Hydraulic Excavator
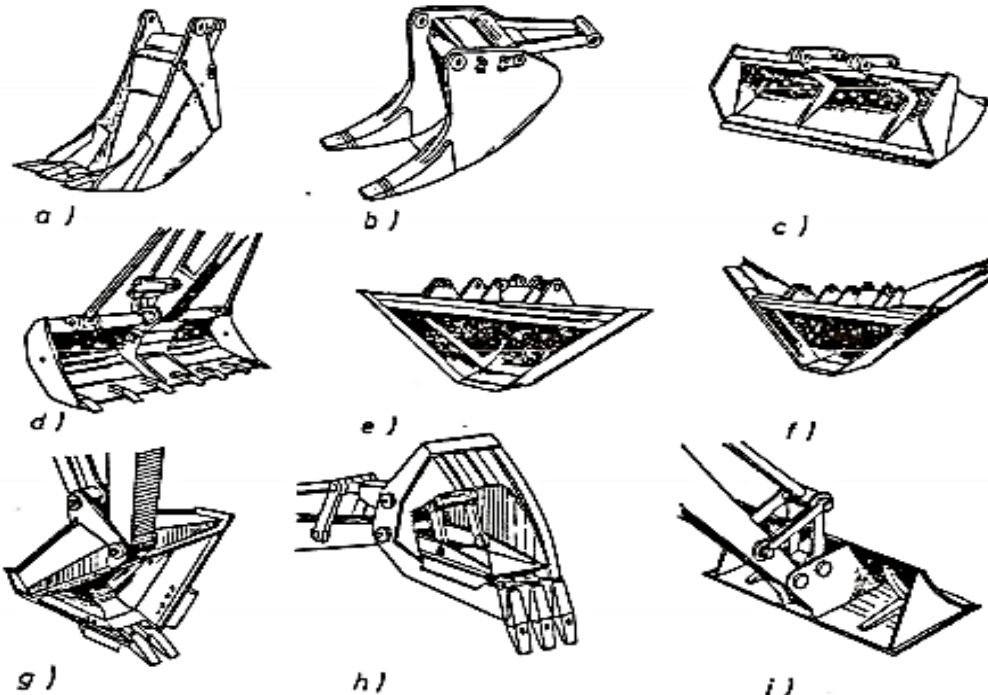
Hydraulic excavator attachments

Earthwork attachmenst

Special bucket-typed attachments
a. drainer; b. ripper; c. canal maintainer; d. ripper-cleaner; e. profile bucket;
f. extended cutter; g. ripper-profiler; h. ejector; i. tamper

Hydraulic Excavator

Hydraulic excavator attachments

Demolisher and Recycler attachments

Screen drum

Bucket-wheel
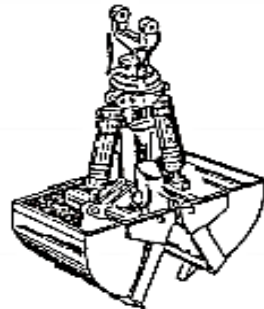

Crusher (mill)

Snapper
(cutter/jaw)

Breaker

Hydraulic Excavator

Hydraulic excavator attachments
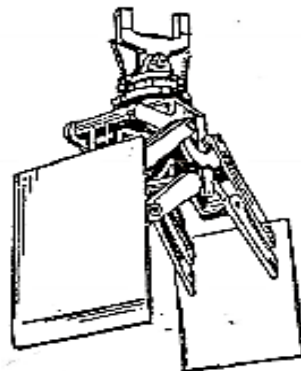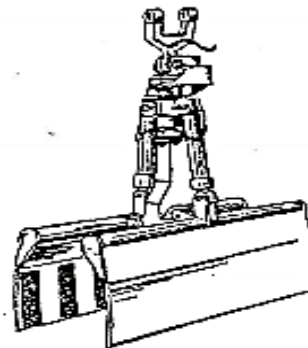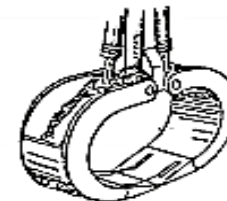
Grabs, grips and loaders

a) b) c)

d) e) f)

Grabbing and loading attachments
a. clamshell; b. boring; c. fingered; d. bale grip; e. barrel/pipe grip; f. logger

Pumping System

Introduction and Classification

Turbomachines divide naturally into those which add energy (pumps) and those which extract energy (turbines). The prefix *turbo-* is a Latin word meaning "spin" or "whirl," appropriate for rotating devices.

1. Positive-displacement pumps

A. Reciprocating
   1. Piston or plunger
   2. Diaphragm
B. Rotary
   1. Single rotor
      a. Sliding vane
      b. Flexible tube or lining
      c. Screw
      d. Peristaltic (wave contraction)
   2. Multiple rotors
      a. Gear
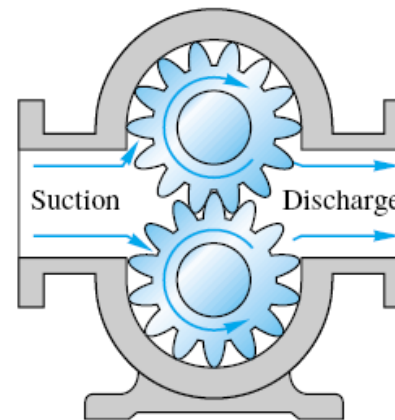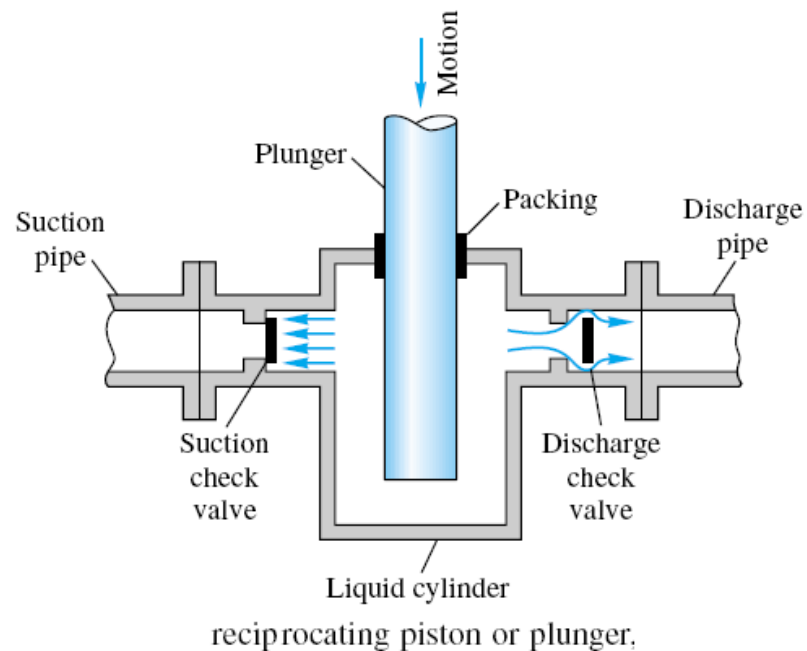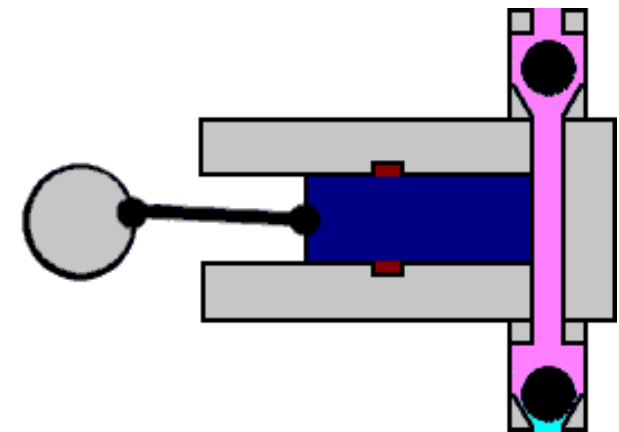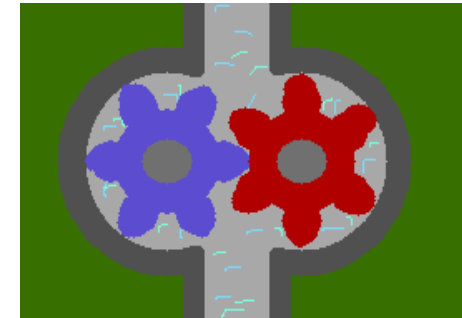   b. Lobe
      c. Screw
      d. Circumferential piston

Pumping System

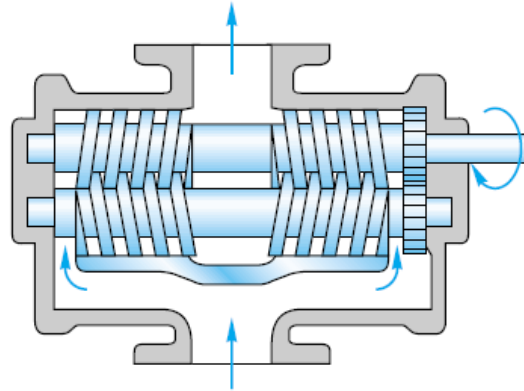## 1. Positive-displacement pumps
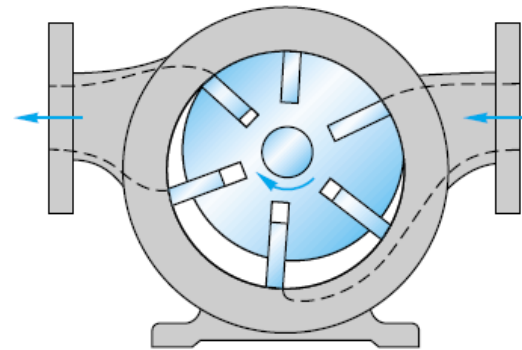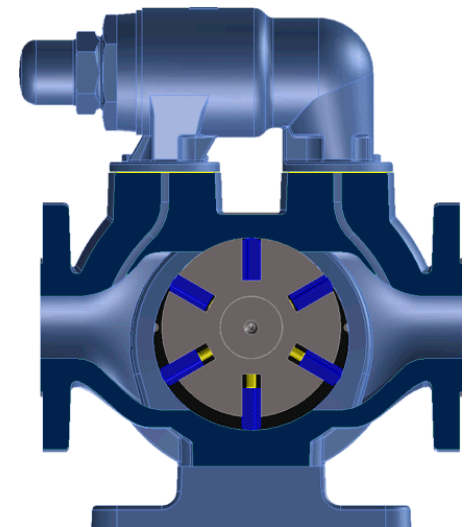

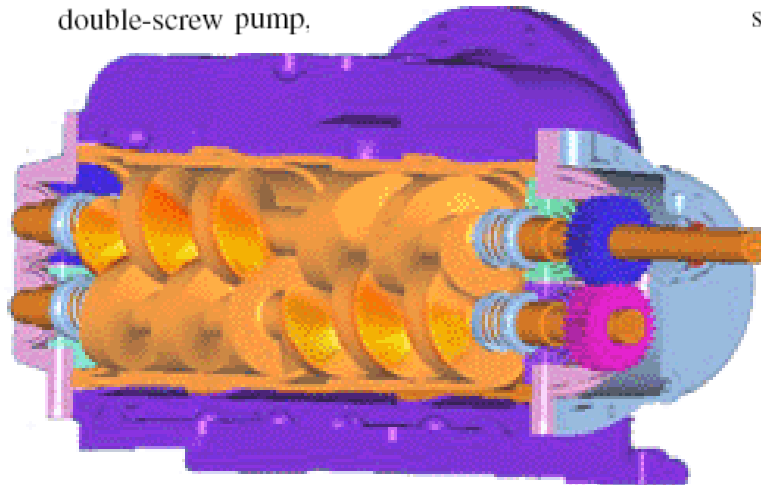reciprocating piston or plunger.

external gear pump.

Pumps

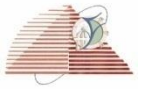## 1. Positive-displacement pumps

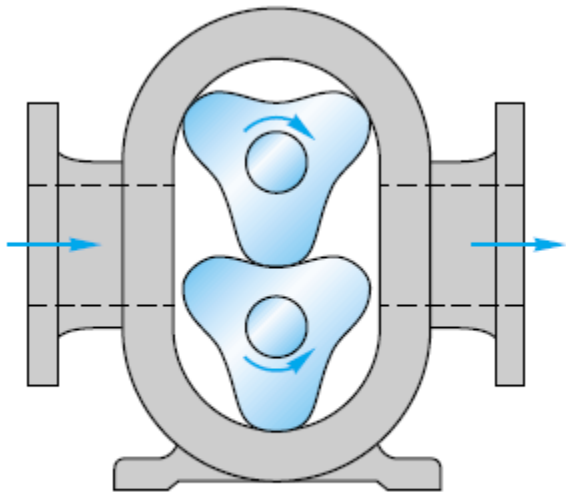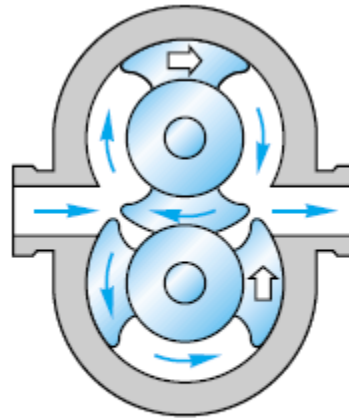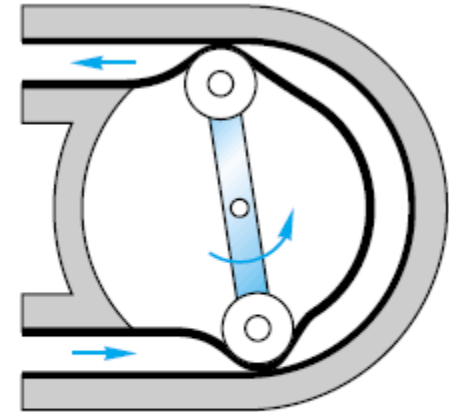double-screw pump.

sliding vane.

Pumping System

1. Positive-displacement pumps

three lobe pump,

double circumfer ential piston,

flexible-tube squeegee.
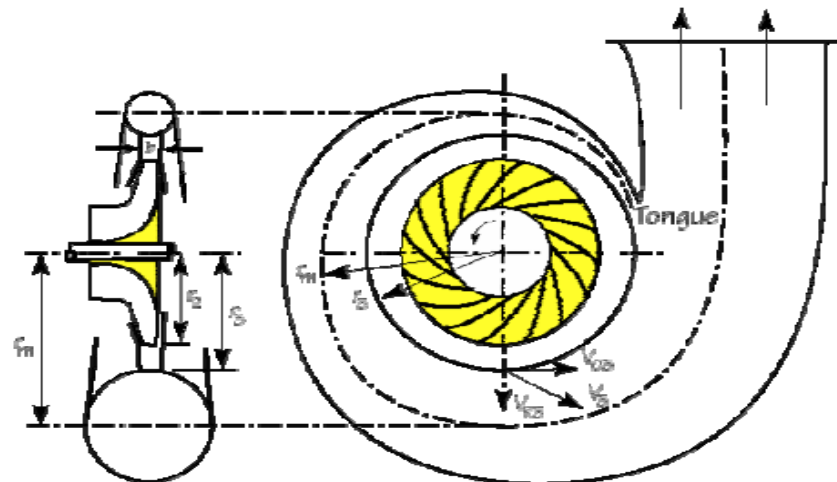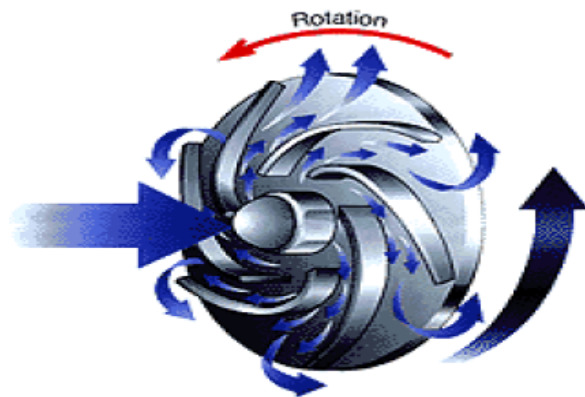
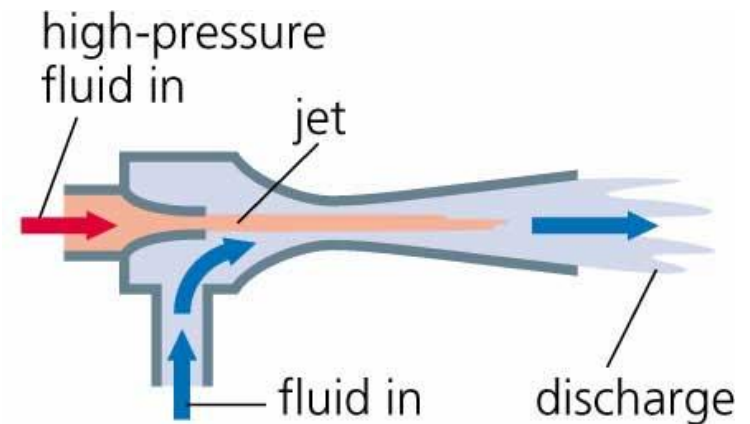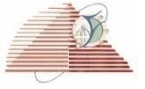# Pumping System

2. Dynamic pumps

A. Rotary
   1. Centrifugal or radial exit flow
   2. Axial flow
   3. Mixed flow (between radial and axial)
B. Special designs
   1. Jet pump or ejector
   2. Electromagnetic pumps for liquid metals
   3. Fluid-actuated: gas-lift or hydraulic-ram
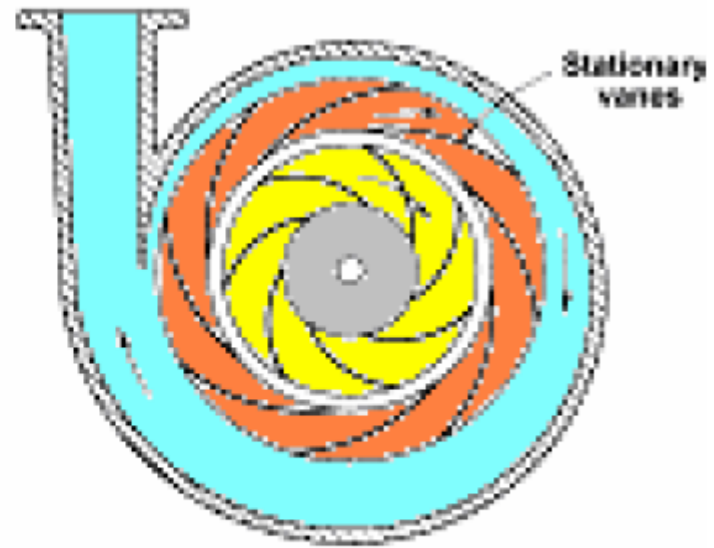
Pumping System
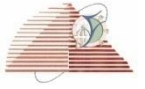
The Centrifugal Pump Types

a. Volute Type

b. Diffuser Type

Pumping System

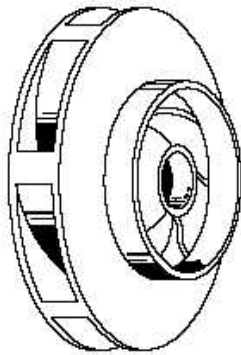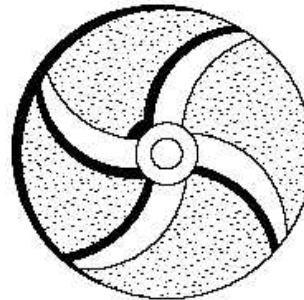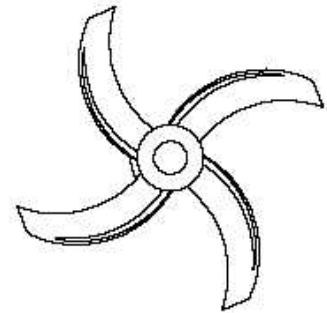## Impeller blades type

(a)   (b)   (c)

Fig. 4.4: Impeller blades type; Closes, (b) semi-closed, (c) open.
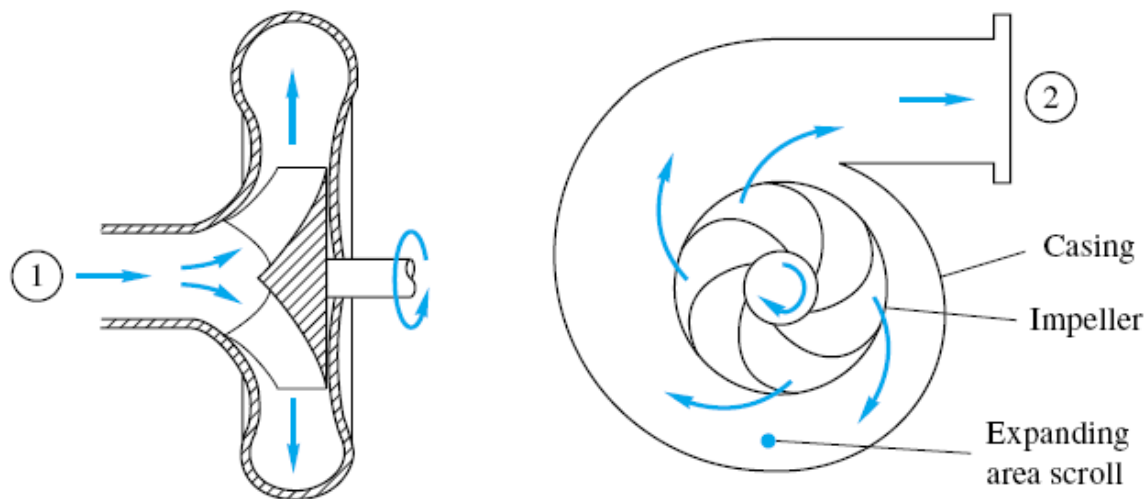
Pumping System

The Centrifugal Pump

$$H = \left(\frac{p}{\rho g} + \frac{V^2}{2g} + z \right)_2 - \left(\frac{p}{\rho g} + \frac{V^2}{2g} + z \right)_1 = h_s - h_f$$

where h_s is the pump head supplied and h_f the losses.

Casing

Impeller

Expanding area scroll

Pumping System

The Centrifugal Pump

Usually V_2 and V_1 are about the same, $z_2 - z_1$ is no more than a meter or so, and the net pump head is essentially equal to the change in pressure head

$$H \approx \frac{p_2 - p_1}{\rho g} = \frac{\Delta p}{\rho g} \quad \text{and} \quad \textit{water horsepower.} \ P_w = \rho g Q H$$

$$\textit{brake horsepower} \quad \text{bhp} = \omega T \quad \text{and} \qquad \eta = \frac{P_w}{\text{bhp}} = \frac{\rho g Q H}{\omega T}$$

The *volumetric efficiency* $\quad \eta_v = \dfrac{Q}{Q + Q_L} \quad$ and The *hydraulic efficiency* $\quad \eta_h = 1 - \dfrac{h_f}{h_s}$

mechanical efficiency $\quad \eta_m = 1 - \dfrac{P_f}{\text{bhp}}$

where P_f is the power loss due to mechanical friction in the bearings, packing glands, and other contact points in the machine.

the total efficiency $\eta \equiv \eta_v \eta_h \eta_m$

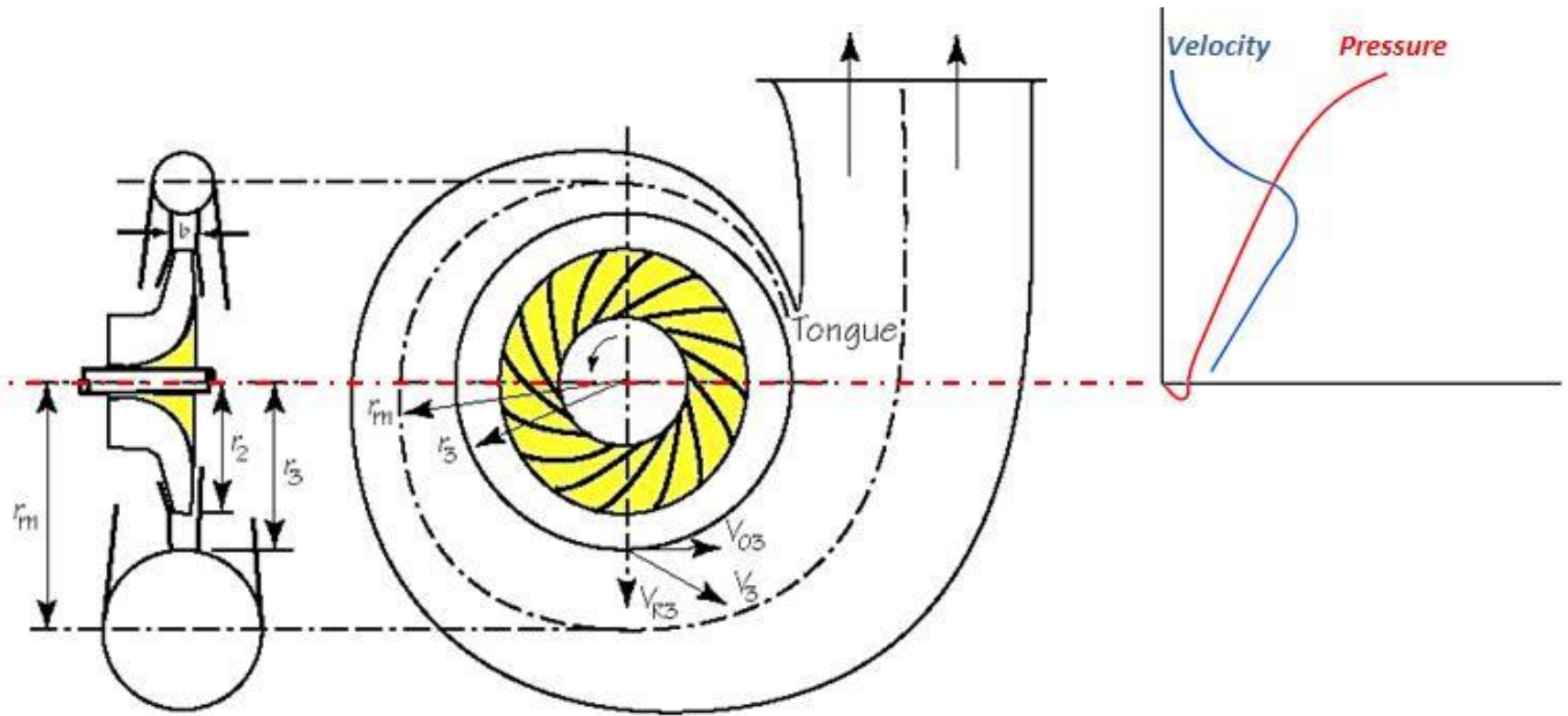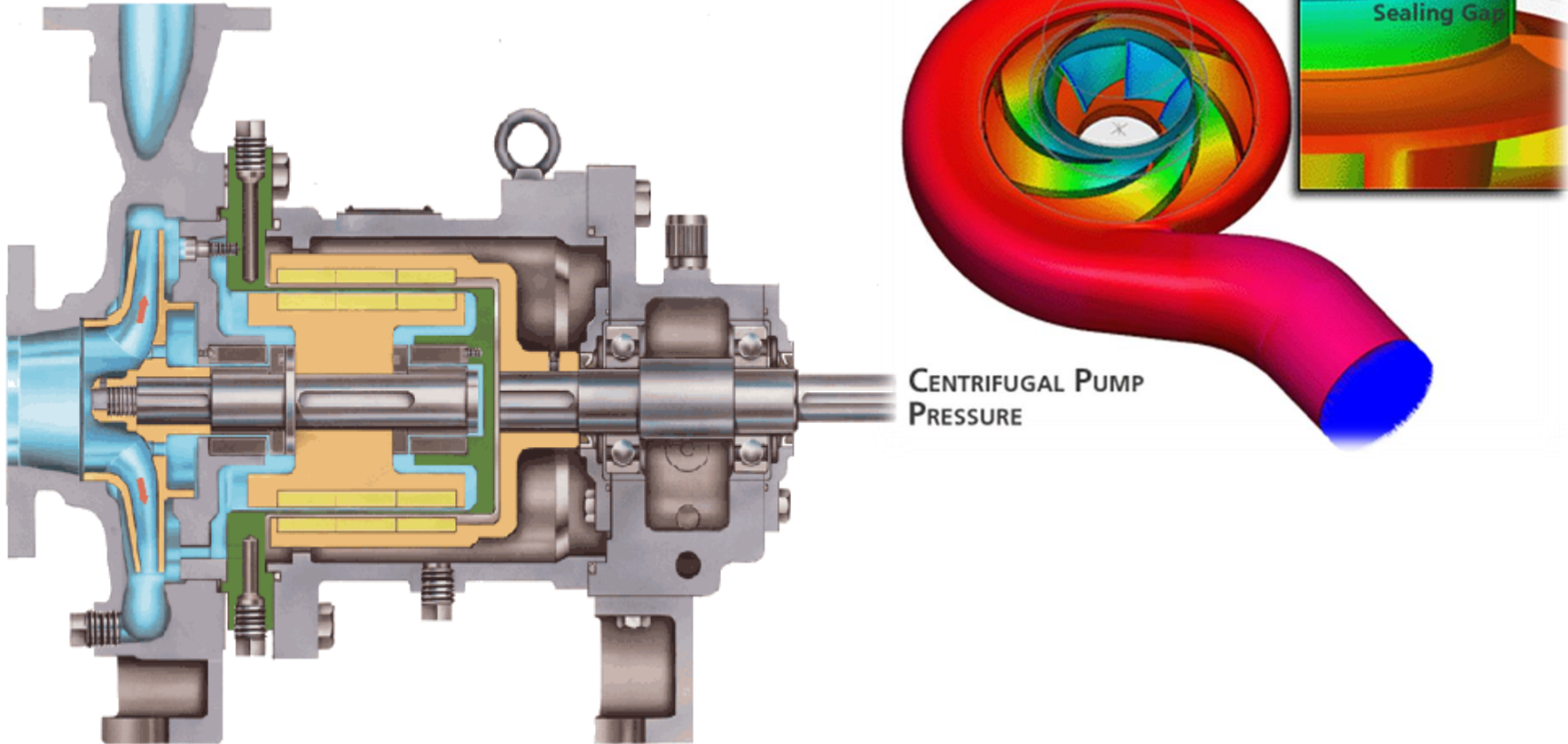# Pumping System

The Centrifugal Pump

Pumps

The Centrifugal Pump

CENTRIFUGAL PUMP
PRESSURE

Pumping System

Centrifugal Pump Actual Performance: