Simulation, optimal management and infrastructure planning of gas transmission networks

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In this talk we plan to present the results of an ongoing collaboration with a Spanish company in the gas industry, for which we have developed a software, GANESO, that simulates and optimizes gas transmission networks. A gas transmission network consists basically of emission and consumption points, compressors and valves that are connected via pipes. The natural gas flows along the pipes, but the friction with the walls of the pipes decreases the pressure of the gas. At the demand points, the gas has to be delivered with a certain pressure, so it is necessary to counterbalance the pressure loss in the pipes using compressor stations. Yet, compressor stations operate consuming part of the gas that flows through the pipes, so it is important to manage the gas network in an efficient way to minimize such consumption.

In order to tackle this problem in the steady-state setting, the methodology we have followed consists of implementing a slight variation of the standard sequential linear programming algorithms that can easily accommodate integer variables, combined with a control theory approach. Further, we have developed a simulator for the transient case, based on well-balanced finite volume methods for general flows and finite element methods for isothermal models. It is worth mentioning that we have also recently added two new features to GANESO in order to deal with energy coupling issues. On the one hand, GANESO was extended to be able to manage heterogeneous gas mixtures in the same network, including Hydrogen-rich mixtures. On the other hand, in order to integrate gas and electricity energy systems, a new simulation/optimization framework was developed for assessing the interdependency of both networks guaranteeing the security of supply of the whole system. In our collaboration we have also studied other related problems to gas networks, such as the allocation of gas losses, the infrastructure planning under uncertainty and the computation of tariffs for networks access according to the different methodologies proposed in EU directives. The developed software, along with the support and consulting analysis provided by the research group, has allowed the company to improve its strategic positioning in the gas sector.