SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)
Coimbatore-35

DEPARTMENT OF BIOMEDICAL ENGINEERING

23BMT203 - BIOMEDICAL TRANSDUCERS AND SENSORS

UNIT III- MEASUREMENT OF PRESSURE & BLOOD FLOW

II Year/ IV Sem

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Direct Pressure Measurement

- ✓ Catheters type
- ✓ Diaphragm type

Indirect Pressure Measurement

- ✓ Doppler Ultrasound
- ✓ Applanation Method

Blood Flow Measurements

- ✓ Electromagnetic Blood Flow
- ✓ Ultrasonic Blood Flow

Ground Force Measurements

- ✓ Strain gauge type force plate
- ✓ Foot Force Distribution Measurements

Direct Pressure Measurement

- **Direct Pressure Measurement** is an **invasive method** used to accurately measure the pressure inside blood vessels, body compartments, or organs by placing a **pressure sensor or catheter** directly into the area of interest.

Features:

- **Real-time and continuous** pressure monitoring.
- **Highly accurate**, often considered the **gold standard**.
- Used in **critical care**, **cardiology**, **neurology**, and **surgery**.

Examples:

- Arterial blood pressure monitoring via **arterial line** in ICU.
- **Central venous pressure (CVP)** measurement through a central catheter.
- **Intracranial pressure (ICP)** monitoring in patients with brain injury.

Direct Pressure Measurement

Types of Direct Pressure Measurement Devices:

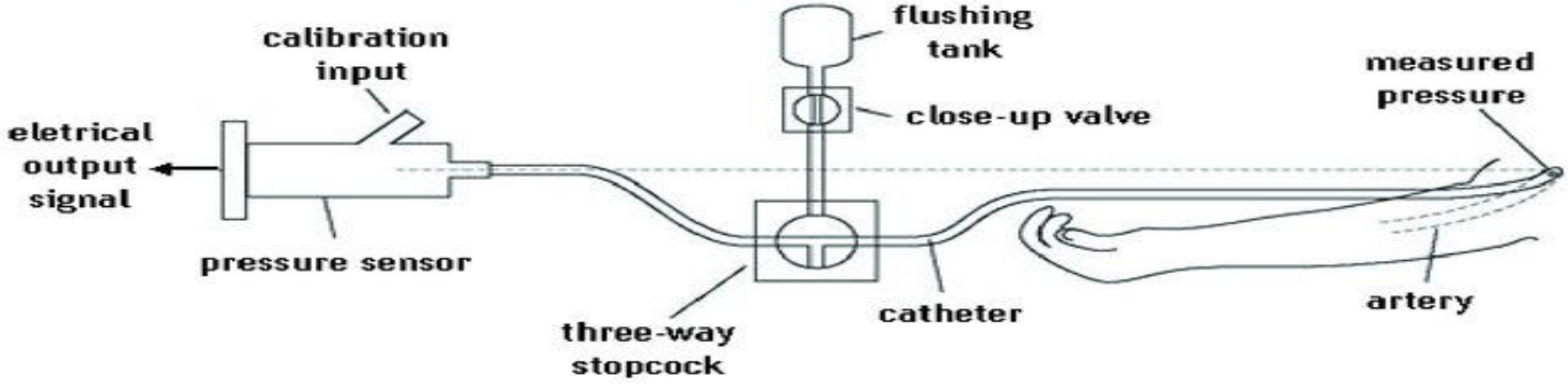
1. **Bourdon Tube:** A mechanical sensor that converts pressure into mechanical displacement, commonly used in industrial applications.
2. **Diaphragm Sensor:** Uses a flexible membrane to measure pressure changes, suitable for low-pressure applications.
3. **Piezoelectric Sensor:** Converts pressure into an electrical signal using piezoelectric materials, ideal for dynamic pressure measurement.
4. **Strain Gauge Pressure Sensor:** Uses strain-sensitive resistors to measure deformation caused by pressure changes, providing accurate electronic readings.
5. **Manometers:** Simple devices that use liquid columns to measure pressure differences, often found in laboratory setups.

Catheters type - Direct Pressure Measurement

In **Direct Pressure Measurement**, **catheters** play a vital role by serving as the medium to directly access and measure pressure inside blood vessels or body compartments.

Catheter-based pressure sensors are miniaturized pressure-sensing devices integrated into or connected to catheters.

They are primarily used in medical applications for measuring fluid pressure inside the body, such as blood pressure in arteries, intracranial pressure, and intrauterine pressure.



Catheters type - Direct Pressure Measurement

1. **Insertion**
   A **catheter** is inserted into a **blood vessel** or body cavity (e.g., artery, vein, ventricle).
2. **Sensor Placement**
   A **pressure sensor** is either **integrated into the catheter tip** or **connected via fluid-filled tubing** to an **external transducer**.
3. **Pressure Transmission**
   The **fluid pressure** inside the body (e.g., blood pressure) is transmitted through the catheter. If fluid-filled, it pushes against the diaphragm of the external transducer.
4. **Signal Conversion**
   The transducer converts **mechanical pressure** into an **electrical signal** (voltage or current).
5. **Signal Amplification & Display**
   The signal is amplified, processed, and displayed on a **monitor** as a **waveform** or numeric value.
6. **Continuous Monitoring**
   Allows **real-time**, **continuous**, and **accurate pressure monitoring**, vital in critical care.

Types of Catheter-Based Pressure Sensors

A. Fluid-Filled Catheters

- Contains a saline or heparinized fluid column that transmits pressure to an external transducer.
- Used in arterial blood pressure monitoring and central venous pressure measurement.
- Requires periodic calibration and maintenance due to fluid damping effects.

B. MEMS (Microelectromechanical Systems) Catheter Sensors

- Miniaturized silicon-based pressure sensors integrated at the catheter tip.
- Provides real-time pressure readings with high accuracy.
- Used in intracranial pressure (ICP) monitoring and cardiovascular applications.

C. Fiber Optic Catheter Sensors

- Uses optical fiber to detect pressure changes.
- Immune to electromagnetic interference, making them suitable for MRI environments.
- Commonly used in neurosurgery and critical care applications.

Advantages of Catheter Pressure Sensors

1. **High Accuracy**
   Provides precise and real-time pressure measurements.
2. **Direct Measurement**
   Measures pressure at the actual site (e.g., artery, ventricle), making it the gold standard.
3. **Continuous Monitoring**
   Enables uninterrupted data collection for critical care and surgeries.
4. **Versatile Applications**
   Used in cardiovascular, neurological, urological, and obstetric monitoring.
5. **Miniaturized Sensors**
   Small and flexible, suitable for accessing narrow or sensitive anatomical locations.
6. **Fast Response Time**
   Instantaneous detection of pressure changes, ideal for dynamic environments.

Disadvantages of Catheter Pressure Sensors

1. **Invasive Procedure**
   Requires insertion into the body, increasing risk of infection or bleeding.
2. **Complex Setup**
   Needs skilled personnel and sterile conditions for proper insertion and calibration.
3. **Cost**
   More expensive than non-invasive methods, especially with disposable sensors.
4. **Patient Discomfort**
   May cause pain or discomfort during and after insertion.
5. **Risk of Complications**
   Includes thrombosis, catheter displacement, or tissue damage.
6. **Limited Long-Term Use**
   Typically unsuitable for long-term implantation due to infection risks.

Applications of Catheter Pressure Sensors

Cardiology: Monitoring intracardiac pressure, catheterization procedures.

Neurology: Measuring intracranial pressure (ICP) in trauma and brain disorders.

Obstetrics & Gynecology: Monitoring intrauterine pressure during labor.

Urology: Evaluating bladder pressure for diagnosing urinary disorders.

Critical Care: Continuous arterial blood pressure monitoring (ABP).