HVAC Pumps: Characteristics and Energy Efficiency

An Online Continuing Education Course for Engineers

Course Number: HV-5012

Credit: 5 Hours / 5 PDH / 5 CPD

Course: HVAC Pumps Characteristics and Energy Efficiency

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Course Description

Most HVAC systems are designed to handle the maximum potential temperature extremes, keeping the building cool on the hottest days and warm on the coldest days. As a result, the HVAC system only needs to work at full capacity on the ten or so hottest and coldest days of the year. On the other 345 days, the system could be operated at reduced capacity.

HVAC pumps are generally designed for peak conditions and the output of these systems is controlled by mechanically constricting the flow with throttling valves. This wastes energy. By using a variable speed drives, chilled water flows can be matched to actual heating and cooling demands.

This 5-hour course provides the students with a firm understanding of the basic principles that centrifugal pumps operate under. Topics covered include the performance curve, series operation, parallel operation, the affinity laws, friction, specific gravity & viscosity, suction lift, and NPSH.

The reader must take a multiple-choice quiz consisting of twenty five (25) questions at the end of this course to obtain PDH credits.

Learning Objective

At the conclusion of this course, the student will:

1) Understand the basic types of pumps used in HVAC applications.
2) Understand the key fluid properties such as viscosity, density, temperature, specific weight, concentration and vapor pressure.
3) Understand why pump performance in typically rated feet of head and not pressure.
4) Understand the various head terms such as suction lift, static head, discharge head, friction head, velocity head and pressure head.
5) Understand the laws of affinity and illustrate them with a pump operating under VFD control.

6) Understand the pump curve, system curve, operating point and the best efficiency point for the pump operation.
7) Understand the flat, smooth and drooping characteristic curve for the centrifugal pump and the applications for which it is best suited.
8) Understand the importance of specific speed and their relationship to the shape of impeller (radial, mixed or axial).
9) Understand pump cavitation and its relationship to net positive suction head (NPSH) available and required.
10) Understand the various techniques for flow control including throttling, speed adjustment and multi-pump installation considerations in parallel or series arrangement.
11) Learn by example the method to compute the frictional head through the HVAC chilled water system.
12) Define the pumping system efficiency and the tips to achieve the same.

Once you finish studying the above course content, you need to take a quiz to obtain the PDH credits.

Section – 1 **PUMPING SYSTEM OVERVIEW**

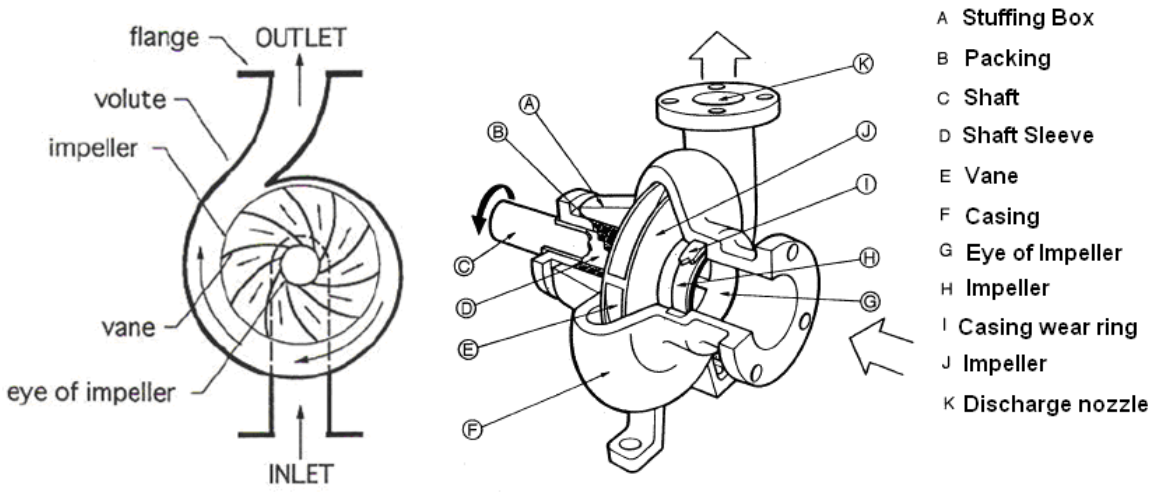
HVAC systems have changed dramatically over the past decades. Code compliance, environmental concerns, cost issues, developments in technology and equipment — these are among the key factors driving changes in HVAC designs. In many cases, tried-and-true solutions are falling by the wayside, replaced by innovative approaches to old problems.

In chilled water HVAC plant, the pumps' role is to provide sufficient pressure to move the fluid through the chiller and condenser water distribution system at the desired flow rate. The pumps are broadly classified in two types: 1) centrifugal pump and 2) positive displacement pump. In HVAC services, centrifugal pumps are popular because of its design simplicity, high efficiency, wide range of capacity and head, smooth flow rate, low operating costs, varied sizes, and ease of operation and maintenance. The positive displacement pumps are only used for chemical dosing in cooling water system.

This course will focus on centrifugal pumps for HVAC applications.

Centrifugal Pumps

Centrifugal pumps in chilled water HVAC plants are used for circulating chilled water through chillers and air handling units in closed loop and for circulating cooling water through condensers and cooling tower in open loop. All centrifugal pumps use an impeller, which is basically a rotating wheel, to add energy to a fluid. Fig below illustrates a cross-section of a typical centrifugal pump.



Fluid enters the inlet port at the center of the rotating impeller, or the suction eye. As the impeller spins in a counter-clockwise direction, it thrusts the fluid outward radially, causing centrifugal acceleration. As it does this, it creates a vacuum in its wake, drawing even more fluid into the inlet. Centrifugal acceleration creates energy proportional to the speed of the impeller. The faster the impeller rotates, the faster the fluid movement and the stronger its force. This energy is harnessed by introducing resistance.

Remember, a pump does not create pressure; it only provides flow. All pumps used in hydronic cooling or heating systems have an operating characteristic in which the flow they produce depends on the resistance they are working against. The resistance is generated by the friction of the fluid moving through the piping systems. The greater this resistance is, the slower a given pump can move fluid through the piping system.

Centrifugal pumps can be segmented into groups based on design, application, service, etc. These pumps can belong to several different groups depending on their construction and application. The following examples demonstrate various segments:

<u>Industry standards:</u>

- Hydraulic Institute (HI) standards
- ANSI pump - ASME B73.1 specifications (chemical industry)
- API pump - API 610 specifications (oil & gas industry)
- DIN pump - DIN 24256 specifications (European standard)
- ISO pump - ISO 2858, 5199 specifications (European standard)
- Nuclear pump - ASME specifications
- UL/FM fire pump - NFPA specifications

<u>Number of impeller/s in the pump:</u>

- Single stage - pump has one impeller only; for low head (pressure) service.

- Two-stage - pump has two impellers in series; for medium head service.
- Multi-stage - pump has three or more impellers in series; for high head service.

Impeller suction:

- Single suction - pump with single suction impeller (suction eye on one side of the impeller only). This design is subject to higher ces due to flow coming in on one side of

both sides). ugh this th sides of

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Type

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Shaft po

- H zontal plane; popular due to ease of servicing and ance.
- Vertical - pump with shaft in vertical plane; used when space is limited, or when pumping from a pit or sump to increase the available NPSH.

Orientation of case-split: