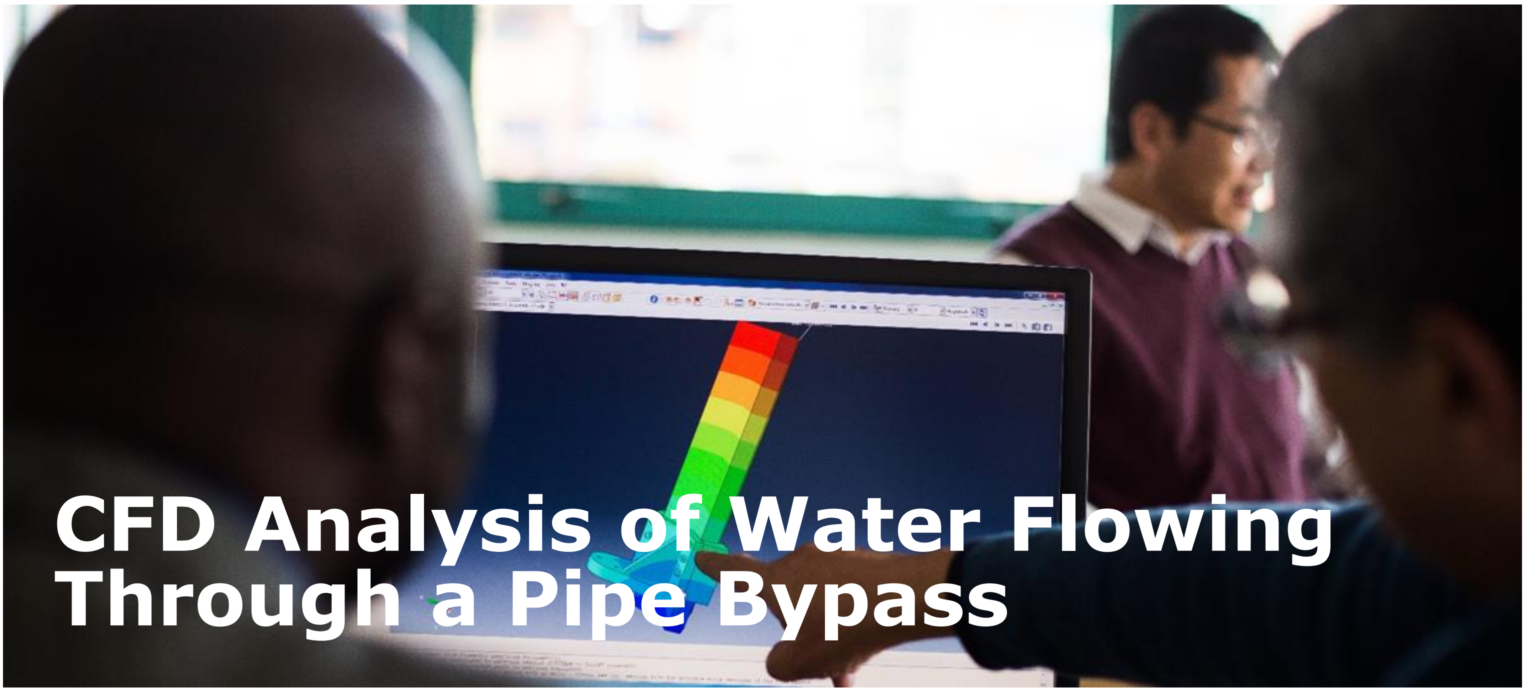

CFD Analysis of Water Flowing Through a Pipe Bypass

Case study

EASL was selected by the client to perform a computational fluid dynamics (CFD) analysis of water flow in a pipe. The analysis was conducted to observe the behaviour of the fluid present in certain sections of the pipework, named the dead-legs. These are the sections of the pipe that effectively become dead ends for the flow after the closing of the primary valve. It was required to know if and when all the water remaining in the dead-legs joins the flow. Our CFD experts were able to tackle this problem following a thorough analysis of a fluid simulation, creating visual representations of the flow such as contours of velocity, pressure, and turbulent kinetic energy, as well as tracking particles to capture the flow of the fluid through the dead-legs.

Our approach

A transient model was set up to be initially flooded with water at a specified temperature, with the boundary conditions of the model designated as the pipe walls, the inlet, the outlet, and the fluid domain contained in the pipe. A calculated Reynolds number of the flow suggested the presence of turbulence, therefore it was important to select the most appropriate turbulence model. The k-ω SST (shear stress transport) model is a two-equation model (turbulent kinetic energy and dissipation) with adequate convergence and low memory requirements. With similarities to the popular k-ε model but with improved accuracy for internal flows, the k-ω SST model was selected for this analysis.

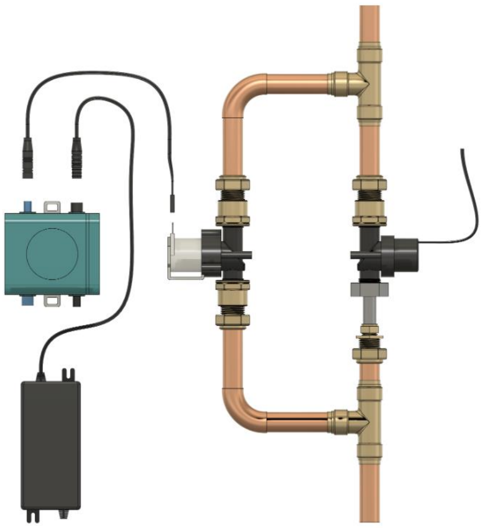

Figure 1 Prototype of the bypass configuration. Closure of the primary valve (in black) on the right will create the dead-legs. The solenoid valve on the left will then open and will allow water flow to be diverted through the bypass.

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The outcome

EASL developed a methodology in scrutinising effectively a transient fluid flow. Using analysis software a whole array of parameters were extracted over a prolonged period of time, thus allowing the means to assist the client in making an informed decision on whether to go ahead with the prototype design.

Contours of velocity magnitude illustrated how the geometry and junctions of the pipe affected the overall speed of the fluid and the areas which were lacking in significant flow. Contours of turbulent kinetic energy (the energy associated with the reverse current generated within a turbulent flow regime) indicated where significant eddies in turbulent flow occurred.

Tracking particles in the model provided the ability to capture the nature of the flow over time. This was most helpful in determining the time at which the contents of each dead-leg were replaced with fresh water. Particles were injected at the face of each dead-leg. The time elapsed between when the particles were injected and then joined the main flow represented the time at which each dead-leg emptied. This was a key parameter for the client in deciding on whether to install the pipe bypass into the pipework system.

Through the extensive use of CFD software, EASL provided a clear, visual demonstration of the water flow in the proposed pipework configuration.

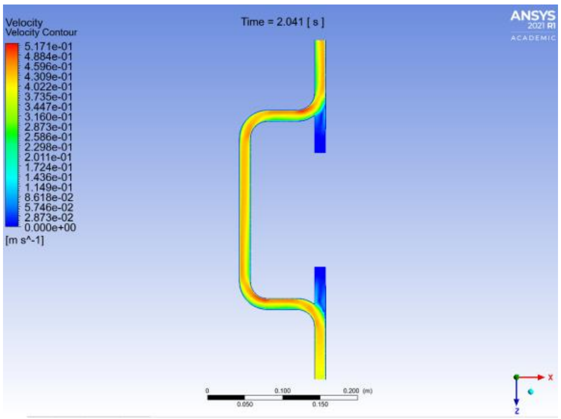

Figure 2 Contour of velocity magnitude.

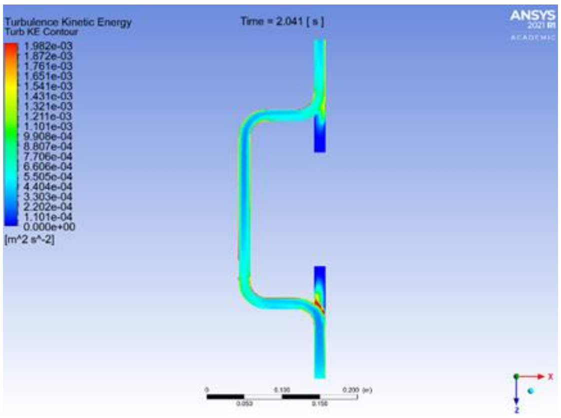

Figure 3 Contour of turbulent kinetic energy.

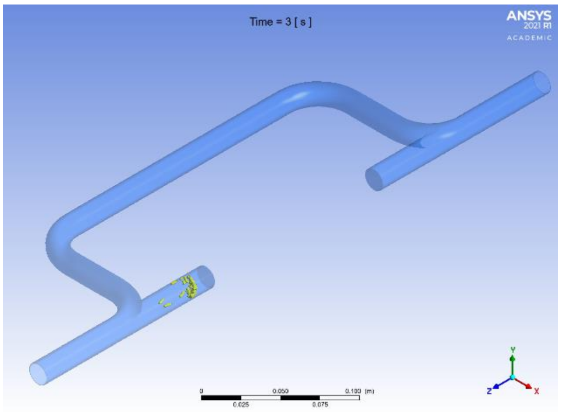

Figure 4 Single frame from particle track animation.

Other applications

EASL always work with clients to identify cost effective solutions to a wide range of operational challenges.

Why not see if EASL can help you? Give us a call.

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