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**DEPARTMENT: CHEMICAL ENGINEERING**

**CHE 312 ASSIGNMENT**

**1a.) what is instrumentation?**

Instrumentation is a collective term for [measuring instruments](https://en.wikipedia.org/wiki/Measuring_instrument) that are used for indicating, measuring and recording physical quantities.

**b.) Explain succinctly the mobile and stationary phases in Gas Chromatography.**

(i) In gas chromatography, the mobile phase (or "moving phase") is a carrier [gas](https://en.wikipedia.org/wiki/Gas), usually an [inert](https://en.wikipedia.org/wiki/Inert_gas) gas such as [helium](https://en.wikipedia.org/wiki/Helium) or an [unreactive](https://en.wikipedia.org/wiki/Reactivity_(chemistry)) gas such as [nitrogen](https://en.wikipedia.org/wiki/Nitrogen). Helium remains the most commonly used carrier gas in about 90% of instruments although hydrogen is preferred for improved separations.

(ii) The stationary phase is a microscopic layer of [liquid](https://en.wikipedia.org/wiki/Liquid) or [polymer](https://en.wikipedia.org/wiki/Polymer) on an inert [solid](https://en.wikipedia.org/wiki/Solid) support, inside a piece of [glass](https://en.wikipedia.org/wiki/Glass) or [metal](https://en.wikipedia.org/wiki/Metal) tubing called a column (a homage to the [fractionating column](https://en.wikipedia.org/wiki/Fractionating_column) used in distillation).

**c.) Highlight four reasons why moisture measurements are germane in process industries and list four methods of moisture measurement.**

**(I) Reasons why moisture measurements are germane in process industries**

(a) Moisture measurement covers a variety of methods for measuring [moisture content](https://en.wikipedia.org/wiki/Moisture_content) in both high level and trace amounts in solids, liquids, or gases.

(b) Moisture in percentage amounts is monitored as a specification in commercial food production.

(c) Moisture measurements are necessary for manufacturing and process [quality assurance](https://en.wikipedia.org/wiki/Quality_assurance).

(d) Moisture measurement applications include dry air, [hydrocarbon](https://en.wikipedia.org/wiki/Hydrocarbon) processing, pure semiconductor gases, and bulk pure gases.

**(II) Methods of moisture measurement**

1. Absolute measurement method
2. Relative humidity method
3. Capacitance method
4. Oxide sensors

**2a.)State four cogent reasons for measuring and controlling process variables.**

1. A process variable is the current measured value of a particular part of a process which is being monitored or controlled.
2. Process variable is an engineering mechanism that uses continuous monitoring of an industrial process’ operational variables (e.g., temperature, pressure, chemical content) and algorithms and then uses that information to adjust variables to reach product output specifications and objectives.
3. Process variable is all about monitoring and controlling certain set of process variable (i.e. temperature, flow, level, pressure etc.) that leads to control whole process.
4. The value of the monitored output parameter is normally held within tight given limits.

**2b.) Magnetic flow meters are highly important in process industries. Mention three typical applications of magnetic flow meters.**

1. The [metallurgical](https://www.thomasnet.com/products/metallurgical-consulting-services-95957726-1.html) properties of the fluid conduit and the measuring apparatus can greatly influence measurement effectiveness.
2. A fluid’s velocity profile and the flow meter system’s capacity for handling flow disturbances or other interference often determine the type of device.
3. In order to ensure reliable performance over an expected period of operation and volume of moving fluid, flow meter scale—both in size and velocity limits—should be taken into careful account.

**2c.) with the aid of diagram briefly describe the working principle of any three pressure measuring devices.**

1. **The Bourdon pressure gauge:** uses the principle that a flattened tube tends to straighten or regain its circular form in cross-section when pressurized. This change in cross-section may be hardly noticeable, involving moderate [stresses](https://en.wikipedia.org/wiki/Stress_(mechanics)) within the elastic range of easily workable materials. The [strain](https://en.wikipedia.org/wiki/Deformation_(mechanics)) of the material of the tube is magnified by forming the tube into a C shape or even a helix, such that the entire tube tends to straighten out or uncoil elastically as it is pressurized.

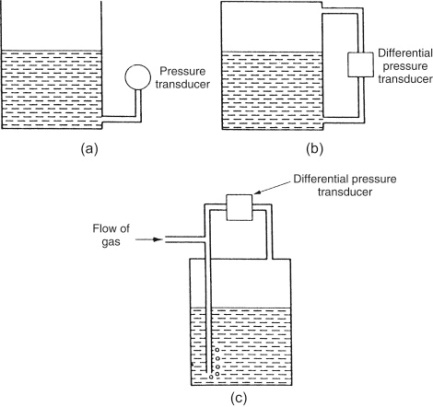


1. **Differential Manometer:** It is used to measure the pressure difference between two points or between two systems. It is again a U-tube manometer with the two ends of the U-tube connected to the two systems between which pressure difference is to be measured. Depending on the range of pressure difference to be measured, a suitable liquid or combination of liquids can be filled in the two arms of the U-tube. If large pressure differences are to be measured a heavy manometer liquid is filled in the U-tube. And to measure very small pressure difference U-tube with long arms is used and two light liquids are filled in the two arms of the U-tube.



1. **Pressure-Measuring Devices (Hydrostatic Systems)**

Several instruments that use this principle are available, and they are widely used in many industries, particularly in harsh chemical environments. In the case of open-topped vessels (or covered ones that are vented to the atmosphere), the level can be measured by inserting a pressure sensor at the bottom of the vessel, as shown in Figure 17.2(a). The liquid level *h* is then related to the measured pressure *P* according to *h* = *P*/*ρg*, where *ρ* is the liquid density and *g* is the acceleration due to gravity. One source of error in this method can be imprecise knowledge of the liquid density. This can be a particular problem in the case of liquid solutions and mixtures (especially hydrocarbons), and in some cases only an estimate of density is available. Where liquid-containing vessels are totally sealed, the liquid level can be calculated by measuring the [differential pressure](https://www.sciencedirect.com/topics/engineering/differential-pressure) between the top and bottom of the tank, as shown in Figure 17.2(b). The differential pressure [transducer](https://www.sciencedirect.com/topics/engineering/transducers) used is normally a standard [diaphragm](https://www.sciencedirect.com/topics/engineering/diaphragms) type, although silicon-based [micro sensors](https://www.sciencedirect.com/topics/engineering/microsensor) are being used in increasing numbers. The liquid level is related to the differential pressure measured, δP, according to h = δP/ρg. The same comments as for the case of the open vessel apply regarding uncertainty in the value of ρ. An additional problem that can occur is an accumulation of liquid on the side of the [differential pressure transducer](https://www.sciencedirect.com/topics/engineering/differential-pressure-transducer) that is measuring the pressure at the top of the vessel. A final pressure-related system of level measurement is the bubbler unit shown in Figure 17.2(c). This uses a dip pipe that reaches to the bottom of the tank and is purged free of liquid by a steady flow of gas through it. The rate of flow is adjusted until gas bubbles are just seen to emerge from the end of the tube. The pressure in the tube, measured by a pressure transducer, is then equal to the liquid pressure at the bottom of the tank. It is important that the gas used is inert with respect to the liquid in the vessel.



**Fig 17.2. Hydrostatic systems: (a) Open-topped vessel; (b) sealed vessel; (c) bubbler unit.**