

# Methods & test results

## Engineering 2 / test release / 30 September 2026

29 worked numerical results passed. This report describes the test release prepared for the separate Engineering 2 website. The existing live engineering, intranet and customer sites retain their prior release until separately updated.

### How the checks were performed

Application outputs were compared with independent arithmetic, supplied workbook values, or source-table cells. The worked checks also cover unit round trips, invalid inputs, chart limits and the base pump catalog. Internal arithmetic retains full precision; results in this report are displayed to at most three decimals.

### Pump selection and motor output

Published curves are screened for flow, pressure, drive, control, head count, family and gearbox. Motor results are shown only when the selected pump, head design, speed, gearing and pressure have a matching reference. An unavailable match remains unavailable; the SLA plunger chart is not applied to EV or LeakLess heads.

### Multi-head arrangements

For identical parallel heads at a common pressure, combined flow is the source flow multiplied by total heads divided by the source head count. Pressure capability is unchanged. An actual supplied dual-head ATP curve is preferred for two heads and is not doubled again. Other scaled arrangements are estimates and require confirmation of the full drive and package.

### Viscosity and catalog coverage

Viscosity is recorded in cP. Above 500 cP, the test selector considers only Extra Viscosity configurations. If no published matching EV curve is available, the tool reports the missing data instead of constructing a performance curve. A configuration control does not prove a combination is available.

### Calculator sections

The all in one calculator includes pump and motor selection, SCFM, stroke length, mass and volume flow, pressure and temperature conversion, line sizing, pipe velocity and loss, plunger displacement, calibration, rod force, NPSH available, chemical dosing, hydraulic power, and pressure/head conversion. The engineering version also contains the flow curve generator.

### Scope of a passed check

A passed check confirms the implementation agrees with its stated equation or source at the tested inputs. It does not establish chemical compatibility, application suitability, installed assembly pressure rating or pump performance outside the source data. Research-only material is outside the routine sizing method documented here.

# Motor sizing

The primary SLA method uses the updated Adam HP charts dated 1 June 2026. The normal tables cover 9:1 and 15:1 gearboxes at 1450 and 1750 RPM, with 1-2, 3-4 and 5-6 head groups.

## SLA motor sizing: Chart motor size

Inputs: SLA-P08; 15:1; 1750 RPM; 1-2 heads; 1000 PSIG

### Expected and calculated: 0.25 HP

Updated Adam workbook, HP Charts 1-2 Head(Adam), F26. Fixed chart lookup at 1-inch stroke and stated 5% safety factor.

## SLA motor sizing: Equivalent power

Inputs: Same SLA chart inputs

### Expected and calculated: 0.186 kW

HP converted with the supplied workbook factor. This is an equivalent power, not a separate IEC motor selection.

## SLA motor sizing: Next-column motor size

Inputs: Same configuration; 1000.01 PSIG

### Expected and calculated: 0.5 HP

Conservative next pressure column: 1100 PSIG, HP Charts 1-2 Head(Adam), G26. No interpolation between motor sizes.

## Other motor chart lookup: Published motor power

Inputs: FXA-02 HP, 1/8-inch, 1250 head; source table 13:1; 1750 RPM; 1000 PSIG

### Expected and calculated: 0.75 HP

Series FXA with VFD Motor Power Charts Rev01-1.pdf, page 1. This standalone lookup uses its own source configuration; it is not an automatic match to a different curve reducer.

## Source and selection rule

SLA Motor Power Charts RevA 20200302BG Unlocked.xlsm: HP Charts 1-2 Head(Adam), HP Charts 3-4 Head(Adam), and HP Charts 5-6 Head(Adam). Supported blocks start at rows 17, 31, 59 and 73. Use the first pressure column at or above the duty. The source row limit still applies; a populated cell beyond that limit cannot be selected. Blank cells do not imply a motor size.

## Fixed chart conditions

The source states a 1-inch stroke and 5% safety factor. Do not scale fixed motor values to unlisted speeds, strokes or mixed head duties. The kW output converts the selected HP with the workbook factor; it is not a separate IEC motor selection. Source labels and cells remain visible in the application.

# Line sizing

Required inputs are liquid flow and operating gauge pressure. Velocity is optional. Blank velocity uses 4 ft/s for suction or 20 ft/s for discharge; the user can enter an application-specific value. General guidance is 2-4 ft/s suction and 15-20 ft/s discharge.

## Line sizing: Default sizing velocity

Inputs: 1000 L/h; 100 bar gauge; suction; velocity blank

### Expected and calculated: 4 ft/s

CheckPoint guidance: suction 2-4 ft/s, discharge 15-20 ft/s; automatic values 4 and 20 ft/s.

## Line sizing: Minimum inside diameter

Inputs: Same line inputs

### Expected and calculated: 0.671 in

$ID = \sqrt{4Q / (\pi v)}$ ; Q in m<sup>3</sup>/s and velocity in m/s, then convert to inches.

## Line sizing: Selected tubing outside diameter

Inputs: Same line inputs; automatic seamless 316 stainless steel

### Expected and calculated: 1 in

Smallest listed common OD meeting both bore and pressure. Parker Table 5: 1-inch OD, 0.065-inch wall, 2400 psi at 72 deg F.

## Line sizing: Selected tubing inside diameter

Inputs: Same line inputs

### Expected and calculated: 0.87 in

$ID = OD - 2 \times \text{wall} = 1 - 2 \times 0.065$ .

## Line sizing: Velocity in selected tubing

Inputs: Same line inputs

### Expected and calculated: 2.376 ft/s

Average liquid velocity = flow / inside cross-sectional area.

## Automatic wall and pressure check

Automatic mode uses published Parker Table 5 ratings for fully annealed seamless 316 stainless steel at 72 deg F. From the listed common OD sizes, it finds the smallest OD and thinnest listed wall meeting both required bore and entered pressure. Temperature derating, corrosion allowance, tolerances, surge pressure and connection ratings require a separate review.

## Manual gauge mode

Manual wall gauges use Tech Steel dimensions only. They do not verify pressure capability. The result is tubing outside diameter, not a nominal pipe size. The calculations use average liquid flow; suction acceleration head, NPSH, pulsation and line losses are separate checks.

# Unit conversions

## Volume flow: Volume flow

Inputs: 1 US gal/min

**Expected and calculated: 227.125 L/h**

1 US gal = 3.785411784 L; multiply by 60 min/h. NIST SP 811.

## Mass flow: Mass flow

Inputs: 100 lb/h

**Expected and calculated: 45.359 kg/h**

1 lb = 0.45359237 kg. NIST SP 811.

## Mass to volume: Volume flow

Inputs: 100 kg/h; density 800 kg/m<sup>3</sup>

**Expected and calculated: 125 L/h**

Volume = mass / density; m<sup>3</sup> converted to L.

## Volume to mass: Mass flow

Inputs: 125 L/h; density 800 kg/m<sup>3</sup>

**Expected and calculated: 100 kg/h**

Mass = volume x density.

## Pressure conversion: Pressure

Inputs: 1 bar

**Expected and calculated: 14.504 psi**

100000 Pa / 6894.757293168 Pa per psi. Reference basis unchanged.

## Temperature conversion: Temperature

Inputs: 20 deg C

**Expected and calculated: 68 deg F**

F = C x 9/5 + 32.

## Temperature conversion: Temperature

Inputs: 20 deg C

**Expected and calculated: 293.15 K**

K = C + 273.15.

## Conditions and limits

Conversions use fixed unit factors. Crossing mass and volume requires actual density at matching temperature and pressure. Gauge pressure stays gauge and absolute stays absolute. Temperature conversions apply to absolute readings, not temperature differences; values below absolute zero are rejected.

# Gas and mechanical calculations

## WRS workbook SCFM: Gas consumption

Inputs: 1250 / 0.5 in; 30 US gal/h; 100 PSIA; 0% allowance

**Expected and calculated: 22.735 SCFM**

Sheet1!B16:J16, P16:Q16. Independently extracted saved workbook result; pressure treated explicitly as absolute.

## Stroke length: Required stroke

Inputs: 10 L/h; 12.7 mm plunger; 60 cycles/min; 95% efficiency

**Expected and calculated: 23.082 mm**

Inverse displacement:  $Q \times 1e6 / (60 \times \text{SPM} \times \text{area} \times \text{efficiency})$ .

## Plunger displacement: Delivery

Inputs: 10 mm plunger; 10 mm stroke; 100 cycles/min; 2 heads; 100% efficiency

**Expected and calculated: 9.425 L/h**

Area x stroke x cycles/min x head count x 60 x efficiency.

## Calibration: Measured delivery

Inputs: 100 mL in 60 s; current setting 50%; target 9 L/h

**Expected and calculated: 6 L/h**

mL/s x 3.6 = L/h.

## Calibration: Proportional setting

Inputs: Same calibration inputs

**Expected and calculated: 75 %**

Current setting x target flow / measured flow.

## Rod force: Rod force

Inputs: 0.75-inch outer diameter; no inner rod; 3400 psi

**Expected and calculated: 1,502.074 lbf**

Net circular area x pressure. Matches supplied workbook E37.

## Gas method and stroke limits

Only the corrected WRS workbook gas method is used. Selected displacement is column Q and air volume is column P. Supply pressure is explicitly converted to absolute before calculating consumption. The workbook does not state a standard gas temperature. Stroke and displacement assume circular, single-acting plungers; enter the actual efficiency and equipment limits.

# Liquid system calculations

## Pipe losses: Pressure loss

Inputs: 10 L/h; 25 mm bore; 20 m length; 1 cP; 1000 kg/m<sup>3</sup>; K=0

**Expected and calculated: 5.795 Pa**

Independent laminar Hagen-Poiseuille check:  $\Delta P = 128 \mu L Q / (\pi D^4)$ . Pa is used here so three-decimal rounding does not hide a small nonzero result.

## NPSH: NPSHa

Inputs: 1 bar absolute surface; zero vapor pressure; 1000 kg/m<sup>3</sup>; elevation 2 m; losses 0.5 + 1 m; NPSHr 3 m

**Expected and calculated: 10.697 m**

$(P_{\text{surface}} - P_{\text{vapor}}) / (\rho g) + \text{elevation} - \text{friction} - \text{acceleration losses}$ .

## Chemical dosing: Solution feed

Inputs: 100 m<sup>3</sup>/h water; 5 mg/L dose; 10% active; solution density 1.1 kg/L

**Expected and calculated: 4.545 L/h**

0.5 kg/h active / 0.1 mass fraction / 1.1 kg/L.

## Hydraulic power: Hydraulic power

Inputs: 3600 L/h; differential pressure 100 bar; pump 80%; motor 90%

**Expected and calculated: 10 kW**

$Q \times \Delta P$ ; shaft 12.5 kW; electrical input 13.889 kW.

## Hydraulic power: Electrical input

Inputs: Same hydraulic inputs

**Expected and calculated: 13.889 kW**

Hydraulic / pump efficiency / motor efficiency.

## Pressure & head: Liquid head

Inputs: 1 bar differential; density 1000 kg/m<sup>3</sup>

**Expected and calculated: 10.197 m**

$\text{Head} = \Delta P / (\rho \times 9.80665)$ .

## Pipe-loss and suction assumptions

Pipe losses use Darcy-Weisbach:  $64/Re$  for laminar flow and iterated Colebrook for turbulent flow. A single friction result is withheld in the transition region. NPSH available subtracts entered friction and acceleration losses from surface pressure head plus elevation. Compare with the actual pump requirement and application margin.

# Pump curves and source references

## Pump curve interpolation: Capacity

Inputs: Reference test curve: 10 GPH at 0 psi, 6 GPH at 1000 psi; duty 500 psi

### Expected and calculated: 8 US gal/h

Linear interpolation gives 8 GPH. This is a synthetic calculation test, not a real pump recommendation.

## Catalog selection checks

The worked run returned 50 base-catalog candidates at 1 US gal/h and 500 psi. Each returned curve was checked for capacity and pressure bounds. This is a regression input, not a recommendation for an installation. The original catalog snapshot contains 78 models; additional test-release references retain their own source labels.

## Flow curve generator

Start with a supplied base curve, a workbook reference or a new draft. Enter pressure/flow points, annotations and author details; validate and save the revision before exporting. Saved curves are engineering records, not newly certified pump ratings. The plotted shape and exported document reflect the entered source points and configuration.

## Motor sources

Updated Adam SLA workbook: named tabs and source cells above. Other standalone motor lookups retain their own FXA, SLA plunger or LeakLess PDF revision, gearing, speed, head-count and pressure limits. The workbook and PDF values are not interchangeable across head designs.

## Gas, stroke and geometry sources

Gas Consumption - Estimated - Corrected WRS.xlsx, Sheet1, selected model row and columns P:Q. Series 1250 manual, CP-MAN-PRD-1250 Rev15: cycle-rate reference in the stroke tool. Rod force, hydraulic power, dosing, calibration, displacement and head use the stated physical equations and user inputs.

## Line-sizing sources

Parker Instrument Tube Fitting Installation Manual, Bulletin 4200-B4, January 2023, Table 5, page 26: ambient tube pressure ratings. Tech Steel tube sizing chart: OD and wall dimensions. Essentra hydraulic hose sizing nomograph: continuity/diameter method. Velocity ranges and defaults were supplied by CheckPoint.

[https://www.parker.com/content/dam/Parker-com/Literature/Instrumentation-Products-Division/Installation-Instructions/Parker\\_Tube\\_Fitting\\_Installation\\_Manual.pdf](https://www.parker.com/content/dam/Parker-com/Literature/Instrumentation-Products-Division/Installation-Instructions/Parker_Tube_Fitting_Installation_Manual.pdf)

<https://www.techsteel.net/tube-sizing-chart/>

<https://www.essentracomponents.com/en-us/news/solutions/general-protection/hydraulic-hose-sizing-nomograph>

## Unit conversion reference

NIST SP 811, Appendix B.8. Exact factors are retained internally; displayed results are rounded.

<https://www.nist.gov/pml/special-publication-811/nist-guide-si-appendix-b-conversion-factors/nist-guide-si-appendix-b8>