Analyser Sample Line Transport Lag

Time for a gas or liquid sample to travel from the tap to the analyser through the sample line, from line size, length, flow and pressure.

Method: Plug-flow residence time t = V / Q (ideal gas at line pressure)

Input parameters

Unit system: SI

Parameter	Value	Unit
Sample line length	40.000	m
Inside diameter of the line	4.0000	mm
Sample flow (at the analyser, atmospheric)	2.0000	L/min
Mean pressure in the line (absolute)	1.0132	bar
Other volumes (filters, coolers)	0.20000	L
Sample	Gas	

Calculated results

Parameter	Value	Unit
Line and component volume	0.70265	L
Transport lag	21.080	s
Velocity in the line	2.6526	m/s

Notes for this case

- Plug flow; the analyser's own response time is added on top. Gas is compressed at line pressure, so higher pressure means a longer lag.

Formula and method

$$V = \frac{\pi d^2}{4} L + V_x, \quad t_d = \frac{V}{Q\,(p_{atm}/p)}$$

Variables

L	Sample line length	m
d	Inside diameter of the line	m
Q_N	Sample flow (at the analyser, atmospheric)	m³/s
p	Mean pressure in the line (absolute)	Pa
V_x	Other volumes (filters, coolers)	m³
fluid	Sample	-
V	Line and component volume	m³
t_d	Transport lag	s
v	Velocity in the line	m/s

Method and standards

Residence time of plug flow.

Assumptions and limits

- Plug flow, no mixing.
- The gas flow is corrected for pressure only. In a heated line (for example a 180 °C CEMS line) the gas is also expanded by temperature, so the real velocity is higher and the lag shorter than computed.

References

- Plug-flow residence time t = V / Q (ideal gas at line pressure)

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/instrumentation/analysers/analyser-sample-lag

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.