

Solvent evaporation parameters and vacuum achievability

Pick the target boiling point, read the absolute pressure the pump has to reach, and check the margin against the pump you already own. Everything below is calculated, not copied from a vendor table.

Data methodology. Saturated vapour pressures are modelled with the Antoine equation, $\log_{10}(P_{\text{mmHg}}) = A - B / (T + C)$, with coefficients taken from the NIST Chemistry WebBook (SRD 69) and cross-checked against the *CRC Handbook of Chemistry and Physics*. Pressures are converted from mmHg to absolute millibars (1 mmHg = 1.33322 mbar) against a standard 100 kPa baseline. Tabulated values are rounded to the nearest whole mbar. A $\pm 3\%$ **engineering margin** covers that rounding plus cross-source variation. One row, acetonitrile, is marked “≈” because its published Antoine coefficients are dispersed; the Clausius–Clapeyron estimate for that row spans 219–245 mbar.

The Rule of 20. Balanced distillation holds a 20 °C differential across the phases, which matches the heat flux into the boiling liquid against what the condenser can remove:

- Bath temperature** $T_{\text{bath}} = T_{\text{bp}} + 20\text{ °C}$
- Chiller temperature** $T_{\text{chiller}} = T_{\text{bp}} - 20\text{ °C}$

If the condenser fluid runs warmer than $T_{\text{bp}} - 20\text{ °C}$, vapour velocity overpowers the heat-exchange capacity of the coil and solvent vapour heads straight for the pump exhaust.

Solvent	B.P. at 1013 mbar	Target B.P.	Required vacuum	Heating bath	Chiller	Margin vs 163 mbar
Acetone	56.1 °C	40 °C	565 mbar	60 °C	20 °C	+402 mbar
Dichloromethane	39.8 °C	20 °C	474 mbar	40 °C	0 °C ¹	+311 mbar
Hexane	68.7 °C	40 °C	373 mbar	60 °C	20 °C	+210 mbar
Methanol	64.7 °C	40 °C	351 mbar	60 °C	20 °C	+188 mbar
Ethyl acetate	77.1 °C	40 °C	254 mbar	60 °C	20 °C	+91 mbar
Isopropanol	82.3 °C	50 °C	239 mbar	70 °C	30 °C	+76 mbar
Ethanol	78.4 °C	45 °C	230 mbar	65 °C	25 °C	+67 mbar
Acetonitrile	81.6 °C	40 °C	≈225 mbar ²	60 °C	20 °C	+62 mbar
Water	100.0 °C	60 °C	199 mbar	80 °C	40 °C	+36 mbar
Toluene	110.6 °C	60 °C	185 mbar	80 °C	40 °C	+22 mbar

Required vacuum is absolute pressure at the stated target boiling point. Green margins leave more than 50 mbar of headroom above a 163 mbar pump; red rows leave less and need a colder trap or a colder chiller. Data derived from the NIST Chemistry WebBook (SRD 69); compilation © XinTester, licensed CC BY 4.0.

- Dichloromethane at 0 °C needs a glycol mix.** Plain water in the chiller circuit freezes at that setpoint. Use a 30 % glycol–water charge below 5 °C.
- Acetonitrile is an estimate, and is marked as one.** Antoine coefficients for acetonitrile are dispersed between sources, so the row is given as ≈225 mbar with a Clausius–Clapeyron spread of 219–245 mbar. Treat it as a sizing band, not a setpoint.
- What the pump margin actually means.** The 163 mbar figure used above is the *blank-off* rating of an oil-free PTFE diaphragm pump (0.085 MPa) — the pressure it reaches with the inlet closed and no gas flowing. Under continuous vapour load the achievable pressure is always higher. For the two red rows, either lower the chiller setpoint or fit a secondary cold trap; do not simply run the pump harder.
- Colour code.** Green margin = more than 50 mbar of headroom. Red row = less than 50 mbar, which is the band where vapour slip past the condenser becomes a real failure mode rather than a theoretical one.

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