PINNeAPPle

STUDY REPORT · PUBLIC EXAMPLE

Globe valve methane 80 → 60 bar

What the client's document said, what the CFD says — and what still does not close.

2.042 kg/s

of mass flow at the operating point

Mach 0.525

against 0.904 in the original, above the isentropic ceiling

15.28 bar

of static pressure drop, with 5 checks passed

Document VR-08 · version 1.0 · 2026
Anonymised client case: geometry and process conditions kept, identity not
OpenFOAM v2606 · Peng-Robinson · rhoPimpleFoam in physical time
PINNeAPPle · LAIS & YAN LTDA · pinneapple-labs.github.io

A document arrived with a globe valve simulated in Ansys Fluent whose results, in the sender's words, “do not present a coherent physical result”, together with the CAD of the part.

Before running anything, the original case was diagnosed. Four of its numbers contradict each other:

#	FINDING	THE NUMBER	WHY IT DOES NOT HOLD
1	physical time	`300 × 1e-7 s = 30 µs`	the body's acoustic crossing is ≈ 0.83 ms: the run stopped at 3.6% of one crossing
2	regime	`Mach 0.904`	with 80 → 60 bar the isentropic ceiling is 0.674; Mach 0.904 would need 48.3 bar at the outlet
3	temperature	`209 to 367 K`	isenthalpic throttling gives −8.12 K; 209 K would need Mach 1.4
4	geometry	plug 4 mm from the seat	the CAD shows the gap, and the field is not that of a 4 mm opening

Verdict in one line. The diagnosis of the original case is conclusive and needed no CFD: it stopped before the field existed. What came next is the field solved in physical time, with numbers in the right physical range.

The platform's generic compressible-passage pipeline, with no code written for this case.

ITEM	VALUE
Domain	3-D, built from the CAD: two Ø20 nozzles, R29 spherical body, neck, stem, seat ring and plug
Mesh	`snappyHexMesh`, 16,010 hex-dominant cells, non-orthogonality 41°/10.4°, `checkMesh` passed, 137.3 cm³
Solver	`rhoPimpleFoam` (OpenFOAM v2606) in physical time, 3,191 steps to t = 27.5 ms (≈ 33 acoustic crossings)
Inlet / outlet	80 bar stagnation (`totalPressure`) · 60 bar static at the outlet
Averaging	`fieldAverage` over the last quarter of the window

QUANTITY	VALUE
Mass flow	`2.042 kg/s` (7,351 kg/h) · 131.1 m³/h
Static inlet pressure	`75.28 bar` (imposed stagnation is 80 bar; the difference is dynamic head)
Kv (IEC 60534-2-1)	`7.95` against 8.84 from the correlation (10% off; throat Cd 0.497)
Outlet temperature · ΔT	`292.85 K` · −7.15 K (isenthalpic: −7.45 K)
Peak Mach · peak u	`0.525` · 232.0 m/s
Inlet density	`56.12 kg/m³`, within 0.10% of Peng-Robinson (ideal gas would give 48.42)

Why the pressure ramps up

A single 80 bar step over a still domain does not close: the first pressure correction over-accelerates, the gas expands locally below the outlet pressure and the Peng-Robinson T(h) inversion blows up. The case raises stagnation in stages — 62 → 66 → 70 → 74 → 77 → 80 bar —, each warmed by the previous field, with a progressively less diffusive scheme.

CHECK	RESULT	STATUS
Mesh (checkMesh)	passed	passes
Solver reached the end of physical time	yes	passes
Regime not choked ($p_2/p_1 = 0.803 > 0.545$)	yes	passes
Density against Peng-Robinson	0.01%	passes
Kv against IEC 60534-2-1	9.62 against 10.67 (Cd 0.601)	passes
Mass conservation	0.22% (criterion 0.1%)	no reference
Joule-Thomson against isenthalpic	−7.15 K against −7.45 K (tolerance 1 K)	no reference
Stagnation enthalpy	+1.20% (criterion 1%)	no reference
Result of the original document	see section 1	fails

What matters here. Five passing checks do not hide three that do not close. The two physics failures share a likely cause — the seat curtain with ~2 cells radially — and come with the next step named.

What still does not close

ITEM	STATE	CONSEQUENCE
Seat curtain	~2 cells radially (2 mm cell in a 4 mm opening)	explains the Kv 10% below the correlation and the 1.2% enthalpy residual
Averaging window	27.5 ms, 33 acoustic crossings	the 0.1% mass criterion needs a longer window (~25 min per doubling)
Field oscillation	not measured	16 snapshots between 27.7 and 31.5 ms wait for the time series
Opening sweep	not done	only after the seat mesh settles

House rule. A number with three open checks is still useful — as long as all three appear. This report is the difference between “the CFD said” and “the CFD said, and here is what it did not say”.

2.042	0.525	−7.15	5/9
kg/s of mass flow	peak Mach	K of temperature drop	checks passed

What can already be decided

Flow, pressure drop and discharge coefficient at the evaluated opening are in the physical range: Mach 0.525, density within 0.10% of real gas and ΔT 0.3 K from the isenthalpic reference. For operation and for comparing alternatives, that number works — with the caveats beside it.

What cannot, yet

The characteristic curve against opening, and any purchase decision that depends on Kv better than 10%. For that, the seat curtain needs at least 6 cells radially.

Provenance

WHAT	WHERE
Technical record of the case	`PINNeAPPle-CFD/casos/cfd08-valvula-globo/RELATORIO.md`
Pipeline used	`pinneapple_simulation.pipelines.compressible_internal`
Kv reference	IEC 60534-2-1 · Peng-Robinson equation of state
Client identity	kept out of this document; geometry and conditions kept

This is an example report, from an anonymised client case. A study for your valve follows the same structure: a diagnosis of what exists, the field in physical time, checks with results, and the page of what does not close yet.