CBE 34487

7/9/20

OPTIMIZATION

- BY SOME PROCEDURE FOR SOME "OBJECTIVE"

WE ARE LOOKING FOR BEST ANSWER TO A PROBLEM

SIMPLE CALCULUS EXAMPLE

CYLINDRICAL TANK

FOR A FIXED V, WHAT RATIO OF D/H USES LEAST AMOUNT OF MATERIAL

$$V = \frac{\pi D^2}{4} H \quad = \quad H = \frac{4V}{\pi D^2}$$

$$A = 2\frac{\pi D^2}{4} + \pi D H$$

$$A = \frac{\pi D^2}{2} + \frac{4V}{D}$$

FIND EXTREMUM

$$\frac{dA}{dD} = \pi D - \frac{4V}{D^2} = 0$$

$$\frac{d^2A}{dD^2} = \pi + \frac{8V}{D^3}$$

SO MINIMUM

$$D^3 = \frac{4V}{\pi}$$

$$D = \sqrt[3]{\frac{4V}{\pi}}, \quad H = \sqrt[3]{\frac{4V}{\pi}}$$

$$\boxed{D/H = 1}$$

IF WE CAN GET THE OBJECTIVE FUNCTION, PRESUMABLY WE CAN FIND AN OR MULTIPLE EXTREMA BY ANALYTICAL OR NUMERICAL MEANS.

FOR A GIVEN FLOW REQUIREMENT, WHAT DIAMETER OF THE PIPE IS OPTIMAL

LARGER D $\Rightarrow$ PUMPING COSTS GO DOWN

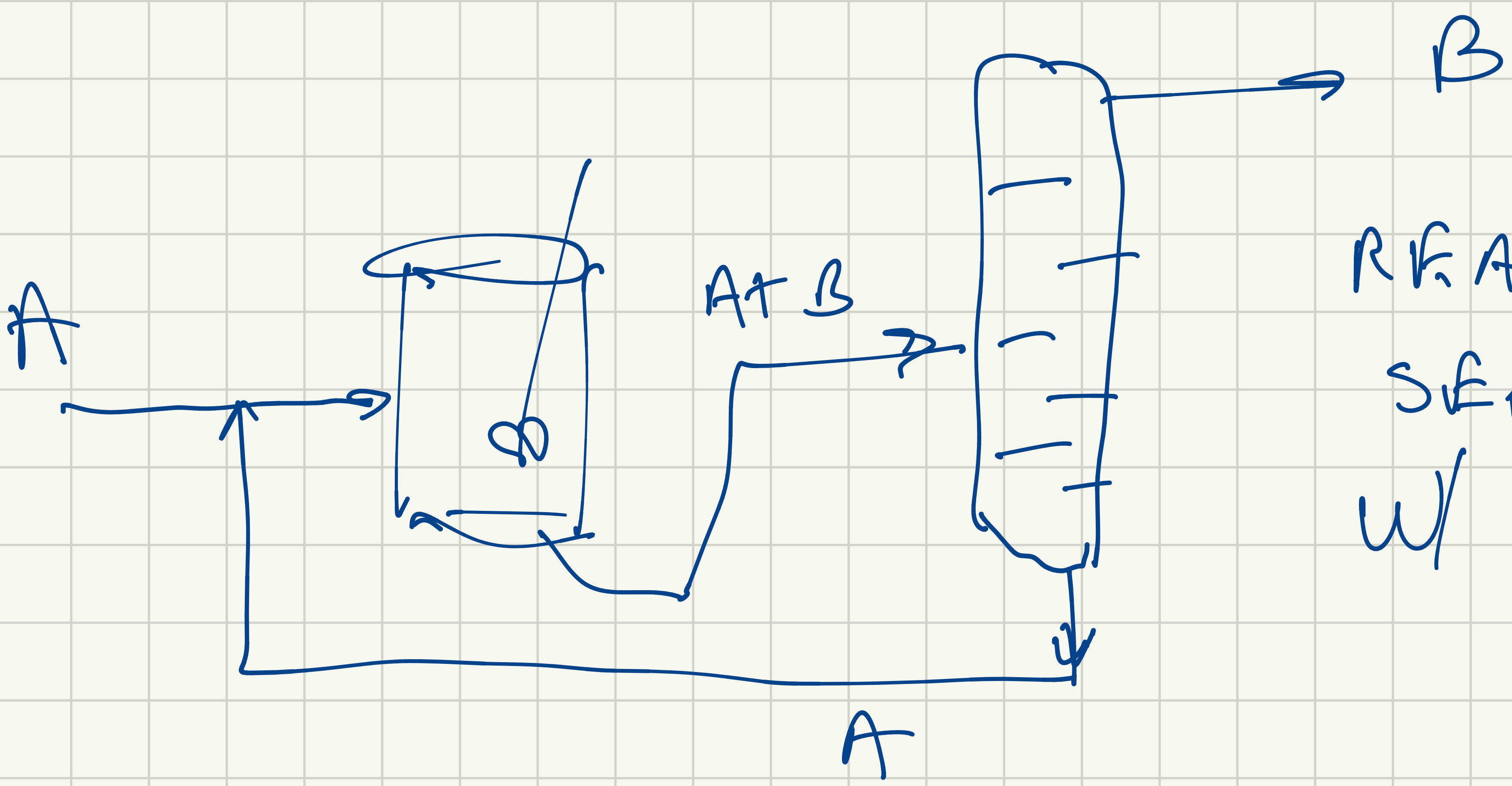
COST OF PIPE GOES UP

IF WE CAN GET THE OBJECTIVE FUNCTION, PRESUMABLY WE CAN FIND AN OR MULTIPLE EXTREMA BY ANALYTICAL OR NUMERICAL MEANS.

"SIMPLE" EXAMPLE

WE WISH TO CONVERT A TO B

AND REALIZE WE NEED A REACTION PROCESS AND A PURIFICATION PROCESS



REACTOR SEPARATOR W/ RECYCLE

WE HAVE THE CONSTRAINT
THAT WE MUST PRODUCE
B MOLES/TIME

WE WANT TO DO THIS
FOR THE MINIMUM
POSSIBLE COST

TOTAL COST = COST OF EQUIPMENT + COST TO RUN PROCESS

"CAPITAL COSTS" + "OPERATING COSTS"

WE WISH TO CONSTRUCT A
FUNCTION THAT INCLUDES
THESE, THEN FIND
MINIMUM !!

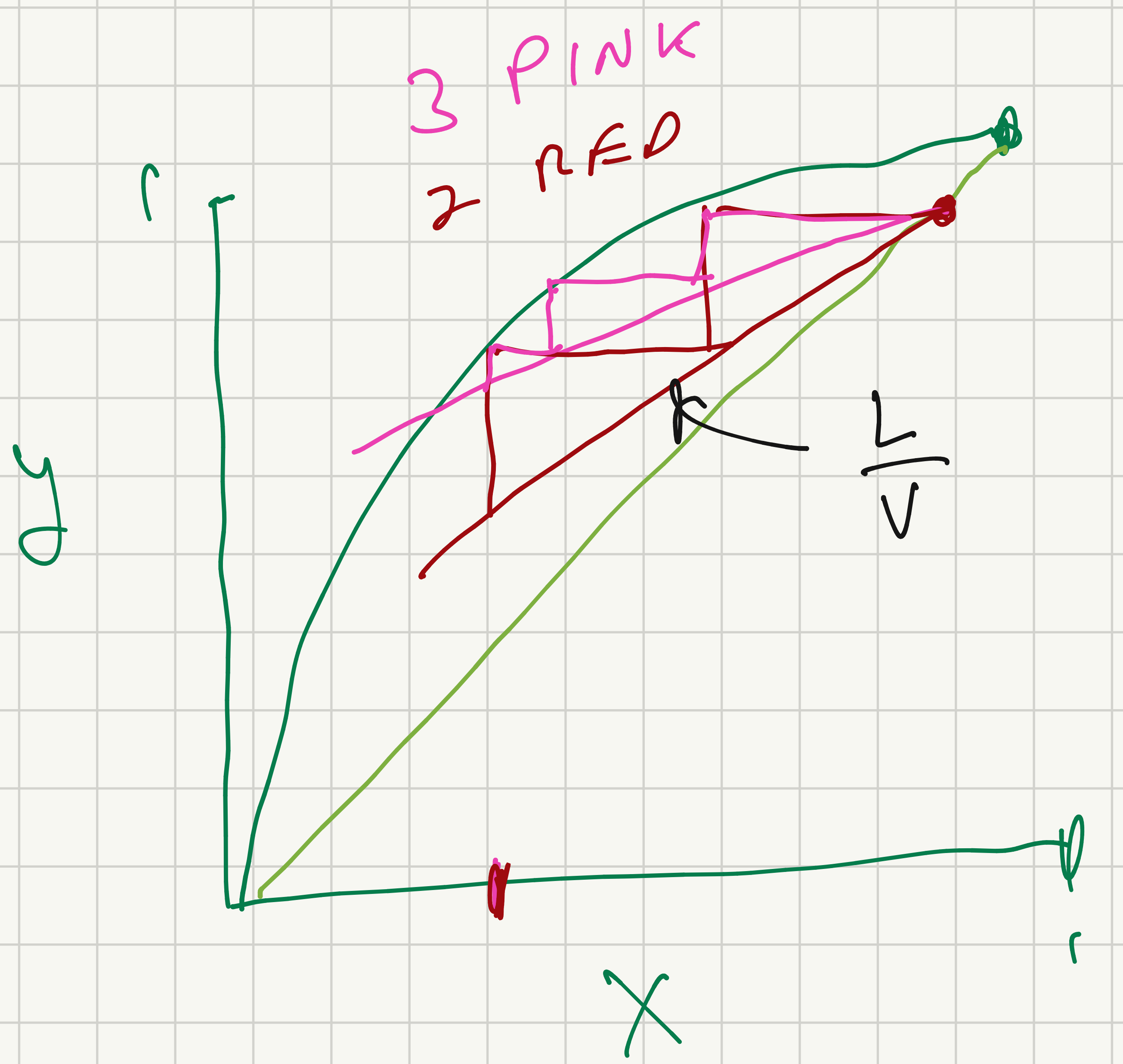
PRESUMABLY THERE IS
A TRADEOFF BETWEEN
SIZE OF REACTOR & AMOUNT
OF A THAT IS RECYCLED

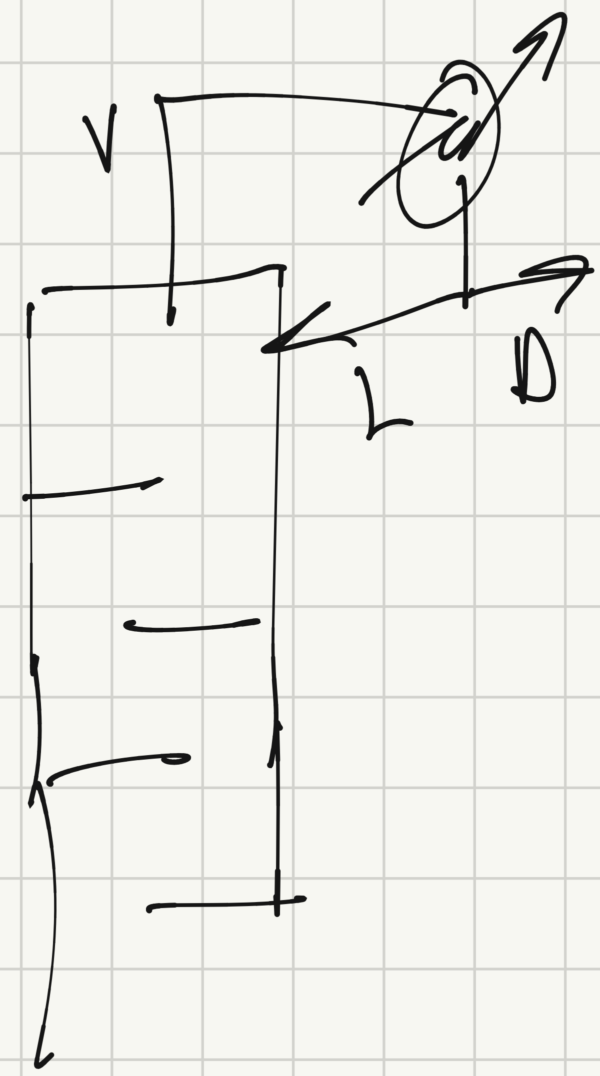
AS $V \uparrow$ CONVERSION IS
INCREASED SO IN THE
LIMIT, PROCESS WOULD
NOT HAVE RECYCLE, NOR
NEED A SEPARATION STEP

THE LIMIT IS IMPRACTICAL
BUT A LARGE REACTOR
SHOULD REDUCE THE ENERGY
NEEDED FOR SEPARATION

FOR SEPARATION, A TRADE OFF EXISTS BETWEEN ENERGY INPUT + NUMBER OF TRAYS NEEDED FOR SEPARATION

MORE $\dot{Q}$, HIGHER INTERNAL FLOW RATES $\Rightarrow$ FEWER TRAYS



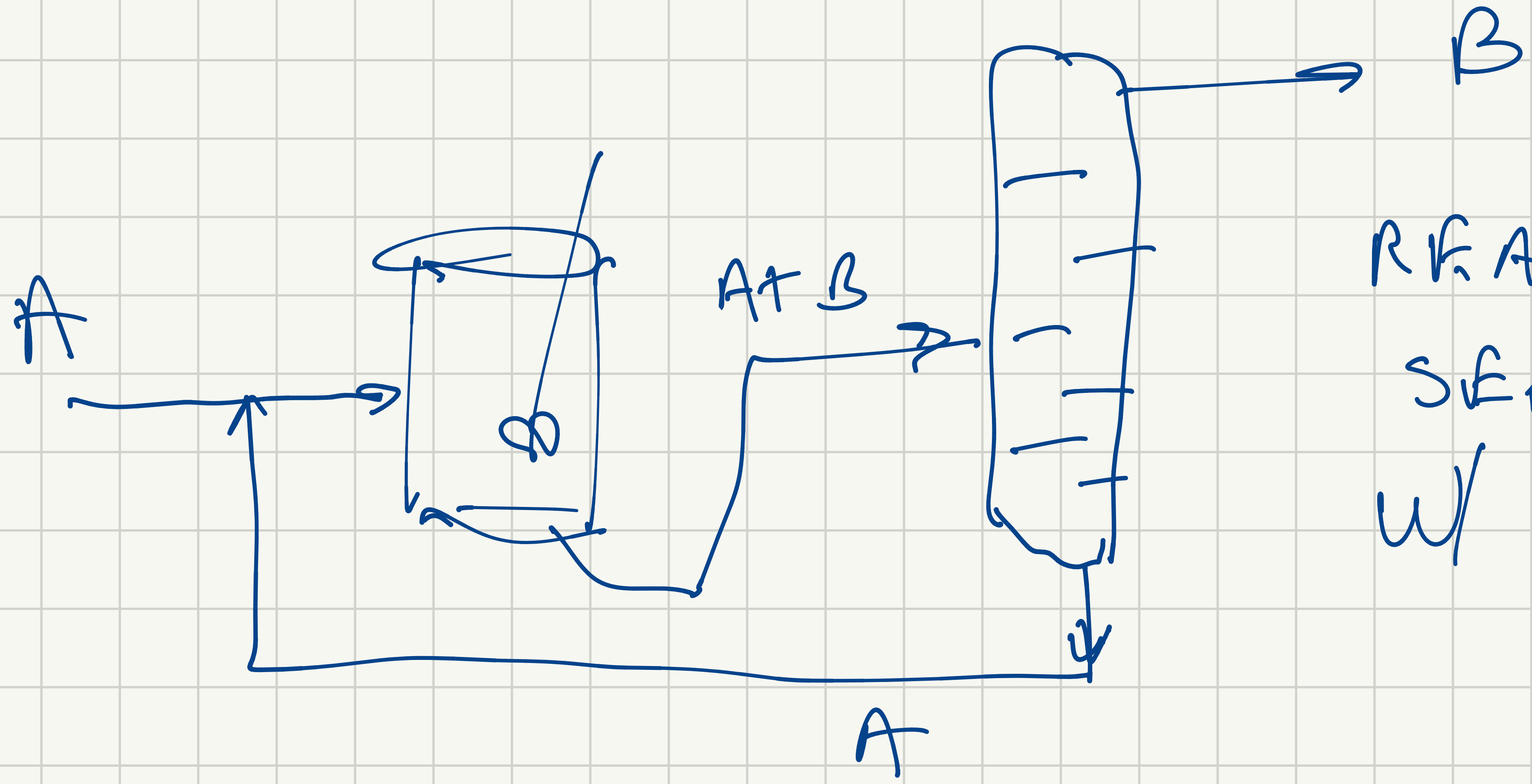


AS $\frac{L}{D} \uparrow$

$\frac{L}{V} \Rightarrow 1$

D IS FIXED SO, IF MOREL IS NEEDED V ↑ SO $\dot{Q}$ ↑.

WE WOULD LIKE INCLUDE THESE EFFECTS IN A "STRAIGHT FORWARD" CALCULATION



REACTOR SEPARATOR W/ RECYCLE

$A \rightarrow B$, FIRST ORDER REACTION

FOR VAPOR-LIQUID EQUILIBRIUM, "CONSTANT RELATIVE VOLATILITY

$$x_i \gamma_i P_i^{VAP} = y_i P$$

SUPPOSE: $\gamma_i = 1$ → CHEMICALLY SIMILAR MOLECULES

$$y_i = \frac{x_i P^{VAP}}{P}$$

$$\alpha \equiv \frac{y_1/x_1}{y_2/x_2} = \text{COSTANT}$$

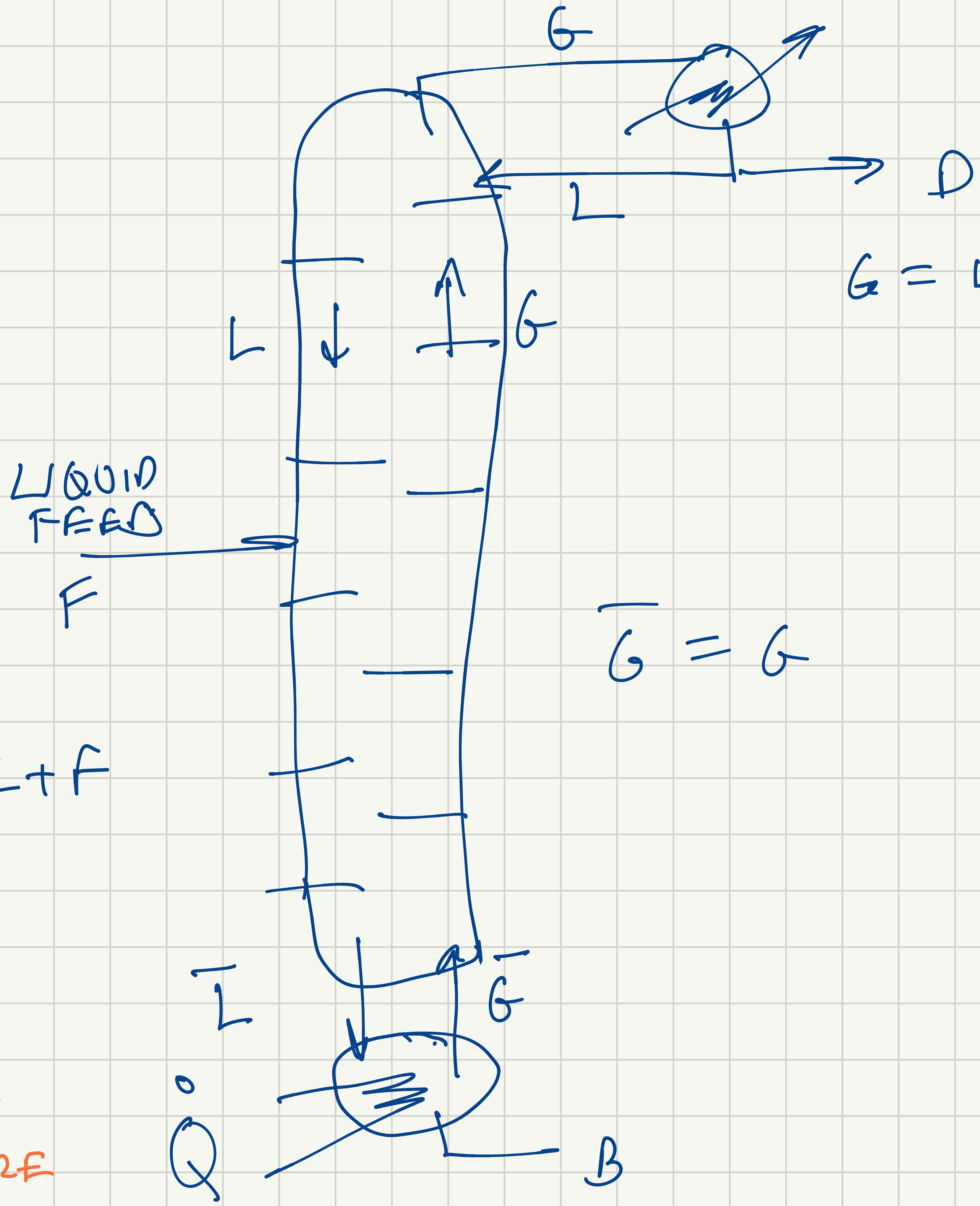
$$= \frac{P_1^{VAP}/P}{P_2^{VAP}/P} = \frac{P_1^{VAP}}{P_2^{VAP}}$$

MAY BE REASONABLE IF ΔH^{VAP} IS ABOUT THE SAME FOR EACH COMPONENT

$$\frac{dP^{SAT}}{dT} = \frac{\Delta H^{VAP}}{T(V^V - V^L)}$$

'CLAPEYRON' EQ

COLUMN OPERATION



$G = L + D$

$\bar{G} = G$

$\bar{L} = L + F$

MORE $\dot{Q}$ FOR MORE G.