Zero Emission Gas Expansion (ZEGEX+) - with excess energy production

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Danish Gas Technology Centre (DGC) has carried out two feasibility projects to clarify the possibilities of installing gas expanders at M/R-stations (Measuring and Regulating) in the transmission and distribution systems of the natural gas grid. The novelty of these projects was the idea of using a heat pump to perform the necessary heating of the gas before the expander, and to "export" to the electricity grid the remaining electricity from the generator connected to the expander.

An earlier project (2007-2008) clarified the possibilities of installing gas expanders at M/R-stations in the transmission system of the Danish natural gas grid where the pressure is reduced from 80 bar to 40 or 20 bar, respectively. A large number of such expanders are installed around the world with different sources of the necessary heating before the expanders. In this case the idea was to use a heat pump for this purpose.

In the latest project (2009-2010) Danish Gas Technology Centre is carrying out a feasibility project to clarify the possibilities of installing gas expanders in the distribution system where the pressure is reduced from 40 or 20 bar to 4 bar. Again, a heat pump is anticipated to perform the necessary heating of the gas before the expander. The preliminary project (year1 of the project) investigated whether components for such smaller systems can be found, and it investigated prices for different quantities. A technical feasibility study was carried out, as were preliminary calculations of payback times.

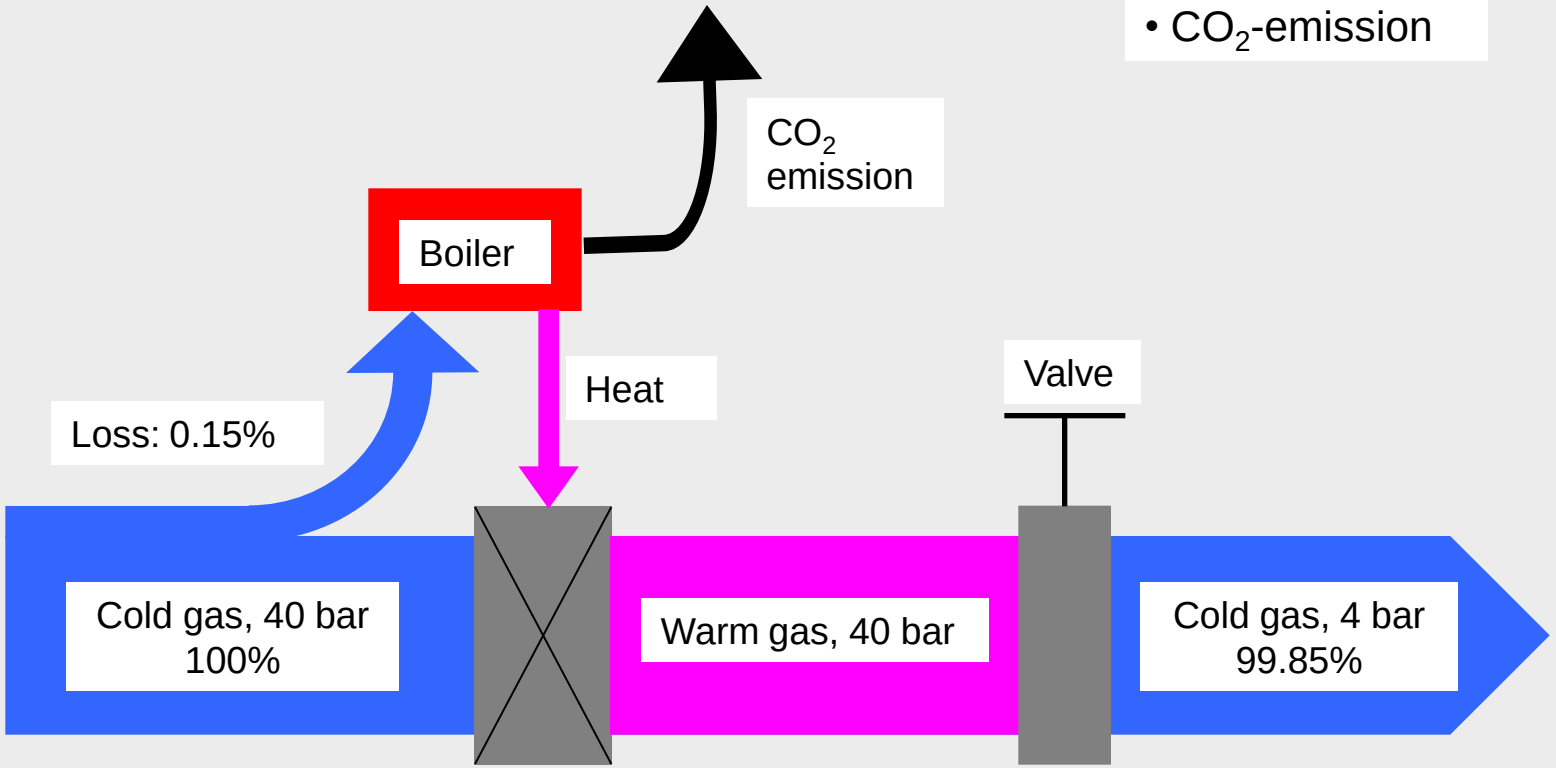
This technology has a large potential of CO_2-reduction both in the high-pressure and the low-pressure systems, based on saving of natural gas combustion and on new electricity production displacing existing production without any use of primary energy.

The main results and conclusions of the two projects are:

- A heat pump is able to produce the necessary heating before the expander using ¼ to ½ of the electricity produced by the generator connected to the expander.
- There are component suppliers for expander systems suitable to the size of distribution network M/R stations as well as for the transmission system stations. The power range is from 5 kW to 1 MW electricity.
- Pressure regulators provided at the Danish distribution stations (low pressure) are laid out with significant overcapacity, enabling a simplified installation of the expander systems.
- If the system were rolled out across the total Danish natural gas grid, the realistic saving potential would be approx 5 million m^3 of gas per year and a net production of almost 80 GWh of electricity.
- This corresponds to about 0.12% of the natural gas consumption and 0.22% of the electricity consumption in Denmark, respectively.
- The CO_2 savings would be in the order of $80 \cdot 10^3$ tons/year. This corresponds to about 0.13% of the total Danish emission, but compared to the natural gas based CO_2-emission it would be about 1%.
- The realistic potential, which includes the most suitable M/R-stations, accounts for approx 35 to 40% of the technical potential.
- The payback time for the ZEGEX+ system was found to be about 6-7 years as an average for both high-pressure and low-pressure systems. The best stations have payback time down to about 3 years. All based on a feed-in tariff of 8 €c/kWh for electricity exported to the grid and on internal price of natural gas.

Present M/R station
with boiler heating

Net result:
- 0.15% gas loss
- CO_2-emission



New/changed M/R station
with gas expander and heat pump

Net result:
- Heat from surroundings
- Electricity sold to grid
- Reduction of CO_2
- No gas loss