

1. Problem 4.1

Sources	Weight%	Flow (kg/s)	Load (kg/s)
Dryer	0.4	5.5	0.022
Coating	1.9	3.0	0.057

Sinks	Weight%	Flow (kg/s)	Load (kg/s)
Dryer	0.1	5.5	0.0055
Coating	0.2	3.0	0.006

Dryer source can be recycled back to the dryer inlet.

$$\text{Dryer recycle} = \frac{\text{Dryer load}}{\text{Dryer weight}\%} = \frac{0.0055}{0.4\%}$$

$$\text{Dryer recycle} = 1.375 \text{ kg/s}$$

There are still 4.125 kg/s available to recycle from the dryer.

$$\text{Coating recycle} = \frac{\text{Coating load}}{\text{Dryer weight}\%} = \frac{0.006}{0.4\%}$$

$$\text{Coating recycle} = 1.5 \text{ kg/s}$$

Maximum load has been achieved.

$$\text{Total recycle} = 2.875 \text{ kg/s}$$

$$\text{Fresh feed saved} = 8.5 - 2.875 = 5.625 \text{ kg/s}$$

$$\text{Discharge reduced} = 8.5 - 2.875 = 5.625 \text{ kg/s}$$

Redirecting 2.875 kg/s from the dryer effluent reduces the total necessary fresh feed to 5.625 kg/s and the total discharge to 5.625 kg/s.

A process that implements this integration would send 1.375 kg/s to the dryer and 1.5 kg/s to coating.

2. Problem 4.2

Sources	Weight%	Flow (kg/h)	Load (kg/h)
Absorber I	5	5100	255
Acid Tower	10	10200	1020

Sinks	Weight%	Flow (kg/h)	Load (kg/h)
Absorber II	14	1400	196
Primary Tower	25	9100	2275

Plot sink and sources composite lines.

Sink lines

$$\text{Load} = 0.05 \cdot \text{Flow}, \text{ until } 5100 \text{ kg/h}$$

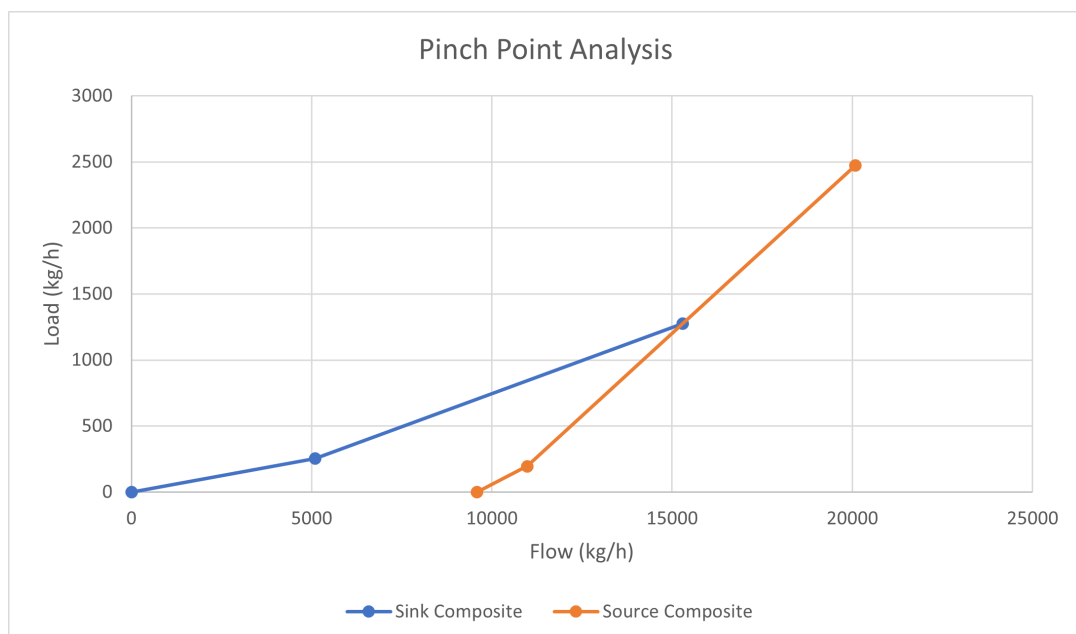
$$\text{Load} = 0.1 \cdot (\text{Flow} - 5100) + 255, \text{ until } 15300 \text{ kg/h}$$

Source lines; guess x-intercept

$$\text{Load} = 0.14 \cdot (\text{Flow} - \text{x-intercept}), \text{ until } \text{x-intercept} + 1400 \text{ kg/h}$$

$$\begin{aligned} \text{Load} = & 0.25 \cdot (\text{Flow} - \text{x-intercept} - 1400) \\ & + 0.14 \cdot (\text{x-intercept} + 1400), \text{ until } \text{x-intercept} + 1400 \text{ kg/h} \\ & , \text{ until } \text{x-intercept} + 10500 \text{ kg/h} \end{aligned}$$

Plot the lines and vary the x-intercept until the sink and source lines intersect.



The pinch point came at an x-intercept of 9584. The target fresh acetic acid usage is 9584 kg/h and the target minimum discharge is 4784 kg/h.

One possible way of achieving this process is by taking the discharge streams and mixing a portion of it with the fresh acetic acid feed, and then sending the mixture to the respective units.

Another way of integrating the process is by reducing the fresh feed rates to the Absorber II and the Primary tower. Then, feed the entirety of the discharge from the Absorber I to the Absorber II. Then, send the rest of the recyclable discharge to the Primary Tower.

The final way of integrating this process is by reducing the fresh feed rates to the Absorber II and the Primary tower. Then, combine the waste discharge streams and make of the rest of the required acetic acid to the Absorber II and the Primary tower with the combined discharge.