# 10 Ways Control Systems Lie

## An Introduction to Instrumentation and Control

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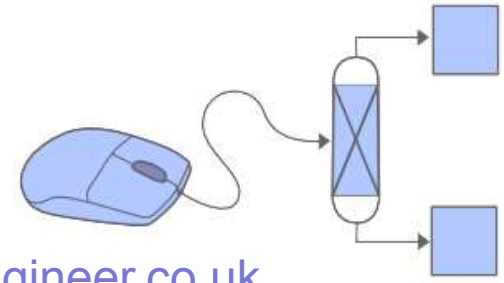
IChemE

Scottish Members Group



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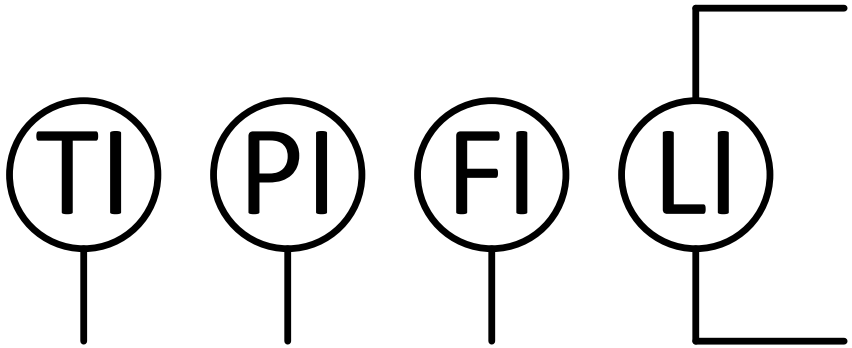
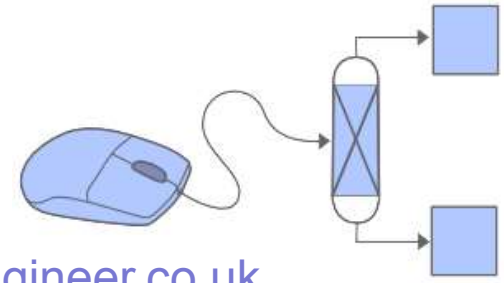
# What Will Be Covered

## Simple Instrumentation




Process → Instrument → DCS



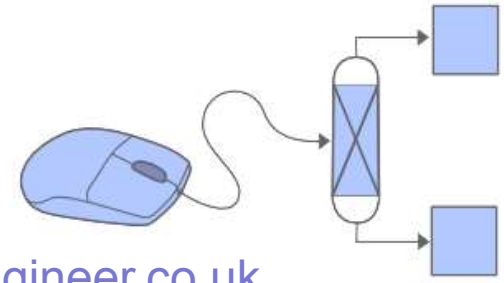
# What Will NOT Be Covered

Analysers

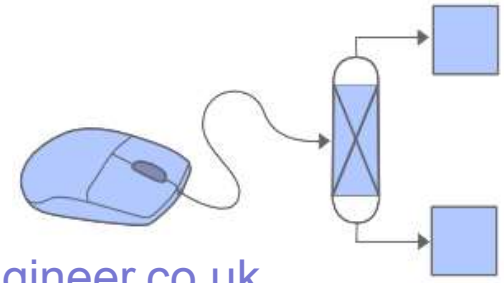
- pH, Density,
- Gas Chromatography etc

Detailed electronics

Control loop design/APC



# Temperature Indication



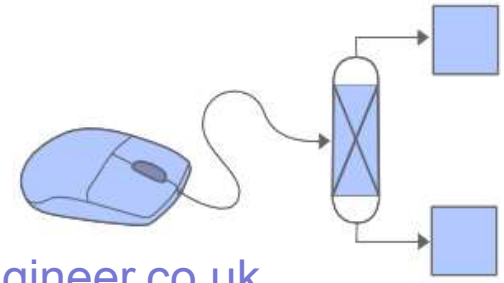
# Temperature

## RTD

No Calibration Required

"They either read
correct or don't read at all"

– *Anonymous Instrument tech*



# Temperature

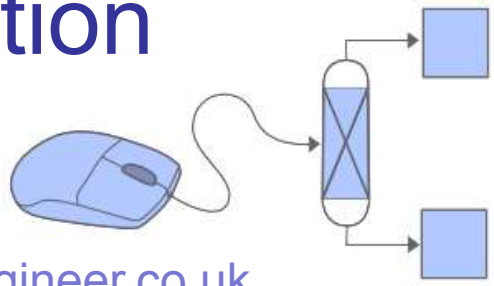
## RTD

Delicate Instrument

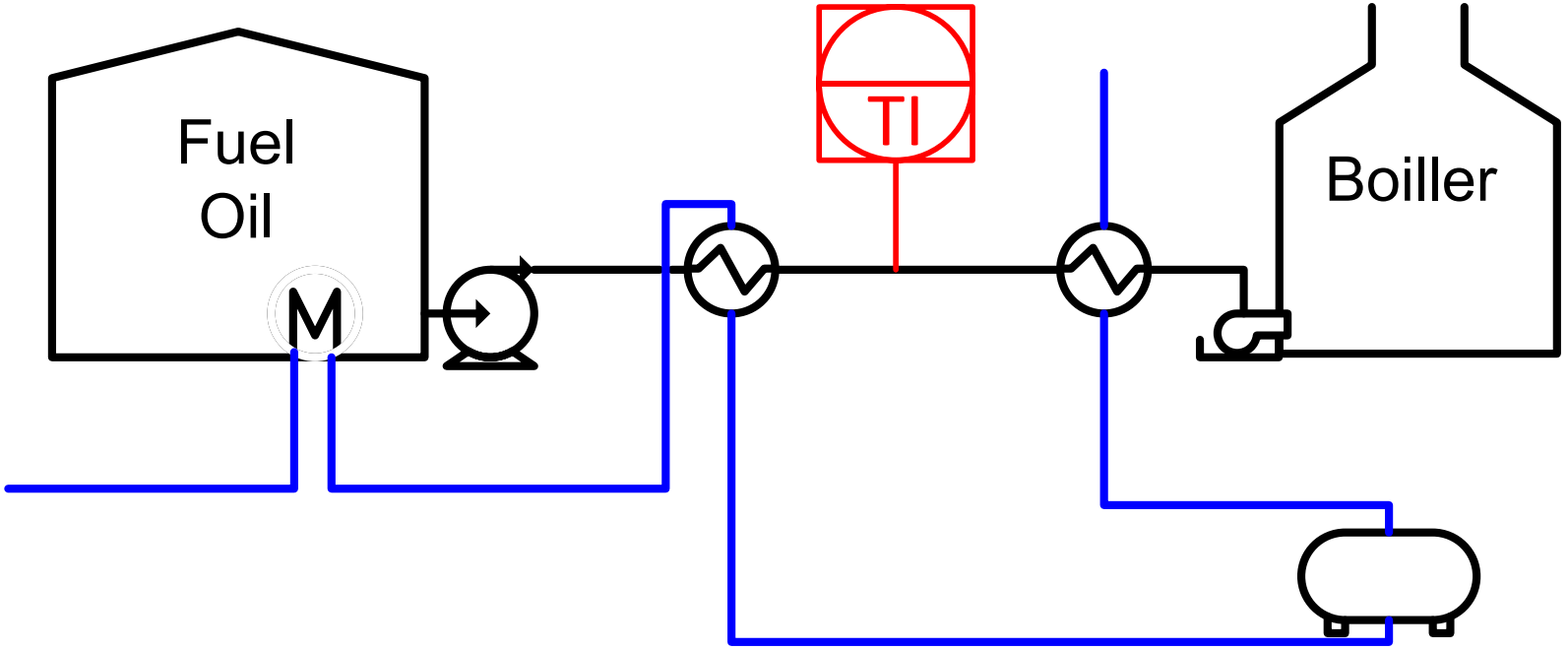
Need Online

Replacement

## Thermowell offers protection



# Lie 1: HFO Import

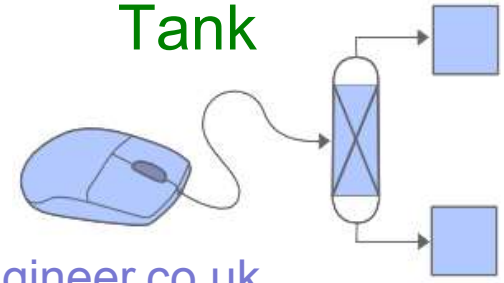



Condensate Coil

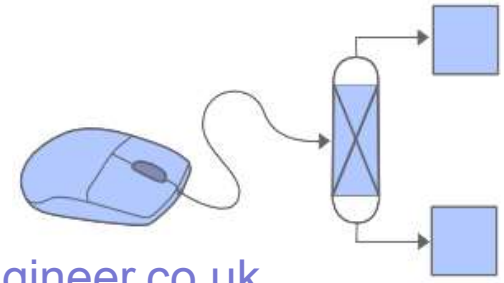
Condensate Heater

Steam Heater

Condensate Tank

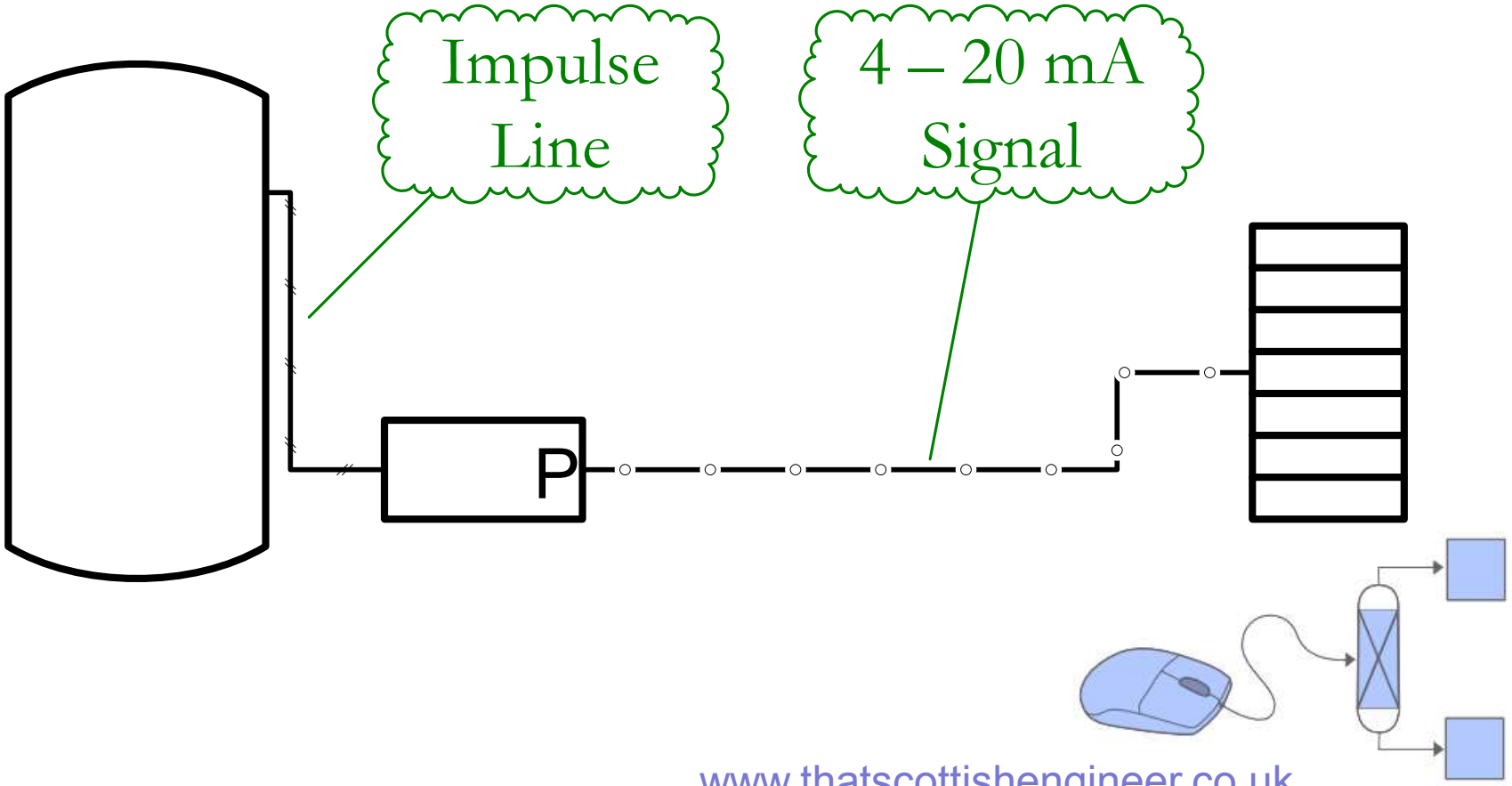


# Pressure Indication



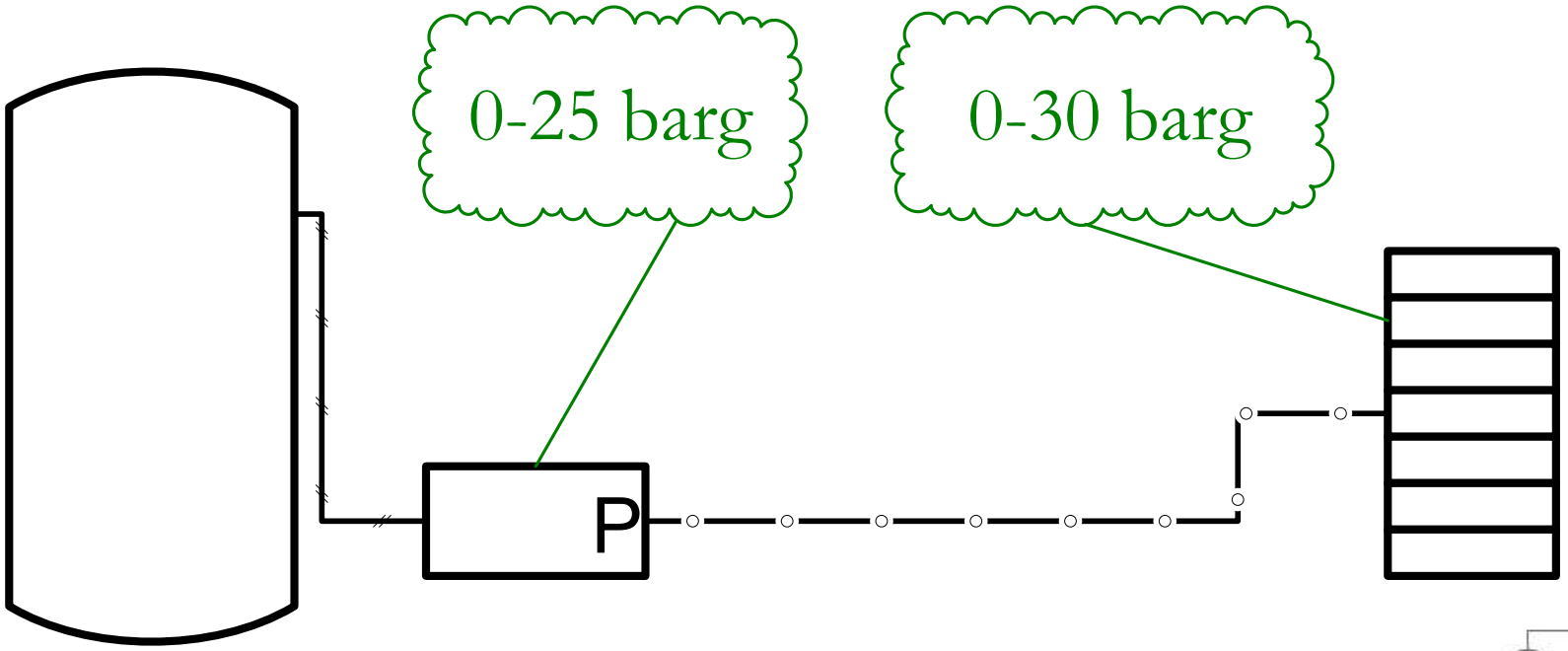
# Pressure

## How is condition transmitted to Control Room

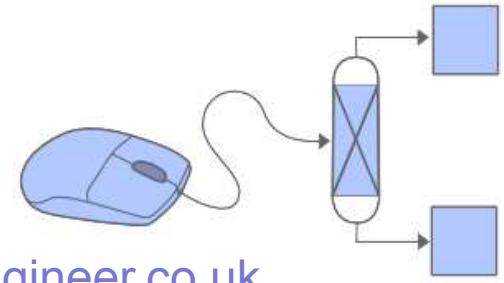


# Lie 2: New Transmitter

## What happens when the ranges don't match?

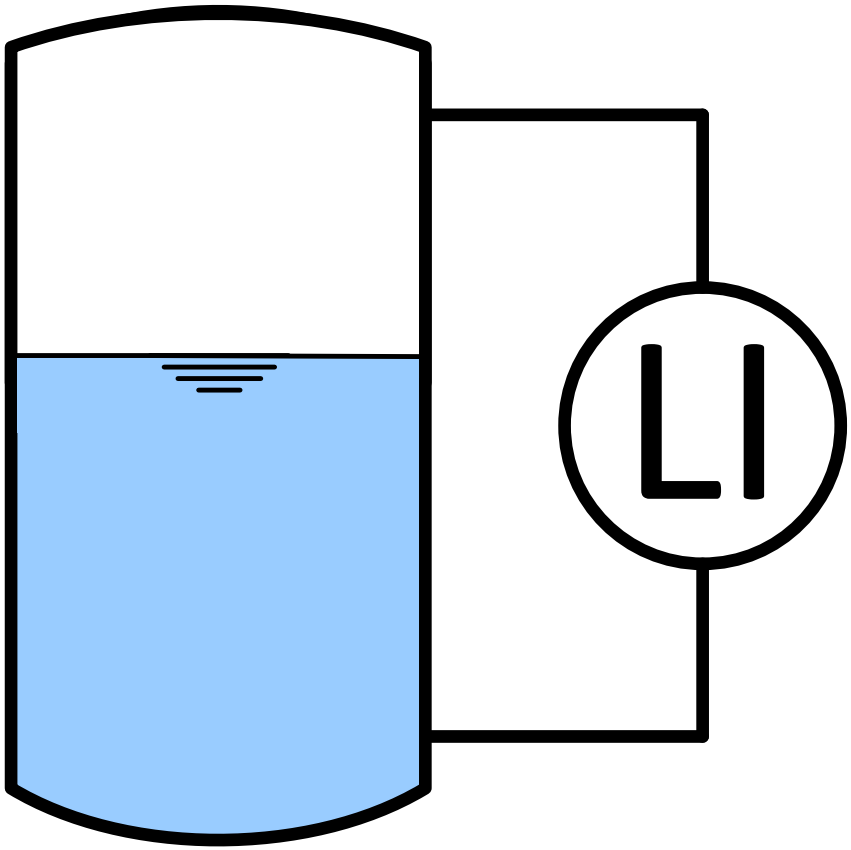


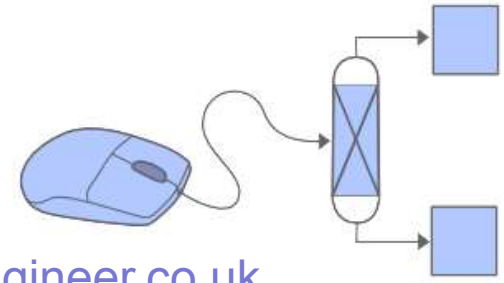
# Level Indication



# Level

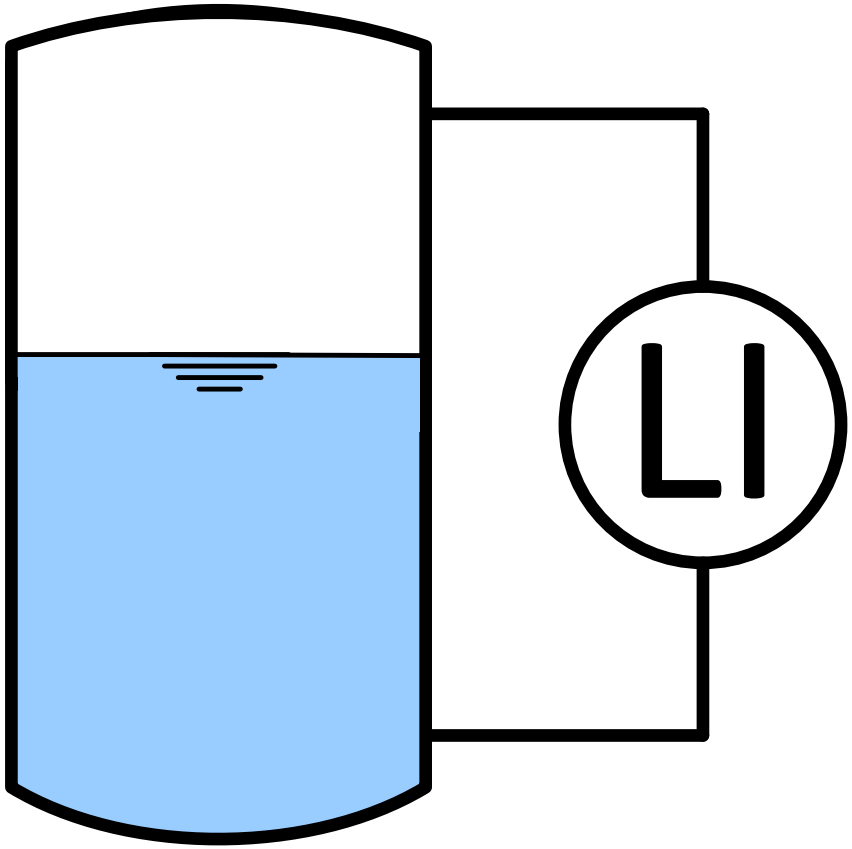
How hard is it to tell how much is in a tank?

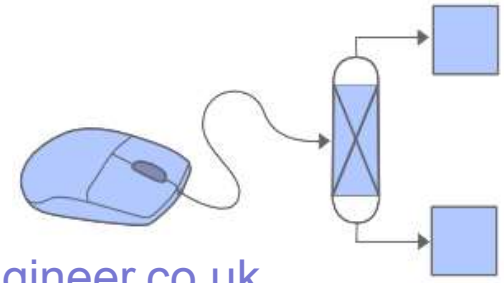


# Level: Delta Pressure

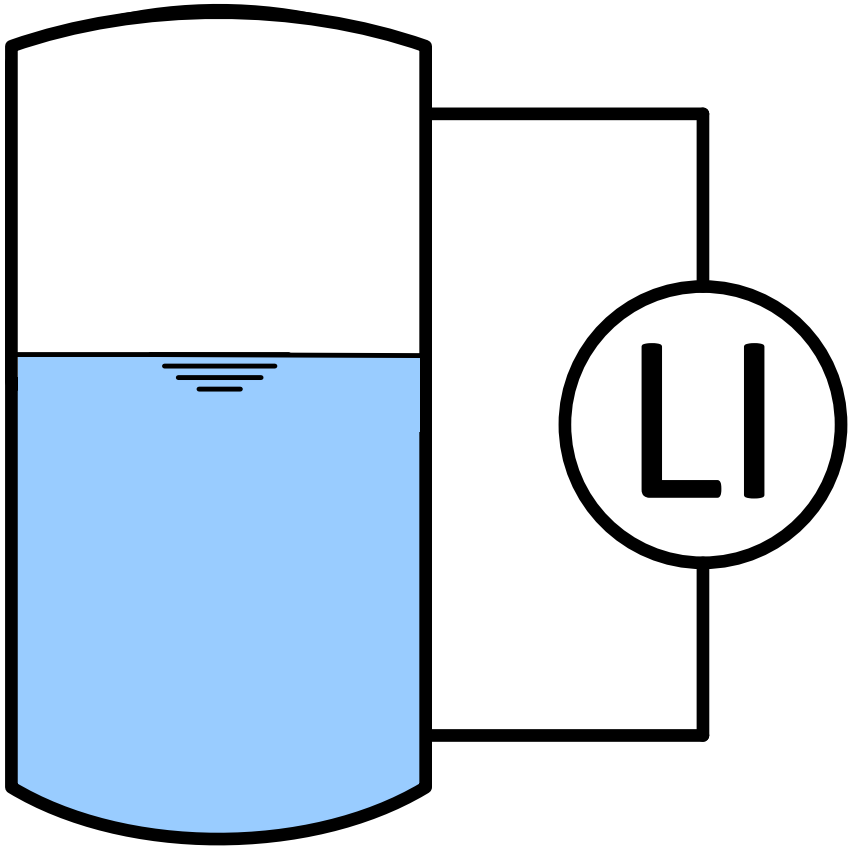
Pressure= Density × Gravity × Liquid Height



# Lie 3: Startup/Shutdown

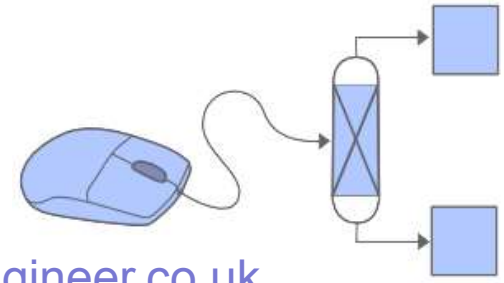
## Sugar Factory




Sugar content

Norm: ~15%

Comm: <1%



# Lie 3: Startup/Shutdown

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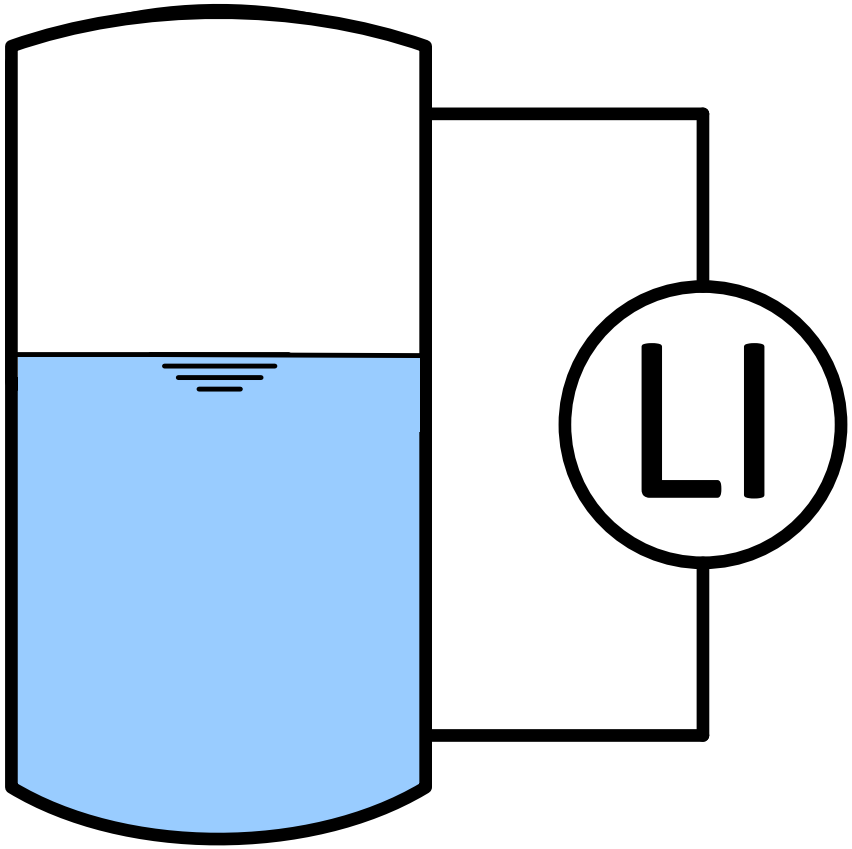
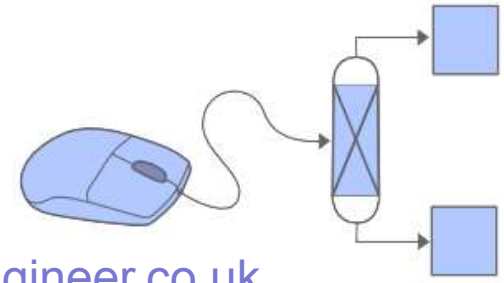
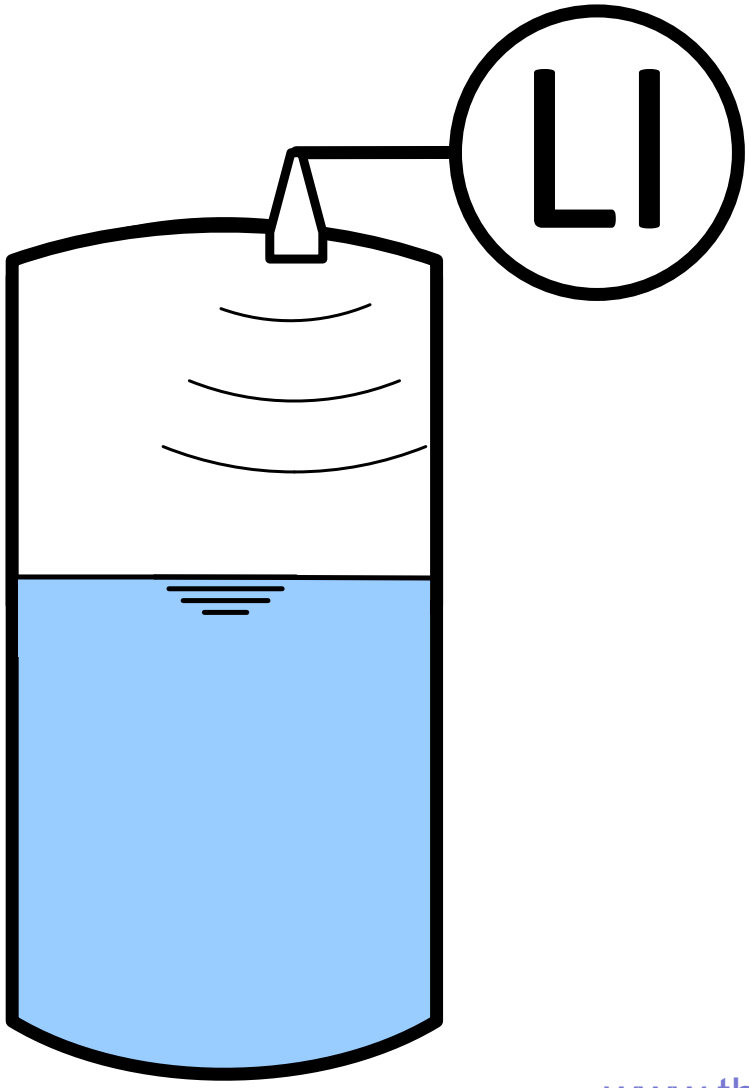


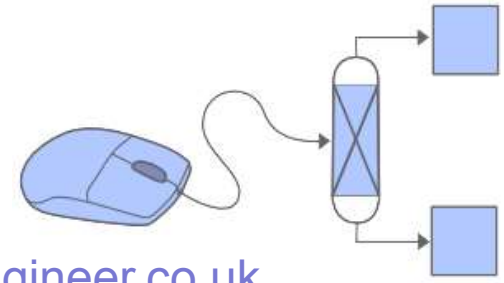

Does the density change at startup or shutdown?



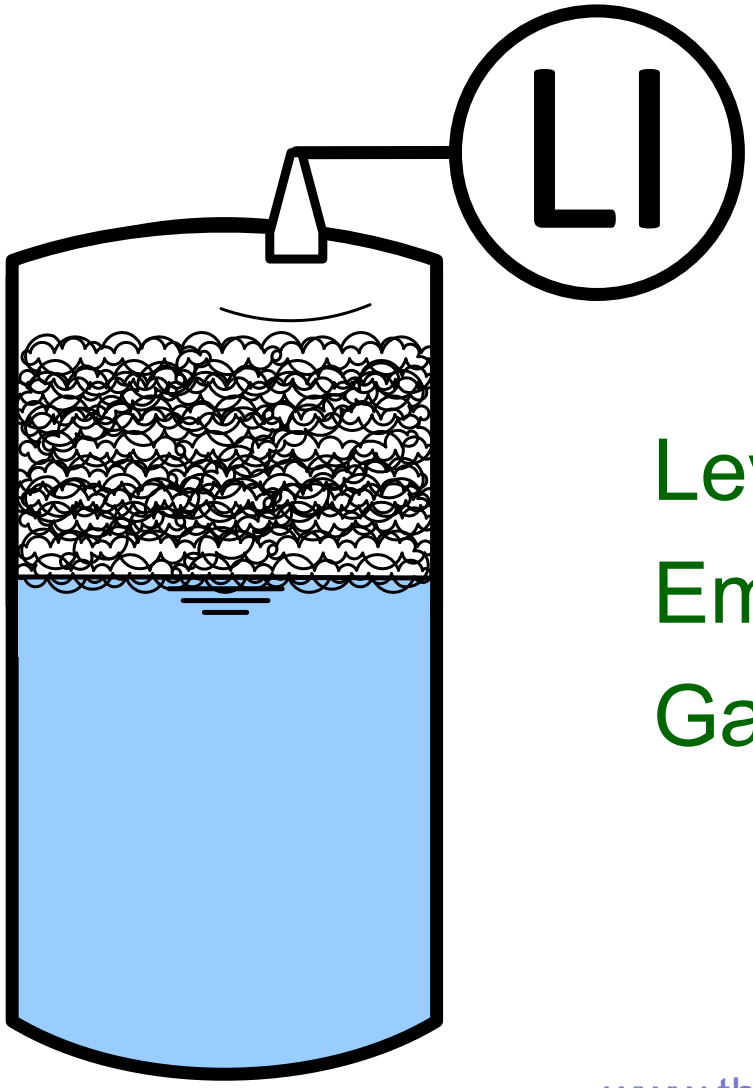
# Level: Radar




Density Independent



# Lie 4: Foam!

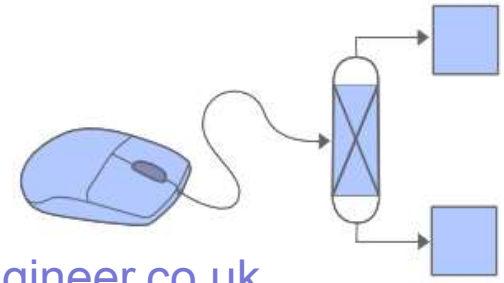



What would happen?

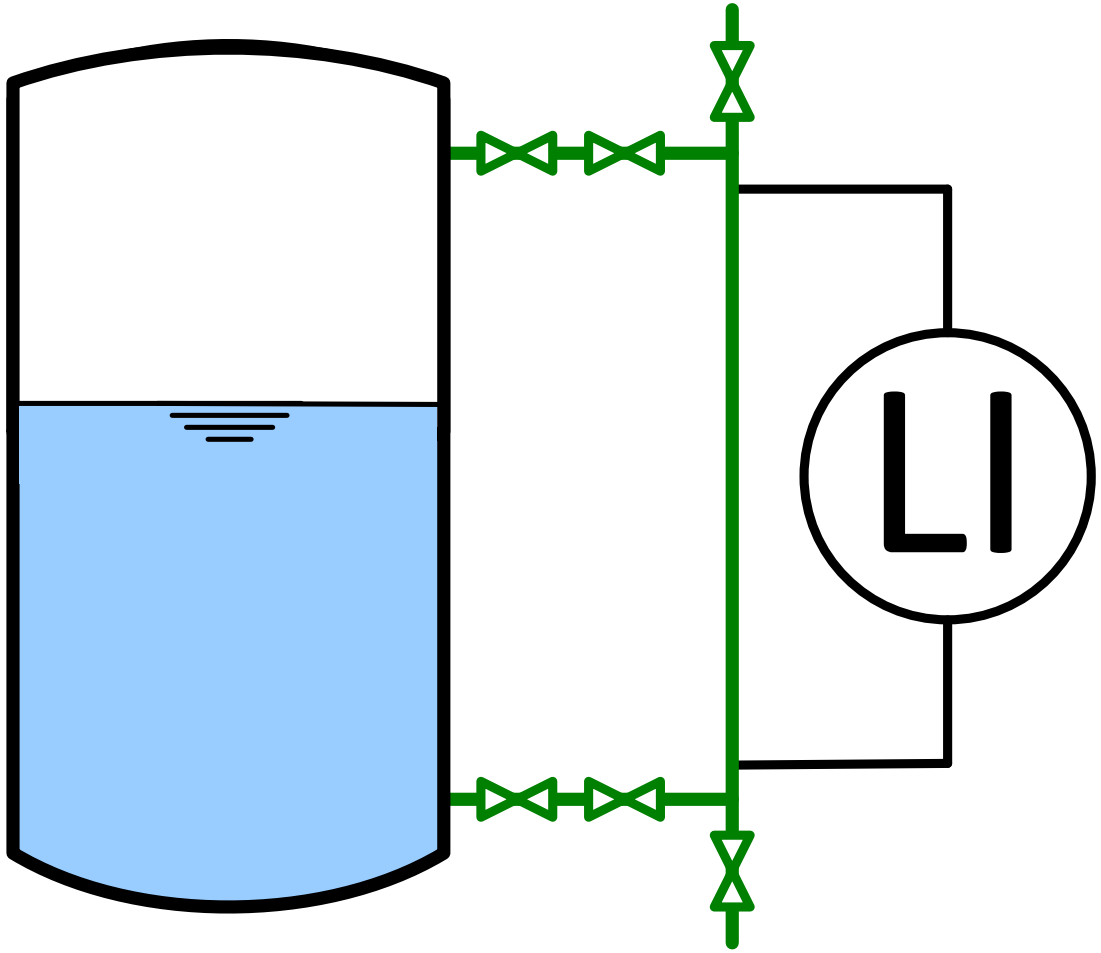
Level decreased

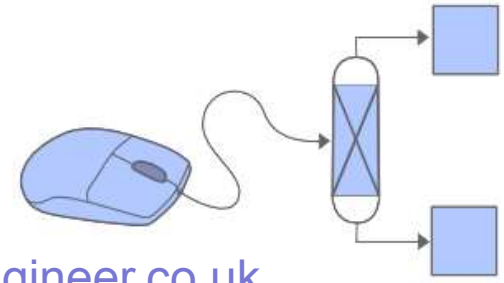
Empties vessel

Gas Breakthrough

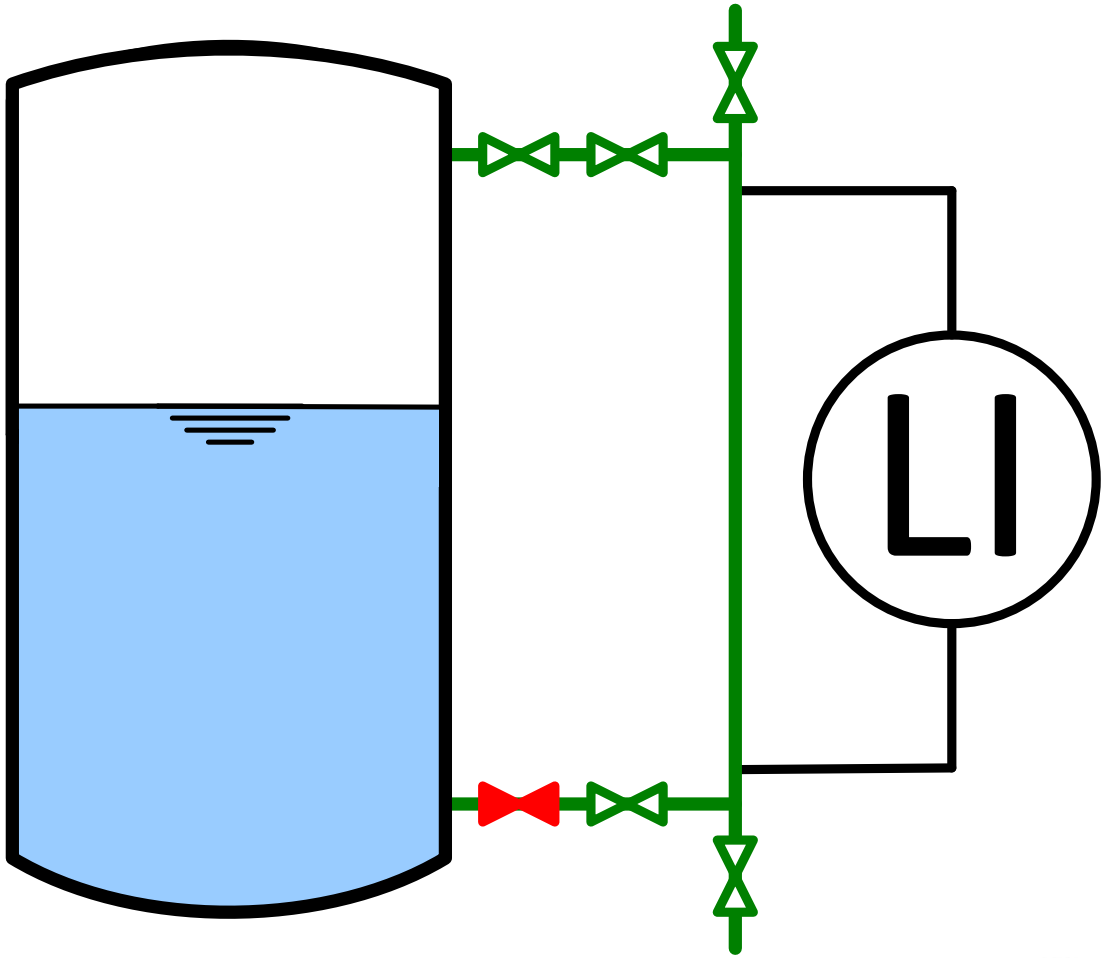


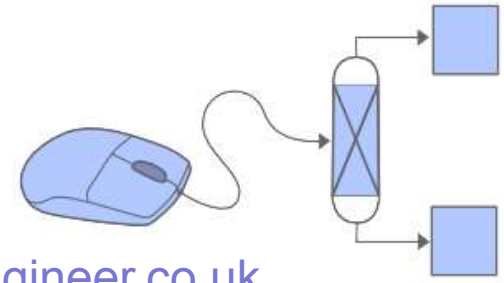
# Level Bridals



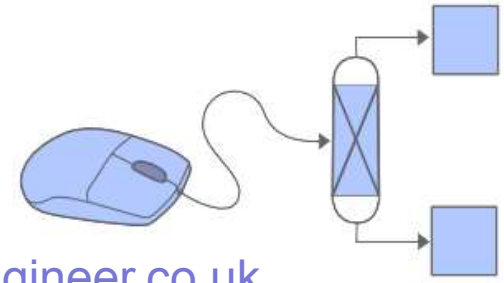



# Lie 5: Blockage

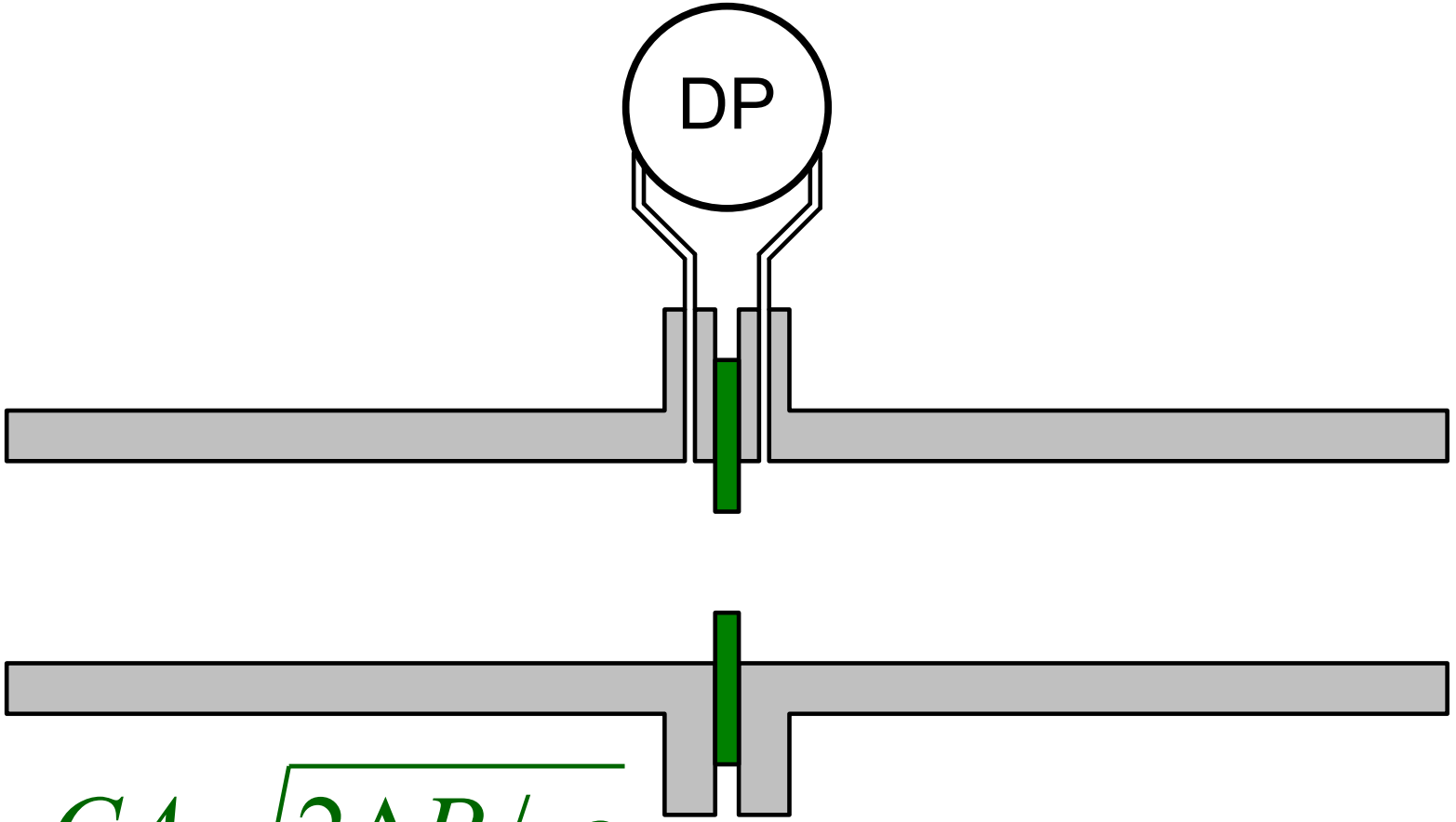


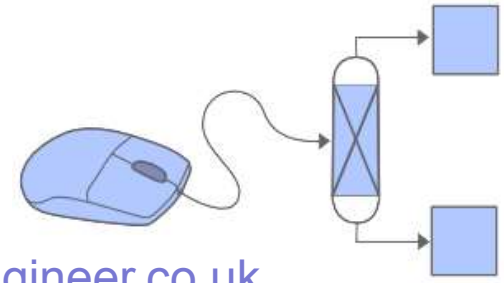
# Flow Indication



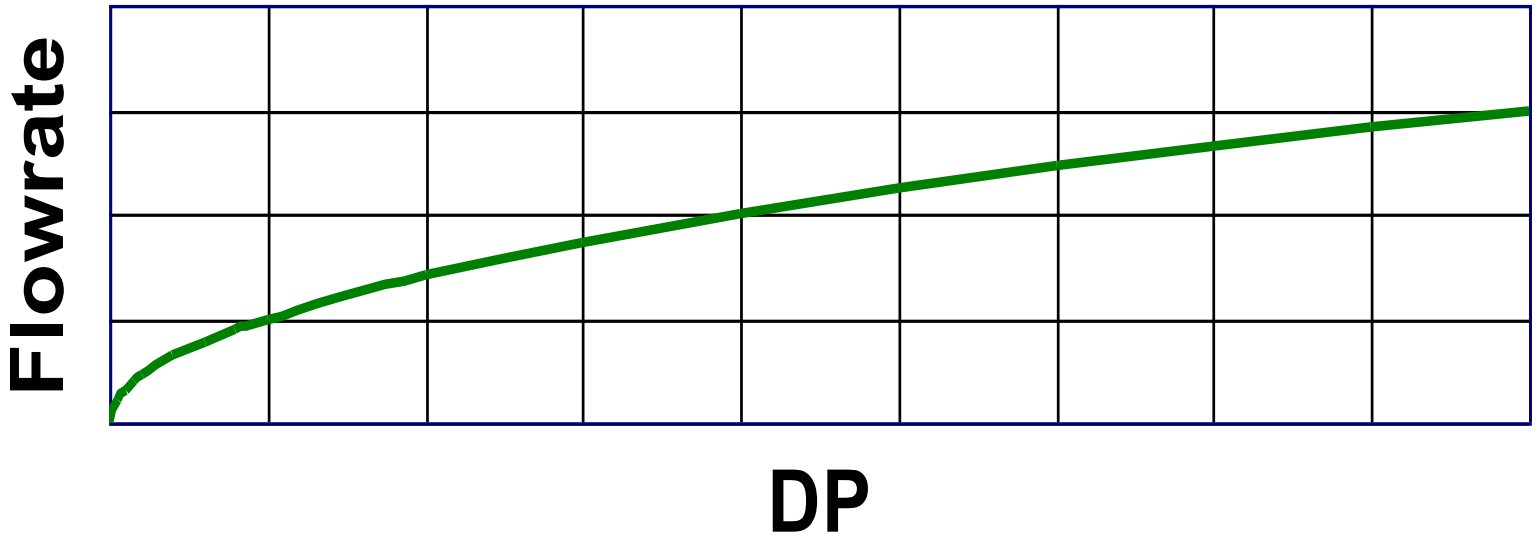
# Flow: Orifice Plate



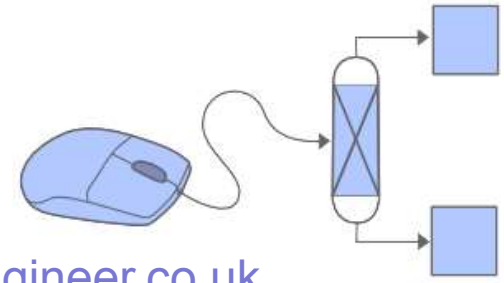

$$Q = CA_2\sqrt{2\Delta P / \rho}$$



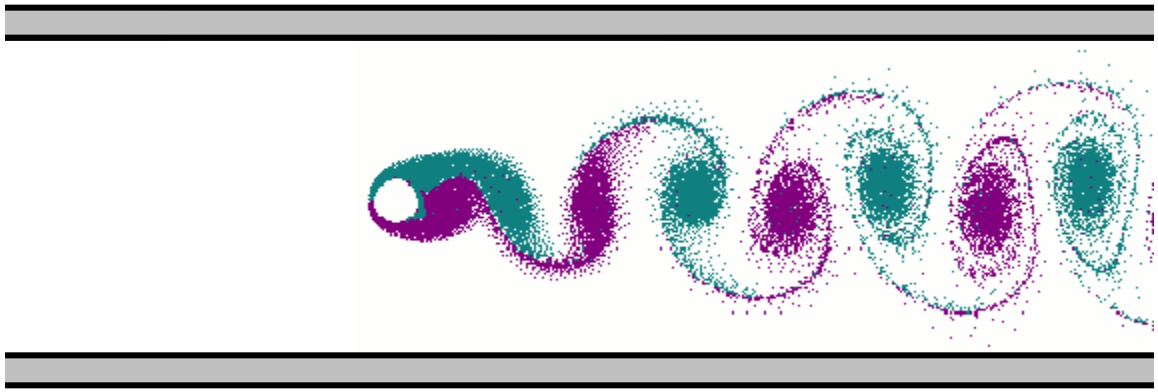
# Lie 6: Square Rooting




$$Q = CA_2\sqrt{2\Delta P / \rho}$$



# Flow: Vortex



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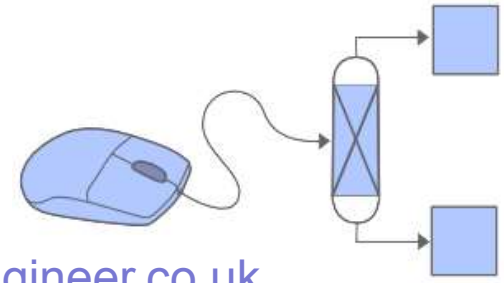
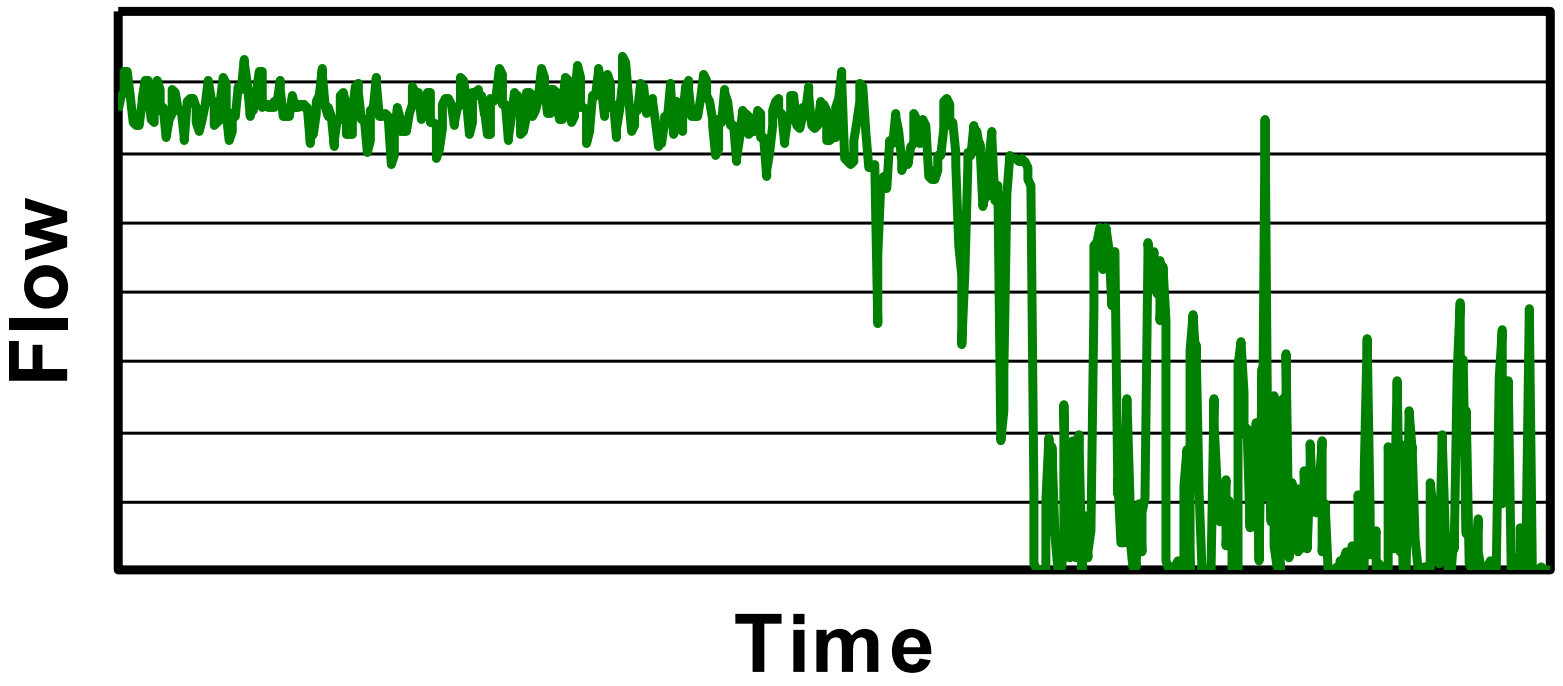
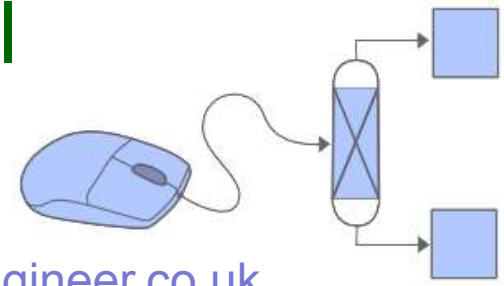


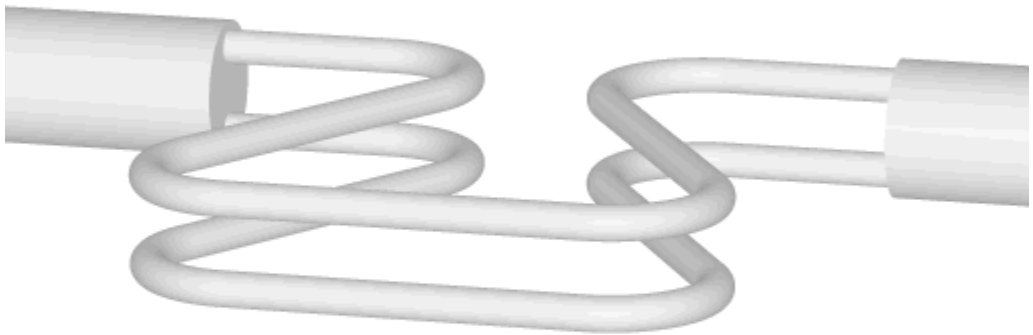
# Lie 7: Low Flow

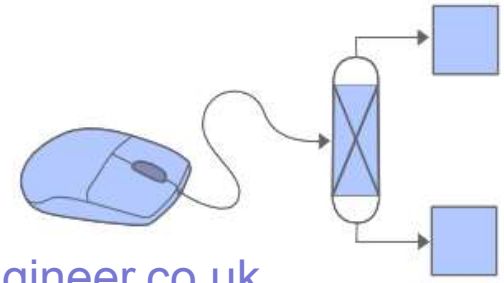



Low Flow → Dropped signal

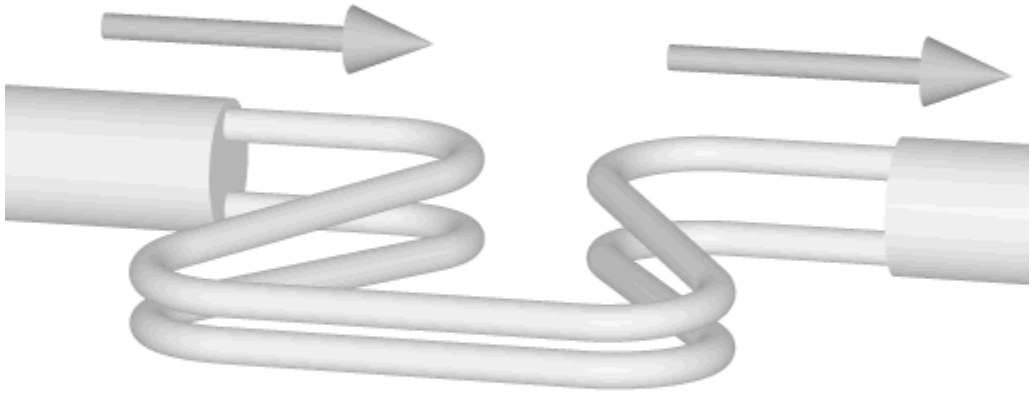


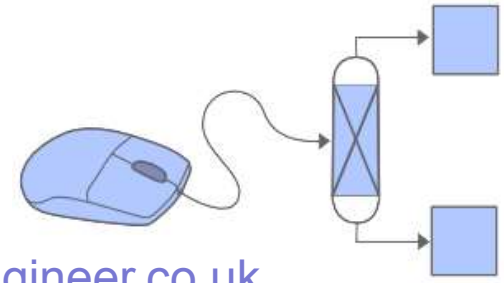
# Flow: Coriolis



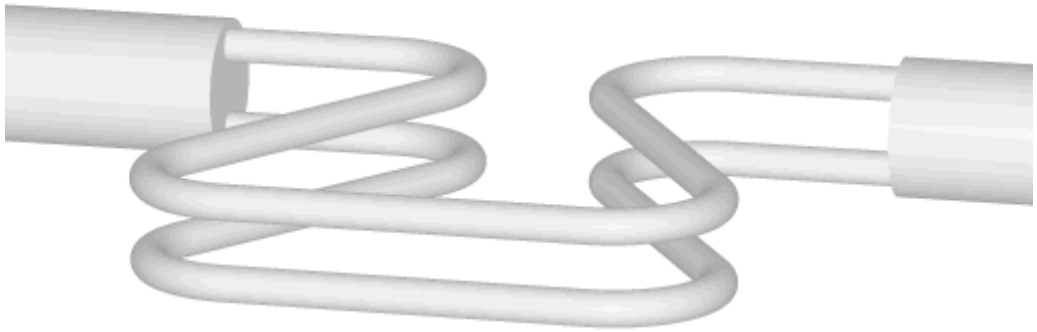


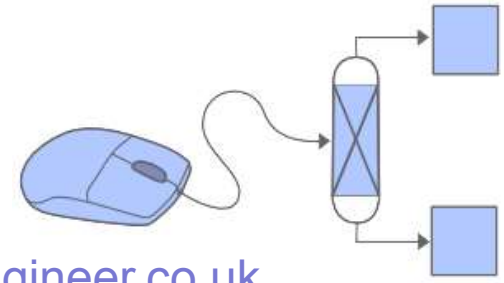
# Flow: Coriolis





# Bonus Example

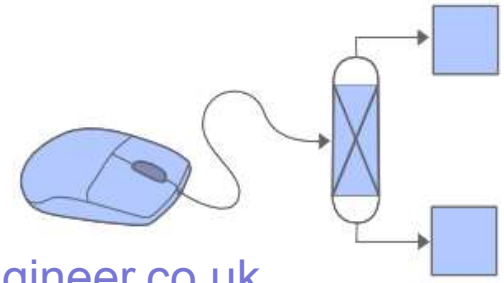




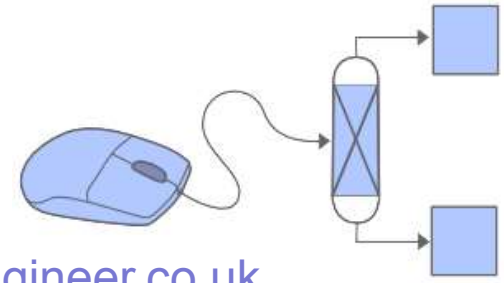
# Flow - Others

## Ultrasonic

## Magflow

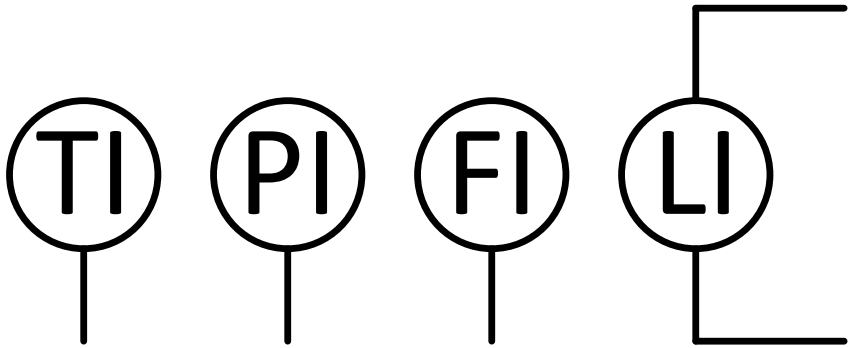


# Summary

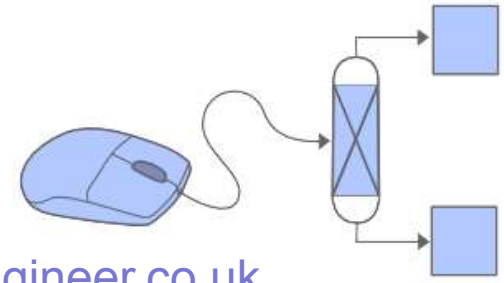


# What Have We Covered

## Simple Instrumentation

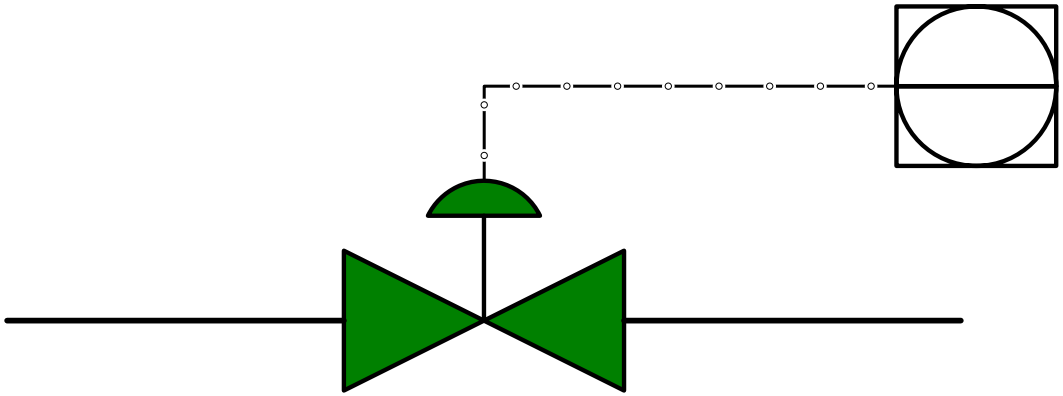



Process → Instrument → DCS

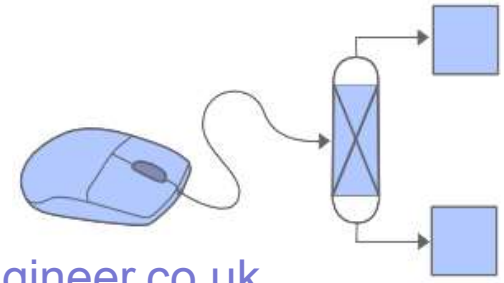


# What Will Be Covered

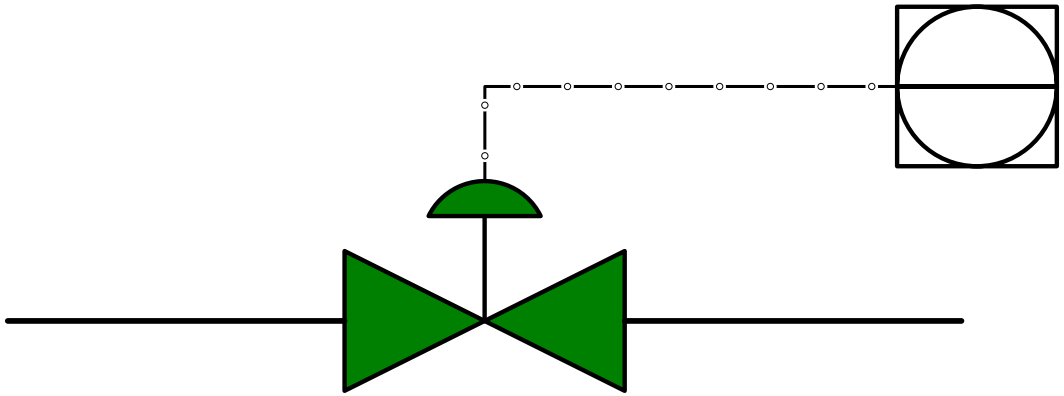
## Simple Control



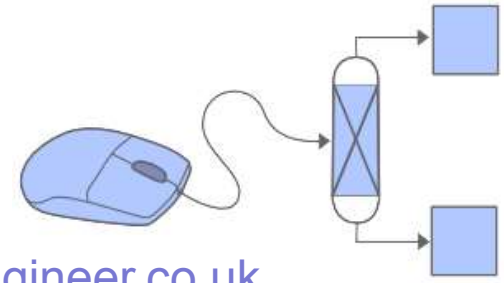
Process ← Valve nent ← DCS



# Lie 8: Valve Position

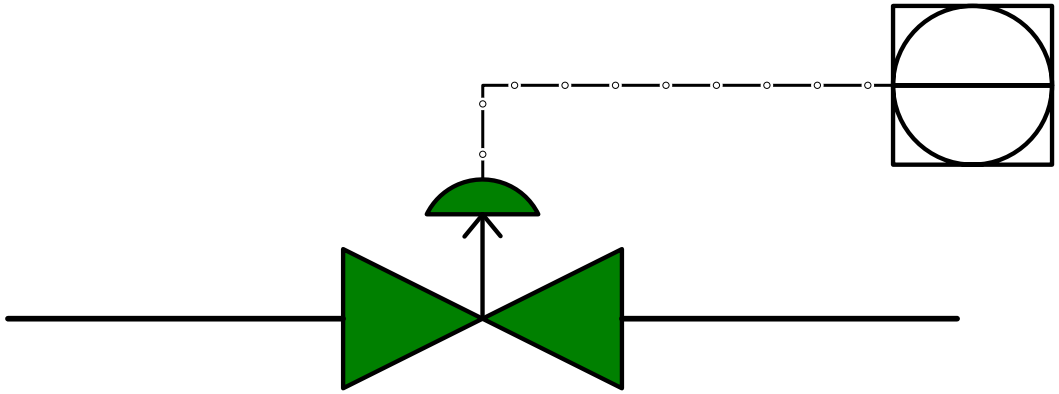


DCS Output ≠ Valve Position



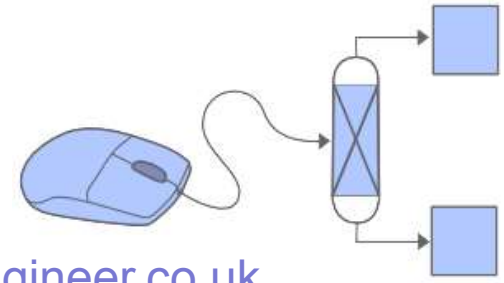
# Lie 9: Valve Fail Direction

## Fail Open

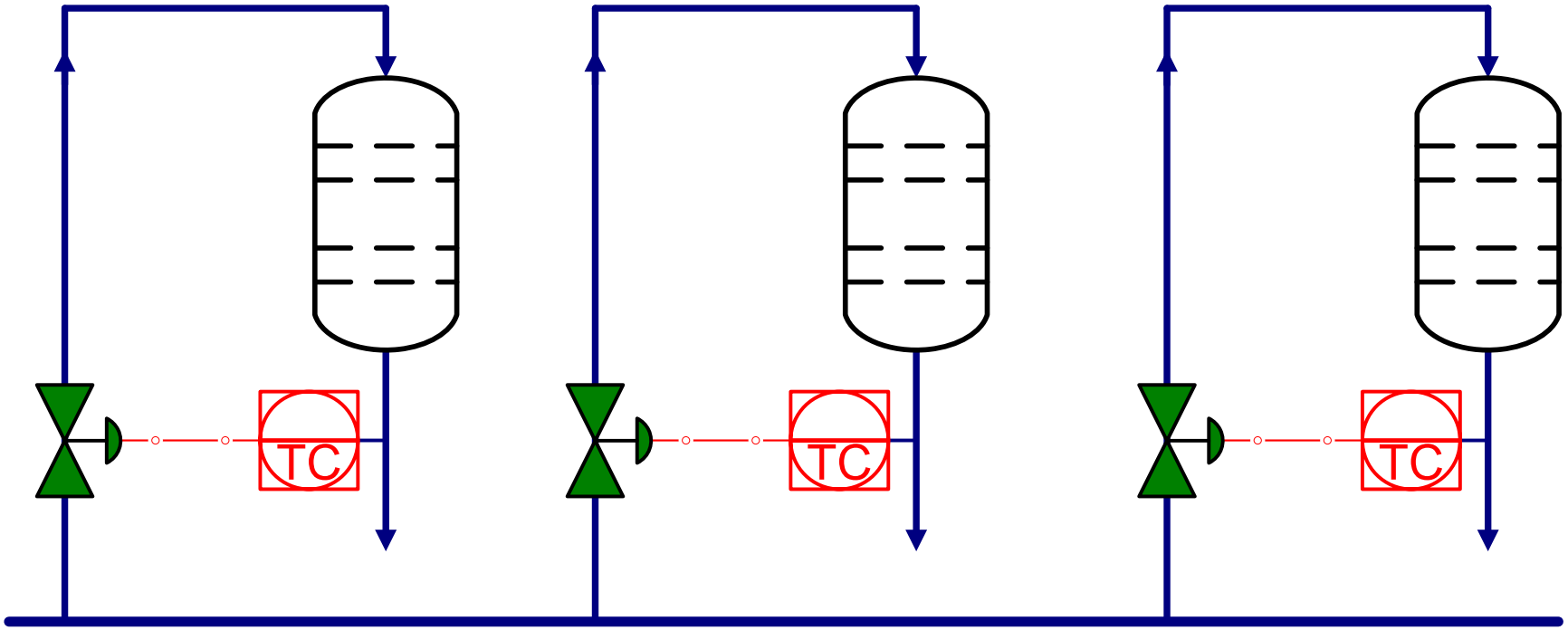


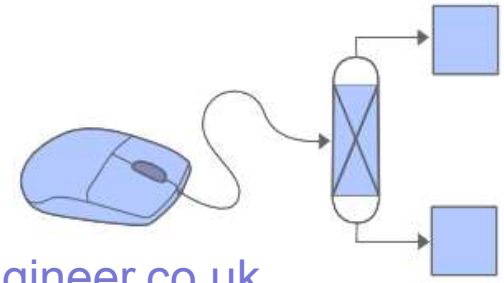
20mA = Fully Closed

4mA = Fully Open



# Lie 10: Condenser Bank



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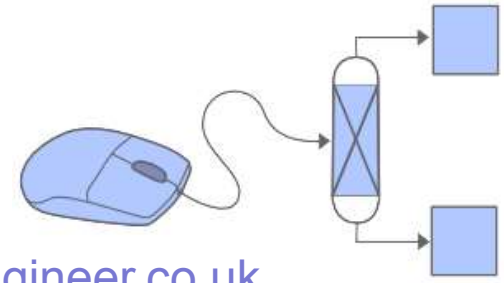
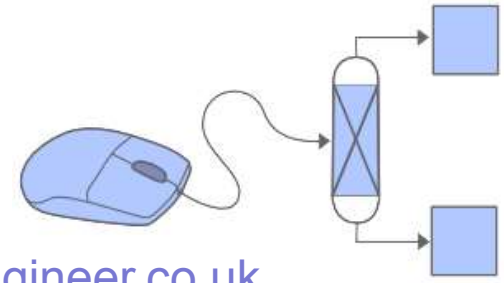


# Summary

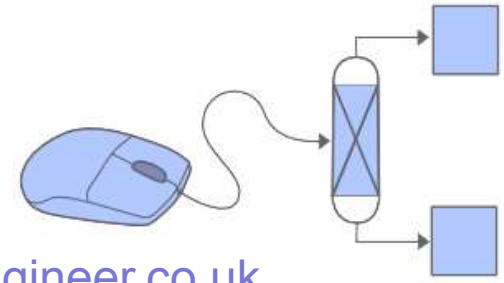


# Summary

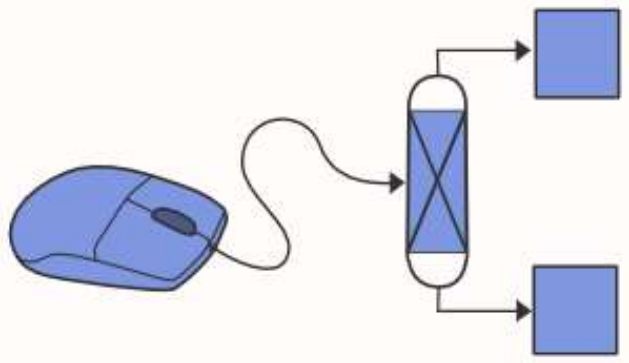
Don’t believe everything on the screen

Physically view the plant

Understand what is actually being measured



# Any Questions?



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Scottish Members Group

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