

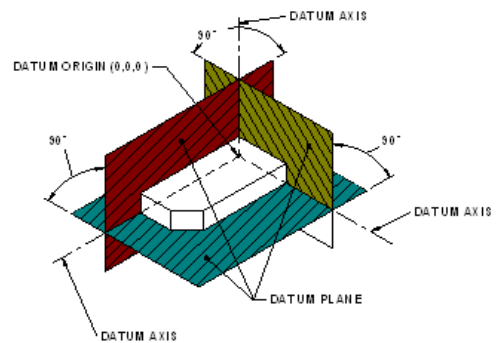


# PDHStorm

Online Engineering &  
Technology Training

510 N. Crosslane Rd.  
Monroe, Georgia 30656  
(770) 266-6915 fax  
(678) 643-1758

## PDH & Professional Training



**Department of Energy  
Fundamentals Handbook**

**MECHANICAL SCIENCE  
Module 3  
Pumps**

---

## TABLE OF CONTENTS

---

LIST OF FIGURES . . . . .	ii
LIST OF TABLES . . . . .	iii
REFERENCES . . . . .	iv
OBJECTIVES . . . . .	v
CENTRIFUGAL PUMPS . . . . .	1
Introduction . . . . .	1
Diffuser . . . . .	3
Impeller Classification . . . . .	3
Centrifugal Pump Classification by Flow . . . . .	4
Multi-Stage Centrifugal Pumps . . . . .	6
Centrifugal Pump Components . . . . .	7
Summary . . . . .	10
CENTRIFUGAL PUMP OPERATION . . . . .	11
Introduction . . . . .	11
Cavitation . . . . .	12
Net Positive Suction Head . . . . .	12
Preventing Cavitation . . . . .	13
Centrifugal Pump Characteristic Curves . . . . .	14
Centrifugal Pump Protection . . . . .	15
Gas Binding . . . . .	15
Priming Centrifugal Pumps . . . . .	15
Summary . . . . .	16
POSITIVE DISPLACEMENT PUMPS . . . . .	18
Introduction . . . . .	18
Principle of Operation . . . . .	19
Reciprocating Pumps . . . . .	19
Rotary Pumps . . . . .	22
Diaphragm Pumps . . . . .	26
Positive Displacement Pump Characteristic Curves . . . . .	27
Positive Displacement Pump Protection . . . . .	28
Summary . . . . .	28

---



---

## LIST OF FIGURES

---

Figure 1 Centrifugal Pump . . . . .	2
Figure 2 Single and Double Volute . . . . .	2
Figure 3 Centrifugal Pump Diffuser . . . . .	3
Figure 4 Single Suction and Double Suction Impellers . . . . .	3
Figure 5 Open, Semi-Open, and Enclosed Impellers . . . . .	4
Figure 6 Radial Flow Centrifugal Pump . . . . .	5
Figure 7 Axial Flow Centrifugal Pump . . . . .	5
Figure 8 Mixed Flow Centrifugal Pump . . . . .	6
Figure 9 Multi-Stage Centrifugal Pump . . . . .	7
Figure 10 Centrifugal Pump Components . . . . .	8
Figure 11 Centrifugal Pump Characteristic Curve . . . . .	14
Figure 12 Reciprocating Positive Displacement Pump Operation . . . . .	19
Figure 13 Single-Acting and Double-Acting Pumps . . . . .	21
Figure 14 Simple Gear Pump . . . . .	22
Figure 15 Types of Gears Used In Pumps . . . . .	23
Figure 16 Lobe Type Pump . . . . .	24
Figure 17 Two-Screw, Low-Pitch, Screw Pump . . . . .	25
Figure 18 Three-Screw, High-Pitch, Screw Pump . . . . .	25
Figure 19 Rotary Moving Vane Pump . . . . .	26
Figure 20 Diaphragm Pump . . . . .	27
Figure 21 Positive Displacement Pump Characteristic Curve . . . . .	27

---

## REFERENCES

---

- Babcock & Wilcox, Steam, Its Generations and Use, Babcock & Wilcox Co.
- Cheremisinoff, N. P., Fluid Flow, Pumps, Pipes and Channels, Ann Arbor Science.
- General Physics, Heat Transfer, Thermodynamics and Fluid Flow Fundamentals, General Physics Corporation.
- Academic Program for Nuclear Power Plant Personnel, Volume III, Columbia, MD, General Physics Corporation, Library of Congress Card #A 326517, 1982.
- Stewart, Harry L., Pneumatics & Hydraulics, Theodore Audel & Company.

---

## TERMINAL OBJECTIVE

---

- 1.0 Without references, **DESCRIBE** the purpose, construction, and principles of operation for centrifugal pumps.

---

## ENABLING OBJECTIVES

---

- 1.1 **STATE** the purposes of the following centrifugal pump components:
- |             |                 |
|-------------|-----------------|
| a. Impeller | d. Packing      |
| b. Volute   | e. Lantern Ring |
| c. Diffuser | f. Wearing ring |
- 1.2 Given a drawing of a centrifugal pump, **IDENTIFY** the following major components:
- |                 |                             |
|-----------------|-----------------------------|
| a. Pump casing  | f. Stuffing box gland       |
| b. Pump shaft   | g. Packing                  |
| c. Impeller     | h. Lantern Ring             |
| d. Volute       | i. Impeller wearing ring    |
| e. Stuffing box | j. Pump casing wearing ring |
- 1.3 **DEFINE** the following terms:
- |  |                 |
|--|-----------------|
| a. Net Positive Suction Head Available | d. Shutoff head |
| b. Cavitation                          | e. Pump runoff  |
| c. Gas binding                         |                 |
- 1.4 **STATE** the relationship between net positive suction head available and net positive suction head required that is necessary to avoid cavitation.
- 1.5 **LIST** three indications that a centrifugal pump may be cavitating.
- 1.6 **LIST** five changes that can be made in a pump or its surrounding system that can reduce cavitation.
- 1.7 **LIST** three effects of cavitation.
- 1.8 **DESCRIBE** the shape of the characteristic curve for a centrifugal pump.
- 1.9 **DESCRIBE** how centrifugal pumps are protected from the conditions of dead heading and pump runoff.

---

## TERMINAL OBJECTIVE

---

- 2.0 Without references, **DESCRIBE** the purpose, construction, and principle of operation for positive displacement pumps.

---

## ENABLING OBJECTIVES

---

- 2.1 **STATE** the difference between the flow characteristics of centrifugal and positive displacement pumps.
- 2.2 Given a simplified drawing of a positive displacement pump, **CLASSIFY** the pump as one of the following:
- a. Reciprocating piston pump
  - b. Gear-type rotary pump
  - c. Screw-type rotary pump
  - d. Lobe-type rotary pump
  - e. Moving vane pump
  - f. Diaphragm pump
- 2.3 **EXPLAIN** the importance of viscosity as it relates to the operation of a reciprocating positive displacement pump.
- 2.4 **DESCRIBE** the characteristic curve for a positive displacement pump.
- 2.5 **DEFINE** the term slippage.
- 2.6 **STATE** how positive displacement pumps are protected against overpressurization.

---

## CENTRIFUGAL PUMPS

---

*Centrifugal pumps are the most common type of pumps found in DOE facilities. Centrifugal pumps enjoy widespread application partly due to their ability to operate over a wide range of flow rates and pump heads.*

**EO 1.1 STATE the purposes of the following centrifugal pump components:**

- |   |  |
|---|--|
| <p><b>a. Impeller</b></p> <p><b>b. Volute</b></p> <p><b>c. Diffuser</b></p> | <p><b>d. Packing</b></p> <p><b>e. Lantern Ring</b></p> <p><b>f. Wearing ring</b></p> |
|---|--|

**EO 1.2 Given a drawing of a centrifugal pump, IDENTIFY the following major components:**

- |  |   |
|--|---|
| <p><b>a. Pump casing</b></p> <p><b>b. Pump shaft</b></p> <p><b>c. Impeller</b></p> <p><b>d. Volute</b></p> <p><b>e. Stuffing box</b></p> | <p><b>f. Stuffing box gland</b></p> <p><b>g. Packing</b></p> <p><b>h. Lantern Ring</b></p> <p><b>i. Impeller wearing ring</b></p> <p><b>j. Pump casing wearing ring</b></p> |
|--|---|
- 

### **Introduction**

Centrifugal pumps basically consist of a stationary pump casing and an impeller mounted on a rotating shaft. The pump casing provides a pressure boundary for the pump and contains channels to properly direct the suction and discharge flow. The pump casing has suction and discharge penetrations for the main flow path of the pump and normally has small drain and vent fittings to remove gases trapped in the pump casing or to drain the pump casing for maintenance.

Figure 1 is a simplified diagram of a typical centrifugal pump that shows the relative locations of the pump suction, impeller, volute, and discharge. The pump casing guides the liquid from the suction connection to the center, or eye, of the impeller. The vanes of the rotating *impeller* impart a radial and rotary motion to the liquid, forcing it to the outer periphery of the pump casing where it is collected in the outer part of the pump casing called the *volute*. The *volute* is a region that expands in cross-sectional area as it wraps around the pump casing. The purpose of the volute is to collect the liquid discharged from the periphery of the impeller at high velocity and gradually cause a reduction in fluid velocity by increasing the flow area. This converts the velocity head to static pressure. The fluid is then discharged from the pump through the discharge connection.



To view the remainder of the course material and complete the quiz to get PDH credit and certificate, you must purchase the course.

First, close this window and click **"Create an Account"** or **"Login"** located on the right side of the webpage then select the link at the bottom of the webpage:

**"Send payment via Paypal or Credit Card"**

Centri  
receiv  
Pump:  
pump:  
bearin  
double

act volutes, each  
any given time.  
to a split volute  
d to the shaft and  
on of single and

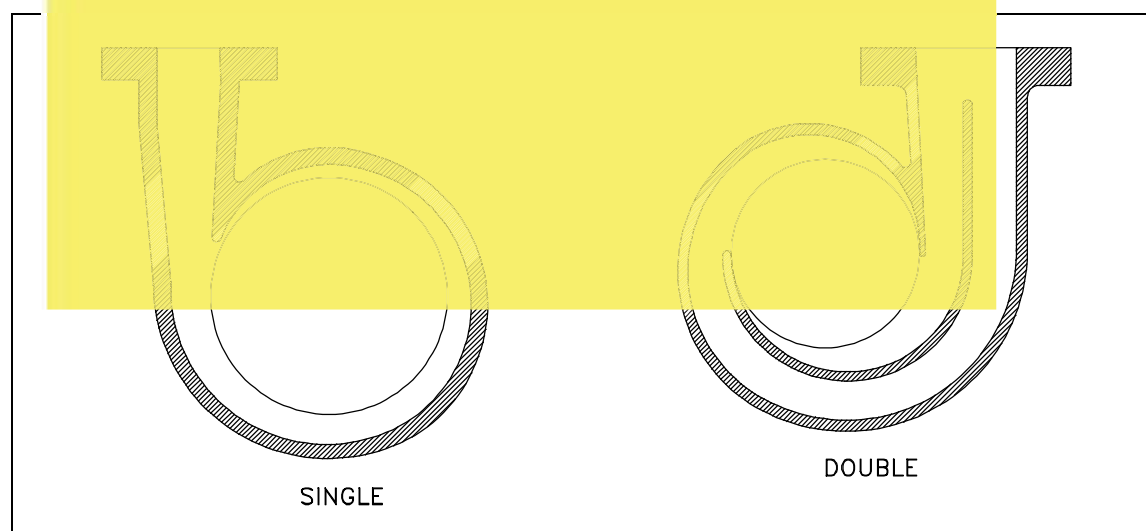


Figure 2 Single and Double Volute