

Annex B. Numerical Results from ANSYS CFD Modelling

Table B.1. The pressure drops value from results of fluent simulation

| Flow rate, l/min | Flow speed, m/s | Pressure drop ΔP , Pa | | | | |
|---------------------|--------------------|-------------------------------|-------|-------|-------|-------|
| | | Pipe | BSP | JIS | DKOL | ORFS |
| 5 | 0.657 | 198 | 243 | 208 | 233 | 211 |
| 10 | 1.318 | 795 | 970 | 837 | 939 | 842 |
| 15 | 1.974 | 1777 | 2166 | 1871 | 2097 | 1878 |
| 20 | 2.600 | 3079 | 3748 | 3221 | 3633 | 3234 |
| 25 | 3.280 | 4898 | 5396 | 5084 | 5105 | 5093 |
| 30 | 3.950 | 7096 | 7520 | 7335 | 7356 | 7348 |
| 35 | 4.610 | 9661 | 10127 | 9894 | 9945 | 9911 |
| 40 | 5.291 | 12713 | 13207 | 12982 | 13033 | 12996 |
| 45 | 5.923 | 15888 | 16489 | 16232 | 16287 | 16268 |
| 50 | 6.550 | 19358 | 20088 | 19839 | 19906 | 19873 |
| 55 | 7.234 | 23587 | 24447 | 24186 | 24267 | 24226 |
| 60 | 7.890 | 28029 | 29065 | 28755 | 28860 | 28804 |
| 65 | 8.570 | 32981 | 34233 | 33925 | 34040 | 33944 |
| 70 | 9.200 | 37948 | 39384 | 39075 | 39206 | 39097 |
| 75 | 9.920 | 44074 | 45764 | 45380 | 45558 | 45430 |
| 80 | 10.550 | 49719 | 51615 | 50709 | 51441 | 51370 |
| 85 | 11.238 | 56298 | 58534 | 57508 | 58337 | 58272 |
| 90 | 11.900 | 63061 | 65596 | 64448 | 65376 | 65303 |
| 95 | 12.540 | 69990 | 72801 | 71219 | 72436 | 72476 |
| 100 | 13.250 | 78140 | 81232 | 79470 | 80647 | 79870 |

Table B.2. The resistance coefficients value from results of fluent simulation

| Flow rate, l/min | Flow speed, m/s | Resistance coefficient ζ | | | | |
|---------------------|--------------------|--------------------------------|-------|--------|--------|--------|
| | | Pipe | BSP | JIS | DKOL | ORFS |
| 5 | 0.657 | 1.054 | 1.288 | 1.103 | 1.238 | 1.119 |
| 10 | 1.318 | 1.048 | 1.278 | 1.102 | 1.237 | 1.109 |
| 15 | 1.974 | 1.043 | 1.272 | 1.098 | 1.231 | 1.102 |
| 20 | 2.600 | 1.042 | 1.268 | 1.090 | 1.229 | 1.095 |
| 25 | 3.280 | 1.041 | 1.147 | 1.081 | 1.085 | 1.083 |
| 30 | 3.950 | 1.0408 | 1.102 | 1.075 | 1.078 | 1.077 |
| 35 | 4.610 | 1.0403 | 1.091 | 1.065 | 1.070 | 1.067 |
| 40 | 5.291 | 1.039 | 1.079 | 1.061 | 1.065 | 1.062 |
| 45 | 5.923 | 1.036 | 1.075 | 1.0588 | 1.062 | 1.061 |
| 50 | 6.550 | 1.032 | 1.071 | 1.0582 | 1.0617 | 1.0599 |
| 55 | 7.234 | 1.031 | 1.069 | 1.0576 | 1.061 | 1.059 |
| 60 | 7.890 | 1.030 | 1.068 | 1.0572 | 1.060 | 1.058 |

End of Table B.2

| Flow rate, l/min | Flow speed, m/s | Resistance coefficient ζ | | | | |
|---------------------|--------------------|--------------------------------|-------|--------|--------|--------|
| | | Pipe | BSP | JIS | DKOL | ORFS |
| 65 | 8.570 | 1.027 | 1.066 | 1.057 | 1.0605 | 1.0576 |
| 70 | 9.200 | 1.025 | 1.064 | 1.056 | 1.0599 | 1.057 |
| 75 | 9.920 | 1.024 | 1.064 | 1.055 | 1.059 | 1.0564 |
| 80 | 10.550 | 1.022 | 1.061 | 1.0425 | 1.0576 | 1.056 |
| 85 | 11.238 | 1.02 | 1.060 | 1.042 | 1.057 | 1.0558 |
| 90 | 11.900 | 1.019 | 1.059 | 1.041 | 1.056 | 1.055 |
| 95 | 12.540 | 1.018 | 1.059 | 1.036 | 1.0546 | 1.054 |
| 100 | 13.250 | 1.018 | 1.058 | 1.035 | 1.054 | 1.051 |

Table B.3. The flow coefficients value from results of fluent simulation

| Flow rate, l/min | Flow speed, m/s | Flow coefficient μ | | | | |
|---------------------|--------------------|------------------------|-------|-------|-------|-------|
| | | Pipe | BSP | JIS | DKOL | ORFS |
| 5 | 0.657 | 0.9 | 0.602 | 0.821 | 0.652 | 0.798 |
| 10 | 1.318 | 0.91 | 0.612 | 0.822 | 0.653 | 0.812 |
| 15 | 1.974 | 0.918 | 0.618 | 0.828 | 0.659 | 0.822 |
| 20 | 2.6 | 0.92 | 0.621 | 0.841 | 0.661 | 0.834 |
| 25 | 3.28 | 0.921 | 0.759 | 0.855 | 0.848 | 0.852 |
| 30 | 3.95 | 0.923 | 0.822 | 0.864 | 0.859 | 0.861 |
| 35 | 4.61 | 0.924 | 0.841 | 0.881 | 0.872 | 0.878 |
| 40 | 5.291 | 0.926 | 0.858 | 0.888 | 0.881 | 0.886 |
| 45 | 5.923 | 0.931 | 0.865 | 0.892 | 0.886 | 0.888 |
| 50 | 6.55 | 0.938 | 0.871 | 0.893 | 0.887 | 0.890 |
| 55 | 7.234 | 0.94 | 0.875 | 0.894 | 0.888 | 0.891 |
| 60 | 7.89 | 0.942 | 0.876 | 0.895 | 0.888 | 0.892 |
| 65 | 8.57 | 0.947 | 0.879 | 0.895 | 0.889 | 0.894 |
| 70 | 9.2 | 0.95 | 0.882 | 0.896 | 0.89 | 0.895 |
| 75 | 9.92 | 0.952 | 0.883 | 0.898 | 0.891 | 0.896 |
| 80 | 10.55 | 0.957 | 0.888 | 0.920 | 0.894 | 0.896 |
| 85 | 11.238 | 0.961 | 0.889 | 0.921 | 0.895 | 0.897 |
| 90 | 11.9 | 0.963 | 0.890 | 0.922 | 0.896 | 0.898 |
| 95 | 12.54 | 0.964 | 0.891 | 0.931 | 0.9 | 0.899 |
| 100 | 13.25 | 0.964 | 0.892 | 0.931 | 0.9 | 0.9 |

Table B.4. The pressure drops values from results of fluent simulation (in backflow)

| Flow rate, l/min | Flow speed, m/s | Pressure drop ΔP , Pa | | | | |
|---------------------|--------------------|-------------------------------|------|------|------|------|
| | | Pipe | BSP | JIS | DKOL | ORFS |
| 5 | 0.657 | 198 | 243 | 209 | 238 | 210 |
| 10 | 1.318 | 795 | 974 | 841 | 953 | 839 |
| 15 | 1.974 | 1777 | 2182 | 1882 | 2130 | 1866 |

End of Table B.4

| Flow rate, l/min | Flow speed, m/s | Pressure drop ΔP , Pa | | | | |
|---------------------|--------------------|-------------------------------|-------|-------|-------|-------|
| | | Pipe | BSP | JIS | DKOL | ORFS |
| 20 | 2.600 | 3079 | 3760 | 3232 | 3641 | 3225 |
| 25 | 3.280 | 4898 | 5457 | 5096 | 5778 | 5075 |
| 30 | 3.950 | 7096 | 7520 | 7348 | 7399 | 7322 |
| 35 | 4.610 | 9661 | 10163 | 9905 | 10043 | 9905 |
| 40 | 5.291 | 12713 | 13253 | 13011 | 13138 | 12996 |
| 45 | 5.923 | 15888 | 16522 | 16259 | 16417 | 16259 |
| 50 | 6.550 | 19358 | 20146 | 19873 | 19974 | 19862 |
| 55 | 7.234 | 23587 | 24517 | 24226 | 24336 | 24199 |
| 60 | 7.890 | 28029 | 29149 | 28804 | 28934 | 28771 |
| 65 | 8.570 | 32981 | 34291 | 33963 | 34097 | 33925 |
| 70 | 9.200 | 37948 | 39451 | 39119 | 39206 | 39075 |
| 75 | 9.920 | 44074 | 45841 | 45456 | 45558 | 45380 |
| 80 | 10.550 | 49719 | 51790 | 51586 | 51470 | 51270 |
| 85 | 11.238 | 56298 | 58699 | 58142 | 58337 | 58014 |
| 90 | 11.900 | 63061 | 65707 | 64800 | 65376 | 64764 |
| 95 | 12.540 | 69990 | 72882 | 71566 | 72557 | 71527 |
| 100 | 13.250 | 78140 | 81323 | 79770 | 80983 | 79770 |

Table B.5. The resistance coefficients value from results of fluent simulation (in back-flow)

| Flow rate, l/min | Flow speed, m/s | Resistance coefficient ζ | | | | |
|---------------------|--------------------|--------------------------------|-------|--------|--------|--------|
| | | Pipe | BSP | JIS | DKOL | ORFS |
| 5 | 0.657 | 1.054 | 1.292 | 1.110 | 1.266 | 1.111 |
| 10 | 1.318 | 1.048 | 1.283 | 1.108 | 1.255 | 1.106 |
| 15 | 1.974 | 1.043 | 1.281 | 1.105 | 1.250 | 1.096 |
| 20 | 2.600 | 1.042 | 1.273 | 1.094 | 1.232 | 1.091 |
| 25 | 3.280 | 1.041 | 1.160 | 1.084 | 1.229 | 1.079 |
| 30 | 3.950 | 1.0408 | 1.102 | 1.077 | 1.085 | 1.073 |
| 35 | 4.610 | 1.0403 | 1.094 | 1.066 | 1.081 | 1.066 |
| 40 | 5.291 | 1.039 | 1.083 | 1.063 | 1.073 | 1.062 |
| 45 | 5.923 | 1.036 | 1.077 | 1.060 | 1.070 | 1.060 |
| 50 | 6.550 | 1.032 | 1.074 | 1.0599 | 1.065 | 1.059 |
| 55 | 7.234 | 1.031 | 1.072 | 1.059 | 1.064 | 1.058 |
| 60 | 7.890 | 1.030 | 1.071 | 1.058 | 1.063 | 1.0576 |
| 65 | 8.570 | 1.027 | 1.068 | 1.058 | 1.062 | 1.057 |
| 70 | 9.200 | 1.025 | 1.066 | 1.057 | 1.0599 | 1.056 |
| 75 | 9.920 | 1.024 | 1.066 | 1.057 | 1.059 | 1.055 |
| 80 | 10.550 | 1.022 | 1.064 | 1.060 | 1.058 | 1.054 |

End of Table B.5

| Flow rate, l/min | Flow speed, m/s | Resistance coefficient ζ | | | | |
|---------------------|--------------------|--------------------------------|-------|-------|--------|-------|
| | | Pipe | BSP | JIS | DKOL | ORFS |
| 85 | 11.238 | 1.02 | 1.063 | 1.053 | 1.057 | 1.051 |
| 90 | 11.900 | 1.019 | 1.061 | 1.047 | 1.056 | 1.046 |
| 95 | 12.540 | 1.018 | 1.060 | 1.041 | 1.0558 | 1.040 |
| 100 | 13.250 | 1.018 | 1.059 | 1.039 | 1.055 | 1.039 |

Table B.6. The flow coefficients value from results of fluent simulation (in backflow)

| Flow rate, l/min | Flow speed, m/s | Flow coefficient μ | | | | |
|---------------------|--------------------|------------------------|-------|-------|-------|-------|
| | | Pipe | BSP | JIS | DKOL | ORFS |
| 5 | 0.657 | 0.9 | 0.599 | 0.811 | 0.623 | 0.809 |
| 10 | 1.318 | 0.91 | 0.607 | 0.814 | 0.634 | 0.817 |
| 15 | 1.974 | 0.918 | 0.609 | 0.818 | 0.639 | 0.832 |
| 20 | 2.6 | 0.92 | 0.617 | 0.835 | 0.658 | 0.839 |
| 25 | 3.28 | 0.921 | 0.742 | 0.851 | 0.662 | 0.858 |
| 30 | 3.95 | 0.923 | 0.822 | 0.861 | 0.849 | 0.867 |
| 35 | 4.61 | 0.924 | 0.835 | 0.879 | 0.855 | 0.879 |
| 40 | 5.291 | 0.926 | 0.852 | 0.884 | 0.867 | 0.886 |
| 45 | 5.923 | 0.931 | 0.861 | 0.889 | 0.872 | 0.889 |
| 50 | 6.55 | 0.938 | 0.866 | 0.890 | 0.881 | 0.891 |
| 55 | 7.234 | 0.94 | 0.870 | 0.891 | 0.883 | 0.893 |
| 60 | 7.89 | 0.942 | 0.871 | 0.892 | 0.884 | 0.894 |
| 65 | 8.57 | 0.947 | 0.876 | 0.893 | 0.886 | 0.895 |
| 70 | 9.2 | 0.95 | 0.879 | 0.894 | 0.890 | 0.896 |
| 75 | 9.92 | 0.952 | 0.880 | 0.895 | 0.891 | 0.898 |
| 80 | 10.55 | 0.957 | 0.882 | 0.899 | 0.893 | 0.900 |
| 85 | 11.238 | 0.961 | 0.884 | 0.901 | 0.895 | 0.905 |
| 90 | 11.9 | 0.963 | 0.887 | 0.912 | 0.896 | 0.913 |
| 95 | 12.54 | 0.964 | 0.889 | 0.922 | 0.897 | 0.923 |
| 100 | 13.25 | 0.964 | 0.890 | 0.925 | 0.897 | 0.925 |