

Separation of Benzene from Air using Compression

Aditi Jain

Department of Chemical Engineering

National Institute of Technology Warangal

Background:

Benzene is a potentially dangerous chemical. High levels of exposure can cause both short-term and long-term health effects. Exposure to benzene liquid or vapor can irritate the skin, eyes, throat, irritation dizziness, sleepiness and convulsions. Long-term exposure to benzene mainly harms the bone marrow, the soft, inner parts of bones where new blood cells are made.

The Occupational Safety & Health Administration (OSHA) is the federal agency responsible for health and safety regulations in most workplaces. OSHA limits exposure to benzene in the air in most workplaces to 1 ppm (part per million) during an average workday and a maximum of 5 ppm over any 15-minute period

This flowsheet is about separation of benzene from air using compressor.

Process:

In this example air-benzene mixture containing 0.982 mole fraction of air, at 26 degree Celsius and 1 atm pressure is sent at the rate of 1kg/s to an **adiabatic compressor** the increase in pressure is 142 atm this is calculated using Raoult's Law. Next the compressed mixture is sent to a **cooler** to bring its temperature down to 26 degree Celsius. This brings about condensation of benzene vapors, air is essentially non-condensable. The adiabatic compressor and cooler, together act as an isothermal compressor. Next the Vapor-Liquid mixture is sent to a **flash separator** to separate liquid benzene from the vapor. Purified air is sent to a **valve** which reduces its pressure from 143 atm to 1 atm. This air can be further purified or let out depending on the safety standards.

Results:

- 1) Purified air at 26 degree Celsius and 1atm contains benzene in the mole fraction of 0.000805 which is very close to the desired value of 0.000916.
- 2) The liquid from the flash separator contains 95% of the initial benzene and very small mole fraction 0.001645 of air.

Conclusion:

- 1) Though air is essentially non-condensable a very small mole fraction of air does get condensed.
- 2) The amount of benzene separated from air can be increased by increasing the pressure in the compressor.
- 3) Adiabatic compressor and the cooler together act as an isothermal compressor which results in the condensation of the benzene vapors.

Reference:

Basic Principles and Calculations in Chemical Engineering (Eighth Edition)- David M. Himmelblau, James B. Riggs
Example 8.6 Condensation of benzene from a vapor Recovery unit (Page no-424).