Airlift Pump: Air Flow, Submergence and Pressure

Free air flow, air pressure and air-to-water ratio for an airlift pump lifting water a given height from its submergence, by isothermal expansion work.

Method: Airlift pump energy balance (isothermal expansion)

Input parameters

Unit system: SI

Parameter	Value	Unit
Water flow to lift	10.000	m³/h
Lift above the water level	6.0000	m
Submergence of the air injection point	12.000	m
Airlift efficiency	40.000	%
Atmospheric pressure	101.33	kPa
Water density	998.00	kg/m³

Calculated results

Parameter	Value	Unit
Submergence ratio H_s/(H_s + H_L)	66.667	%
Air pressure needed at injection (gauge)	117.44	kPa
Free air flow	18.824	m³/h
Air-to-water ratio	1.8824	
Isothermal air power	0.40779	kW

Notes for this case

• Air injected at depth H_s expands as it rises, lowering the mixture density in the riser so the column lifts water H_L above the free surface. The useful work ρgQH_L divided by the efficiency (typically 30–50 % at submergence ratios of 0.5–0.7) must equal the isothermal expansion work of the free air, p_aV̇_a ln[(p_a + ρgH_s)/p_a]. Efficiency falls sharply at low submergence; lifts above about a third of the total length need deep injection. Airlifts have no moving parts below ground, suiting boreholes, slurries and aquaculture.

Formula and method

$$p_a V_a \ln \frac{p_a + \rho g H_s}{p_a} = \frac{\rho g Q_w H_L}{\eta}$$

Variables

Q_w	Water flow to lift	m³/s
H_L	Lift above the water level	m
H_s	Submergence of the air injection point	m
η	Airlift efficiency	-
p_a	Atmospheric pressure	Pa
ρ	Water density	kg/m³
s	Submergence ratio H_s/(H_s + H_L)	-
p_g	Air pressure needed at injection (gauge)	Pa
$\dot{V}_a$	Free air flow	m³/s
$\dot{V}_a/Q_w$	Air-to-water ratio	-
P_a	Isothermal air power	W

Method and standards

Airlift pump.

Assumptions and limits

- Isothermal expansion; efficiency from experience; steady flow.

References

Airlift pump energy balance (isothermal expansion)

Report details

Report reference	FCC-ST98-BAAN (the same inputs always give the same reference)
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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

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Reopens the calculator with the inputs of this report.