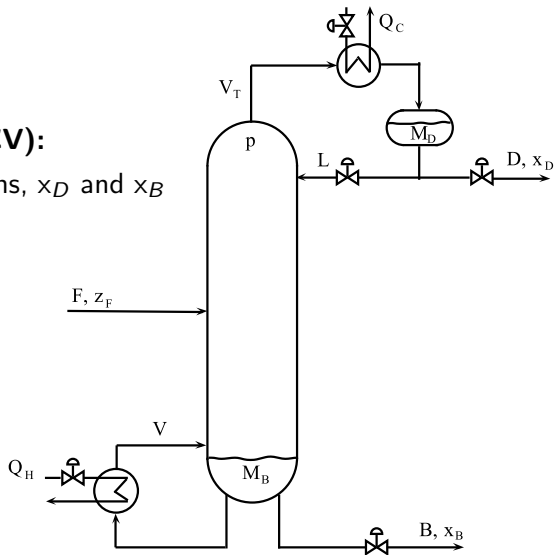
Controlled variables (CV):



Distillation control

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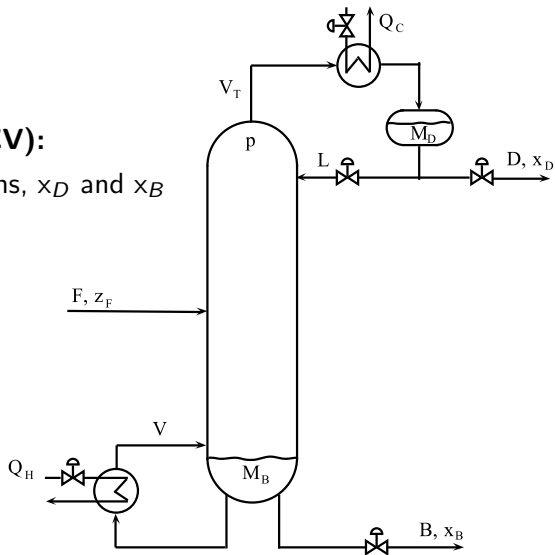
- ▶ Product compositions, x_D and x_B



Distillation control

Controlled variables (CV):

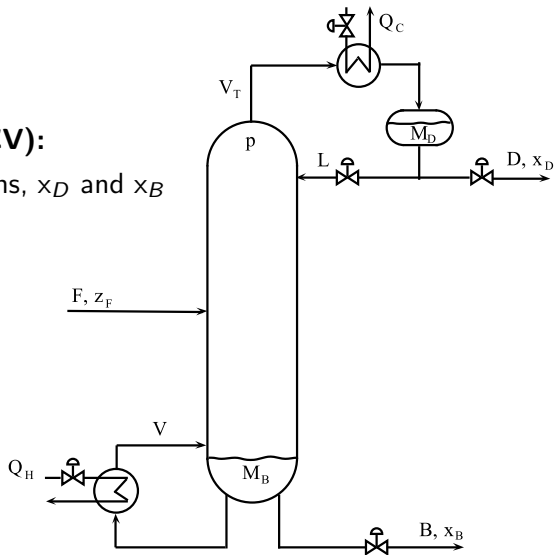
- ▶ Product compositions, x_D and x_B
- ▶ Pressure, p



Distillation control

Controlled variables (CV):

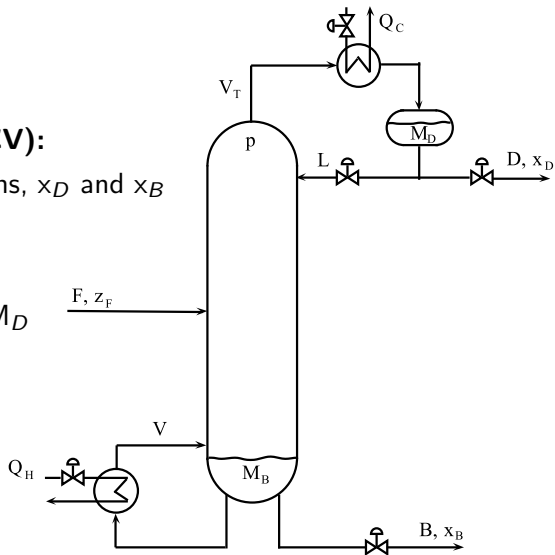
- ▶ Product compositions, x_D and x_B
- ▶ Pressure, p
- ▶ Column level, M_B



Distillation control

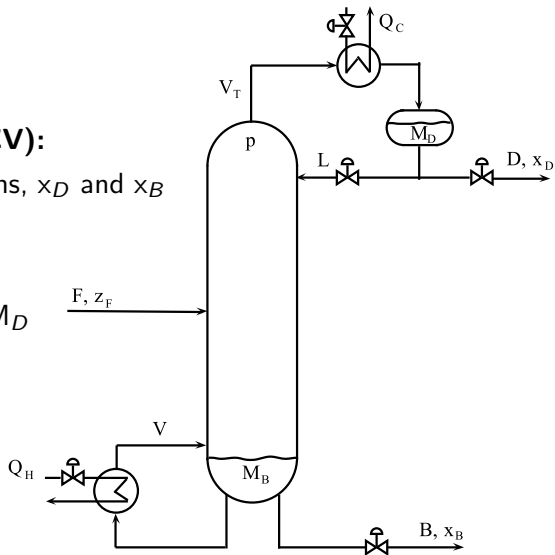
Controlled variables (CV):

- ▶ Product compositions, x_D and x_B
- ▶ Pressure, p
- ▶ Column level, M_B
- ▶ Reflux drum level, M_D



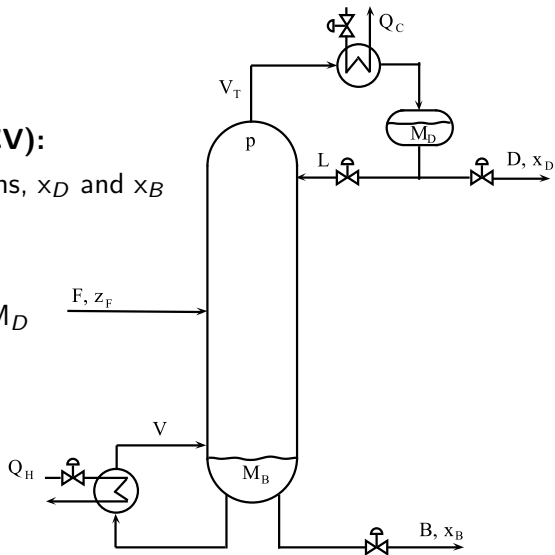
Controlled variables (CV):

- ▶ Product compositions, x_D and x_B
- ▶ Pressure, p
- ▶ Column level, M_B
- ▶ Reflux drum level, M_D
- ▶ Temperature

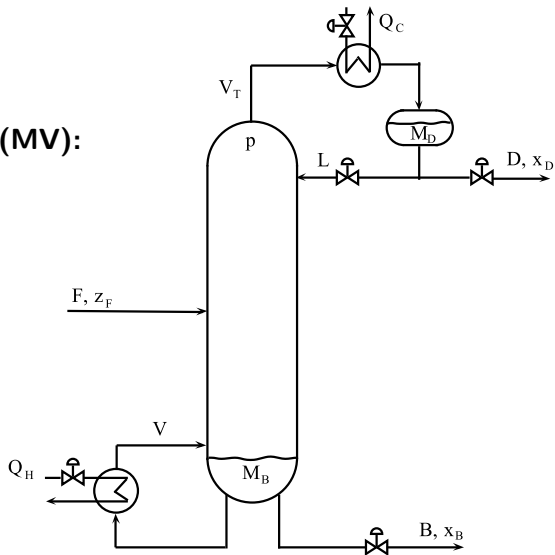


Controlled variables (CV):

- ▶ Product compositions, x_D and x_B
- ▶ Pressure, p
- ▶ Column level, M_B
- ▶ Reflux drum level, M_D
- ▶ Temperature

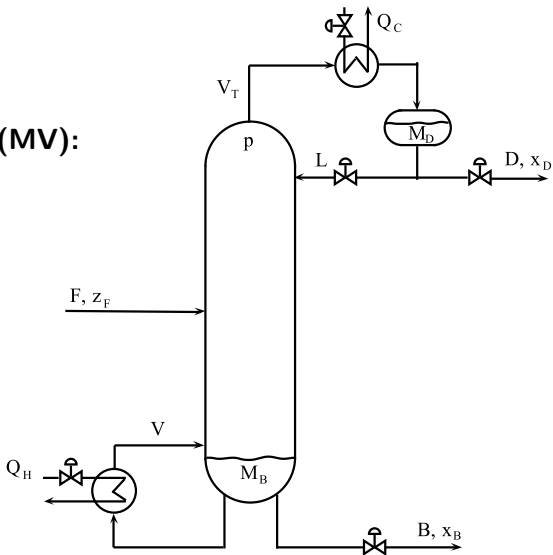


Manipulated variables (MV):



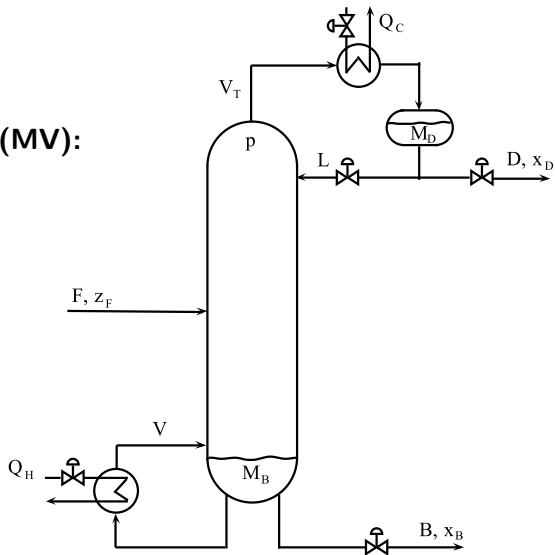
Manipulated variables (MV):

- ▶ Reflux flow, L



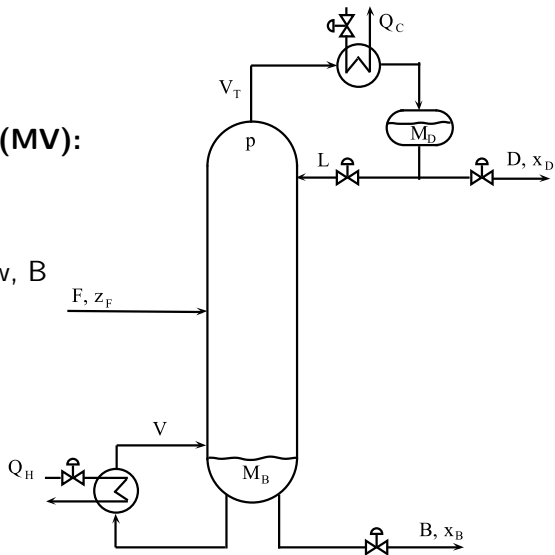
Manipulated variables (MV):

- ▶ Reflux flow, L
- ▶ Distillate flow, D



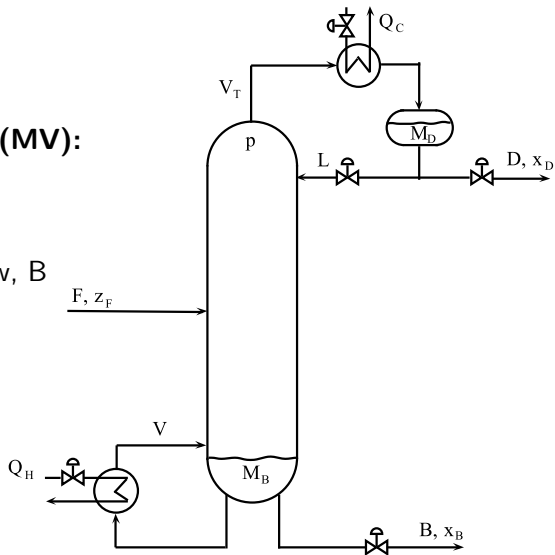
Manipulated variables (MV):

- ▶ Reflux flow, L
- ▶ Distillate flow, D
- ▶ Bottom product flow, B



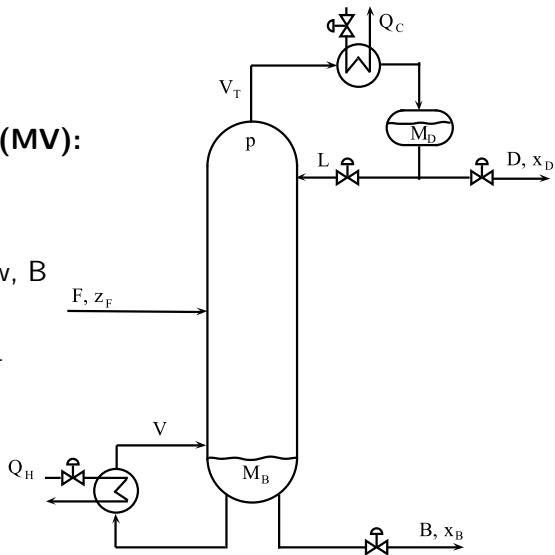
Manipulated variables (MV):

- ▶ Reflux flow, L
- ▶ Distillate flow, D
- ▶ Bottom product flow, B
- ▶ Vapor boilup, V



Manipulated variables (MV):

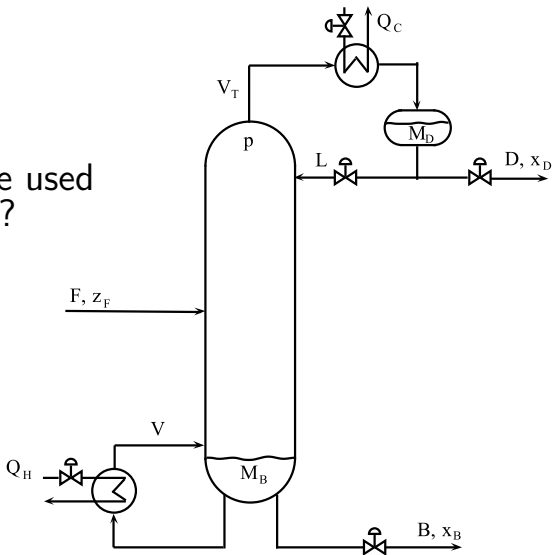
- ▶ Reflux flow, L
- ▶ Distillate flow, D
- ▶ Bottom product flow, B
- ▶ Vapor boilup, V
- ▶ Overhead vapor, V_T



Control configurations

Question:

What MV should be used to control what CV?

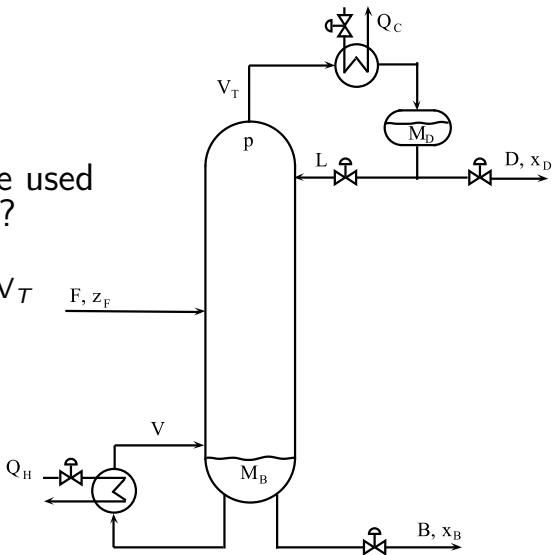


Control configurations

Question:

What MV should be used to control what CV?

Usually: p controlled by V_T



Control configurations

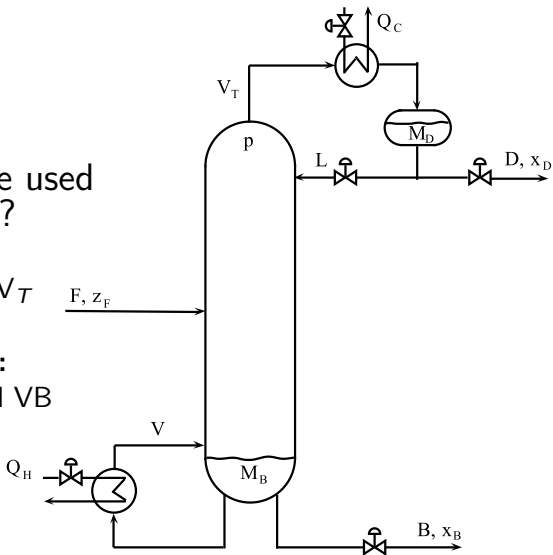
Question:

What MV should be used to control what CV?

Usually: p controlled by V_T

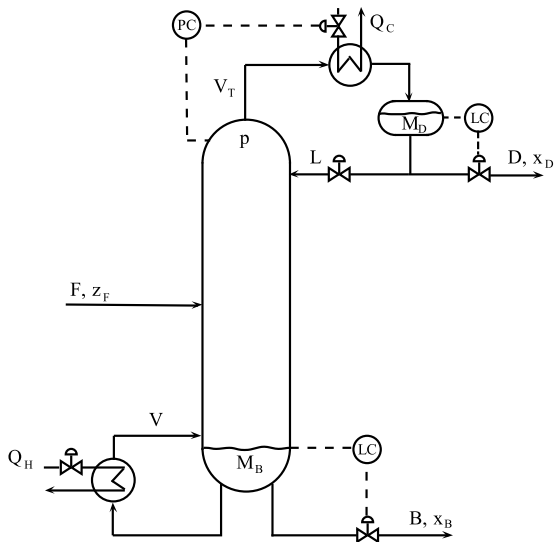
Possible configurations:

LV, DV, LB, DB, LD and VB



Example: LV-configuration

M_D controlled by D.
 M_B controlled by B.

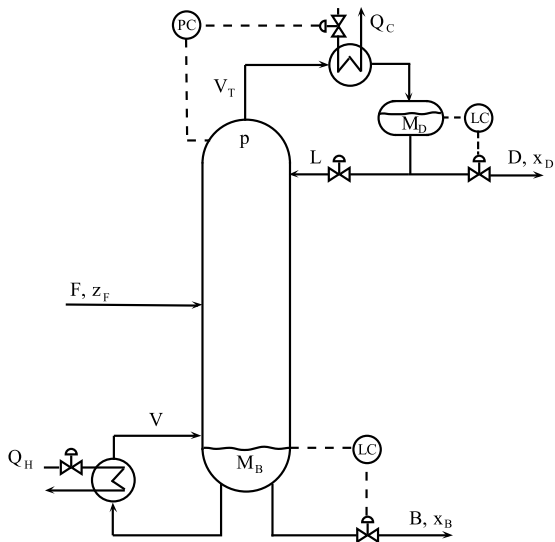


Example: LV-configuration

M_D controlled by D.

M_B controlled by B.

L and V are "unused".



But what to choose?

Possible configurations:

LV, DV, LB, DB, LD and VB

But what to choose?

Possible configurations:

LV, DV, LB, DB, LD and VB

LV, DV: Most common.

But what to choose?

Possible configurations:

LV, DV, LB, DB, LD and VB

LV, DV: Most common.

LD, VB: Time delays.

But what to choose?

Possible configurations:

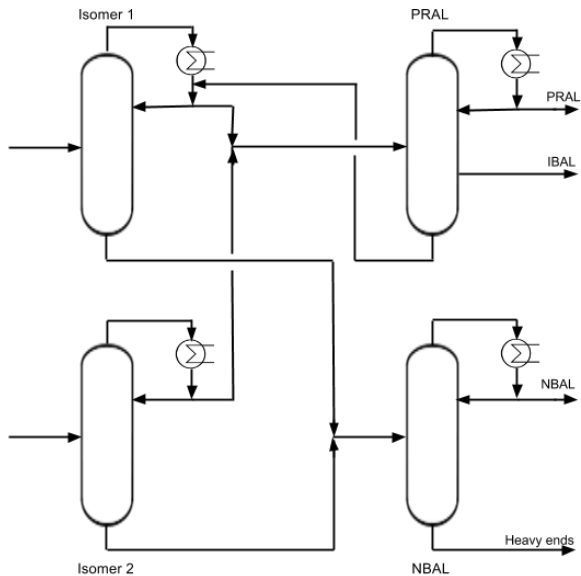
LV, DV, LB, DB, LD and VB

LV, DV: Most common.

LD, VB: Time delays.

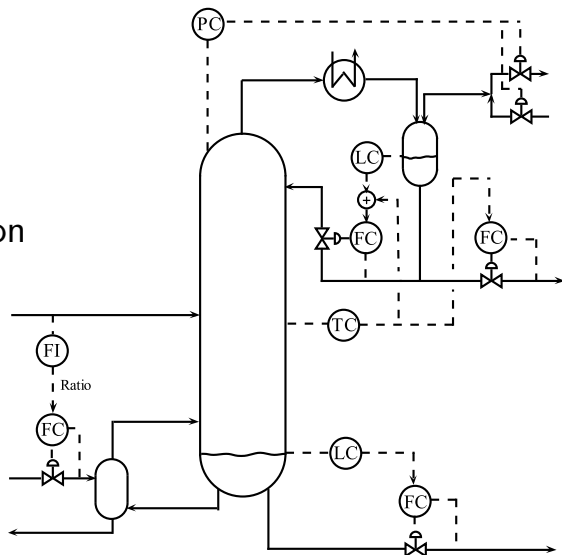
DB: Infeasible from steady state point of view.

Distillation train



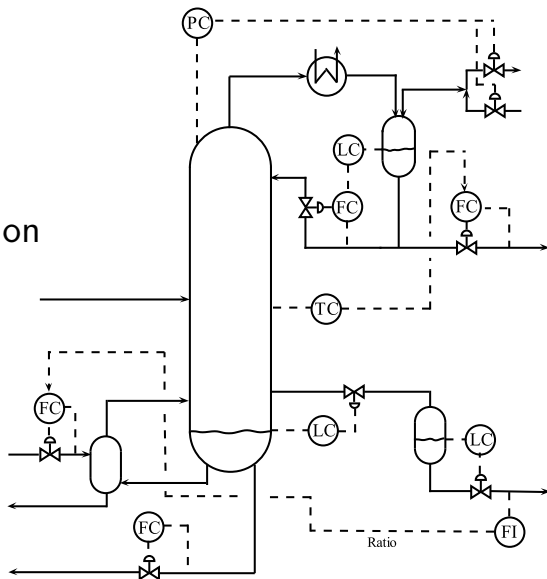
Control structure - Isomer columns

DV-configuration



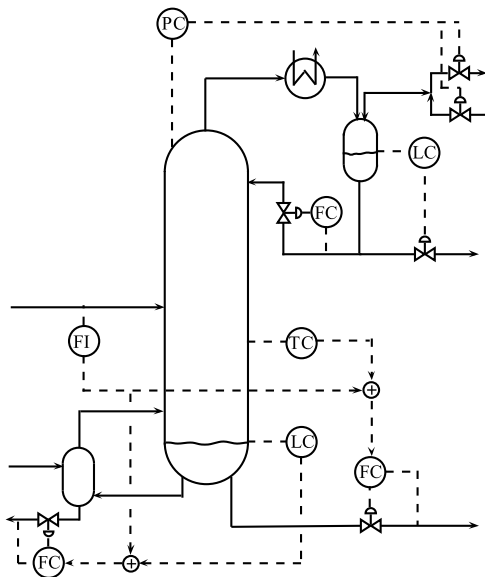
Control structure - PRAL column

"DV"-configuration

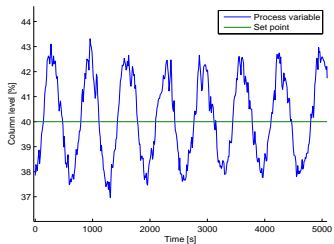


Control structure - NBAL column

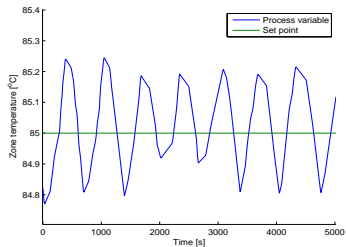
LB-configuration



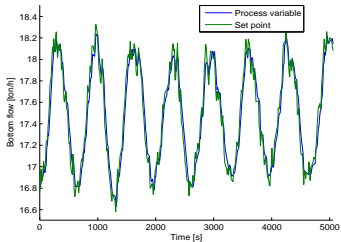
Isomer 1 column oscillates



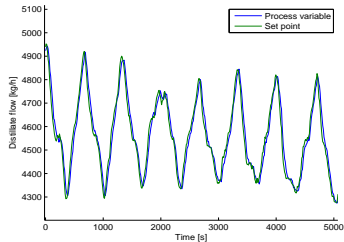
Column level



Zone temperature

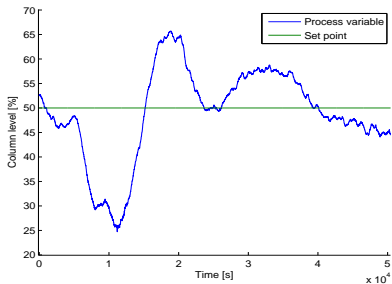
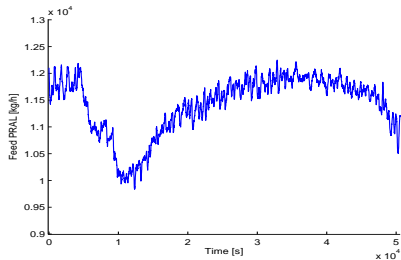


Bottom product flow

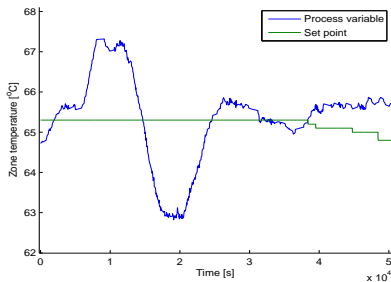


Distillate flow

Poor performance in PRAL column

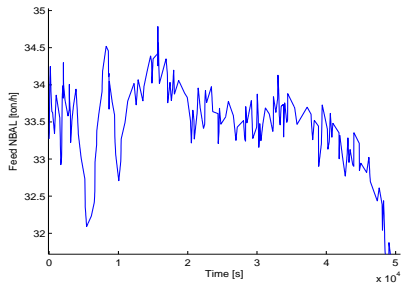


Column level

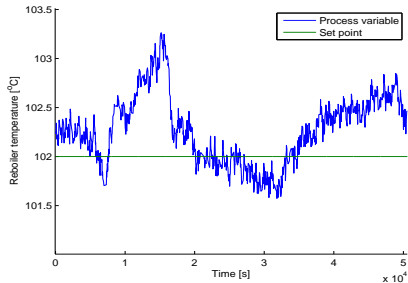


Zone temperature

Temperature control in NBAL column



Feed flow



Zone temperature

Thank you!