



Pipe Thickness Measurement Utilizing Ultrasonic Technology for Knowing Corrosion Aspects Information of Carbon Steel



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Objective

The objective of this project is to develop a non-invasive solution using ultrasonic thickness gauges to detect pipeline corrosion, and predict the operational lifespan and corrosion rate utilising a software program.

Problem Statement

It's required to detect internal corrosion in pipes by a device to address internal damage of the pipe thickness and measure its lifespan and corrosion rate utilising software program.

Constrains

1. Corrosion Parameters : allowance 6mm, rate 25 microns/year, lifespan 25 years.
2. Initial investment Budget : SR 4,100.
3. Non-Destructive 100% pipe integrity.
4. Long-term Functional Maintenance, 5 years.
5. Long piping system range 0.5 m

Target Specifications

Thickness

range 50-200 mm, accuracy of ± 0.05mm.



Reverberation ± 5 mm tolerance.

Time of process < 5 Minutes



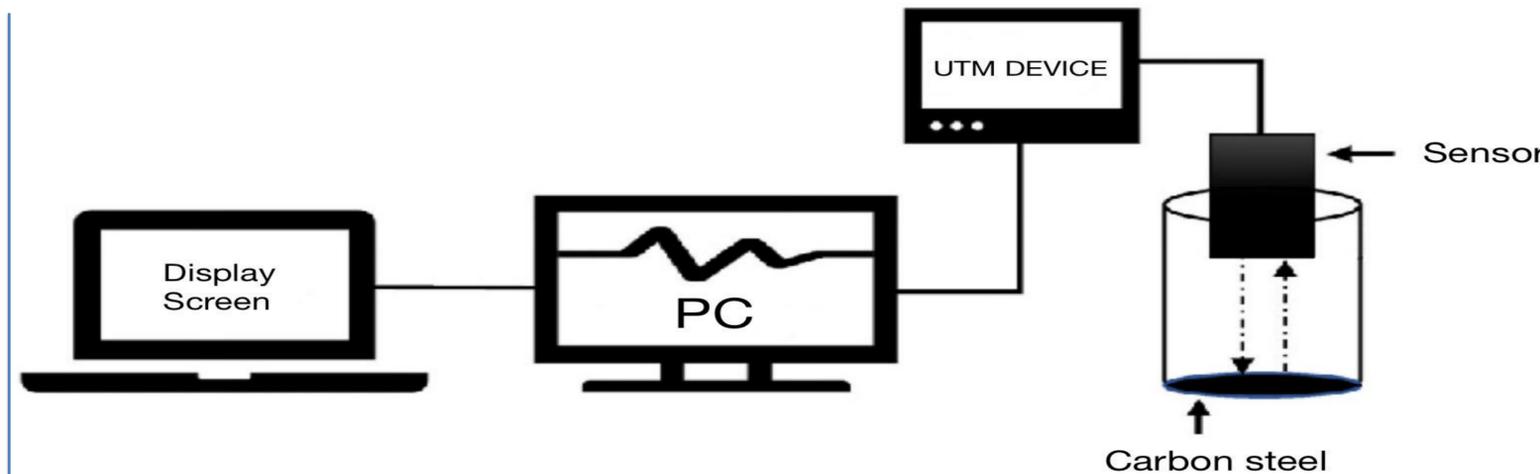
Weight of Device < 20Kg

Speed wave < 6000 m/s

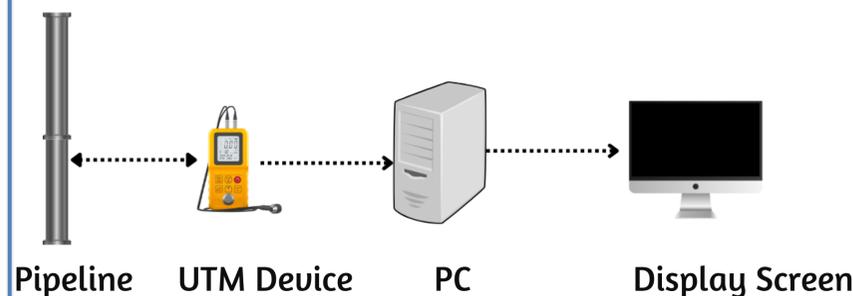


Temperature range < 50 C

Final Design Details



Data Flow System



Test Outputs

Time (days)	Initial Thickness (mm)	Current Thickness (mm)	Pipe Shape	Outer Diameter (mm)	Flow Rate (m³/s)	Type of Fluid	Corrosion Rate (mm/day)	Inner Diameter (mm)	Area (m²)	Reynolds Number	Pressure Drop (bar)	Corrosion State	Pipe Status
0	3	3	circular	12.7	0.000333	Water	0	6.7	126.6769	0	0	New	Operational
1	3	3	circular	12.7	0.000333	Water	0	6.7	126.6769	37544.97	1.08E-05	New	Operational
2	3	3	circular	12.7	0.000333	Water	0	6.7	126.6769	37544.97	1.08E-05	New	Operational
3	3	3	circular	12.7	0.000333	Water	0	6.7	126.6769	37544.97	1.08E-05	New	Operational
4	3	3	circular	12.7	0.000333	Water	0	6.7	126.6769	37544.97	1.08E-05	New	Operational
5	3	3	circular	12.7	0.000333	Water	0	6.7	126.6769	37544.97	1.08E-05	New	Operational

Validation

- ✓ Measurements accuracy: ± 0.05mm.
- ✓ Detecting Process: 1 minutes.
- ✓ Thickness range : 1 – 225 mm
- ✓ Reverberation : ± 5 mm
- ✓ Temperature : 40 C
- ✓ speed wave : 5900 m/s
- ✓ Corrosion allowance > 8 mm

Important Equations

Corrosion Rate (length/time)	$CR (mm/year) = \frac{(T_i - T_f)}{t}$
Remaining Lifetime (years)	$RL(years) = \frac{(T_{current} - Min T)}{(CR \times 365)}$
Darcy-Weisbach Equation (Pa)	$\Delta P = f \left(\frac{L}{D}\right) \left(\frac{\rho v^2}{2}\right)$
Reynolds Number	$Re = \frac{\rho v D}{\mu}$
Darcy Friction Factor Calculation (Colebrook Equation)	$Friction Factor (f) = \frac{64}{Reynolds Number}$
	$1/\sqrt{f} + 2 \log_{10} \left(\frac{5.74}{(Re \times \sqrt{f})}\right) = 0$

Conclusion

This project integrates an ultrasonic measurement device with custom Python software to analyze pipeline thickness and calculate corrosion rates. By automating data analysis, the system enhances corrosion monitoring, supporting safer and more efficient pipeline maintenance in industrial applications.