Development of a compressor model for gas network simulation

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Problem background

Oil and gas flowing out of a reservoir enter a production network of pipelines, compressors, pumps and other equipment which brings the gas and oil to their right destinations. This network flow is modelled in network simulators. The flow through these network elements can be modelled in various ways, depending on the physics and the detail that is required. For pipelines we can use e.g. algebraic pressure drop models for simple approximations, or the one-dimensional Euler equations for transient behaviour and for more detail.

Also for compressor models simple algebraic relations are available relating the flow rate through the compressor to the pressure drop over the compressor, but in reality a compressor is a complex piece of equipment with various constraints on its operation, and these need to be taken into account as well. In the model such operational constraints can be modelled as mathematical inequalities, but this may lead to impractical models for network simulation. On the other extreme there are the three-dimensional computational fluid dynamics (CFD) models which aim to model the complete flow field in the compressor, but such models are too time-consuming to be used in network solvers. Furthermore, there are several types of compressors, of which centrifugal compressors and reciprocating compressors are the most important, and compressors may have multiple stages.

Assignment

The assignment is to search for a robust model for a one-stage centrifugal compressor for use in network simulations. A typical situation it should solve is: given the inlet pressure, temperature and fluid properties, and the outlet pressure, what is the outflow temperature, the mass rate and the power required. This assignment typically will start with a literature study to see what models there are. From this one model will be chosen and will be demonstrated in a simple network case. The assignment consists of the following parts:

1. Literature study.
2. Analysis of the compressor models, and their appropriateness for network simulations.
3. Setting up and testing the resulting numerical model.
4. Writing the thesis.