Sheet E6 · Experimental validation

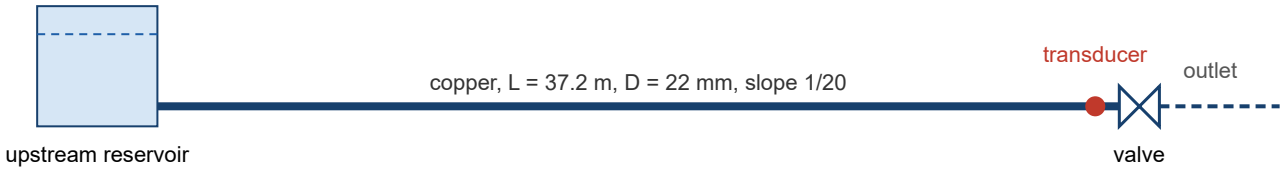
Column separation at the valve (Simpson and Bergant, 1994)

Source : A. R. Simpson, A. Bergant, Journal of Hydraulic Research 32(2), 1994, pp. 183-194, figure 10

1. The question

After a very fast closure, the pressure drops to vapour pressure, a cavity forms and then collapses, creating peaks higher than Joukowsky. Does CBELIER, with its cavitation model, reproduce these peaks and their timing?

2. The case

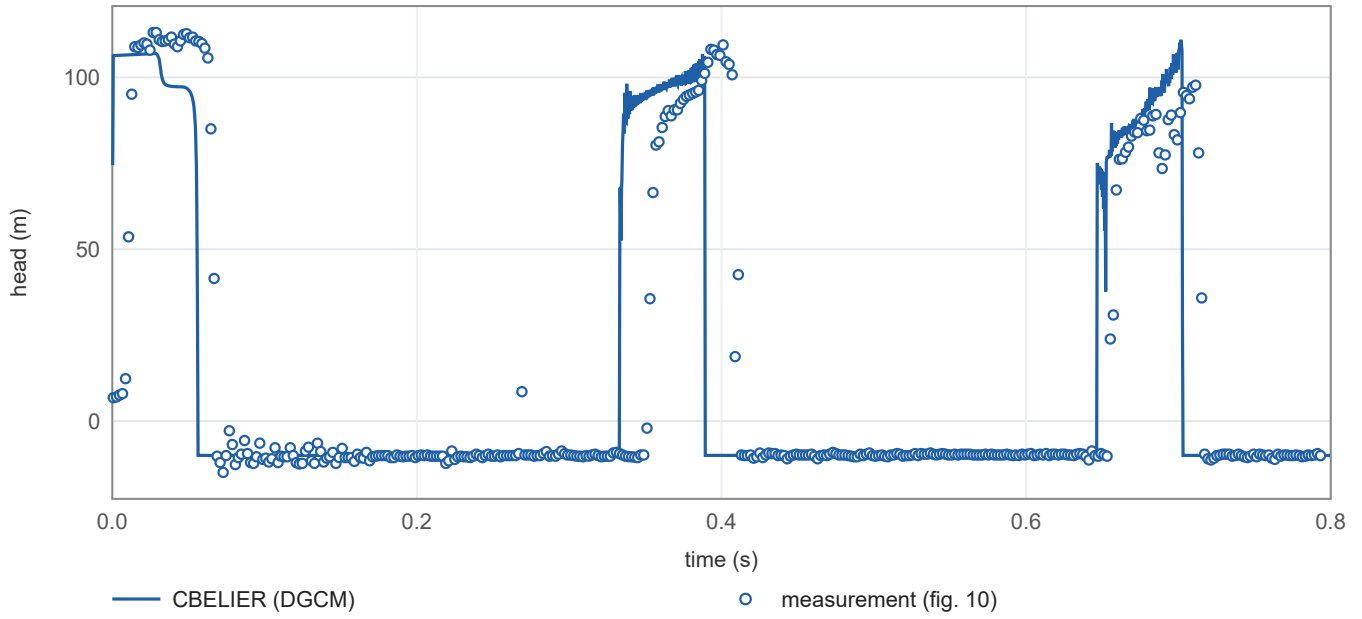


A 37.2 m copper pipe slopes down to a valve closed in 10 ms, with an initial velocity of 0.76 m/s. Head is measured at the valve by a piezoelectric transducer. CBELIER uses the discrete gas cavity model (DGCM).

3. Data and status

Data	Value	Status
Pipe: L, D, wall thickness	37.2 m; 22 mm; 1.63 mm	PUBLISHED
Measured wave speed; initial velocity	1,328 m/s; 0.76 m/s	PUBLISHED
Closure time; upstream reservoir head	10 ms; 8.2 m	PUBLISHED
Head curve at the valve (fig. 10)	± 1 m; ± 1 ms	READ FROM FIGURE
Initial head at the valve	7.0 m	READ FROM FIGURE
Elevation drop (slope ≈ 1/20)	1.86 m	DERIVED
Roughness; open-valve loss; linear closure	1.5 µm; 0.5 m	ASSUMED

4. Results



Head at the valve: CBELIER, DGCM (line) and measurement digitised from figure 10 (circles, one in three).

5. Differences

Indicator	CBELIER	Reference	Difference
Peak no. 1	107.0 m	113.1 m	−5.4 %
Time of peak no. 1	0.029 s	0.027 s	2 ms
Peak no. 2	106.8 m	110.2 m	−3.1 %
Time of peak no. 2	0.388 s	0.402 s	−14 ms
Peak no. 3	110.9 m	98.5 m	12.6 %
Time of peak no. 3	0.702 s	0.710 s	−8 ms

The first two peaks are reproduced within 6 % and all the times within 15 ms. The third peak is overestimated by 13 %. The RMS difference is not a good indicator here: with almost vertical fronts, a 10 ms shift is enough to make it explode.

6. Limitations and assumptions

- Five test data are not published and are assumed or read (roughness, exact elevation drop, valve loss, closure shape, valve head).
- The third peak exceeds the 10 % target: repeated column separation remains the hardest phenomenon for every model.
- The measured minimum pressure falls below the theoretical vapour pressure: an effect of the transducer or the datum, not modelled.

Computation: CBELIER engine 3c.26, 2026-11-06. Re-run with every release by the verification suite (verification/qv1). Alfa Wamane engineering consultancy — cbelier.alfawamane.ma