THERMAL ENERGY QUALITY BASED ON EXERGY CONCEPT

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ABSTRACT

The actual value of thermal energy can only be obtained by a qualitative or exergy analysis of its conversion, transport and distribution. The exergy value of heat, or its capacity to perform work, can contribute to formation of a good basis for determining a fair economic price for thermal energy [1]
In 1955, Rant [2] stated that the selling price of heat based on enthalpy difference was inappropriate. He proposed the introduction of the heat exergy value as the basis for determining the price of heat. Recent thermoeconomic analyses have been performed by Tozer et al. [3], Lozano and Valero [4] leading to the development of the ‘‘Theory of the exergetic cost’’ and its application in operation optimisation, cost allocation and the economic optimisation of different thermal systems. Nieuwlaar and Dijk [5] made use of the fact that exergy value of energy represents its quality, when they performed a thermodynamic analysis of heating in buildings for the end users of heat. They estimated that for the case of consumption, there are many possibilities for improving energy efficiency. Rosen [6] also performed an energy and exergy analysis for energy consumption. He estimated that the exergy losses in all branches of industry are relatively high and introduced possibilities for the reduction of these losses. In most cases, the distributed heat has the same price, which depends only on the quantity of the heat and not on the quality of the heat. This is in accordance with the first law of thermodynamics but in contradiction with the second law.

In the first part of presentation, an exergy analysis of heat transfer and distribution based on our previous work [7] will be presented. The analysis looks at the case of heat distribution through a distributed district heating network to consumers requiring different hot water temperatures. In the second part of presentation will be shown, how these results are used to determine the differentiated price factor of heat. This factor X, based on a thermodynamic analysis of a distributed district heating system, is one of the most crucial and influential factors for determining the correct economic value of heat.

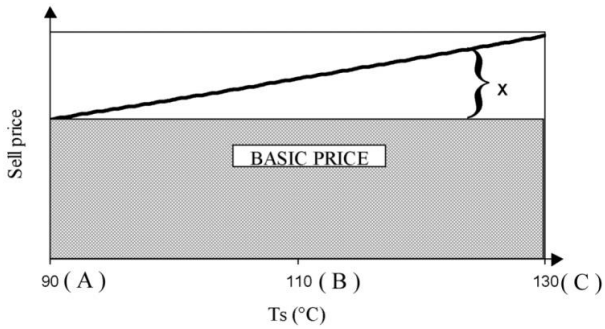

Figure 1: Sales price of thermal energy depending on its quality

The analysis of the exergy loss which occurs during the transport of thermal energy to consumers indicates that this loss is large and primarily dependent on the temperature of the hot water. The analysis shows the direct influence of measures instituted to reduce this loss during heat transfer in thermal stations, by reducing heat loss in pipelines and by reducing the consumption of electrical energy during the transport of hot water to the consumer. In a complex economic analysis, measures for the exergy loss reduction should also play a role.
The described model for exergy analysis and the influence of exergy losses on the heat price in distributed district heating systems provides a thermodynamic fairer basis for the determination of heat price. It also contributes to a lower consumption of the primary energy sources on the consumer’s side.

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