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# Improving gas cooling technology at its compression in the booster compressor station

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**Abstract**

Improving the efficiency of gas air-cooling units of compressor stations requires consideration of a whole complex of varying parameters and appropriate regulation when there is decline in reservoir pressure and gas production volume in the fields. It determines the need to use two or more stages of compression, replaceable flow parts of gas compressors, new assembly available on the air coolers station. On the other hand, for many years of operation it is necessary to determine the optimum number of devices included in the cooling process, the total number of fans or a share of their total working load. The analysis shows the possibility of reducing energy consumption for fan drives which can reach 20-30%.

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*Keywords:* booster compressor station; gas air-cooling units; the consumption of energy; regulation

## 1. Introduction

Improved technology of gas compression and cooling at the booster compressor stations (BCS) is developing in two directions [1-4].

On the one hand, the transition BCS work in two or more stages of compression is supposed to use the new assembly as the existing gas pumping units (GPU) and air cooling units (GASU). For example, a phased transition to a three-stage compression scheme for BCS of West-Tarkosalinskoye gas field is due to the change in the number and arrangement of GPU for compressor shops. In particular, during the transition to a two-stage compression scheme the compressor shop CS-1 consisting of four GPU was added with a compressor shop CS-2.1 also including four gas

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pumping units. All GPU CS-2.1 form the first stage of compression (three GPA operate, one is in reserve), and all GPA CS-1 form the second stage.

In turn, during the transition to a three-stage compression scheme the compressor shops CS-2.1 and CS-1 are added with compressor shop CS -2.2 including only one GPU. It involves a reassembly of gas pumping units into three compression stages: the first stage includes a GPU from CS-2.2 and two GPU from CS-2.1 (two GPU operate, one is in reserve); the second compression stage includes two GPU from CS-2.1 and one GPU from CS-1; the third compression stage includes three GPU from CS-1.

Similarly if we increase the number and reassembly then air cooling apparatuses at sites GASU 1.1, GASU 2.1 and GASU 2.2 can be changed. Reassembly will allow more efficient use of the available devices and reduce their required number.

On the other hand, in terms of gradual decline in gas volume extraction (compression volume) during long-term operation it is necessary to determine the optimum number included in the cooling process GASU, the total number of fans running, or fan load share at frequency regulation.

The aim of this work defining its scientific novelty is to improve the efficiency of the gas cooling units BCS, considering the whole complex of changing parameters during long-term operation, the corresponding modernization (reassembly of the compressor and heat exchange equipment) and regulation. At the same time, within the scientific and practical significance framework of the issues recommendations for the cooling technology are to be developed, the GASU number included in the cooling process, the total number of working fans and their load share are to be determined for each year of operation.

## 2. Study subject

The study subject is a technological section (TS) including two or more stages of compression stations (compressor plant BCS), after each there are gas air-cooling installations (GASI) on the basis of GASU, the installation of gas purification, linear plot, and the next compressor station (CS). TS optimum performance composition and characteristics depend on several factors, among which are the location of the CS (booster, linear, end); the operation period (year-round, seasonal); assembly of equipment (plant-wide, modular); type of air-cooled gas units (two or six fans); method of cooling control (discrete, frequency, combined).

## 3. Methods

Optimization of the process area involves the determination of the optimal temperature gas cooling modes at compressor stations, including BCS, the dominant parameter in their formation (as well as in the implementation of regulation) is the temperature of the gas cooling (gas temperature after GASI) $t_{cool.opt}$ . In particular $t_{cool.opt}$ levels are ensured with discrete regulation - the number of operating fans on the GASU and at frequency regulation with changing their performance. Determination of the recommended gas cooling temperatures in the GASU and other optimization parameters can be carried out at the stage of energy optimization for a given part of the process area.

As a part of the used methodology the problem of determining the optimum temperature of gas cooling mode in the DCS allows to determine the annual operating costs for the fan drives from the station schedule load (the amount of the compressed gas $\boldsymbol{Q}_{c\ m}$), sequentially for each *m-th* month, the average air temperature of the *m-th* month $t_{a\ m}$, the average temperature of the compressed gas supplied to the GASI from the corresponding level of compression $t_{c\ m}$, and the pressure of the compressed gas entering the GASI from the corresponding compression stage $p_{c\ m}$.

As local criteria of GASI efficiency we consider the power consumption $N_{el}$, its value is $C_{cool.}$, and the payback period $\tau_{payback}$ [5, 6]. Then, at the seasonal operation within 12 months, the task of optimizing the temperature mode can be summarized as follows:

$$\begin{cases} \psi = \underset{U}{opt}\, \psi(\, t_{cool\ opt}\ , t_a\ , t_c\ , p_c\ , Q_c\,) \\ U = \left\{ t_{cool\ opt} = t_{cool}^{other} = t_{cool}^{VFD} \right\}, \end{cases} \qquad (1)$$