Prediction of flowmeter performances, installed in industrial environment, by CFD simulation

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The control of flow rates is a major concern for the operational and security of many industrial processes and especially in power plants. That's why there are a multitude of measurement devices, based on different physical principles, from basic technologies as differential pressure meters (square-edged orifice, Venturi) to more advanced as electromagnetic, Coriolis or ultrasonic flowmeters. The use of these devices is often supported by international standards and completed by R&D investigations to evaluate performances and adaptabilities in the real environment. These studies are based, when possible, on a combination of experimental and numerical approach with the use of 3D CFD simulations (Computational Fluid Dynamics). However, in many cases, it is very difficult to access experimental data which would result from the real configuration or of scale model of this one, making the numerical results essential.

EDF R&D investigates how to best estimate the metrological behavior of a flowmeter device when no experimental data are available. EDF R&D chose to use CFD simulations performed with an open-source CFD package *Code\_Saturne* to test and predict the metrological performances of a flow meter installed in real conditions. This study is carrying out on an invasive multi-path ultrasonic flow meter where physics measurement principle can be easily simulated with CFD post processing software. This investigation include identification and quantification of main uncertainty sources. Three uncertainty groups are studied, first about numerical parameters as mesh refinement, turbulence models (k-eps, k-omega, Rij, EBRSM). Second group concerns the physical parameters as flow conditions (Reynolds number, the inlet profile, and density of the fluid) and the geometric details (presence or absence of ultrasonic sensors in the pipe, wall roughness). Finally, user’s choices as CFD and post-processing softwares.

The combination of these parameters leads to the realization of ambitious design of experiments including 70 runs, covering the maximum source of uncertainty. Following this investigation EDF will have a new database to estimate the reachable metrological performances of the device, taking into account as much as possible the real conditions.