Increasing efficiency of technological steam consumption at oil and gas enterprise

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Abstract. One of the most common energy carriers in the petrochemical industry is water vapor, which is mainly used as a heating medium in process plants. The effective functioning of steam supply, condensate collection and return systems is one of the criteria that affect the cost of production. Improper organization of the steam supply system leads to overuse of heating steam, uneven operation of the steam system and emergency situations. This paper analyzes possible problems in steam supply systems in the absence or incorrect operation of steam traps. The specific indicators of the object of study, circuit solutions and the economic efficiency of the use of steam traps are calculated.

1. Introduction

Energy saving has recently taken the leading place in the production process. Reducing the consumption of thermal energy in the form of steam is the main way to reduce the cost of production and therefore to increase competitive ability.

The operation of steam condensate systems involves the following possible problems [1-3]:

- poor quality of steam;
- the lack of automatic control of process parameters;
• the lack of suitable steam traps;

The latter point leads to the occurrence of flying steam, hydroshocks, difficulties in collecting and returning condensate.

Condensate formation leads to a number of problems:

• reducing throughput capability and pressure;
• increasing steam humidity;
• occurring hydroshocks.

These problems cause longitudinal cracks in pipes and damage to other elements of the pipeline. Hydroshocks are also extremely dangerous for heat exchangers, equipments and people's lives.

Steam traps are required to reduce the probability of problems occurring from hydroshocks and unplanned repair costs.

The defective technical condition of the steam traps or their lack in the steam-consuming equipment results in significant losses of thermal energy from the flying vapor, steam overconsumption and increasing the specific consumption of heat energy per unit of production. On the other hand, it leads to deterioration of the operation of condensate lines that are not designed to work with a significant content of flight steam in condensate [4-6]. At the same time, the hydraulic resistance in condensate lines increases and the backpressure occurs that leads to the beginning hydraulic shocks [8-12].

2. Methods

The processing department of the organic synthesis enterprise, the vapor supply of which is carried out according to the scheme given in figure 1, is considered as the object of research.

![Diagram of steam consumption](figure1.png)

**Figure 1.** Balance scheme of the steam consumption of the processing department.
Medium pressure steam $P = 19 \text{ kgf/cm}^2$ is repeatedly used, passing through consumers of heat of the enterprise (heating jackets and coils of tanks and food pipelines), with pressure $P = 7.5-8.4 \text{ kgf/cm}^2$ and temperature 163-181°C, is transferred for use on the technological needs of the section. The volume of medium pressure steam is 82-84% of the total steam consumption in the section.

Low pressure steam heats the jackets of product pipelines and tanks, as well as the pipelines of feeding the reaction initiators of four process lines. The volume of low-pressure steam is 16 -18% of the total consumption of the section.

The low-pressure steam condensate is collected into the condensate tank, from where, after the steam has been cooling, it is pumped to feed the collecting tank and the intermediate cooling tank of condensate.

The diagram of the condensate collection unit is shown in figure 2.

![Figure 2. The diagram of low-pressure condensate collection unit.](image)

Analysis of the condensate unit of the section showed the following:

- The lack of accounting of condensate consumption for own needs;
- The balance between the receipt and use of condensate is carried out by overflow from the granulation tank into the sewerage system;
- The presence of significant vented steam from the respiratory pipe of the low pressure condensate tank despite the presence of the vented steam condenser on the respiratory pipe;
- Steam traps on low pressure steam consumers are operated for a long time without replacement;
- Welded joint after repair are visible on the bodies and tops of steam traps.

These factors indicate the presence of flying steam in the steam condensate mixture for low-pressure steam consumers.

3. Results

It is proposed to determine the volume of flying steam, in other words the potential reduction of vapour consumption with a pressure of 4.5 kgf/cm² during installing steam traps for consumers.

Consequently, the analysis of dependence of vapour consumption of 4.5 kgf/cm² on the section for the semi-annual period production was performed (figure 3).
Nature of low pressure steam consumption (heating steam jackets of cyclone-separators, heating sections of the product steam pipeline, heating pipelines of the reaction initiator on three process lines) allows to conclude that the consumption of low pressure steam depends on the temperature of the product mixture, the working time and does not depend on the amount of supplied product flow. Thus, the change in specific steam consumption is associated with the presence of flying steam.

The possible reduction in steam consumption can be defined as the difference between the average and the minimum specific consumption [13,14]:

$$\Delta q = q_{\text{aver.}} - q_{\text{min}} = 0,1134 - 0,1074 = 0,06 \text{ Gcal/t}.$$  

where $q_{\text{aver.}}$ is the average specific consumption of low-pressure steam during the period; $q_{\text{min}}$ is the minimum specific steam consumption during the period.

Therefore, the savings of thermal energy on annual output is:

$$Q = \Delta q \cdot G = 0.06 \cdot 75006 = 400 \text{ Gcal/year}. $$

where $G$ is the annual output, t/year.

4. Discussion

The installation of steam traps allows to reduce the amount of heat with the flying steam, reduce the specific annual consumption of heat energy by 400 Gcal, which is amount to 480 000 rubles in
monetary terms. In addition, this installation increases the reliability of the vapor supply system by reducing the probability of hydroshocks.

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