Unit 69: Fluids – Static and Dynamic in Building Services Engineering

Unit code: L/600/0371

QCF Level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

This unit develops learner knowledge and understanding of the properties and behaviour of fluids, both at rest and when flowing in pipe and ductwork systems, and the design of fluid flow systems. Learners will understand that fluids can be usefully characterised by their state of motion, their state of compression and their internal temperature. The two fluids most commonly transported and used today are water and air. This unit is predominantly concerned with the characteristics and behaviour of these two fluids, both when static and when in motion.

Learning outcomes and assessment criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes	Assessment criteria
1 Know the properties and behaviour of fluids	1.1 Identify the physical properties of fluids
	1.2 Describe the factors that affect the physical properties of fluids
2 Understand the theory and applications of static fluid systems	2.1 Explain the principles that underpin the behaviour of static fluids
	2.2 Explain the use of pressure-recording devices
	2.3 Apply basic principles to determine pressure in static fluid systems

3 Be able to use the principles of dynamic fluid flow in pipes and ducts to solve problems	3.1 Explain the principle of continuity of flow for fluids as applied to pipe and duct networks and components
	3.2 Explain how the conservation of energy principle applies to flowing fluids
	3.3 Apply Bernoulli's equation to solve simple problems associated with pipe and ductwork systems and devices
4 Understand the applications of basic principles to the design of fluid flow systems	4.1 Explain the factors contributing to the energy loss in pipe and ductwork systems and how good design practice can minimise such losses
	4.2 Discuss energy losses in pipe and ductwork systems under turbulent and laminar flow conditions
	4.3 Explain the operating principles of pumps, fans and compressors and how their performance can be altered

Unit content

1 Know the properties and behaviour of fluids

Physical properties: general definitions; associated units and notation; ideal fluids; real fluids; viscosity; flow (uniform, non-uniform, steady, unsteady, laminar, turbulent); boundary layers; variation of density with temperature; pressure; units of pressure; measurement of pressure (absolute, atmospheric, gauge)

Behaviour: static; flowing; fluid flow behaviour; use of Reynolds number to predict flow type

Fluids: compressible eg air; incompressible eg water

2 Understand the theory and applications of static fluid systems

Principles: pressure at any point in a liquid is equal in all directions; pressure at any two points at the same depth in a liquid is equal; liquids 'find their own level'; Pascal's principle; pressure expressed as 'metres head'; $P = \rho gh = wh$; depth of centre of pressure

Pressure-recording devices: construction, operating principles and application of compound pressure gauges; barometers; simple piezometers; manometers (U-tube; differential pressure and inclined limb); fluids used in manometers; calculation of pressures in manometers containing different fluids and combinations of fluids

3 Be able to use the principles of dynamic fluid flow in pipes and ducts to solve problems

Principles: continuity of flow equation; forms of energy; principle of conservation of energy; steady flow energy equation; Bernoulli's equation; units and notation for potential energy, pressure energy and kinetic (velocity) energy; velocity of flow; volume flow rate; mass flow rate; viscosity and its effect on flow

Problems associated with pipes and ductwork: use of continuity flow equation to solve duct and pipe flow problems; use of steady flow equation to solve simple flow problems; use of Bernoulli's equation to solve problems relating to continuous flow systems; determination of flow arrangements through orifice contractions, pipe contractions and ductwork branches; application of Bernoulli's equation in orifice plate meter and venturi meter

4 Understand the applications of basic principles to the design of fluid flow systems

Factors contributing to energy losses: eg friction in straight pipes and ducts, turbulence caused by fittings and changes in direction and/or size of pipes and ducts

Energy losses in pipe and ductwork systems: energy loss in systems with laminar flow; solution of problems involving Poiseuille's equation (Hagen–Poiseuille's Law); energy loss in systems with turbulent flow; solution of problems involving use of D'Arcy and Chezy

formula; use of friction coefficients; energy losses due to fittings; pressure loss factors for pipe and ductwork fittings; expressing fittings as equivalent lengths of pipe; solution of problems involving pressure loss due to fittings and changes in flow conditions

Pumps, fans and compressors: propeller, centrifugal and axial fans; liquid pumping devices; reciprocating compression devices and rotary compression devices; fan and pump performance curves; simple fan and pump laws; ways of changing performance; matching pumps and fans to pipe and ductwork systems; determining the duty point; connecting in series and parallel