Sheet N3 · Numerical validation

Air-inlet valve at a high point (Wylie & Streeter, example 5-2)

Source : E. B. Wylie, V. L. Streeter, Fluid Transients, McGraw-Hill, 1978, example 5-2, program D-1 and results D-2

1. The question

When the pressure drops at the high point, an air valve lets air in and then expels it. Does CBELIER reproduce the head at the valve and the air volume and mass computed by the book?

2. The case

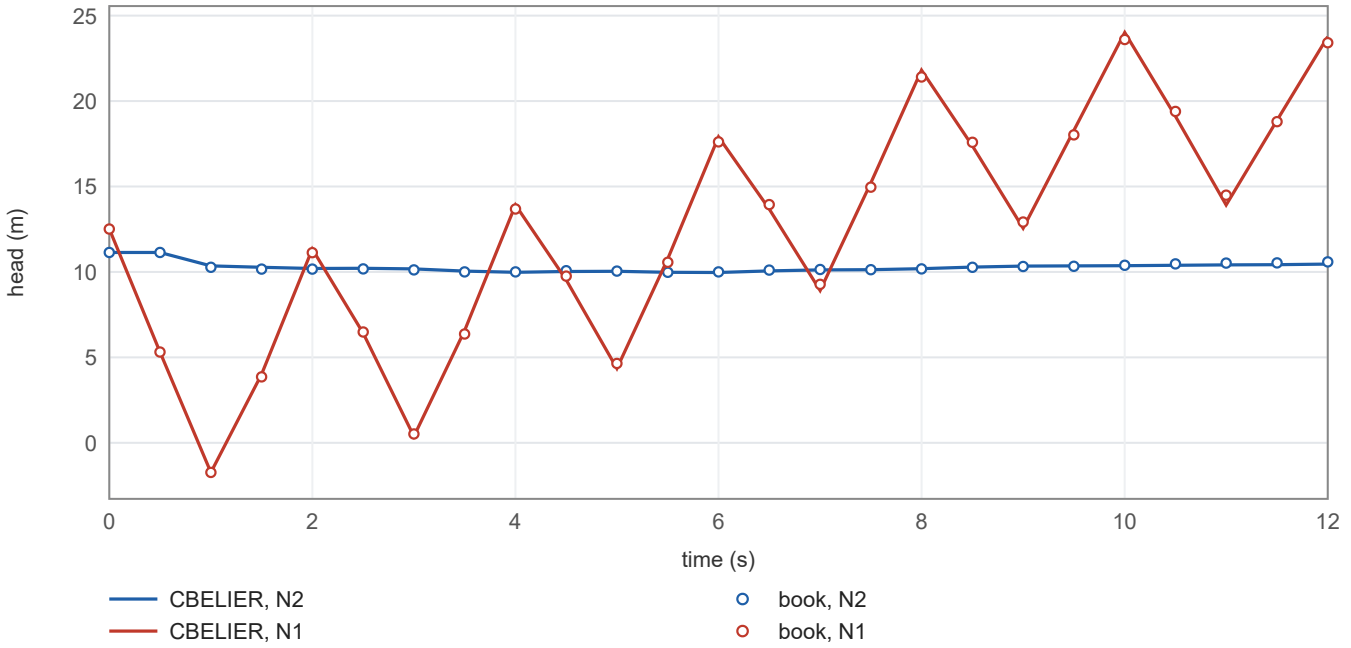


Two 610 m pipes connect a varying inflow, 16·(0.75 − 0.25·sin 0.3t) ft³/s, to a downstream reservoir, through an air valve at the high point (elevation 10.36 m). The book computes with one reach per pipe and a 0.5 s step; so does CBELIER.

3. Data and status

Data	Value	Status
Pipes: L, D, wave speed	2 × 610 m; 0.61 m; 1,219 m/s	PUBLISHED
Friction factor; initial flow	0.02; 0.34 m³/s	PUBLISHED
Air valve: elevation; inlet Cd; outlet Cd; opening	10.36 m; 0.65; 0.975; 0.02 ft²	PUBLISHED
Downstream reservoir	9.75 m	PUBLISHED
Time step; reaches per pipe	0.5 s; 1	PUBLISHED

4. Results



Heads at the air valve (N2) and upstream (N1): CBELIER (lines) and book (circles).

5. Differences

Indicator	CBELIER	Reference	Difference
Maximum head difference, air valve N2	0.13 m	—	—
Maximum head difference, upstream N1 (at peaks)	0.58 m	—	tolerance 0.6 m
Maximum air volume (20.28 ft³)	0.578 m³	0.574 m³	0.7 %
Air mass at 12 s (0.0388 slug)	0.574 kg	0.566 kg	1.4 %

The head at the air valve follows the book within 0.15 m, the upstream head within 0.6 m at the oscillation peaks; the maximum air volume and the air mass are reproduced within 2 %. The air-valve law (four-regime compressible orifice) is therefore consistent.

6. Limitations and assumptions

- Numerical validation, with a large time step (0.5 s) and one reach per pipe, like the book: this is not a design mesh.
- The book values are read from a scanned listing.