# Tutorial 2: Steady State Flow Distribution in a Compressed Air Network

# Problem Description:

A flow circuit filled with air, as shown in Figure 4, is considered. The flow distribution in the network is required to be estimated. The geometrical details of various pipes in the circuit are given in Table 6. A constant friction factor of 0.03 shall be considered for all the pipes. Supply pressure (node 1 and node 14) is 6 bar, and delivery pressures (nodes 4, 7, 9, 10, 12, 16, 19, 20, 22, 25, 27, 28, 29) is 3 bar. A uniform temperature of 15 °C shall be assumed throughout the circuit.

Diagram, schematic

Description automatically generated

Figure 4: Schematic of Flow Circuit for Problem 3.1.2

Table 6: Geometrical Details for Problem 3.1.2

|  |  |  |
| --- | --- | --- |
| Elements | Diameter (m) | Length (m) |
| 1, 12 | 0.019 | 200 |
| 2-3, 9, 11, 13, 15, 19, 21, 24, 26 | 0.01588 | 400 |
| 4-8, 10, 14, 16-18, 20, 22-23, 25, 27-29 | 0.010 | 100 |

# Results

The nodal pressures and element flow rates predicted by the PINET code are given in Table 7 and Table 8, respectively, along with the values reported in [15]. It is seen that the values match very well. Thus, the PINET code can estimate the steady-state flow distribution in circuits with compressible fluids. Note that a pressure-pressure boundary condition is used in this problem compared to the pressure-mass flow rate boundary condition used in Problem 3.1.1. Thus, the code can handle different types of flow boundary conditions.

Table 7: Nodal Pressure (bar) Results for Problem 3.1.2

|  |  |  |  |
| --- | --- | --- | --- |
| Node no. | [15] | PINET | Deviation |
| 1 | 6.0000 | 6.0000 | 0.0000 |
| 2 | 5.2151 | 5.2150 | -0.0001 |
| 3 | 4.1131 | 4.1131 | 0.0000 |
| 5 | 3.8546 | 3.8547 | 0.0001 |
| 6 | 3.2057 | 3.2057 | 0.0000 |
| 8 | 3.0423 | 3.0423 | 0.0000 |
| 11 | 4.1131 | 4.1132 | 0.0001 |
| 13 | 5.2151 | 5.2149 | -0.0002 |
| 14 | 6.0000 | 6.0000 | 0.0000 |
| 15 | 3.9848 | 3.9848 | 0.0000 |
| 17 | 3.5975 | 3.5975 | 0.0000 |
| 18 | 3.1286 | 3.1287 | 0.0001 |
| 21 | 3.5478 | 3.5478 | 0.0000 |
| 23 | 3.5975 | 3.5975 | 0.0000 |
| 24 | 3.1286 | 3.1286 | 0.0000 |
| 26 | 3.9848 | 3.9847 | -0.0001 |

Table 8: Element Volumetric Flow Rates (g/s) for Problem 3.1.2

|  |  |  |  |
| --- | --- | --- | --- |
| Element No. | [15] | PINET | Deviation |
| 1 | 16.461 | 16.461 | 0.000 |
| 2 | 8.033 | 8.032 | -0.001 |
| 3 | 3.596 | 3.596 | 0.000 |
| 4 | 3.375 | 3.376 | 0.001 |
| 5 | 1.782 | 1.782 | 0.000 |
| 6 | 1.593 | 1.594 | 0.001 |
| 7 | 0.797 | 0.797 | 0.000 |
| 8 | 0.797 | 0.797 | 0.000 |
| 9 | -3.596 | -3.597 | -0.001 |
| 10 | 4.437 | 4.437 | 0.000 |
| 11 | -8.033 | -8.034 | -0.001 |
| 12 | 16.461 | 16.464 | 0.003 |
| 13 | 8.429 | 8.430 | 0.001 |
| 14 | 4.135 | 4.135 | 0.000 |
| 15 | -4.293 | -4.294 | -0.001 |
| 16 | 2.800 | 2.801 | 0.001 |
| 17 | 1.400 | 1.400 | 0.000 |
| 18 | 1.400 | 1.400 | 0.000 |
| 19 | -1.493 | -1.494 | -0.001 |
| 20 | 2.986 | 2.987 | 0.001 |
| 21 | 1.493 | 1.493 | 0.000 |
| 22 | 2.800 | 2.801 | 0.001 |
| 23 | 1.400 | 1.400 | 0.000 |
| 24 | 4.293 | 4.294 | 0.001 |
| 25 | 4.135 | 4.135 | 0.000 |
| 26 | 8.429 | 8.429 | 0.000 |
| 27 | 4.437 | 4.436 | -0.001 |
| 28 | 3.816 | 3.817 | 0.001 |
| 29 | 1.400 | 1.400 | 0.000 |