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Saint Petersburg, Russia

ANALYSIS OF METHODS FOR UTILIZING THE HEAT OF TREATMENT FACILITIES USING HEAT PUMPS

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Relevance

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Increasing environmental requirements, energy efficiency of industrial facilities, the need to reduce losses from waste heat flows require the development of methods for their utilization.

One of the effective methods of utilization of waste heat flows is the use of heat pumps, where CO_2 is used as a working substance. At the same time, it becomes possible not only to improve the mass-dimensional characteristics of pumps, to increase efficiency, but also to simplify the processes of forming collection methods, preparing for the utilization of heat from flows of different potential.

Methods for increasing the efficiency of the heat utilization system

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The formation of a heat utilization system is based on:

- the use of CO_2 in the transcritical pressure range;
- the use of turbocharger (centrifugal compressor) with a combined control method;
- the use of pumping and circulation schemes, which allow combining heat consumers of various levels and heat sources into a common branched system;
- development of efficient heat exchange equipment;
- development of optimal control algorithms.

Combining forward and reverse cycles

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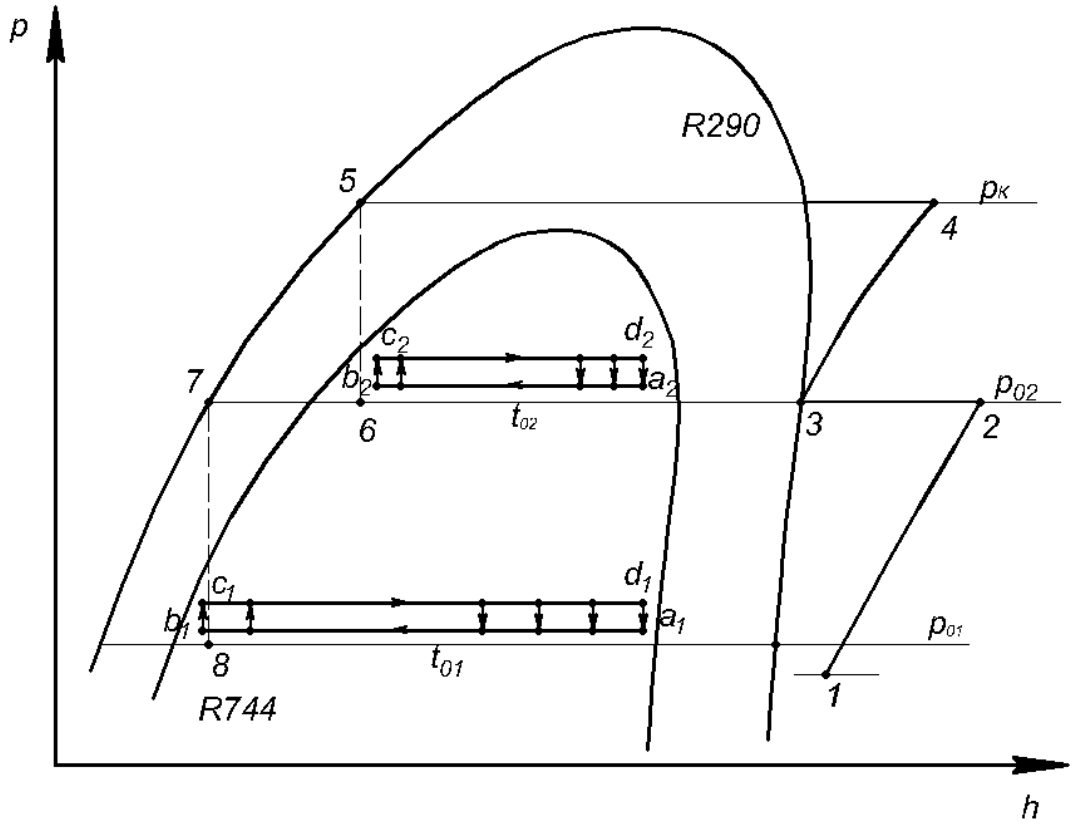

Fig.1 – Combining forward and reverse cycles (R744 and propane R290)

Heat pump cycle in the p-h diagram

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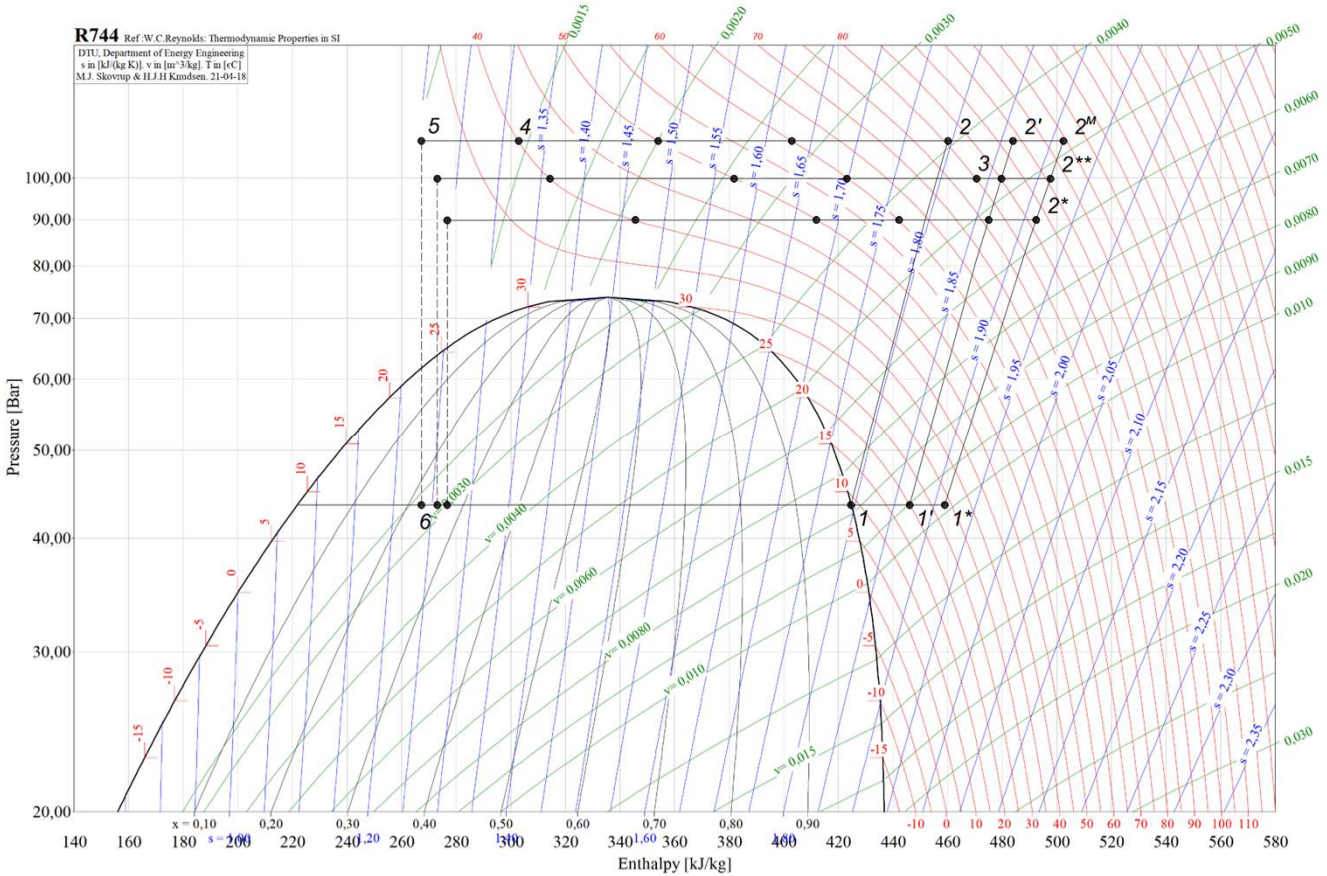

Fig.2 – Heat pump cycle in the p-h diagram R744

Heat pump circuit diagram

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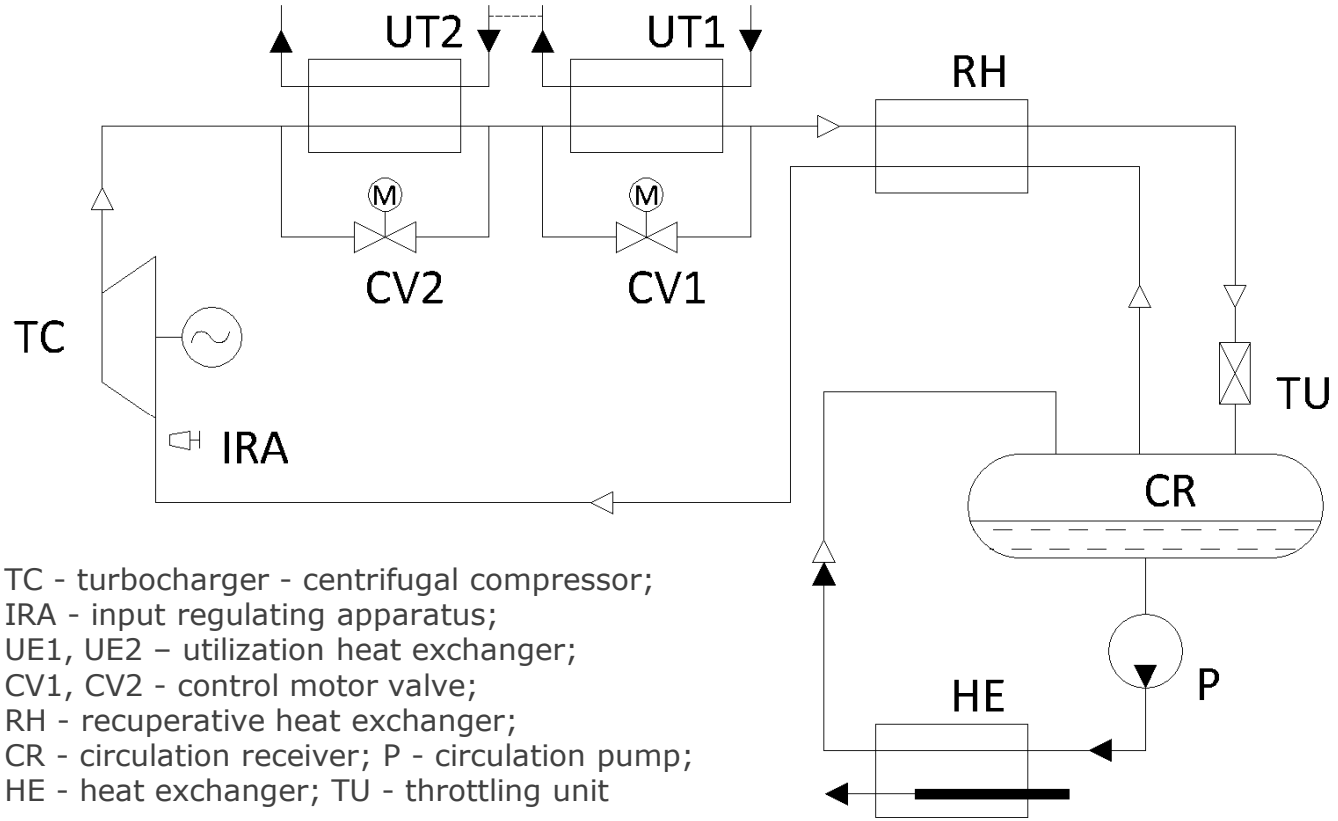

TC - turbocharger - centrifugal compressor;
IRA - input regulating apparatus;
UE1, UE2 – utilization heat exchanger;
CV1, CV2 - control motor valve;
RH - recuperative heat exchanger;
CR - circulation receiver; P - circulation pump;
HE - heat exchanger; TU - throttling unit

Fig.3 – Circuit diagram of a CO_2-based heat pump (R744)

Heat exchanger for waste water heat recovery

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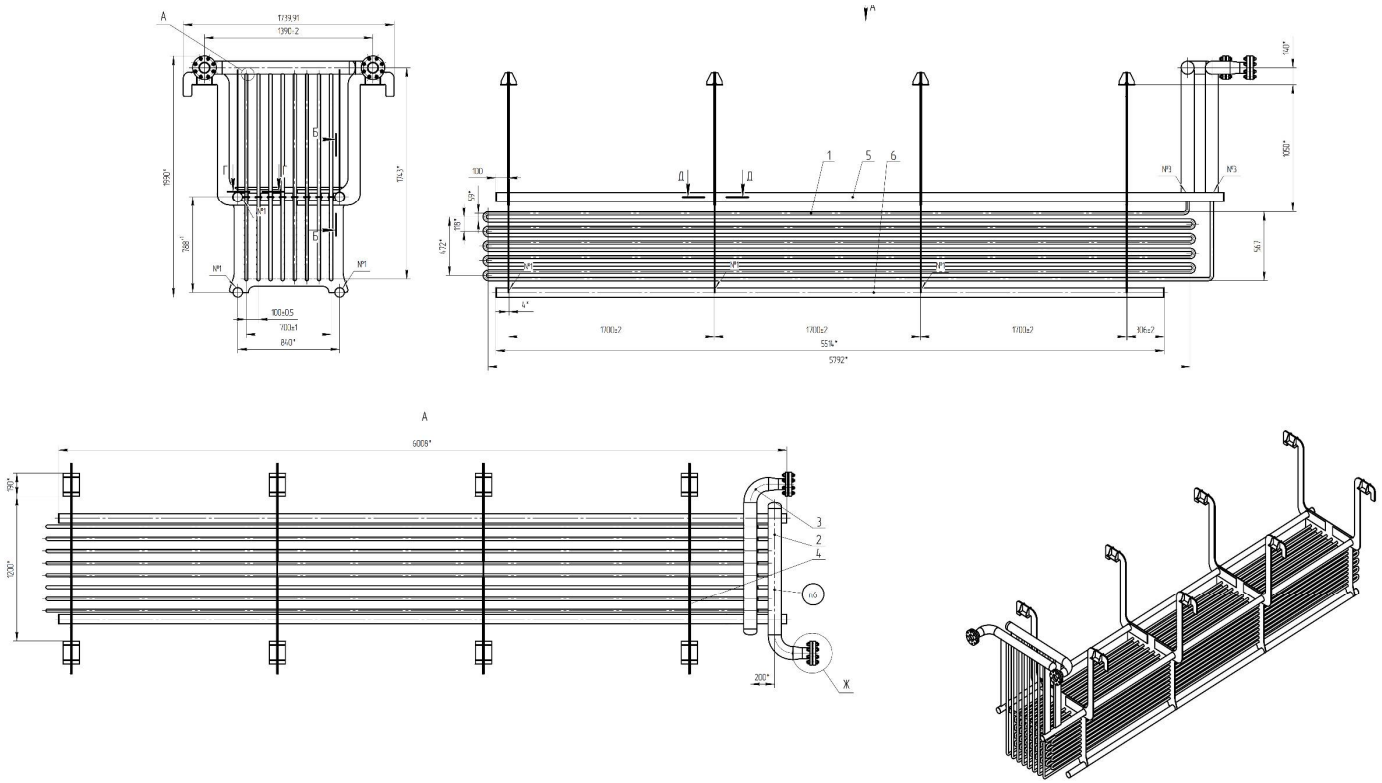

Fig.4 – Heat exchanger for waste water heat recovery

Conclusion

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1. The use of CO_2-powered transcritical refrigeration cycles allows minimizing the weight, size and operational parameters of the system. The means for regulating the performance of the compressors ensure a high level of their efficiency.

2. Pump-circulation circuits with a feed rate of n=3..4 ensure both uniform distribution of the refrigerant through the pipes and high efficiency of heat exchange.

3. The design of the heat exchanger has been developed, which ensures the efficiency of heat utilization due to the periodic cleaning of the heat exchange surface.

4. The characteristics of all elements of the low-potential heat supply system are coordinated during operation by changing the parameters of the refrigeration cycle and the performance of the centrifugal compressor (with speed variation + IRA).

Thank you for your attention!

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