

CH0302 Process Instrumentation

Lecture 2 – Introduction



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Introduction - outline

- Why Process Instrumentation?
- What does measurement mean?
- Direct and indirect measurements.
- Functions fulfilled by instruments
- Elements of a measuring instrument

- **Why Process Instrumentation?**
- What does measurement mean?
- Direct and indirect measurements.
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- Elements of a measuring instrument

Introduction - Why Process Instrumentation?

- One of the **important phase** in industrial measurement.
- Designed for **guiding the progress** of various steps in manufacturing process.
- The **fundamental and underlying** purpose of measurements in industrial manufacturing and process is to aid “**the economics** of industrial operations by **improving the quality of product** and **efficiency of production**”.

Introduction - outline

- Why Process Instrumentation?
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Introduction - What does measurement mean?

- Measurement is an **essential activity** in every branch of science, engineering and technology.
- Measurement means **quantification of parameters** or identification of a **physical quantity**.
- A **measuring instrument** is a **device** that determines the value of a **physical or chemical quantity**.

Introduction - outline

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Direct Measurement – Lathe Machine

- Used for processing or **designing a mechanical part**
- Purpose of the machine is to process a part with **given physical dimension.**
- During **pre- and post operations** measurements of the part are usually made.
- This is a direct measurement (**determining a physical dimension**) and the purpose of processing operation (**producing a physical dimension**) are identical.

Indirect Measurement – Milk Pasteurization

- Measurement of **temperature in a milk pasteurizer**.
- Purpose of the Pasteurization operation is to **eliminate bacteria**.
- During **pre- and post operations** measurement of the temperature is usually made.
- This is an indirect measurement (**determining the temperature of milk**) and the purpose of processing milk (**eliminate bacteria**) are not identical but are **related to each other**.
- The direct measurement in this example could be **a bacteria count**.

Introduction - outline

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Introduction - Functions fulfilled by instruments

- Transmitting
- Signaling
- Registering
- Indicating
- Recording

- **Transmitting**

- In which the instrument is **intended to convey information** concerning the measured quantity **over some distance to a remote point.**
- The value (magnitude) of measurement **may not be known** because **it may be used** for some **other purpose.**
- **Telephone**

- **Signaling**
 - In which the instrument indicates the **general value or range of values** of its measured quantity.
 - **Grocer's scale**
 - Show only weight which may be **too little or too great**.

- **Registering**
 - In which the instrument indicates, **by numbers or some other symbols of discrete increments**, the value of some quantity.
 - A **cash register** and certain **water meters**

- **Indicating**

- In which the instrument provides some **kind of calibrated scale or pointer.**
- the value of the quantity may be read on the scale within the limitations of instrument and human eye.
- **Clocks**

- **Recording**
 - In which the instrument makes a **written record**, usually on **paper**.
 - the value of the **measured quantity against some other variable or against time**.
 - ECG papers.

Introduction - outline

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- Functions fulfilled by instruments
- **Elements of a measuring instrument**

Introduction - Elements of a measuring instrument

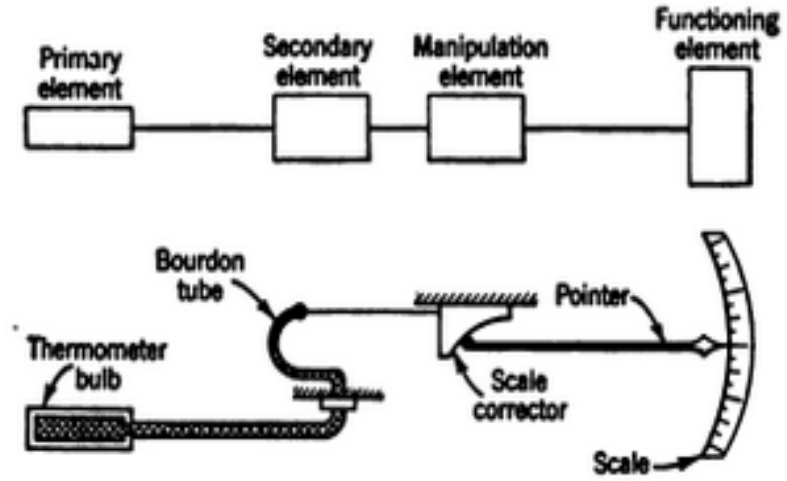
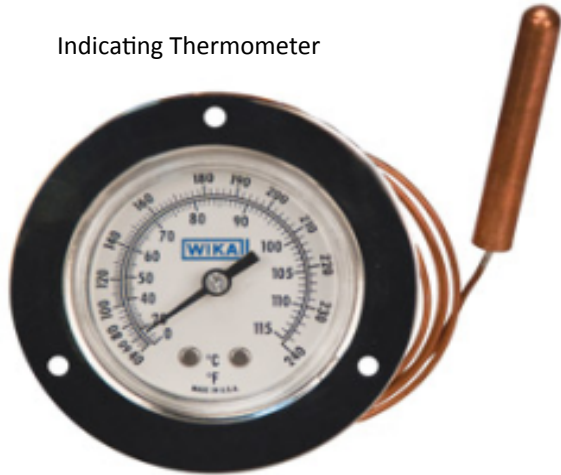
- All the instruments contains **various parts** that **performs prescribed functions** in **converting a variable quantity or condition** in to a corresponding **indication**.
- The process of conversion in an instrument is necessary in order to **change the measured variable**, a temperature, a pressure, a flow, or a chemical composition into **a more useful quantity**, such as displacement, force and so on.
- In most cases an instrument **ultimately converts the measured variable into a displacement**.

Introduction - Elements of a measuring instrument

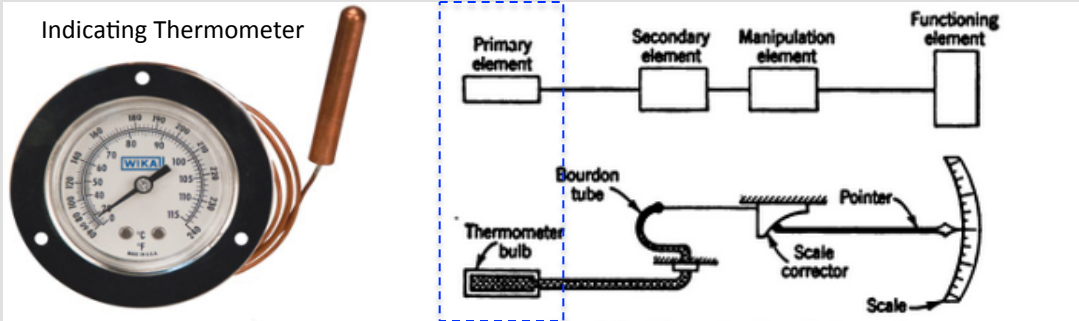
- Primary element
- Secondary element
- Manipulation element
- Functioning element

Introduction - Elements of a measuring instrument

Indicating Thermometer



Introduction - Elements of a measuring instrument

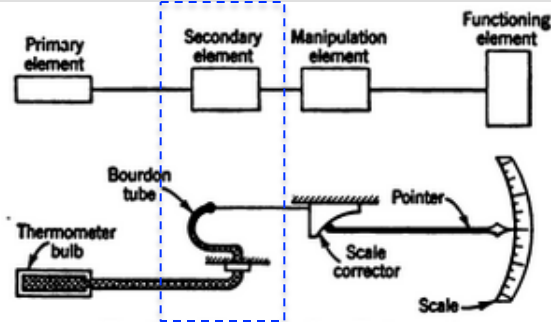
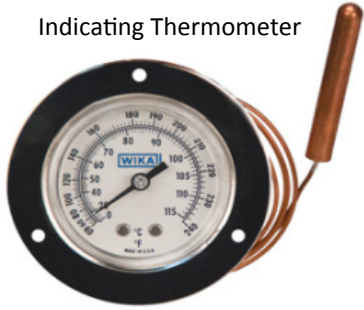


-Primary element

- It is the part of the instrument that **first utilizes energy from the measured medium** to produce a **condition that representing the value** of measured variable.
- In this case, **thermometer bulb** is the primary element, because it first **converts the energy in the form of heat into a fluid displacement**, which is **proportional to the temperature at the bulb**.

Introduction - Elements of a measuring instrument

Indicating Thermometer

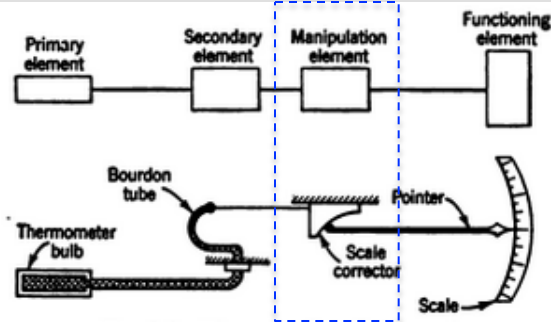
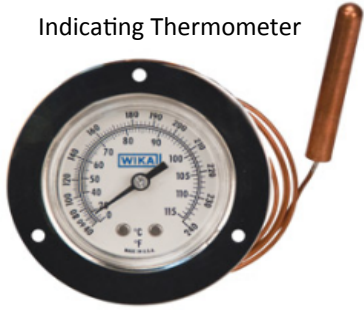


- Secondary element

- Merely converts the conditions produced by the primary element into a condition useful to the function of the instrument.
- In this case, **pressure spring** is the secondary element, it converts the fluid displacement into a displacement of link.

Introduction - Elements of a measuring instrument

Indicating Thermometer



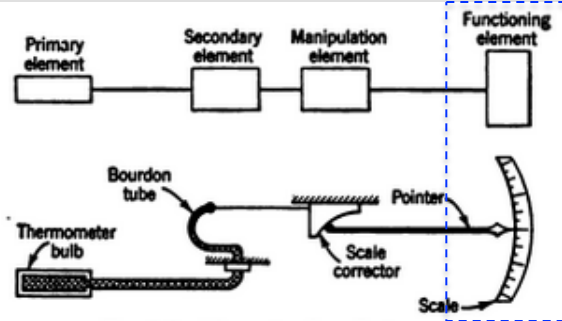
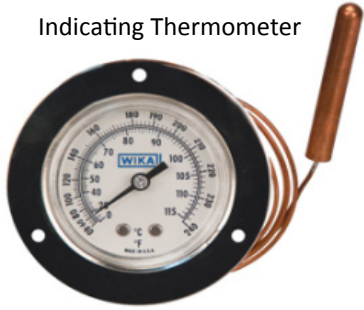
- Manipulation element

- This element performs **given operations on the conditions produced** by the secondary element.
- In the above figure the **motion of spring** is modified by the **cam** in order to **correct non linearity** in the preceding conversion process.

Note Manipulation elements **sometimes precedes** the **secondary element**.

Introduction - Elements of a measuring instrument

Indicating Thermometer



- Functioning element

- This element simply denotes the part of an instrument **used for transmitting, signaling, registering, indicating or recording.**
- In the above figure **pointer and the scale** is the example for the functioning element

Note

- The parts of the instrument named previously **do not appear in all the instruments.**
- Some instruments like **mercury-in-glass thermometer** are made much simpler.
- On the other hand, an instrument like the **automatic balanced potentiometer thermocouple pyrometer** is much more complex than the example as we discussed in the previous slides.

Introduction – Types

- Automatic
- Manual
- Self operated
- Power operated
- Self contained
- Non-self contained

Introduction – Types

- Automatic – does **not require service of an operator** in fulfilling its function
- Manual – **requires** service of an operator
- Self operated – instrument like mercury-in-thermometer **derives its power wholly from thermal expansion of mercury**
- Power operated – instrument requires **a source of auxiliary power** such as compressed air, electricity, hydraulic supply or mechanical source of power.
- Self contained – instrument such as mercury-in-thermometer, **all the parts from primary element to functioning element are contained in one assembly**
- Non-self contained - primary element will **be located at some distance**, say 15 – 100 ft from the secondary element. Indicating element may also be remotely located

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