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INTENSIFICATION OF HYDROCARBON VAPOR CONDENSATION PROCESS

Abdullaeva S.Sh.
Tashkent Institute of Chemical Technology, Uzbekistan

Nodirkhonova S.I.
Tashkent Institute of Chemical Technology, Uzbekistan

Radjabova S.R.
Tashkent Institute of Chemical Technology, Uzbekistan

K.K. Sharipov
Tashkent Institute of Chemical Technology, Uzbekistan

Abstract
This article analyzes the method of using gas-liquid contactors to improve the hydrocarbon vapor condensation process and increase its efficiency. Compared to conventional methods, this technology reduces energy consumption, minimizes emissions into the atmosphere, and enables efficient hydrocarbon recovery. The working mechanism of gas-liquid contactors, their technical advantages, and their industrial applications are examined.

Keywords: Hydrocarbon condensation, gas-liquid contactor, energy efficiency, environmental safety, petrochemistry, processing industry.

INTRODUCTION
Condensation is one of the key technological processes in the oil and gas and petrochemical industries. The process of separating hydrocarbon vapors into lubricants, fuels, and chemical substances is widely used in the industry. Traditional condensation methods require high energy consumption and lead to emissions into the atmosphere.
Improving the efficiency of heat transfer in the condensation process is one of the critical tasks. The heat transfer process is described by the following equation:

$$q = UA\Delta T$$

Where:
q- heat flux (W)
U – overall heat transfer coefficient (W/m^2K)
A – heat exchange surface area m^2
ΔT – temperature difference (K)

As an innovative approach, gas-liquid contactors have been successfully implemented in the industry. These contactors effectively organize mass and heat transfer processes, increasing condensation efficiency.

Gas-liquid contactors are devices that ensure intensive mixing of gas and liquid flows by directing them counter-currently or perpendicularly using specialized nozzles. These contactors exhibit a high mass transfer coefficient while maintaining minimal hydrodynamic resistance.

The differences between gas-liquid contactors and traditional condensers are presented in the following table:

Parameter	**Traditional Condensers**	**Gas-Liquid Contactors**
Condensation Efficiency (%)	75-85	90-98
Energy Consumption (kWh/ton)	150-200	100-130
Atmospheric Emissions (%)	3-5	0.5-1
Mass Transfer Coefficient (β) $м^{-1}$	100-200	300-600

These data indicate that gas-liquid contactors not only ensure effective condensation but also significantly reduce emissions.

Enhancing condensation efficiency – Due to a larger phase contact area, hydrocarbon molecules are effectively captured. Reducing energy consumption – This method requires 30-40% less energy compared to conventional methods. Ensuring environmental safety – Gas emissions are reduced by 3–5 times, preventing the release of harmful substances into the atmosphere. Reducing the size of condensation equipment – High efficiency allows for the use of compact equipment.

In conventional condensation processes, hydrocarbon emissions are released into the atmosphere, leading to environmental concerns. However, gas-liquid contactors recycle these emissions, reintegrating them into the production process.

Gas-liquid contactors have proven to be particularly effective in oil refining plants, gas separation facilities, and chemical purification processes.

Gas-liquid contactors represent an innovative solution for improving the efficiency of condensation processes, reducing energy consumption, and ensuring environmental safety. The widespread implementation of this method in the industry offers a promising technological advancement for the future of the oil and gas and processing industries.

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