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ПЕРЕРОБНОЇ ТА ХАРЧОВОЇ ПРОМИСЛОВОСТІ

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**ANALYTICAL REVIEW OF DALMEC PNEUMATIC MANIPULATORS FOR
WORKING WITH ROLL MATERIALS**

In the modern conditions of development of garment industry, the strategic task is to increase productivity and quality of production while simultaneously reducing the labor intensity of technological processes. Laying and cutting complexes play a key role in the preparation of materials, directly affecting the rational use of raw materials and the overall efficiency of production. However, the efficiency of even most modern complexes from market leaders, such as Lectra, Gerber or Kuris, is often limited by the low level of automation of auxiliary operations [1, 2].

One of the most laborious and physically demanding stages is the process of loading fabric rolls onto the laying tables. Traditional roll loaders, despite their widespread use, have significant limitations: they are mainly designed for linear movements and are ineffective in flexible production with a wide range of fabrics, differing in weight, width and type of winding [3]. Working with heavy rolls increases the risk of injuries and personnel errors, which leads to downtime of expensive equipment.

An alternative and promising approach is the integration of pneumatic manipulators, which provide high adaptability to specific production conditions. The world leader in this industry is the Italian company Dalmec SpA, whose technological equipment meets international quality (ISO 9001:2015) and safety (2006/42/EU) standards. The pneumatic drivers of Dalmec manipulators are distinguished by reliability, smooth movements and the ability to accurately balance the load regardless of external factors (high humidity, dust, etc.) [4].

For the needs of the textile industry, it makes sense to distinguish 6 main configurations of manipulators of the **Dalmec Partner** series (Fig. 1):

1) **Manipulator with adjustable forks.** Designed for a load capacity of up to 300 kg. Adjustable forks allow to grab rolls of different diameters, ensuring their rotation and tilt for precise positioning;

2) **Pneumatic balancer with vacuum gripper.** Uses a multi-stage Venturi ejector for non-contact handling of rolls weighing up to 250 kg. This is critical for delicate fabrics where mechanical clamping can damage the structure of the material;

3) **Manipulator with centering grippers.** Has a load capacity of up to 550 kg. The system automatically centers the roll during the gripping process, which minimizes errors during subsequent unwinding;

4) **Column manipulator with an expandable mandrel.** Designed for working with extra-heavy loads (up to 900 kg). Fixation is carried out by the inner sleeve of the roll, which ensures maximum stability during movement;

5) **Top-mounted system.** Optimal for departments with limited space. The manipulator moves along an aluminum rail system, using an axial pin to fix the roll;

6) **Manipulator with internal expandable cartridge.** Specialized solution for gripping rolls from the inner core side, capable of handling loads weighing up to 900 kg with the ability to rotate 90°.

The practical application of such systems at leading enterprises in Ukraine, in particular at the logistics centers of Intertop, Kadar shoe factory, as well as at the textile production plants of

Yaroslav concern and Rosa factory, confirms a significant reduction in the time for preparatory operations [5, 6]. The use of manipulators allows them to be integrated into general digital production management systems, which contributes to the transition to Industry 4.0.

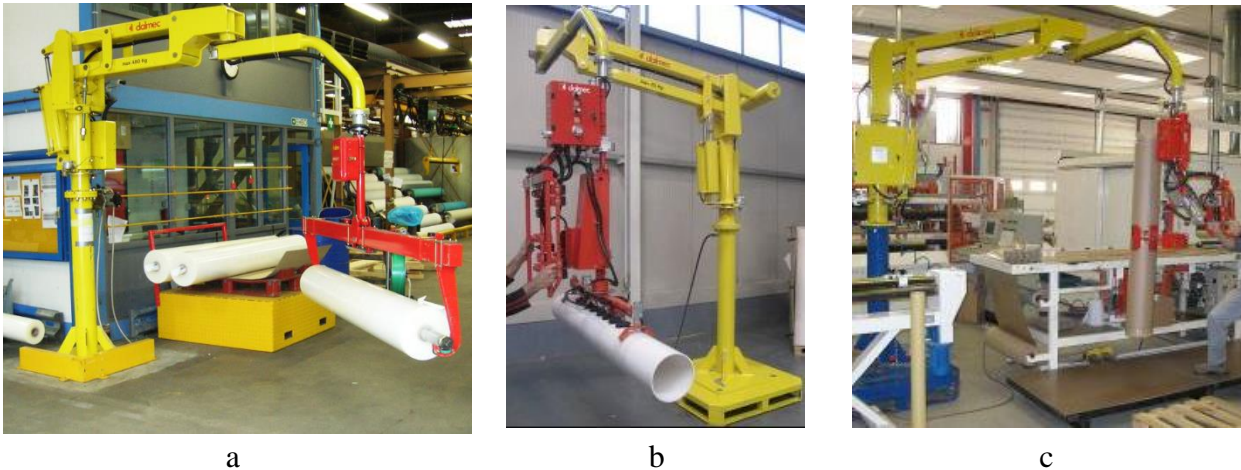


Fig. 1 – Dalmec Partner manipulators of various designs: a) with adjustable forks; b) pneumatic balancer with vacuum gripper; c) with centering grippers

The integration of Dalmec pneumatic manipulators instead of traditional loaders is a strategically justified step for the modernization of cutting and preparatory departments in garment manufacturing. This approach reduces the physical load of personnel, improves occupational safety, ensures high positioning accuracy of roll materials, minimizes material waste, and increases the overall flexibility of the production cycle. Compared to conventional equipment, pneumatic manipulators provide higher adaptability to varying production conditions and enable safe handling of materials with different characteristics through the use of interchangeable gripping devices. The effectiveness of such systems is significantly enhanced when integrated into digital production environments, supporting the transition to Industry 4.0 level. Their combination with CAD/CAM systems, automated storage solutions, and monitoring tools enables the creation of adaptive production systems. Further research should focus on evaluating the economic efficiency of implementation and the integration of manipulators with advanced technologies such as machine vision, artificial intelligence, and Internet of Things platforms.

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