Functions of the network optimization system

The software package is developed for the economical and operational optimization of gas pipeline networks. All target functions, are available:

1. Minimization of fuel gas and operating energy;
2. Minimization of purchased-gas costs;
3. Optimization of storage injection and withdrawal for storage facilities within the pipeline network (e.g. for underground reservoirs);
4. Profit maximization.
   Both a quality tracking and a tracking of deliveries are available. This allows the costs to be tracked and optimum selling prices to be determined.

The problems solved, are related to the area of large-scale, non-linear, discrete-continuous optimization for general networks. The optimization process that has been developed represents a branched multi-level computational process. It is based on non-linear and integral optimization and on graph theory. Its main feature is the obtaining of dominant solutions for network fragments.

During optimization the methods adapt themselves to the specific networks and to the topology of surfaces corresponding to objective functions, restrictions, and variables.

The software has both an input interface and an output interface in the form of Data Transfer Files (DTF). As DTF, text files are used.

As a result, the software provides:

- Graphical User Interface (GUI)
- A graphics editor
- Database (DB) support
- Integration with a Geographic Information System (GIS)
- Integration with a Distributed Control Systems (DCS), which includes Supervisory Control and Data Acquisition (SCADA).

These tools and features allow:

- to create a network;
- to obtain initial values of supplies, demands and gas parameters;
- to generate and present a tabular and graphical output.

1.1 Functions in Network Optimization

1.1.1 List of objective functions

1. Zero-valued objective function
2. Flow maximization
3. Minimization of deviation from set values for some flows, pressures and contract values
4. Minimization of operating power, i.e. of fuel gas and electrical energy
5. Minimization of operating energy costs, i.e. costs of fuel gas and electrical energy
6. Minimization of transport costs as a sum of operating drive energy and pipeline flow costs)
7. WACOG minimization (Weighted Average Cost Of Gas) that provides achieving a WACOG value that is most closed to a desirable ones
8. Minimization of transport costs as pipeline flow costs
9. Profit maximization as minimization of costs of total in- and off-takes
10. Profit maximization as minimization of distance to a desirable value of profit.
11. Maximization of line pack
12. Minimization of capital outlays i.e. investment costs
13. Minimization of total costs of operating energy, transport and investment (capital outlay)

1.1.2 Operational Optimization

1. Minimization of operating power, i.e. of fuel gas and electrical energy
2. Minimization of operating energy costs, i.e. costs of fuel gas and electrical energy
3. Flow maximization
4. Target state, i.e. a feasible network state, which some parameters are as close as possible to their set values

1.1.3 Economic Optimization

1. Minimizing deviation from set values for some flows, pressures and contract values
2. WACOG minimization (Weighted Average Cost Of Gas)
3. Profit maximization

1.2 Variables

1.2.1 Discrete variables

Operational modes for compressor stations, i.e. schemes of linking the operating compressors; pressure regulators. Flow regulators can be adjusted.

1.2.2 Continuous variables

1. Pressure values
2. Compression ratios of regulators and compressor stations
3. Gas volumes as gas quantities in relation to suppliers and consumers
4. Flows

2 Advantages of the optimization system

- The network optimizer in the software is flexible, highly customizable, yet feature-rich program
- It determines an optimal parameters for a new network as well as operational parameters for an existing one
- It determines an optimal load sharing in the entire network and in every compressor station that takes into account the developed driven power and local energy prices
- By determination of optimal network state, it determines an optimal load sharing in every compressor station that takes into account local energy prices
- It can be used as a network regulator that produces stations set-points that minimize costs of operating energy and provide reliable operating of equipment of network and stations
- It possesses a set of objective functions that have both economic and operating meaning
- Economic objective functions can be used by transport planning for increasing returns, net and total profit
- Economic objective functions that consider purchase prices can be used for optimal definition of purchase gas
- Network optimization is one of the base to plan renovation and repair of equipment in field and in the stations