

Pneumatic Power

Pneumatics

- The use of a _____ flowing under pressure to transmit power from one location to another
- Gas in a pneumatic system behaves like a _____ since it is compressible.

Pneumatics vs. Hydraulics

Pneumatic Systems . . .

- Use a compressible gas
- Possess a _____, jumpier motion
- Are not as _____
- Require a lubricant
- Are generally cleaner, leak gases
- Often operate at pressures around _____ psi
- Generally produce _____ power

Hydraulic Systems . . .

- Use almost non compressible liquids
- Possess smoother and _____ controlled motion
- Are _____
- Require a lubricant
- Are generally messy, leak liquids
- Often operate at pressures around 1000 to _____ psi
- Generally produce _____ power

Properties of Gases

Perfect Gas Laws

Gases are affected by 3 variables

- _____ (T)
- _____ (p)
- _____ (V)

Gases have _____ definite volume

Gases are highly _____

Gases are _____ than liquids

Absolute Pressure:

Gauge Pressure: Pressure on a gauge does not account for atmospheric pressure on all sides of the system

Absolute Pressure: Atmospheric pressure plus gauge pressure

$$\text{Gauge Pressure} + \text{-----} = \text{Absolute Pressure}$$

Absolute Temperature:

0°F does not represent a true 0°

Absolute Zero = -460.°F

Absolute Temperature is measured in degrees Rankine (°R)

$$^{\circ}\text{R} = ^{\circ}\text{F} + \text{-----}$$

Example Problem: If the temperature of the air in a system is 65 °F, what is the absolute temperature?

Perfect Gas Laws

Boyle's Law

The ----- of a gas at constant temperature varies inversely with the pressure exerted on it.

Formula:

Example Problem: A cylinder is filled with 40 in³ of air at a pressure of 60 psi. The cylinder is compressed to 10 in³. What is the resulting absolute pressure?

1st determine Absolute pressure:

Pressure of gauge + 14.7 lb/in²

Substitute Values into Boyle's Formula:

Charles' Law

Volume of gas increases or decreases as the -----

increases or decreases, provided the amount of gas and pressure remain constant.

Formula:

Example Problem: An expandable container is filled with 28 in.³ of air and is sitting in ice water that is 32 °F. The container is removed from the icy water and then heated to 200 °F. What is the resulting volume?

Find Absolute Temperature 1st:

$$^{\circ}\text{F} + 460 = ^{\circ}\text{R}$$

2nd Substitute Values into Charles' Law formula:

Gay-Lussac's Law

Absolute pressure of a gas increases or decreases as the temperature increases or decreases, provided the amount of gas and the volume remain _____.

Formula:

Example Problem: A 300 in.³ sealed air tank is sitting outside. In the morning, the temperature inside the tank is 62 °F, and the pressure gauge reads 120 lb/in.². By afternoon, the temperature inside the tank is expected to be close to 90 °F. What will the absolute pressure be at that point?

1st Find Absolute Pressure:

$$\text{Pressure of gauge} + 14.7 \text{ lb/in}^2$$

Convert T₁ and T₂ into absolute temperature:

$$^{\circ}\text{F} + 460 = ^{\circ}\text{R}$$

Substitute values in Gay-Lussac's Law formula:

Pneumatic Systems Practice Problems

1. The gauge pressure of a pneumatic cylinder reads 20 lb/in^2 when the volume is 30 in^3 . The cylinder is compressed until the gauge reads 60 lb/in^2 . Assume standard atmospheric pressure (14.7 psi).

a. What is the absolute pressure before the cylinder gas is compressed?

b. What is the absolute pressure after the cylinder gas is compressed?

c. What is the volume in the cylinder after the gas is compressed?

2. The air temperature in a 28 in^3 container with a free-sliding piston is initially measured at $45 \text{ }^\circ\text{F}$. The temperature is raised to $200 \text{ }^\circ\text{F}$.

a. What is the initial absolute temperature reading?

b. What is the absolute temperature reading after the temperature is raised?

c. What is the volume in the cylinder after the temperature is raised?

3. A 60-ft³ compressor tank container has a gauge pressure of 160 lb/in² and a temperature of 70 °F. After some time, the temperature decreases to 40 °F. Find the final pressure in the tank. Assume standard atmospheric pressure.

a. What is the initial absolute temperature reading?

b. What is the absolute temperature reading after the temperature decreases?

c. What is the absolute pressure of the system before the temperature decreases?

d. What is the absolute pressure of the system after the temperature decreases?