KARALIT
Simplicity without compromise

KARALIT CFD VALIDATION: REMOSA

REMOSA

A validation study of KARALIT CFD has been carried out on a pipe line in which a system of valves has been set. The available data for comparison is provided by a company operating in the Oil&Gas sector and it is given in terms of the pressure drop through the pipe line. More comprehensive and detailed information can be found in [1]. The line is an assembly of a total of three valves: one FlueGas valve and two Butterfly valves. The model's geometry is shown in Figure 1 together with the grid inside the Butterfly valve.

Figure 1: Pipe line model geometry; grid inside the Butterfly valve

SIMULATION PARAMETERS:

- Steady state 3D simulation
- Viscous turbulent flow
- Internal Flow App
- Number of cells in the computational domain: about 5 millions
- Spalart-Allmaras turbulence model
- 50 m/s velocity inlet
- Re = 2.8 x 10^6 based on the inlet diameter
- Grid resolution: a posteriori was estimated that y+ at the first grid node is in the range of [1:290]
- Numerics: implicit scheme, 2nd order symmetric TVD discretization scheme, CFL = 10
- Boundary conditions:
  - Mass flow rate boundary condition at the pipe inlet
  - Pressure outlet boundary condition at the pipe outlet
  - No slip conditions on the assembly's walls

Figures 2 and 3 show the normalized z-momentum residual's convergence history and the convergence history of average relative pressure inside the pipe line, respectively.
The value of the pressure drop expected when using a semi-empirical formulae is of about 125 [kPa]. As it can be seen in Figure 3 the calculated pressure drop is of 129 [kPa].

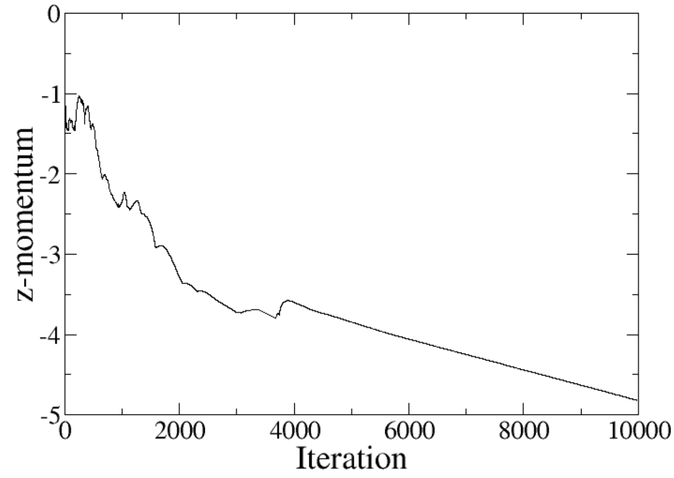

Figure 2: normalized z-momentum residual's convergence history

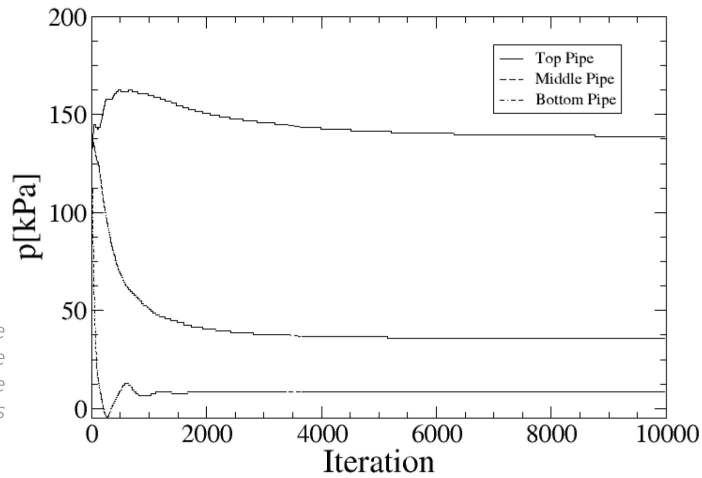

Figure 3: convergence history of average relative pressure inside the three pipes

Figure 4 shows the pressure distribution along the centerline of the pipe. Pressure seems to reach a plateau inside the middle pipe of the configuration. An ordered behavior of the fluid inside the pipe results into a smooth pressure distribution.

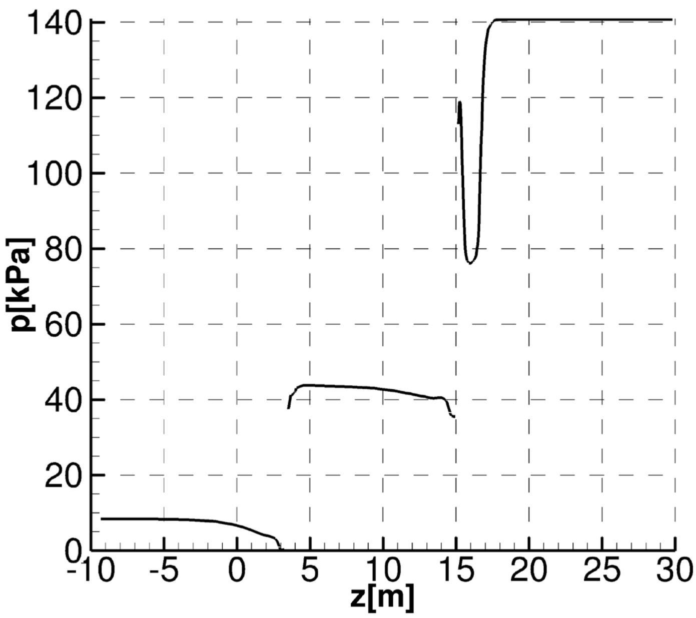

Figure 4: relative pressure along the valve line's axis

Figure 5 provides a three-dimensional visualization of the flow's pattern inside the pipe line. Figure 6 shows contour plots of velocity magnitude and pressure.

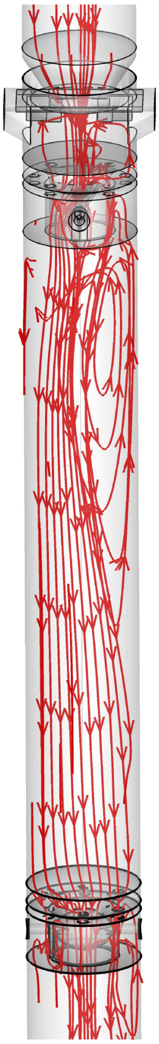

Figure 5: Streamlines inside the valve line

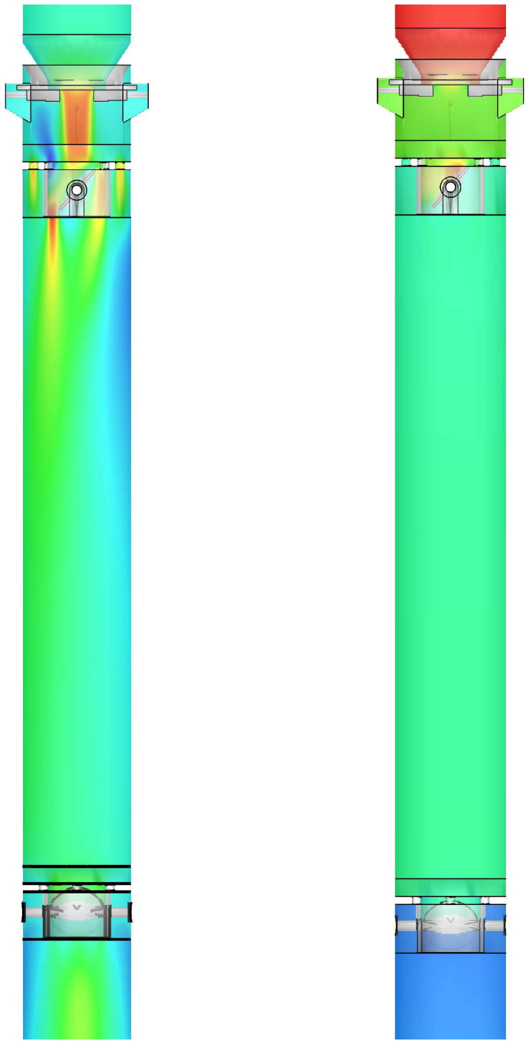

Figure 6: Velocity magnitude contour plot; pressure contourplot

Figure 7 shows the flow's streamlines on two orthogonal meridian planes and on a cross section along the pipe taken at the position where a vortex system is located.
The existence of two stationary vortexes can be noticed.
Their combined action results into the creation of a fluid nozzle whose throat section forces the fluid to accelerate in the first part of the pipe and then to recover its original pressure level in the diverging part of the fluid nozzle. Flow patterns on the cross section A-A shown on the right hand side of Figure 7, suggest the absence of vorticity on planes orthogonal to the pipe axis. This is an indication of a well established and ordered flow regime.

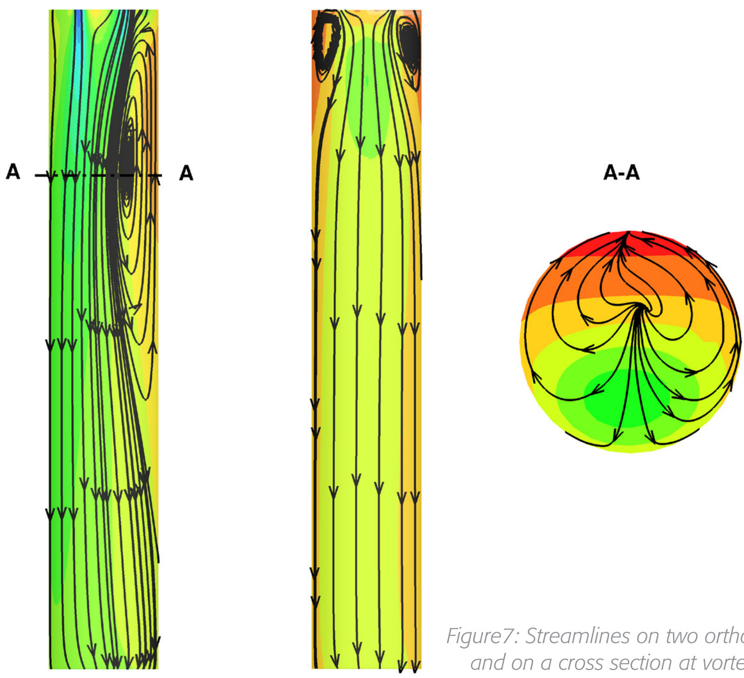

Figure7: Streamlines on two orthogonal meridian planes and on a cross section at vortex center along the pipe

CONCLUSIONS

The calculations undertaken with the KARALIT CFD code using the Immersed Mesh technique predict a correct pressure drop value when compared against available data.

Predictions obtained with the KARALIT CFD code demonstrate the degree of understanding that can be made available to users with minimum setup for quite challenging flow-field scenarios.

The calculations can be extended invoking different turbulence models in future efforts toward this validation.

REFERENCES

1. Marco Mulas, Marco Talice, Annabella N. Grozescu, A Hybrid Immersed Boundary CFD Approach to Oil & Gas Applications, in Proceedings of the ASME Turbo Expo 2013, June 03-07, 2013, San Antonio, Tx, USA.

2. Courtesy of Remosa, an IMI plc company.

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