UDC 628.511 https://doi.org/10.18372/2786-8168.20.21217
O.O. Zhuha, PhD student,
D.V. Davydov, PhD student
National Technical University «Kharkiv Polytechnic Institute» , Kharkiv

REMOVAL OF WEIGHED FRACTIONS FROM GAS EMISSIONS IN JET-BUBBLE CONTACTORS

Summary. *The production of dry milk products involves energy-intensive drying units where fine particles (0-30 μm) are often lost through exhaust air. While primary purification via cyclone banks achieves an efficiency of 95-97.7%, actual product losses can exceed 1% of the dryer's capacity, especially in older systems. Given that fine particles under 5 μm are prone to escaping these systems, there is a clear economic and environmental imperative to implement a second stage of purification. The analysis of experimental data reveals that the efficiency of capturing dry milk from the air stream is at least 99%.*

Keywords: process intensification, scrubber, contact devices, gas purification, jet-bubble contactor, dust removal efficiency, wet gas cleaning, active hydrodynamic mode

In the milk industry, the production of dry milk products involves energy-intensive drying units where fine particles ranging from 0 to 30 μm are frequently lost through exhaust air. Given that fine particles under 5 μm are specifically prone to escaping these primary systems, there is a clear economic and environmental imperative to implement a second stage of purification [1]. Reducing these dust levels helps improve working conditions, boosts productivity, and leads to higher product quality by minimizing the loss of finished materials into the atmosphere [2].

This study evaluates the use of a scrubber equipped with jet-bubble contact devices operating in an active hydrodynamic bubbling mode as a high-efficiency secondary purification stage. Experimental research was conducted using a laboratory test bench modified with a vibrating feeder and an electromagnet to ensure uniform product dosing while preventing caking. The study identified two distinct purification zones within the apparatus: a coarse zone in the initial sections and a fine zone within the foam layer under intense bubbling conditions. The analysis of experimental data reveals that the efficiency of capturing dry milk from the air stream using this method is at least 99%. Minor efficiency losses were only observed at the maximum operating loads of the gas blower, confirming the stability of the jet-bubble mechanism. Based on these results, an industrial exhaust air purification scheme was proposed, integrating the scrubber immediately after the primary cyclone stage.

To manage hydraulic resistance and pressure losses, the proposed diagram includes four parallel cyclones instead of two to maintain optimal airflow dynamics. In this configuration, the captured milk-water mixture is processed through a foam separator and milk filter before being redirected to vacuum evaporators for further processing.

The implementation of a second stage of purification is highly feasible, allowing for the recovery of 18 to 30 tons of additional dry milk annually for a standard 500 kg/h drying unit. By returning this captured material to the production cycle, enterprises can significantly reduce the loss of valuable finished products and increase overall

profitability. Reducing dry milk emissions minimizes environmental damage and ensures compliance with modern sanitary and hygienic standards at the production site.

The proposed system is designed for integration into existing industrial dryers with minimal disruption, providing a scalable solution for the dairy canning industry.

A study was conducted in a scrubber equipped with jet-bubble contact devices to evaluate the efficiency of water in capturing dry milk from an air stream. High performance is attributed to the presence of two distinct purification zones: a coarse zone in the initial sections and a fine zone within the intense foam layer, which effectively captures ultra-fine particles under 5 μm that typically bypass conventional cyclone systems. The implementation of a second stage of purification is highly feasible from an economic standpoint, as it allows for the recovery of tons of additional dry milk per year for a standard unit. By returning this captured material to the production cycle via vacuum evaporators, enterprises can significantly reduce the loss of valuable finished products. Reducing dry milk emissions into the atmosphere minimizes environmental damage and significantly improves sanitary and hygienic conditions at the production site. This dual benefit ensures compliance with environmental standards while fostering a safer and more productive working environment for personnel.

Recommendations have been developed for the industrial use of jet-bubble contact devices in scrubber units for the purification of dust-laden gas emissions. The proposed system is designed to be integrated into existing industrial dryers with minimal disruption. By utilizing a modified cyclone arrangement to compensate for hydraulic resistance, the scrubber unit can be installed as a highly effective secondary stage without compromising the overall airflow dynamics of the drying plant.

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Науковий керівник – Є. В. Манойло, к.т.н., проф.