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# Issues of an optimization of measurements location in redundant measurements systems of an energy conversion process – a case study

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## Abstract

The measurements system of an energy conversion process is treated as a redundant if it fulfills the conditions for the application of the advanced data validation and reconciliation. At the design stage of such a system, the problem of the number of redundant measurements as well as their location appears from the point of view of the optimization method. In this case, the solved superior optimization problem is the problem of the combinatorial optimization. These tasks are difficult from a computational point of view. For contemporary computers, this may become impossible for larger-scale tasks because the computing time of the corresponding algorithm is an exponential function from the problem dimension to the solution. Example calculations for the redundant measurement system of a selected gas-and-steam CHP unit have been carried out. As an objective function of the combinatorial optimization task, the relative uncertainty of the energy utilization factor in the CHP unit was assumed. To evaluate the redundant measurements system as a whole the relative information entropy – *Kullback-Leibler* divergence has been accepted. The optimization calculations for all elements of space of states, i.e. for all possible location configurations of the redundant measurements in the thermal system of CHP unit have been performed. Discussion of received results due to the possibility of limiting the dimensionality of the solved optimization combinatorial task and consequently the significant reduction of the numerical calculation time has been carried out. Analyses of a suitability of proposed methods for limiting the number of sets of redundant measurements configurations in the optimization calculations have been performed.

## 1. Introduction

The analysis of possible equations of mass and energy balances as well as other formulas for the energy conversion process in its steady state of operation and available measurements may in many cases show, that the number of unknown values is smaller than the number of equations of the mathematical description of the process. This is due to occur of a redundancy of measurement information. The system of equations of the mathematical description of the process is overdetermined in this case, and there are no solutions in the usual sense. The redundancy of measurement information and unavoidable measurements errors lead to the following consequences:

- several different sets of equations of the mathematical model can be selected to calculate

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