EuroTeQ Collider 2022

Theme: Optimization of power production at gas pressure reduction facilities

Introduction

Companies try to optimize their production processes. Amongst others, this can be achieved by applying new innovative technologies, or by finding ways how to increase utilization of the existing machinery park.
This also holds true for energy companies, and even more in the current market situation of very high electricity prices. By producing (more) electricity in an environmentally friendly way, can improve the results of the company, but also help the Czech Republic to improve its primary fuel mix for the purpose of electricity production by replacing coal by other low carbon alternative production methods.

Who is behind this initiative?

GasNet is the operator of the largest gas distribution network in the Czech Republic. It provides reliable and secure natural gas supplies for more than 2.3 million customers. GasNet has a roughly 80% share in the distribution of natural gas in the Czech Republic and manages 65,000 kilometers of gas pipelines in almost all regions of the Czech Republic.
The company's primary focus, in addition to reliably and safely delivering energy to 2.3 million customers, is to support the Czech Republic's decarbonization goals. These goals include the replacement of lignite for heat and power production by natural gas and biomethane in a first phase till 2030 to 2038. In phase 2, the goal of reaching net zero carbon emissions by 2050 by replacing natural gas by hydrogen and by eliminating emissions in GasNet's own operations shall be achieved. To successfully manage this unprecedent transformation process, GasNet will intensely invest not only into the renewal and retrofit of its network, but also into new advanced technologies and new work approaches.

What is the challenge to optimize power production at pressure reduction stations?

GasNet operates more than 3000 pressure reduction stations which make sure that the gas flow between the entry point of the (natural) gas into the system on one hand, and the off-take points of 2.3 million customers on the other hand, occurs at the right pressure level and makes sure that sufficient gas is being distributed reliably 24*7 to all customers. The pressure reduction at gas pressure reduction stations can be assured by different valve technologies.
At the largest pressure stations, it makes sense to use the pressure differential between the inbound and outbound flow into and from the station for electricity production. For this purpose, GasNet has developed a specific expansion unit which drives a generator. The expansion unit is being operated in combination with a cogeneration unit to assure the necessary preheating of the gas, and to produce additional volumes of electricity.

The amount of electricity produced depends on the gas flow through the pressure reduction station. The gas flow fluctuates usually in the course of night and day. On top of that, there is a strong seasonal profile, with higher gas flow in winter when customers use the gas for heating purposes, compared to the gas flow in the summer.

Consequently, the gas expansion unit as well as the closely connected cogeneration unit operate in winter almost without interruption, in spring and autumn mainly over the day. For a couple of stations, the cogeneration units cannot be operated in summer at all, as the gas flow is too low.
Logically, GasNet tries to optimize the production by producing electricity when the daily electricity prices are at its maximum.

GasNet is looking for a technical solution which increases the number of operating hours of the cogeneration unit, and thus to increase their utilization, mainly in the period from spring to autumn.
Alternatively, students are asked to develop alternative set-ups, for example by combining expansion units with steam engines and steam turbines, instead of the current solution combining expansion unit with cogeneration units.

Interested student teams are asked to engage in the above area by

- By providing a description of the proposal, especially in terms of the technologies applied
- Provide calculations on fuel inputs, energy output, operating hours, energy efficiencies
- Provide the methodology to calculate specific margins per MWh produced, to provide a methodology for an overall business case, and where possible to estimate or quantify financial and non-financial input and output factors.
- Provide an assessment of the proposed solution against other solutions which have been discussed.

Relevant considerations for the challenge / theme:
Be open minded in terms of potential technologies applied.
Provide a profound argumentation line, in favor or disregard the proposed solution.
Students are asked to sign a NDA prior to the start of its work.