The Forbes Marshall Idea-thon

for IANC 2024 (Vellore Institute of Technology)

Background:

Steam is widely used in various Process Industries as a source of heat due to its many advantages such as high heat content, high heat transfer rate & accurate control of process parameters.

Once steam supplies its heat to the process, it condenses and converts to saturated liquid water or condensate. This condensate is at the same pressure & temperature as the supplied steam and it needs to be evacuated effectively to ensure that the heat transfer surfaces are always available to the next supply of steam. If not evacuated, the heat exchanger can flood with this condensate; leading to reduced heat transfer rates, increased batch times and even batch rejections.

Steam trap is a selective valve that distinguishes between the condensate & steam and **only evacuates the condensate, "trapping the steam"-** hence the name! As a result, it ensures a healthy operation of the process heat exchangers, prevents any steam leakages and avoids corresponding losses in steam, fuel & operating costs.

There are several principles on which steam traps operate. e.g.-

- Float & inverted bucket traps distinguish between steam & condensate based on their density & buoyancy.
- Thermostatic traps distinguish between them based on temperature.
- Thermodynamic traps distinguish between them based on Bernoulli's principle, etc.

Participating students are advised to study these devices, their operations along-with the fundamental principles carefully before proceeding to their solutions.

Challenge:

Your challenge is to **design a steam trap that can**-

- **Distinguish between the condensate & steam electronically.**
    a. You can use any fundamental principle- it may or may not be mentioned here or anywhere else. However, it must generate an electronic signal that can be subsequently transmitted to a monitoring & control system.
    b. This signal will also need to be used to actuate a valve to OPEN/CLOSE position to evacuate condensate without any live steam passing out.
- **Measure the quantity of condensate flowing out of the steam trap.**
    a. The condensate may flow out of the trap intermittently or consistently, at constant or varying flow rates.
    b. Condensate quantification can be done upstream or downstream of the steam trap; however, special care must be taken to ensure that the amount of **flash steam** (if any) is accounted for in this quantification.
    c. The expected output is **the quantity of condensate (in kg)** during a specified timeframe such as 1 hour OR 8 hours OR 24 hours etc.
    d. This value must also be available in the form of an electronic signal that can be subsequently transmitted to a monitoring & control system.

Design Conditions:

- Working substance: Steam & Condensate in Phase Equilibrium
- Max Operating Pressure = 10 bar(g)
- Max Operating Temperature = 185 ℃
- Range of Condensate Flow: 25kg/hr to 500 kg/hr

Acceptable Outcome:

- A report with a detailed Concept Design in accordance with the given information & specifications.
    - Engineering design, details etc. of sensors, mechanisms, protocols, simulations etc. will be an added advantage.
    - A physical prototype is not mandatory.