Memo

To
WANDA users

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Number of pages
4

From
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Subject
Use of the characteristic type air valve

Introduction

The goal of this memo is to explain how a characteristic type air valve can be used in WANDA. The air valve in WANDA 3.7 is extended with the possibility to use a tabulated capacity curve instead of the parameterised curve, which was available in previous versions of WANDA. Two parameters were given as input to WANDA for the parameterized curve. These two parameters were used to calculate the flow rate at a certain pressure drop over the air valve, according to an orifice-like resistance with sub- and supercritical air flows. Air valves with capacity curves similar to Figure 1 (outflow detail in figure 2) could not be modelled completely. The new air valve characterises the capacity curve in a tabular format.

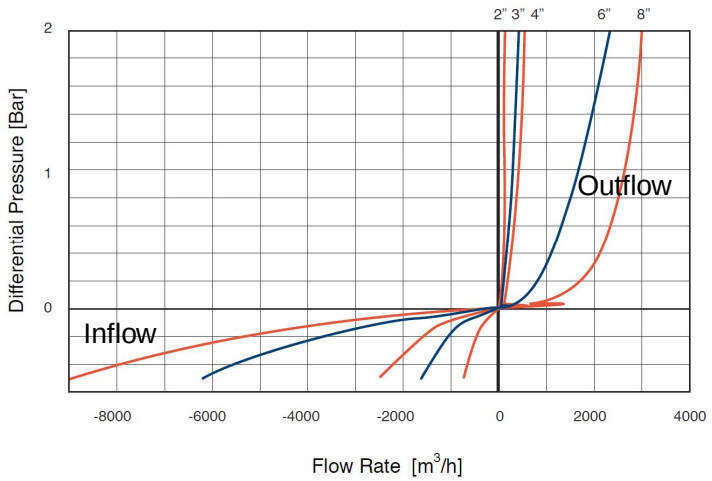

Figure 1. Capacity graph of a commercially available air valve.

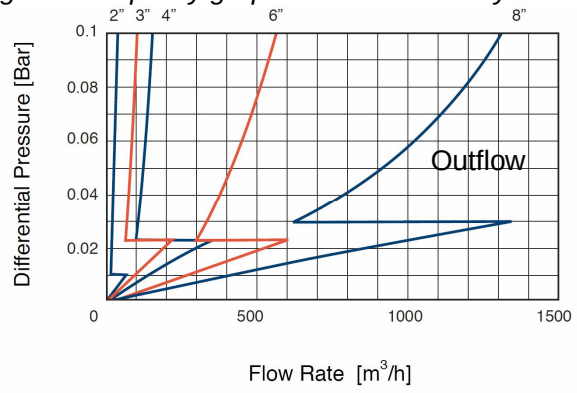

Figure 2. Close up of the outflow curve as shown in Figure 1.

How to model the air valves of figure 1.

The air valve capacity curve of Figure 1 can be easily modelled in WANDA. Figure 3 and Figure 4 show the capacity curves of the 3" air valve in WANDA. The first column in WANDA is the differential pressure and the second column is the flow rate (the axes are inverted); furthermore all ΔP values are positive. If the pressure difference exceeds the last tabulated value ($\Delta P_{last,\ in/out}$), then WANDA applies linear extrapolation based on the last two table entries. As an example, the behaviour of the 3" air valve during the start-up of a gravity line is evaluated below.

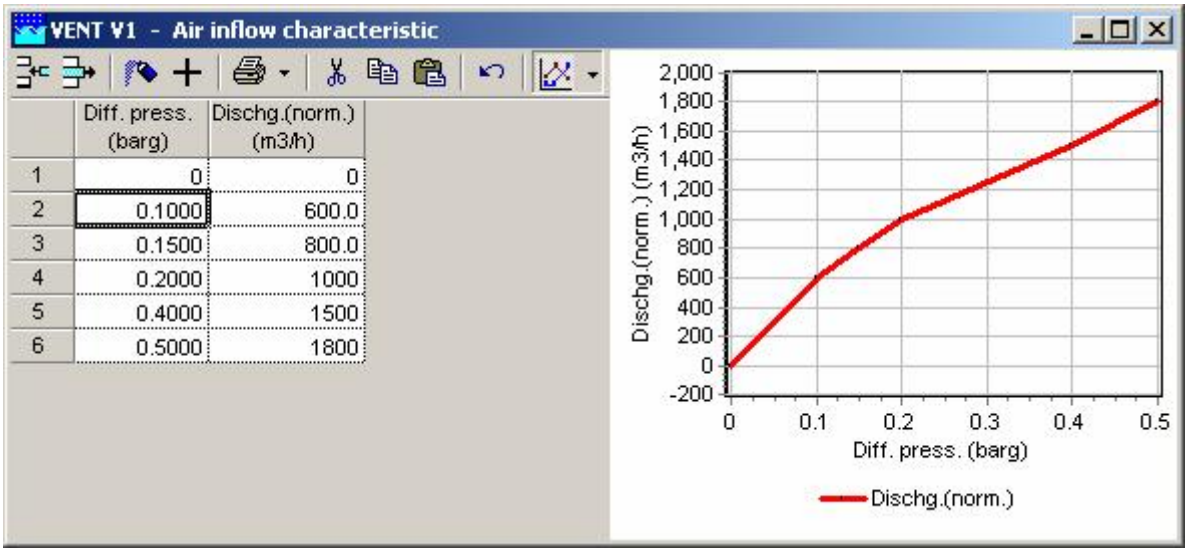

Figure 3. WANDA input table for the inflow characteristic.

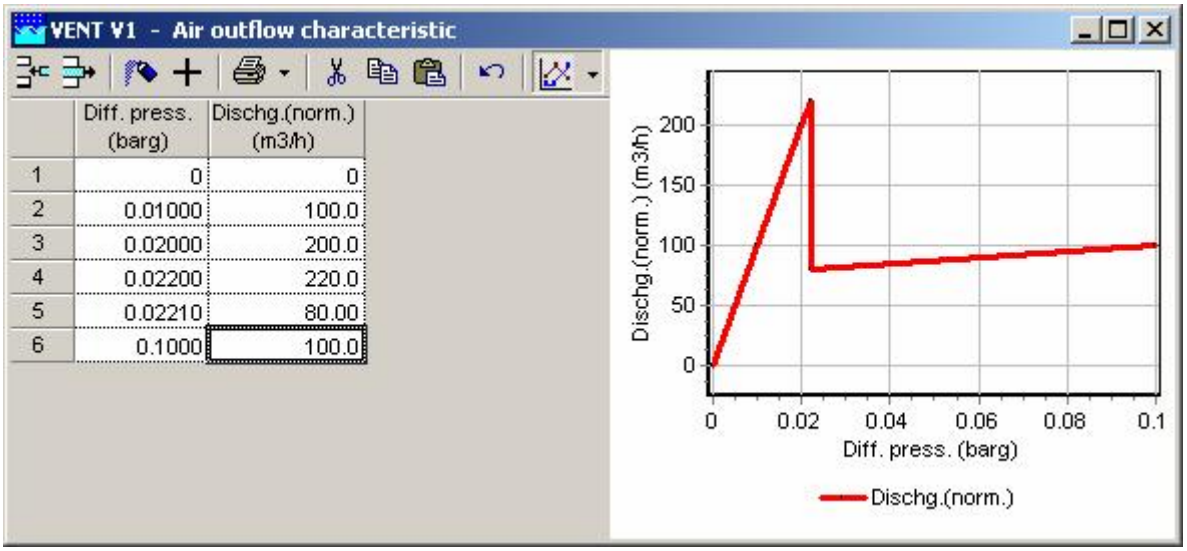

Figure 4. WANDA input table for the outflow characteristic.

Example study: Start-up of a gravity supply line

A 1000 mm pipeline with a total length of 3 km crosses a hill; see the profile in figure 6. This pipeline supplies water by gravity to the downstream reservoir. At the local high point at a chainage of 1000m, a 3-inch air valve is installed with the characteristic as shown in figure 4. The pipeline is partly drained and there is an air volume of 5 m^3 present in the pipeline at the location of the air vent. Figure 5 shows an overview of the WANDA model.

The valve is slowly opened in two stages to expel all the air out of the system. In the first stage, the valve opens 40% in 120 s and keeps this position until *t = 240 s* to expel the air from the system. Hereafter, the valve reaches the fully open position in 60 s (*t = 300 s*).

Figure 7 shows the air pressure and volume in time. The air pressure increases, which results in an increased airflow. When the pressure difference over the vent becomes greater than 0.022 bar there is a sharp decrease in airflow rate due to closure of the large float, see Figure 8 after 60 s. The air is released via the smaller orifice. After 200 s, the air valve closes and generates a mild transient.

Figure 9 shows the system velocity during the start-up operation, which stabilises during air release and increases towards the design velocity after all air has been expelled from the system.

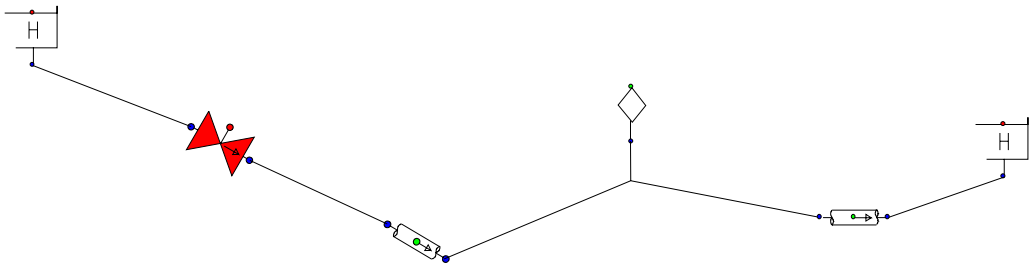

Figure 5. WANDA model for filling of a pipeline.

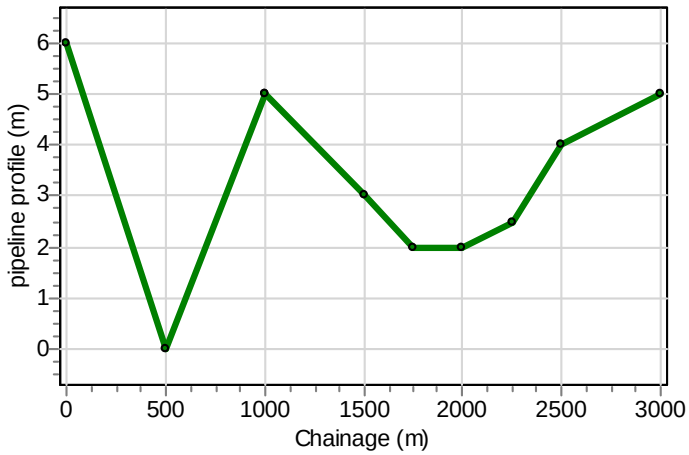

Figure 6. Profile of the pipeline of the WANDA model in Figure 5.

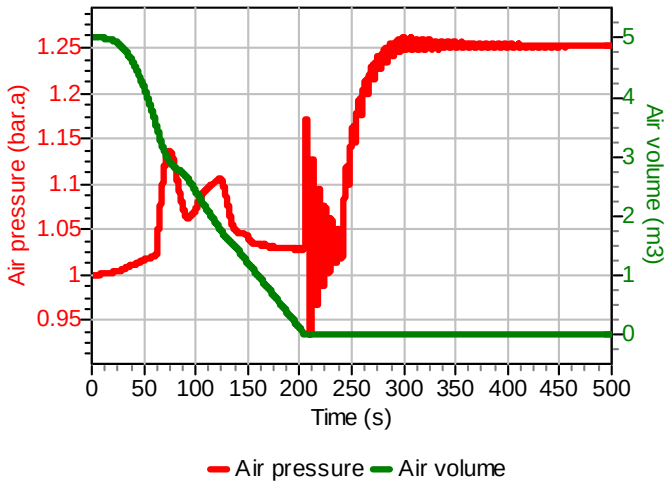

Figure 7. Air pressure and volume in time.

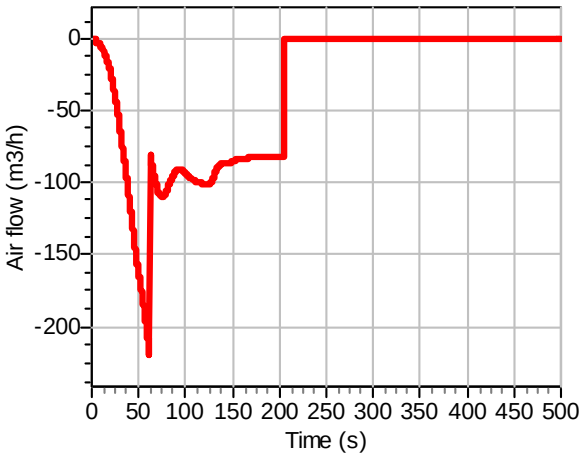

Figure 8. Airflow rate in time.

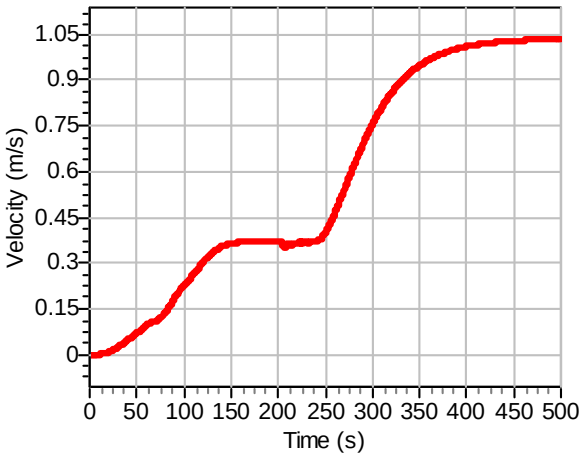

Figure 9. System velocity in time