Optimization of industrial steam supply and steam-and-condensate farming of machine building enterprise

2014 IOP Conf. Ser.: Mater. Sci. Eng. 69 012025

(http://iopscience.iop.org/1757-899X/69/1/012025)

IOP Conf. Series: Materials Science and Engineering **69** (2014) 012025 doi:10.1088/1757-899X/69/1/012025

Optimization of industrial steam supply and steam-and-condensate farming of machine building enterprise

I A Konahina[1], N F Kashapov[1], I R Gil'manshin[1], R R Ganiev[2]
[1]Kazan Federal University,
420008, Kremlevskaja Street, 18, Kazan, Russia
[2]Kazan State Power Engineering University,
420066, Krasnosel'skaja Street, 56, Kazan, Russia

E-mail: chelny@kpfu.ru

Abstract. The article studies efficient control methods of steam condensing economy of the machine building enterprise. There are recommendations about development of complex decisions based on indicators of energy, technical and economic efficiency.

1. Introduction

Currently, in the energy of Russian Federation a key strategic direction is energy saving at all levels. Particularly acutely it is concerned energy intensive industries. Machine building enterprises are the largest consumers of steam. Basically it is consumed for technological needs, but also providing of "domestic" consumers with steam is not an exception – on heating, ventilation and hot water (DHW).

The steam for enterprise is released from the industrial CHP, as a rule, with the help of one steampipe where the maximum pressure of the system is maintained, and the real consumption of steam by numerous consumers is realized at lower settings. Application of reduction plants or reducing-cooler settings (PRDS) in these cases leads to a loss of exergy of energy source that makes us to look for solutions for eliminating such losses [1,2].

The use of steam for heating needs leads to formation of high pressured condensate, towards of atmospheric, which also represents the reserve of energy saving. Except condensate of thermal needs the exhaust steam with the forging hammers' pressure of 0.2-0.3 MPa, presses and other installations with steam drive can be used.

2. The basic part

Based on the analysis of the structure of machine building enterprises' power balance the following ways of improving efficiency in the use of steam and condensate were identified:

1) Installation of low pressure turbines PRDS (Image 1);
2) Applying of recompression to recover the capacity of waste steam;
3) Accumulation of steam and heat energy;
4) Organization of effective systems of collection and return of steam condensate, as well as re-use of energy supply (regeneration, recompression of flashing steam and so on.);
5) Optimization of steam supply systems, including steam condensate farming enterprises

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Image 1 shows a diagram of the replacement of pressure reductionin PDRS on its expansion process in the turbine. Using of this scheme allows generating of 98.3 kWh of electricity per 1 tone of steam for the specified mode parameters and configuration.

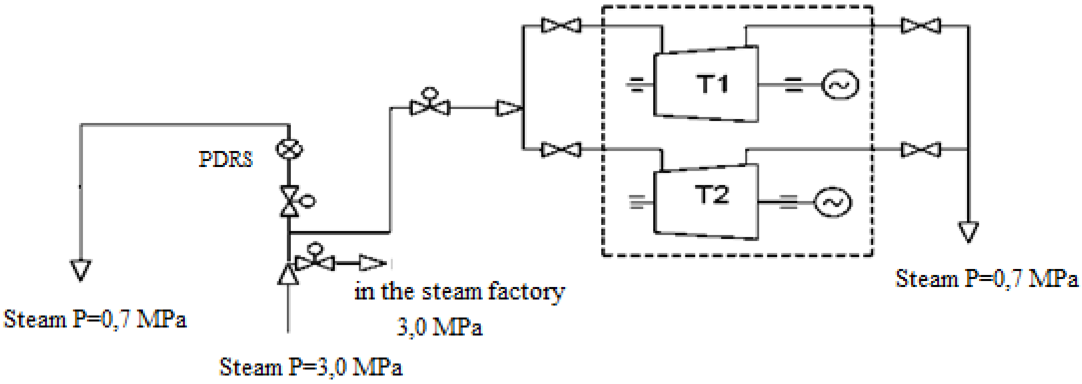

Fig.1. Cogeneration bundle
T1, T2 - turbines P-1,6-2,8/0,7

After using the steam in power technological processes low potential renewable energy resource (RER) of waste steam is formed, the continued use of which is difficult because of its low pressure and temperature, so such a heat-transfer fluid is usually released into the atmosphere – either directly or via the circulating water system. To increase the pressure of secondary steam to an acceptable level it is advisable to use recompression methods based on different types of compressors, including steam jet. During this process the additional costs of energy resources – electricity or steam of industrial settings are produced.

Disposing of waste steam, steam jet compressor (2a) at the same time works as PDRS, reducing high-grade steam parameters to the calculated working values. The steam with the operating parameters is then delivered to the consumer.

Gas generator installation (im. 2b) compresses the steam to the designed pressure. The thermal using of pressurized steam effect of fuel economy reaches 3-6 times value compared to the produced electricity costs on the compressor’s drive.

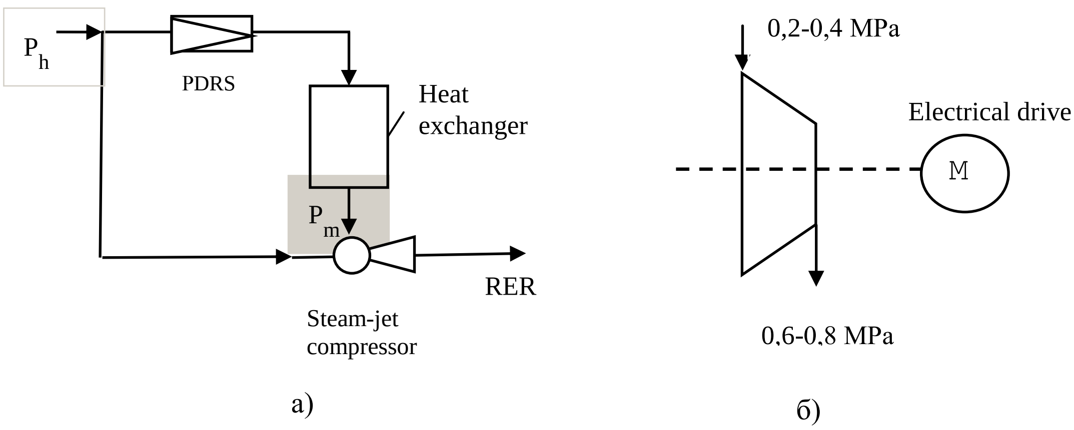

Fig. 2. Steam recompression by
а) Steam-jet compressor, б) turbo compressor

Daily schedules of steam consumption at the enterprise are characterized by unsteadiness. Accumulation of the steam (Fig. 3) lets to stabilize the schedule and ensure the effectiveness of steam supply systems and steam consumption teamwork [2]. Charging the battery takes place in a period of excess income of high pressure steam and discharge in a period of inadequate intake of medium pressure steam.

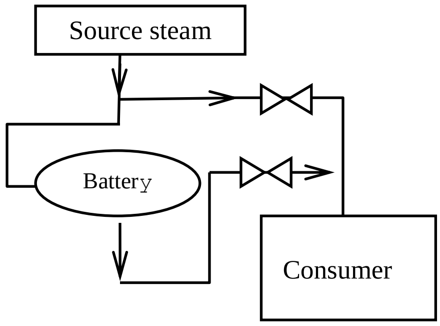

Fig. 3 Enabling the battery in steam consumption system of the enterprise

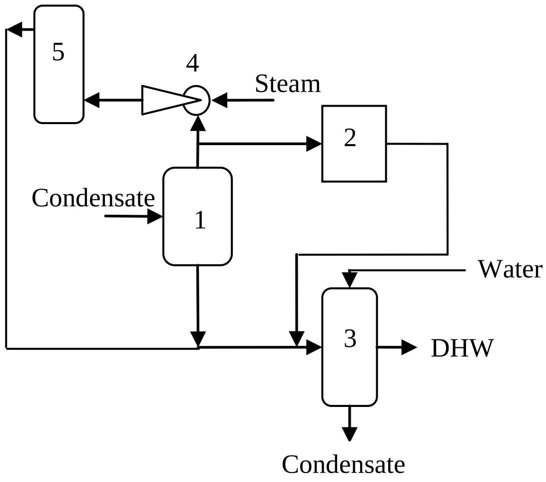

Fig. 4 Heat recovery condensate of different pressure

For the purpose of beneficial use of RER steam condensate a complex of measures is proposed (Fig. 4), which includes the installation: Expansion tank for emission of flash steam; – Steam jet compressor to pressurize the recycling steam to the desired pressure; – Waste-heat exchangers -utilizers for use RER of residual condensate.

Condensate after using enters the expansion tank 1, generated flash steam is fed into the process unit 2, and a steam jet compressor 4 (to increase the capacity of the steam). Steam after steam jet compressor enters the technological unit – the consumer 5. Condensate from 1, 2, 5, enters the heat exchanger 3, where also gives its residual heat to system of domestic hot water (DHW).

The task of improving the steam-and-condensate farming of machine building enterprises is complex and has many solutions. Search of the most profitable of these methods requires the use of system analysis, structural modeling and optimization [2, 3]. The challenge of energy-economic optimization in this case is to find the set of technical solutions and operational parameters that correspond to the maximum achievable fuel economy B_e at imposing restrictions caused by the peculiarities of the applied technologies and equipment [2].

$$B_e = \sum_{i=1}^{i_k} \left(\Delta B_D + \Delta B_N \right)_i ; \qquad (1)$$

where – ΔB_D is change of fuel equivalent of steam consumption by enterprise from external sources t/h; ΔB_N is change of fuel equivalent cost of electricity from external sources; i – the serial number of the event; i_k – the total number of events.

However, as shown in [2], optimization of complex according to the energy parameters represents idealized problem, in which does not take into account the level of capital and operating costs of a particular event. Meanwhile, the decision to implement complex in practice is adopted on the basis of technical and economic parameters of the project. Therefore, the problem (1) must be

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solved together with the task of finding the maximum economic benefit ΔE_c or minimum payback period τ_r (2) of the energy-saving measures, taking into account the cost of providing the required conditions of reliability and safety upgradeable complex:

$$\tau_r = \frac{\sum_{i=1}^{i_k} (\Delta S_c)_i}{\sum_{i=1}^{i_k} (\Delta E_c)_i} \quad ; \qquad (2)$$

where ΔS_c - is capital costs on event, rub.

3. References

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