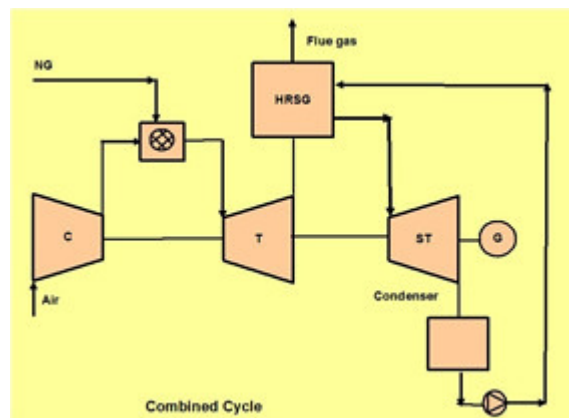


KEMA -SPENCE® for simulation of processes for energy conversion and electricity production.

KEMA has developed a software package called SPENCE® for simulation of processes for energy conversion and electricity production. SPENCE® is intended to support thermodynamic and chemical engineers employed within electricity companies or industry.

SPENCE® supports are used in:

- system and feasibility studies
- basic design
- design reviews
- process optimization
- upgrading and re-powering
- exergy analyses
- technical and functional specifications
- development of on-line conditioning monitoring modules.



SPENCE® is a static flow sheet simulator based on thermodynamics to determine the technical data and merits of energy conversion systems, including:

- efficiency
- environmental impact
- cost/benefits.

Developed in 1982, the program has been continuously improved during 25 years of research activities in improving the processes of electricity production.

The program is extremely flexible, missing equipment can easily be added to calculations. In design calculation with the program the design values can be stored and used again in part load calculation. Results are presented in tables and in graphs. Also, the process data can be exported to the graphical interface GRASP, which allows plotting flow sheets on large plotters.

In the program, libraries are included for gases, water, steam, fuels and solids. For water-steam the Industrial Standard IAPWS-IF97 for the thermodynamic properties and supplementary equations for other properties are applied. For gases non-linear behavior can be considered.

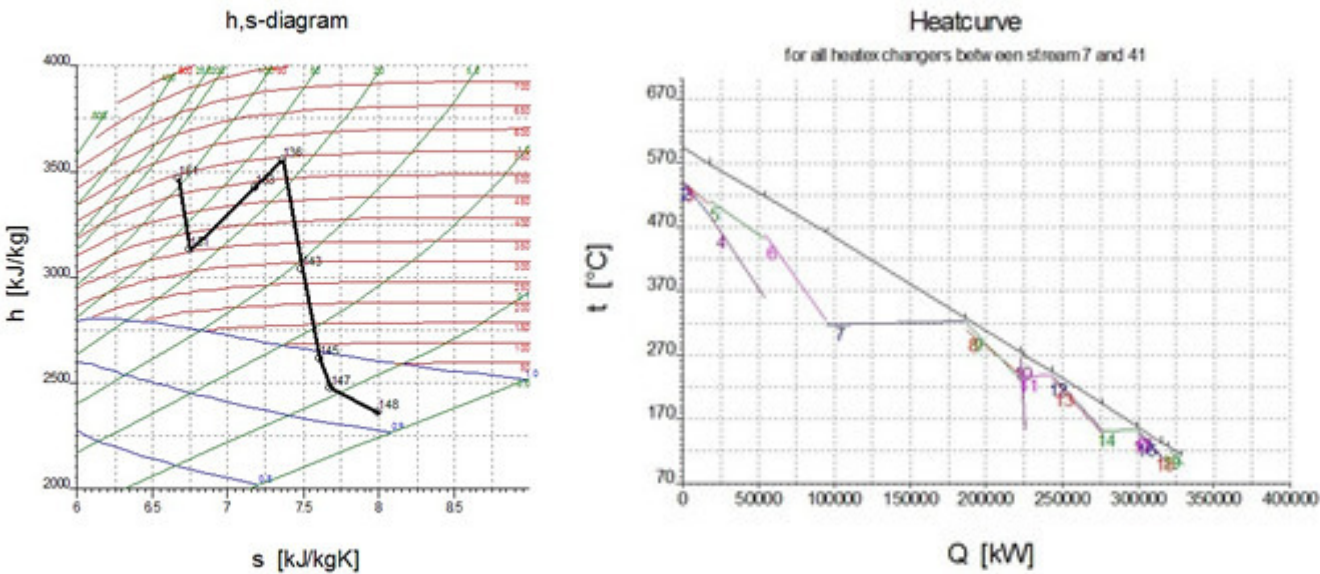
Program for optimization of energy conversion processes

With the program several system studies have been carried out, such as the impact of CO2 capture in existing power plants like IGCC, PC and NGCC. In the UPSWING project, funded by EC, the integration of municipal waste incineration in existing PC boilers has been carried out.

In the NextGenBioWaste project, also funded by EC, several studies to improve the efficiency of Waste to Energy (WtE) plants have been carried out, for example applying increased steam parameters, reducing oxygen content, integration of steam cycle of WtE plant with steam cycle of combined cycle plant, applying dry ash removal and analysis to predict location of air in-leakage.

With SPENCE® the cold end system of power plants can also be analyzed. The influence of changing cooling water conditions has been determined for several power plants.

With SPENCE® detailed tailor-made models of HRSG have been constructed to verify the given guarantee values for HP and LP steam production. In that case the non-homogenous flue gas temperatures between each heat exchanger section will be taken into account.



Other examples of application are coal firing and gasification, gas turbine combined cycles, feasibility studies, design reviews and other applications such as combined cycles with desalination.

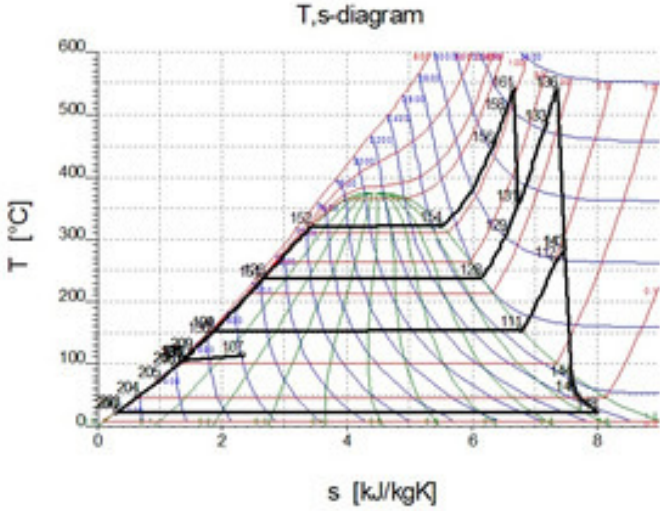
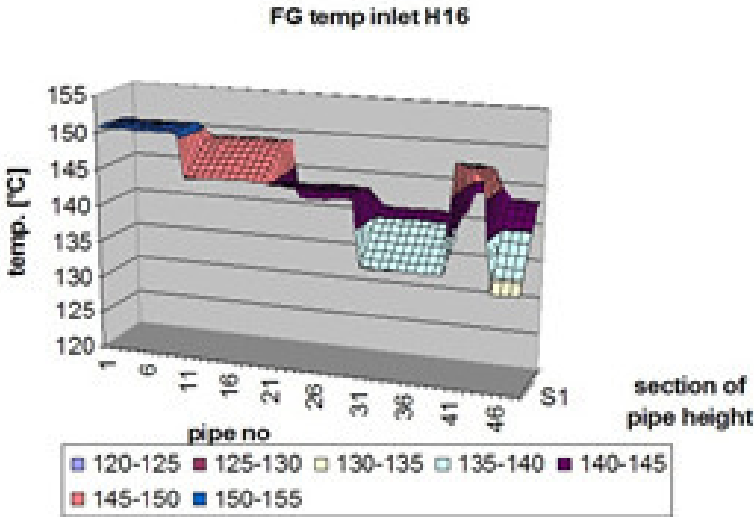
Plant design and performance calculations

With the program also integrated correction curves can be constructed of complicated units composed with equipment delivered by different manufacturers and only provided with correction curves for the different equipment. This has been done for several Combined Heat and Power (CHP) plants based on gas turbines.

For a combined heat and power plant with desalination of water a special cost allocation model for the products have been developed, using special exergy functions of SPENCE.

For several clients integrated models are made with an interface with DCS systems to predict the performance of the plant based on design and actual ambient conditions.

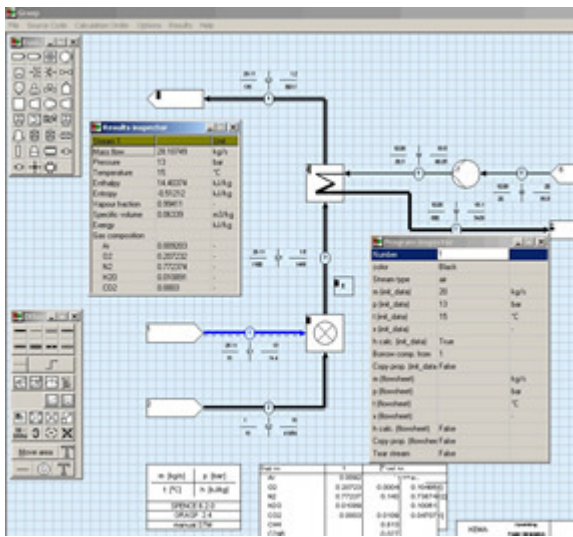
With the program the impact of steam and or heat delivery on the electricity generation of power plants and waste to energy plants have been carried out to determine the heat and or steam price.



On-line process calculations to control operation processes

The basic libraries of SPENCE® have been translated and implemented on the process computer of the 265 MWe IGCC “Prins Willem Alexander” power plant in Buggenum. They are used for on-line process calculations to control the coal gasification process.

To determine the influence of co-firing of biomass in coal fired power plants very detailed burner models have been developed. With the models the limitations of 5 pulverized coals (PC) fired boilers were investigated considering co-firing of biomass up to 25% on energy basis.



A special version of SPENCE has been developed to generate models for on-line calculation on power plants. A model of a combined cycle is implemented at a plant in Hong Kong and a model of a coal fired power plant with co-combustion of biomass is implemented at Amercentrale.