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Criteria of Effectiveness Evaluation of Centrifugal Pumps in District Heating Systems

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ABSTRACT

The goal of this research is the derivation of criteria of effectiveness evaluation of variable speed centrifugal pumps in district heating systems.

For this purpose, the efficiency level of centrifugal pumps of various designs has been analyzed at certain head and flow range.

There is also the change of the efficiency level of circulators has been investigated in the article. It has been done at different deviations from the nominal pump head.

As a criterion, the effectiveness of the proportional pressure control mode has also been analyzed for centrifugal pumps with variable speed motors. It has been done if the proportional pressure control mode is used in comparison with the constant pressure control mode.

For these reasons, a great number of energy analyses have been realized for different pumps and the regression equations with the coefficients of determination have been derived.

As the result, the three criteria of effectiveness evaluation of centrifugal pumps have been derived. These criteria are design of centrifugal pumps; duty point location comparatively the nominal pump head; use of the proportional pressure. The trend of the reduction of energy consumption has been determined. In this connection the regression equations have been derived.

The conclusions are as follow:

- Vertical in-line single-stage pumps are less efficient in comparison with horizontal end-suction single-stage pumps, when the flow rate varies from 20 to 220 m³/h at the definite range of the head (from 10 to 72 m). The difference in the efficiency level of the centrifugal pumps is from 3% up to 6% at the definite range of flow and head.
- The reduction of annual energy consumption can be achieved up to 33%, if the proportional pressure is applied and the deviations from the head value of duty point at zero flow declines up to 60%.
- The efficiency level drops up to 3% if the deviation of the head value of the best efficiency point is up to 30% from its nominal value.
- A slight decrease of the efficiency level is observed if the deviation from the nominal head value is up to 30%. If the head deviation is above 30%, then the efficiency level drops rapidly.

Keywords: centrifugal pump, control mode, efficiency

Industrial/Professional Applications

- Results of the article can be applied for pump audit in low and medium-scale HVAC systems.
- Results allow increasing the level of efficiency in HVAC systems, thus contributing to energy saving in the world.
- Results of the article can be used as a guide for designers with a focus on pumping systems.