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The Impact of Corrugated Panels on Temperature Reduction and Efficiency Improvement of Booster Compressor Stations

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ABSTRACT: Booster compressor stations (BCS) play a key role in maintaining natural gas pressure in main pipelines. During hot weather, the operation of BCS becomes more challenging due to increased ambient temperatures, which can negatively affect the performance of gas compressor units (GCU), increase energy consumption, and reduce equipment efficiency. One effective solution for maintaining an optimal microclimate and improving station efficiency is the use of corrugated panels. This article examines the advantages and applications of corrugated panels in BCS, their impact on station performance, and the efficiency of compressor equipment.

KEYWORDS: gas turbine unit (GTU), microclimate, gas pumping unit (GPU), booster compressor station (BCS), gas processing plant (GPP), corrugated air cooler.

I. INTRODUCTION

In the oil and gas industry, booster compressor stations are crucial for maintaining optimal pipeline pressure and ensuring efficient gas transportation. However, BCS operations are often associated with significant energy costs, making efficiency improvement a key task. During hot weather, the operation of BCS becomes particularly challenging, as high temperatures negatively impact the performance of gas compressor units, leading to increased energy consumption, reduced equipment productivity, and accelerated wear [1]. Maintaining an optimal microclimate within stations is critical to ensuring uninterrupted and cost-effective operation.

High ambient temperatures create several issues for BCS operations:
- Overheating of compressors and equipment, reducing performance, increasing the likelihood of breakdowns, and requiring costly repairs. Overheating also accelerates wear and shortens the service life of equipment [2].
- Increased energy consumption of cooling systems. Maintaining optimal equipment temperature requires intensive use of cooling systems, significantly increasing station energy consumption and operational costs [3].
- Changes in gas flow parameters, affecting compression and transportation efficiency. Temperature influences gas density and viscosity, which can negatively impact compression and transportation efficiency. Optimal compression parameters are achieved within a specific temperature range.
- Deterioration of working conditions for personnel due to high temperatures and increased noise levels. High temperatures and excessive noise create uncomfortable and hazardous working conditions, leading to reduced productivity and a higher risk of accidents.

A typical BCS consumes a significant amount of energy for gas compression. Factors affecting BCS energy efficiency include:
- Heat losses: Compressors, pipelines, and other equipment emit large amounts of heat that dissipate into the environment. This is particularly relevant in hot periods when the temperature difference between equipment and the environment is minimal, reducing heat dissipation efficiency and contributing to overheating.
- Aerodynamic resistance: Gas movement through pipelines and equipment creates aerodynamic resistance, requiring additional energy to overcome. Suboptimal pipeline and equipment designs can significantly increase this resistance [4].
- Inefficient cooling systems: Poorly designed or maintained cooling systems fail to provide optimal gas temperatures at the compressor inlet, reducing performance and increasing energy consumption. Cooling system efficiency is directly dependent on ambient temperature.

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- Outdated technologies: The use of outdated equipment and technologies reduces overall BCS efficiency. Modern compressors and automation systems significantly improve station efficiency [5].

These factors necessitate the adoption of measures for effective microclimate regulation within compressor facilities.

II. SIGNIFICANCE OF THE SYSTEM

This article discusses a rational approach to improving the efficiency of BCS operation in hot weather by creating a microclimate using corrugated structures. An analysis of existing solutions and experimental data shows that the use of corrugated air coolers at the compressor intake allows reducing the gas temperature, increasing its density, and, as a result, increasing the productivity of the BCS, reducing energy consumption, and reducing equipment wear. The Methodology and Discussion is presented in section III, section IV covers the experimental results of the study, and section V discusses the future study and conclusion.

III. METHODOLOGY AND DISCUSSION

In recent years, increasing attention has been given to innovative technologies, such as corrugated panels, to optimize BCS operations. Corrugated panels are multilayer thermal insulation structures that can significantly improve operating conditions at BCS through several factors:
1. Thermal insulation: Corrugated panels, with high thermal insulation properties, can be used to cover compressors, pipelines, and other BCS elements. This minimizes heat losses and maintains optimal gas temperature at the compressor inlet.
2. Aerodynamics improvement: Corrugated panels can be used to create aerodynamic fairings that reduce air resistance around BCS equipment, decreasing energy consumption for ventilation and cooling.
3. Cooling system optimization: Corrugated panels can be integrated into BCS cooling systems to enhance their efficiency. For example, they can be used to create efficient heat exchangers for faster and more effective gas cooling or to insulate cooling towers, reducing heat loss.
4. Noise reduction: Corrugated panels have good soundproofing properties, reducing noise levels generated by BCS. This improves working conditions for personnel and reduces environmental impact. Noise reduction is also an important factor for regulatory compliance.

Benefits of Implementing Corrugated Panels in BCS
- Reduced energy consumption: By minimizing heat losses (or heat inflow) and improving aerodynamics, corrugated panels significantly reduce BCS energy costs, primarily by decreasing electricity consumption of cooling systems.
- Increased productivity: Optimizing gas temperature at the compressor inlet enhances performance and increases the volume of transported gas. Stable temperature conditions also ensure more reliable equipment operation and lower the risk of unplanned shutdowns.
- Lower operational costs: Reducing heat losses and optimizing cooling systems decrease equipment load and extend service life, leading to lower maintenance costs.
- Improved working conditions: Reduced noise levels and maintained comfortable temperatures inside BCS facilities enhance working conditions and boost personnel productivity.
- Environmental safety: Lower energy consumption and emissions contribute to improved environmental safety at BCS.
- Quick installation and durability: Corrugated panels are relatively easy to install and highly durable, reducing installation and maintenance costs.

Areas of Corrugated Panel Installation in BCS
- Cladding of compressor workshops and process facilities.
- Thermal insulation covering for roofs and walls.
- Noise-insulating partition construction.
- Air duct and ventilation shaft arrangements.

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IV. EXPERIMENTAL RESULTS

Due to their lightweight, strength, and resistance to external influences, corrugated panels are an optimal solution for operation in hot climates.

Research on the Use of Corrugated Panels in BCS
The creation of a controlled microclimate in BCS using corrugated structures is a rational, cost-effective, and environmentally friendly solution for improving compressor equipment efficiency. Our research was conducted under hot climate conditions, where gas compressor units at BCS faced excessive combustion chamber temperatures, leading to increased inlet gas pressure from 19 to 22 atm and reduced gas withdrawal from 525,000 to 495,000 cubic meters per hour. This could result in a decrease in daily natural gas production by over 250,000 cubic meters and a reduction in liquefied petroleum gas (LPG) production by 40–50 tons.

The proposed solution involves installing a microclimate system with corrugated structures around gas compressor units at a gas processing plant (GPP). This system effectively cools hot air flows in summer and prevents sharp temperature increases within enclosed chambers.
Scientific studies have shown that for reducing air intake temperatures in air-cooling unit (ACU) systems on GCU-100 and GCU-200, a microclimate system made of corrugated panels was installed on a reinforced frame at the air intake platform.
Results of the Implementation
- Prevented efficiency loss of GCUs and avoided a daily gas production decline of 250,000 cubic meters during summer.
- Increased LPG production by 50 tons.

Below is a diagram illustrating the performance of gas pumping units (GPA) at a booster compressor station (BCS) with the use of cooling corrugated panels (Fig. 1). It provides a comparative analysis of gas pumping units (GPA-100, GPA-200, and GPA-300) operating under an ambient air temperature of 35°C. The diagram displays temperature values at the system's inlet and outlet both without and with the installation of corrugated panels, along with the calculated temperature difference and cooling efficiency.

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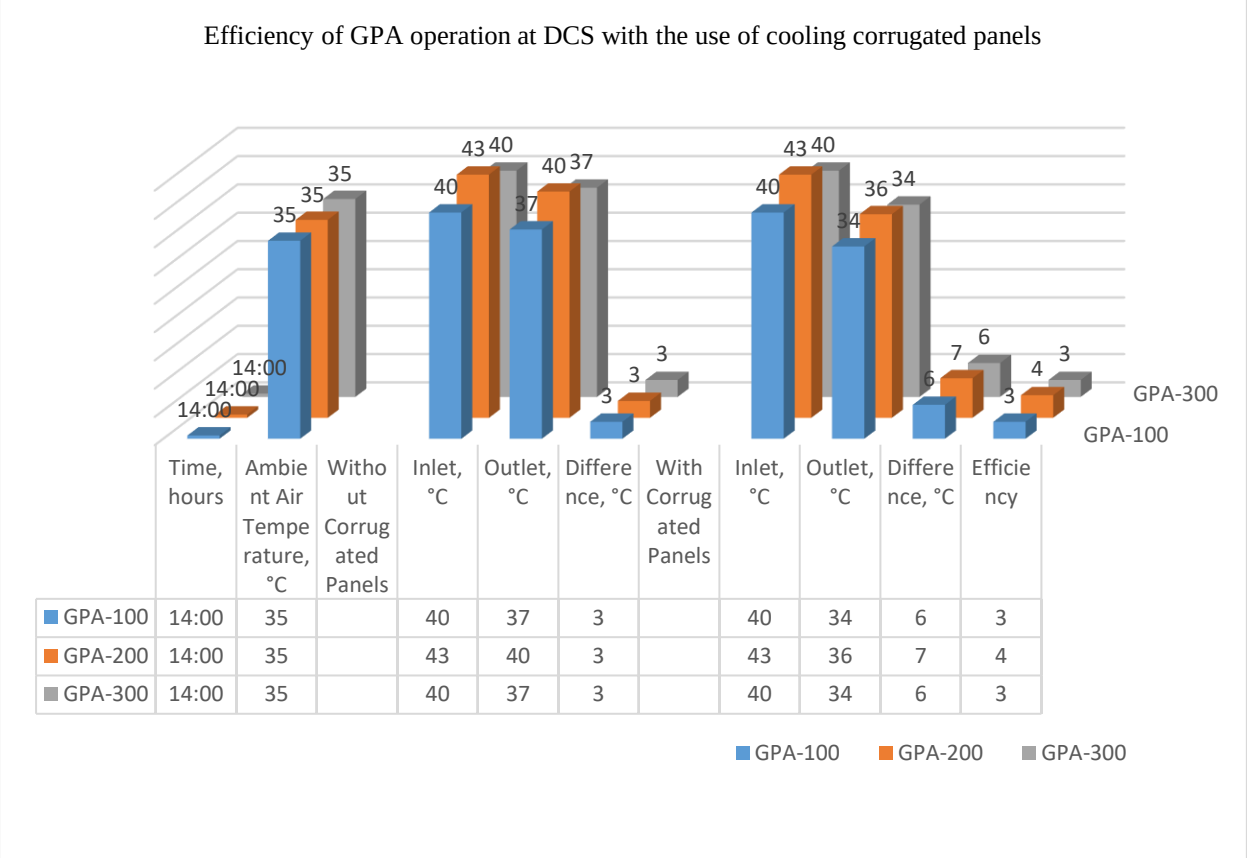

	Time, hours	Ambient Air Temperature, °C	Without Corrugated Panels	Inlet, °C	Outlet, °C	Difference, °C	With Corrugated Panels	Inlet, °C	Outlet, °C	Difference, °C	Efficiency
GPA-100	14:00	35		40	37	3		40	34	6	3
GPA-200	14:00	35		43	40	3		43	36	7	4
GPA-300	14:00	35		40	37	3		40	34	6	3

Fig. 1. Efficiency of GCUs with Corrugated Cooling Panels

Without corrugated panels: The temperature difference between inlet and outlet was 3°C for all three types of GCUs, indicating limited cooling efficiency. With corrugated panels: Installation significantly reduced outlet temperatures – the temperature difference increased to 6°C for GCU-100 and GCU-300, and to 7°C for GCU-200.

V. CONCLUSION AND FUTURE WORK

Thus, the installation of corrugated panels enhances heat exchange and lowers operating temperatures, positively impacting GCU performance. Incorporating corrugated panels into BCS design significantly improves station efficiency in hot weather, reducing equipment overheating, lowering energy consumption, improving working conditions, and extending equipment lifespan. Implementing modern thermal insulation solutions, such as corrugated panels, is a crucial step in increasing the energy efficiency and reliability of booster compressor stations.

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