

## Adiabatic flash drum with binary liquid feed

Name(s) \_\_\_\_\_

A two-component, pressurized liquid is fed to an adiabatic flash drum and mass balances are used to determine the vapor composition and flow rate. A T-x-y diagram is generated from measurements at constant drum pressure and different feed conditions. The T-x-y diagram is compared to Raoult's law.

### Student learning objectives

1. Be able to explain the principles of flash distillation,
2. Be able to create a T-x-y diagram for a binary mixture at constant pressure.
3. Be able to apply Raoult's law.
4. Be able to do mass balances on a flash drum.
5. Be able to explain how changes in feed temperature and drum pressure affect the relative amounts of liquid and vapor, the compositions of the phases leaving the drum, and the separation ability of the drum.

### Equipment

- A lab-scale, insulated flash drum with liquid feed and vapor and liquid outlets. The drum contains pressure and temperature sensors and a pressure relief valve.
- A system (with a temperature controller and temperature sensor) to preheat the feed mixture.
- A pressure controller to maintain a constant pressure within the drum.
- Mass flow meters to measure the flow rates of the feed and the liquid outlet.
- A gas chromatograph to analyze the composition of the liquid outlet.

### Before starting

Select the binary mixture (A, B, C, D, or E) to study from the dropdown menu.

Mixture \_\_\_\_\_

Record the molecular weights of the two components:  $MW_1$  \_\_\_\_\_  $MW_2$  \_\_\_\_\_

Record the Antoine constants for the two components.

$A_1$  \_\_\_\_\_  $B_1$  \_\_\_\_\_  $C_1$  \_\_\_\_\_

$A_2$  \_\_\_\_\_  $B_2$  \_\_\_\_\_  $C_2$  \_\_\_\_\_

Select one pressure of the flash drum for your measurements.

Pressure \_\_\_\_\_

### Measure outlet conditions

The feed flow rate is 100 mol/h, and the feed pressure is high enough that the feed is liquid.

Select a feed composition and temperature and record them in the Table below. Once the feed mixture is at the desired temperature, introduce it to the flash drum.

Allow the system to reach steady state.

Measure drum temperature and record in the table below.

Measure outlet liquid mass flow rate.

Take samples of the liquid outlet stream and inject into a GC to measure molar compositions.

Use molecular weights to calculate outlet liquid molar flow rate.

Use mass balances to determine vapor molar flow rate and composition and record in the Table.

Repeat these measurements for a range of feed compositions and temperatures and record the results in the Table.

Feed temp °C	Feed mole fraction $z_1$	Drum temp °C	Outlet liquid mass flow rate (g/h)	Outlet liquid mole fraction $x_1$	Outlet liquid molar flow rate (mol/h)	Outlet vapor molar flow rate (mol/h)	Outlet vapor mole fraction $y_1$

### Create a T-x-y diagram

Use the data in the Table to create a spreadsheet and generate a T-x-y diagram at constant pressure.

Does the system obey Raoult's law? Explain.

**Questions to answer**

1. Where might these measurements have errors?
2. In an adiabatic flash drum, why is the drum temperature lower than the feed temperature?
3. How does changing the feed temperature affect the outlet compositions and flow rates?
4. Suppose you repeated measurements at a lower pressure. What would be different in the outlet flow rates and compositions?
5. What safety precautions would you take to conduct this experiment in the laboratory?