SOLUTION MANUAL
CHAPTER 1

Tenth Edition

Fundamentals of Thermodynamics

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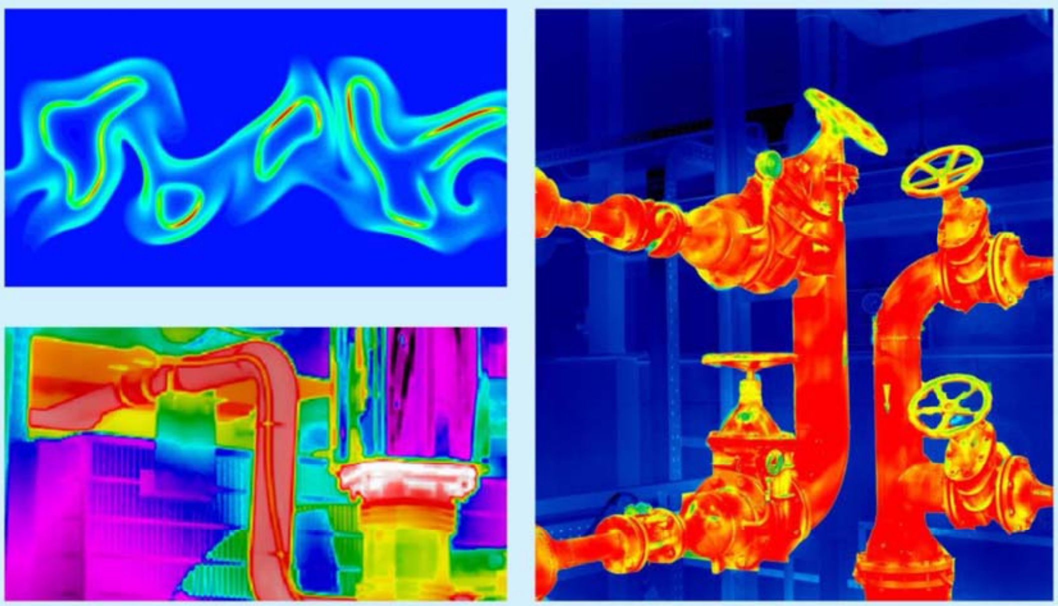

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CONTENT CHAPTER 1

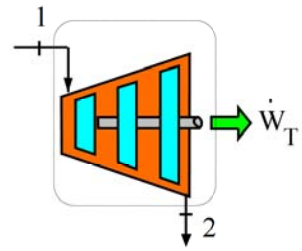
In-Text Concept Questions

1.a

Make a control volume around the turbine in the steam power plant in Fig. 1.2 and list the flows of mass and energy that are there.

Solution:

We see hot high pressure steam flowing in at state 1 from the steam drum through a flow control (not shown). The steam leaves at a lower pressure to the condenser (heat exchanger) at state 2. A rotating shaft gives a rate of energy (power) to the electric generator set.

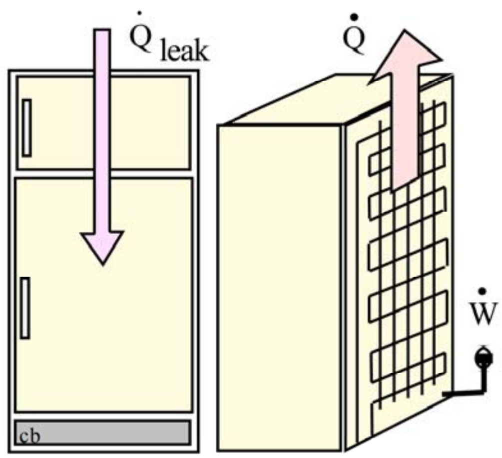


1.b

Take a control volume around your kitchen refrigerator and indicate where the components shown in Figure 1.3 are located and show all flows of energy transfers.

Solution:

The valve and the cold line, the evaporator, is inside close to the inside wall and usually a small blower distributes cold air from the freezer box to the refrigerator room.



The black grille in the back or at the bottom is the condenser that gives heat to the room air.

The compressor sits at the bottom.

1.c

Why do people float high in the water when swimming in the Dead Sea as compared with swimming in a fresh water lake?

As the dead sea is very salty its density is higher than fresh water density. The buoyancy effect gives a force up that equals the weight of the displaced water. Since salt water density is higher the displaced volume is smaller for the same force.

$$F = m_{H2O\ salt}\ g - m_{H2O\ fresh}\ g = (\rho V)_{H2O\ salt}\ g - (\rho V)_{H2O\ fresh}\ g$$

1.d

Density of liquid water is $\rho = 1008 - T/2$ [kg/m^3] with T in °C. If the temperature increases, what happens to the density and specific volume?

Solution:

The density is seen to decrease as the temperature increases.

$$\Delta\rho = -\Delta T/2$$

Since the specific volume is the inverse of the density $v = 1/\rho$ it will increase.

1.e

A car tire gauge indicates 195 kPa; what is the air pressure inside?

The pressure you read on the gauge is a gauge pressure, ΔP, so the absolute pressure is found as

$$P = P_o + \Delta P = 101 + 195 = 296 \text{ kPa}$$

Figure 1.21

1.f

Can I always neglect ΔP in the fluid above location A in figure 1.13? What does that depend on?

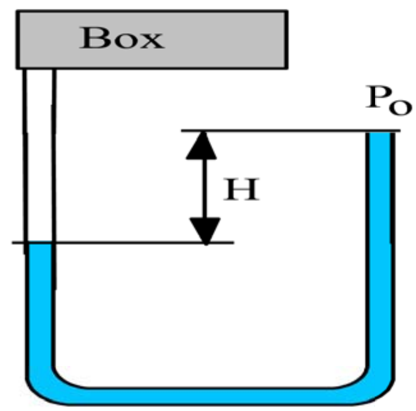
If the fluid density above A is low relative to the manometer fluid then you neglect the pressure variation above position A, say the fluid is a gas like air and the manometer fluid is like liquid water. However, if the fluid above A has a density of the same order of magnitude as the manometer fluid then the pressure variation with elevation is as large as in the manometer fluid and it must be accounted for.

1.g

A U tube manometer has the left branch connected to a box with a pressure of 110 kPa and the right branch open. Which side has a higher column of fluid?

Solution:

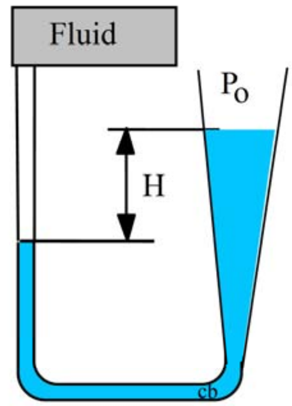
Since the left branch fluid surface feels 110 kPa and the right branch surface is at 100 kPa you must go further down to match the 110 kPa. The right branch has a higher column of fluid.



1.h

If the right side pipe section in Fig. 1.13 is V shaped like a funnel does that change the pressure at location B?

The shape does not affect the pressure only depth from surface at P_o matters.



Comment: the slanted surface has a component of the pressure (normal to the surface) that points upwards.

1.i

If the cylinder pressure in Ex. 1.3 does not give $F_{net} = 0$ what happens?

If: $\quad F_{net} = ma \neq 0 \quad \Rightarrow \quad a \neq 0$

The piston will accelerate up if $P_{cyl} > 250$ kPa given F = 932.9 N
or down up if $P_{cyl} < 250$ kPa given F = 932.9 N which changes the cylinder volume. Thus by controlling the pressure you can move the piston, which is the basis for the hydraulic cylinder used in a bulldozer, a backhoe or front loader.