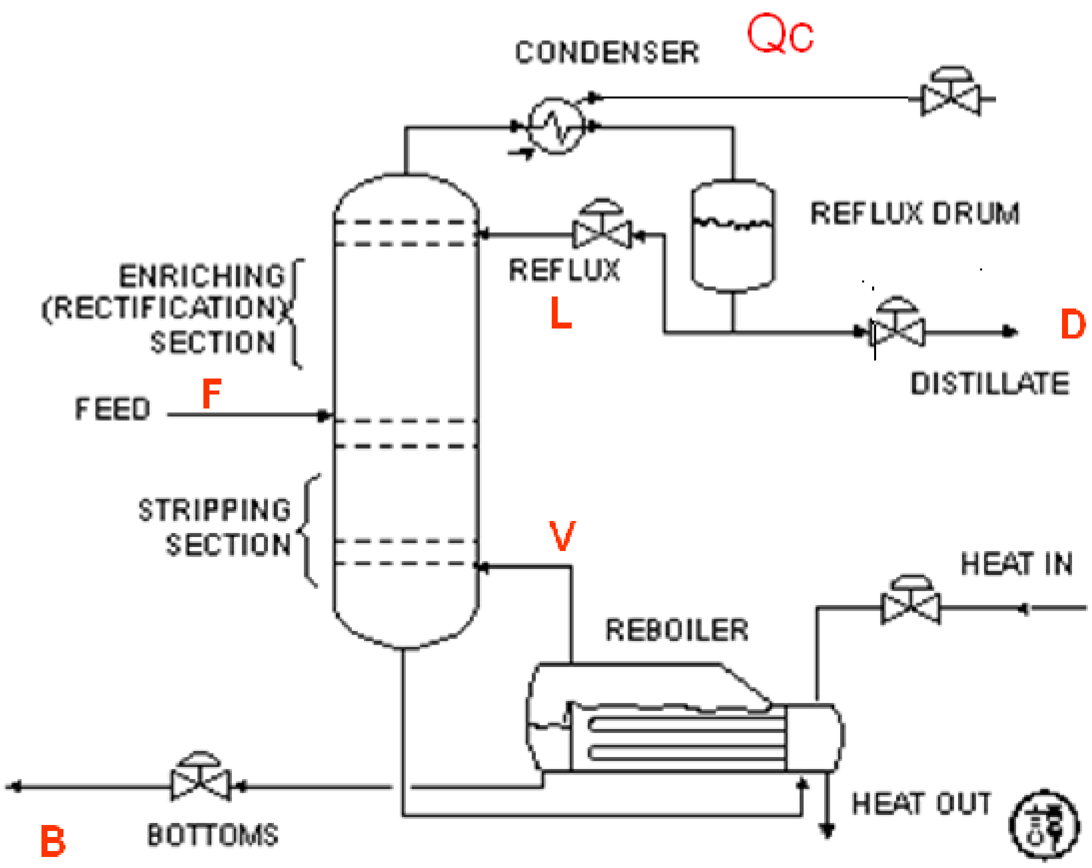
Eksamensoppgave prosessregulering, desember 2006

(a) Forklar prinsippene for forover- og tilbakekobling.
(b) Angi fordeler og ulemper med forover- og tilbakekobling



Du skal foreslå reguleringsstruktur for destillasjonskolonnen vist i Figuren. Føden er gitt (kommer fra en annen del av prosessen). Oppkoket (V) er gitt (varmen "HEAT IN" kommer fra en annen del av prosessen). For å "stabilisere" kolonnen skal følgende reguleres: Trykk (p), nivå i koker (Lb), nivå i reflukstank (Ld), temperatur (Tt) i midten av øvre del av kolonnen (anrikningsdelen).

(c) Klassifiser variable: Utganger (y), innganger (u), viktige forstyrrelser (d)

(d) Sett opp prosessesmatrisen fra u til y (fyll inn tabell med +,-,0) og brukt dette til å foreslå parringer.

(e) Tegn inn din foreslåtte reguleringsstruktur på et flytskjema av kolonnen (med TC, PC og 2 LC).

(f) Foreslå evt. bruk av foroverkobling for kolonnen.

Eksamensoppgave prosessregulering, desember 2006. English text

(c) Explain the principles for feedforward and feedback control.
(d) Explain the advantages and disadvantages of feedforward and feedback control

You should propose a control structure for the distillation column shown in the figure. The feed is given (comes from another part of the process). The boilup (V) is given (”HEAT IN” comes from another part of the process). To “stabilize” the column one needs to control the following: Pressure (p), level in the reboiler (Lb), level in the reflux drum (Ld), temperature (Tt) in the middle of the top part of the column (rectification section).

(c) Classify the variables: Outputs (y), inputs (u), disturbances (d)

(d) Give the “process matrix” from u to y (a table with +,-,0 as entries) and use this to suggest pairings.

(e) Make a drawing with your proposed control structure on a flowsheet of the column (with TC, PC and 2 LCs).

(f) Suggest the possible use of feedforward control for the column.

Solution

(a) Feedback: Measure the output (y) and adjust the input (u).
Feedforward: Measure the disturbance (y) and adjust the input (u).

(b) Feedback.
\+ "Self-correcting" because actual output is controlled: Works for any disturbance and works if there are changes in the process conditions
\+ Do not need good process model (but need to know at least sign)
- Can get instability of we "overreact" (i.e., if the controller gain is too large), especially if there is a delay in the loop.
- Need a measurement of the output

Feedforward
\+ Can get faster response if disturbance is measured "early" (especially if the process has a delay)
- Need a good process model (main exception: ratio control)
- Sensitive to changes and unmeasured disturbance
- Need to measure the important disturbance

(c) y = p, Lb, Ld, Tt
u = L, D, Qc, B
d = changes in F (feed) and "HEAT IN"

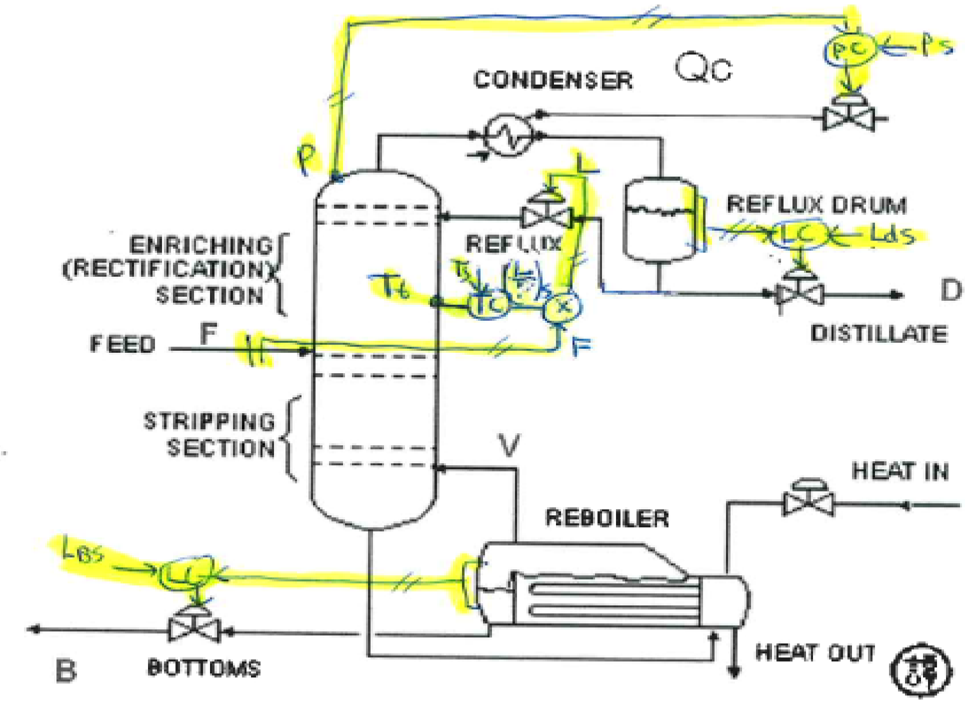
(d)

u y->	p	Lb (level btm)	Ld (level drum)	Tt
L (reflux)	0 (or small -)	+ (but delayed)	-	- (more light -> colder)
D	0	0	-	0
Qc	-	0 (or small -)	+	+ (small)
B	0	-	0	+

(d) Suggested pairings based on table (rule 1: avoid pairing on 0, rule 2: "pair close"))
Control p with Qc
Control Lb with B (avoid using L because we want to "pair close")
Control Ld with D (Qc is already used and we need to use L to control Tt)
Control Tt with L

(e) see Figure

(f) The main disturbances are in the feed F and in "HEAT IN". Assume here that the federate is the main disturbance. Can then use a ratio controller where we keep L/F constant, this results in a kind of cascade scheme where TC sets L/F, see Figure (we could also use ratio controller for other loops, but it is assumed that the "slowest" loop with the most potential need for feedforward is the temperature loop).



CONDENSER
Qc
REFLUX DRUM
REFLUX
ENRICHING
(RECTIFICATION)
SECTION
FEED
F
D
DISTILLATE
STRIPPING
SECTION
V
HEAT IN
REBOILER
HEAT OUT
B
BOTTOMS