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ANALYSIS OF THE CURRENT STATE OF NON-WOVEN FABRIC PRODUCTION FOR MEDICAL PURPOSES IN THE MATLAB PROGRAM

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Abstract
Nonwoven material have emerged as indispensable components in various industries due to their unusual properties such as softness, specific density and absorbency. In certain, in the medical field, nonwoven fabric has played an important role in products ranging from wound dressing to surgical curtains due to its ability to ensure more efficient protection and convenience to external antimicrobial patients. This paper presents an in-depth analysis of the current state of non-woven fabric production for medical purposes, utilizing the MATLAB program for comprehensive evaluation. The study focuses on the integration of advanced technologies, including automation, artificial intelligence (AI), and 3D-Lofter technology, to enhance production efficiency and quality. By implementing precise fiber placement and sophisticated control systems, these innovations contribute to the creation of high-quality, durable medical fabrics.

Keywords: nonwoven materials, spunbond nonwoven, meltblown nonwoven,spunlaced nonwoven, natural, silk waste, medical, control,system, production.

Introduction

Today, modern technologies are used for the production of non-woven fabrics. They are disposable products used for masks, wipes, masks, wound dressing and other medical protection. Products made from these non-woven fabrics are widely used in various fields in addition to medicine, and in recent years the requirements for them have increased. Non-woven fabrics are versatile materials and have various advantages for medical applications such as breathability, liquid resistance and economic capacity[1]. Non-woven fabrics are usually cheaper and more durable than consistency fabrics. [2,3]. There are physicochemical and mechanical methods of obtaining non-woven fabrics. Physicochemically, fibers or threads are attached with binder material (adhesives), heated and pressed, launched through paper-taking machines. In the filament method, synthetic fibers falling from the spinning machine filler (hole-hole device) are stretched by air, passing through special channels, then turned into fabric on the moving transporter. A tacky substance can also be used in this.

Mechanically, fabrics are obtained by sewing Holst (non-woven fabric from solid fibers), sewing and attaching threads, pressing wool fibers, and other methods [2]. There are many types of molten fibers such as Polyester non-woven fabrics, including Spunbond non-woven, molten non-woven (Melt-blown), SMS non-woven, needle-punctured non-woven , Spunlace non-woven , and composite non-woven fabrics.

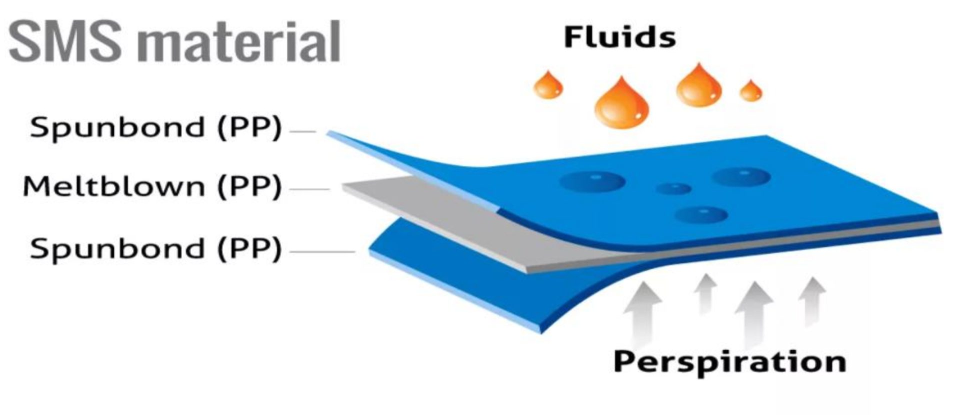

Fig. 1. Non Woven Medical Face Mask Production Line

In the United States, several enterprises are known for the production of non-woven fabrics of natural quality. Spunbond nonwoven fabric is made by converting continuous filaments of polypropylene or other thermoplastic polymers into a mesh-like structure. This means that it is famous for its strength, durability and uniform design. The Spunbond fabric is breathable, lightweight, and fluid-resistant, and is recommended for use as surgical, face masks, and safety clothing [3].

Table. 1. Double-S's Spunbonded Nonwoven fabric production line

Model NO.	ONL-M	Customized	Non-Customized
Condition	New	Name	Spunbonded Non Woven Fabric Production Line Ss
Non Woven Fabric Width	1.6m/2.4m/3.2m	Non Woven Fabric Production Output	5ton / Day
Non Woven Fabric Weight	10-260 Grams / Square Meter	Non Woven Fabric Machine Equipment	S Line/ Ss Line/ SMS
Non Woven Fabric Machine Packing	Within 4 Container	Non Woven Fabric Machine Shippin Time	Within 3 Month After Received Deposit
Non Woven Fabric Machine Support	3 Years Warranty	Transport Package	Accept Customer's Requirement, Within 4 Container
Specification	CE; ISO9001	Trademark	OUNUO
Origin	Zhejiang, Wenzhou	HS Code	8449009000

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Table. 2 Tres PP melt-blown nonwoven rolls melt-blown non-woven fabric manufacturer pp melt-blown for face

TECHNICAL INFORMATION SHEET				
Bacterial filtration efficiency (BFE 90-95%)-FFP2				
Est number:	Quality parameter	Union	Test method	THE MEAN IS GIVEN BY
1	Uniformity of weight	GSM	ASTM sample d 3776-96 &113mm	28 +_3
2	Color		Vizual	Oq
3	Width	MM	Scale	250 +_3
4	Rulo Diametri	MM	Scale	480
5	Rulo length	MTR	Scale	800
6	125pa air permeability in the head 20 cm2	CFM	ASTM D 737-96	40-45
7	Average hole size	mikron	PMI	10-15
8	Thickness	Mils	ASTM D 1777-96	14-16
9	Tenslle power	Lbs	ASTM D5035-95	
	MD			4-5
	CD			3-4

Kimberly-Clark offers a range of medical non-woven fabrics for surgical clothing, curtains, and sterilization wrappers, and supplies non-woven fabrics for infection prevention products.

The Berry factory manufactures spunbond and molten non-woven fabrics for medical and hygiene applications, including surgical curtains, face masks, and protective clothing[5].Freudenberg Korporatsiyasi yaralarni bog'lash, jarrohlik kiyimlari va bemorlarni yotqizish kabi tibbiy qo'llanmalar uchun ilg'or noto’qima matolar uchun echimlarni taklif etadi [4].

1 Method

2.1. Scheme and principle of operation of new technologies of non-woven fabric production enterprises

In recent years, the non-woven fabric industry has witnessed remarkable advancements through the integration of new technologies and innovative methodologies. These advancements are pivotal in enhancing the efficiency, quality, and environmental sustainability of non-woven fabric production. This paper explores the cutting-edge technologies that have revolutionized the industry and delves into their operating principles and schemes[6].

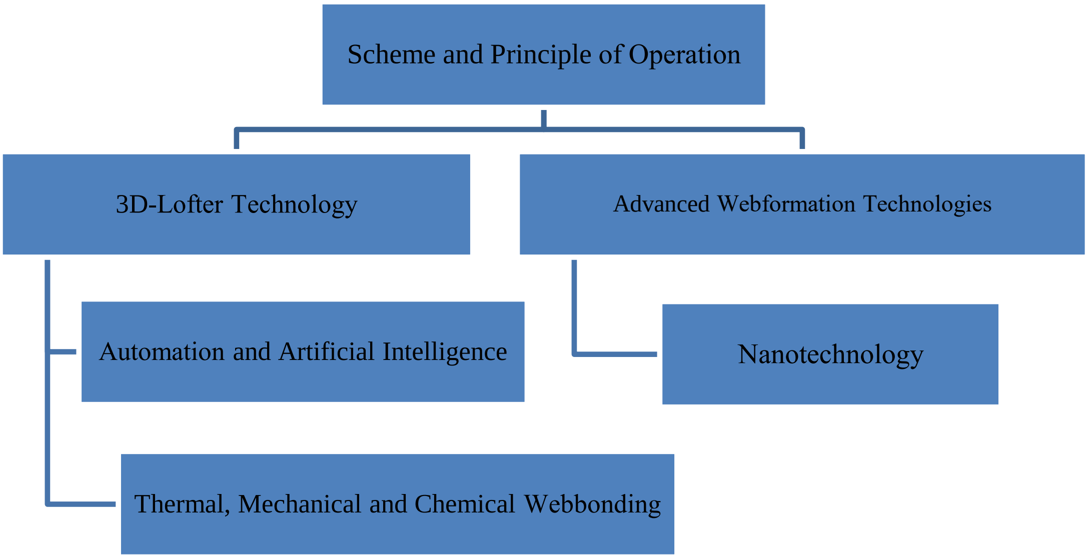

Fig. 2. Non-woven fabric manufacturing technologies

The Italian private company suggestion a comprehensive range of Master Roll Winders Slitter-Rewinders featuring state-of-the-art solutions customized to spunbond, spunmelt, spunlace and airlaid nonwovens roll merchandise production with a special attention on lightweight materials and high-speed production. The machinery range is completed by finishing & reprocessing lines including R-WAY Automatic Pack-aging System a modular, flexible and customizable system for reel handling and packaging, adjustableto any layout and any production line. Spunbond is a process in which polymers, such as polyester, are smelt at raised temperatures and extruded into filament fibers. The filament lattice is inadvertently arranged on the conveyor belt, and the spunbonded fabric is made by linking the fibers. Melt process is the main method of spunbond technology, in addition to dried or moist spunbond technology for choice. Fabrics compose by the spunbond process generally have strong strength, tensile resistance and steadiness, which is very relevant for agricultural geotextile, industrial filter materials, disposable medical cloth in the field of health care, etc. The specific order of spunbond method is introduced as follows[7].

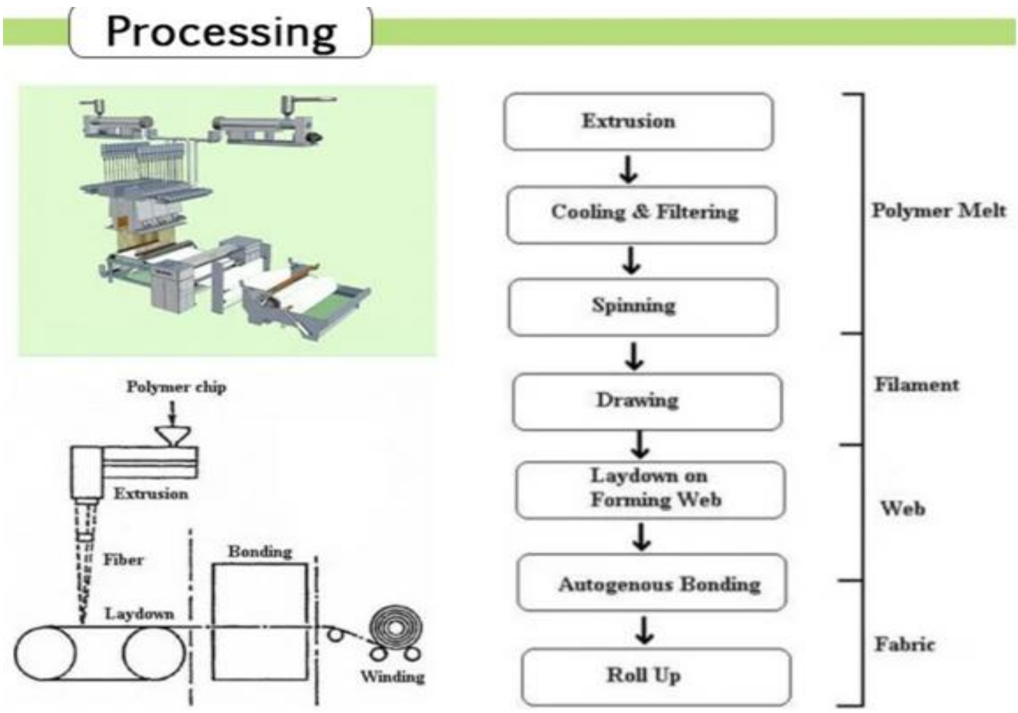

Fig.3. Overall schematic of spunbonding process

Characteristics and features of spunbonded webs are:

- Haphazardly fibrous structure
- Usually the web is white in color with high opacity per unit area.
- The base weight range is from 10 to 200 kg/m2

2 Results

3.1Annual analysis of non-woven fabric production enterprises.

In the half of 2023, the production of non-woven fabric has significantly decreased.By 2024, this situation has increased to a high level of production due to increasing demand.

Table 3. Non-woven fabric production enterprises investment in 3 years

Year	Production Volume (H, million m^2)	Quality Indicator (S, %)	Labor Efficiency (L)	Machine Efficiency (M)	Capital Efficiency (K)	Production Efficiency (P)	Quality Coeffici
2022	600	89	12	6	5	$\frac{600}{23} = 26.09$	$\frac{89}{600} = 0.15$
2023	650	90	12	7	6	$\frac{650}{25} = 26.00$	$\frac{90}{650} = 0.14$
2024	700	92	13	7	6	$\frac{700}{26} = 26.92$	$\frac{92}{700} = 0.13$

Defining Parameters

- Production Volume (H)
- Quality Indicator (S)
- Labor Efficiency (L)
- Machine Efficiency (M)
- Capital Efficiency (K)

Mathematical Formulas

This formula measures productivity. For example, if the production volume for 2022 is 600 million square meters, the labor efficiency is 12, the efficiency of the means is 6, and the capital efficiency is 5, the production efficiency is calculated as follows:

- Production Efficienc : $P = \frac{H}{(L+M+K)}$
- Quality Coefficient: $Q = \frac{S}{H}$

2022 year

✓ $P = \frac{600}{(12+6+5)} = \frac{600}{23} \approx 26.09$

✓ $Q = \frac{89}{600} = 0.15$

2023 year

✓ $P = \frac{650}{(12+7+5)} = \frac{650}{25} \approx 26.00$

✓ $Q = \frac{90}{650} = 0.14$

2022 year

✓ $P = \frac{700}{(132+6+5)} = \frac{700}{26} \approx 26.92$

✓ $Q = \frac{89}{600} = 0.15$

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The above formula measures the quality of the product.For example, if the quality indicator for 2022 is 89% and the production volume is 600 million square meters, the quality coefficient is calculated as follows. It was with the help of formulas and explanations to determine the volume and quality indicators of production, evaluate the efficiency of production. Through these coefficients, it was shown that it improves the efficiency and quality of the production process

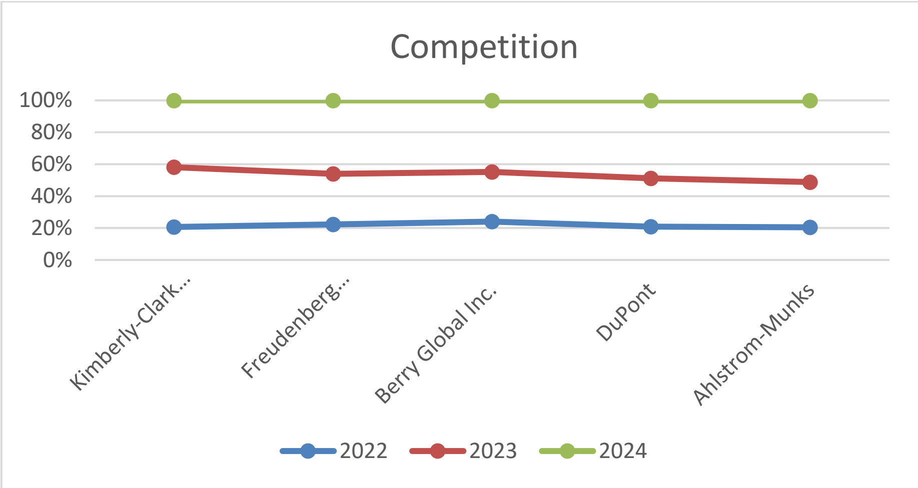

Fig. 4. Quarterly earnings from 2022 to 2024

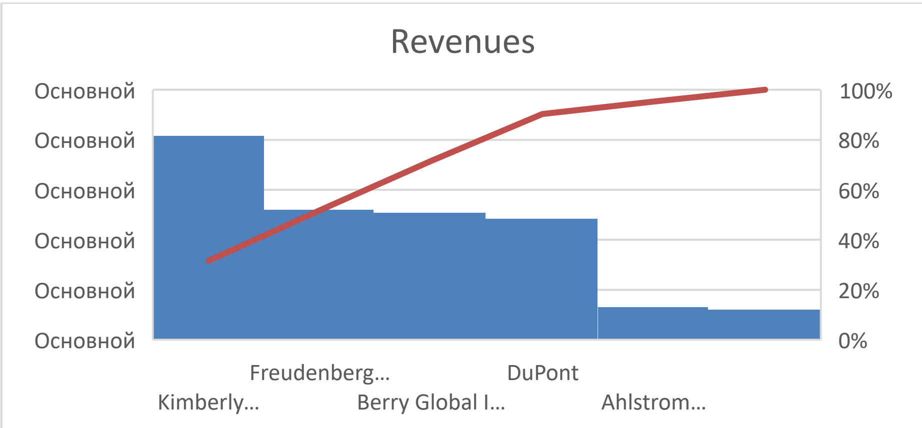

Fig. 5 Net income from 2024 to the last quarter report:

3 Discussion

4.1. Results of analysis of non-woven fabric production enterprises

Production volumes are constantly increasing compared to data from 2022 to 2024. In 2022, 600 million square meters were produced, while in 2024 this figure reached 700 million square meters. This indicates that production is constantly developing[8].

Production Efficiency (P)

We calculated the production efficiency based on the above formula. The efficiency index is on average around 26-28 million square meters, which indicates the stability of Labor, tools and capital efficiency. The peak in 2024 was 26.92, which means that production processes are optimized[9].

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Quality Coefficient (Q)

The quality coefficient has decreased slightly over the years, which indicates that the quality indicator has stabilized depending on the increase in production volumes. In 2020, this figure fell to 0.17, while in 2024 it fell to 0.13. This means that there is a slight decrease in quality, but still high quality is maintained.

The increase in annual volume refers to the expansion of production and the emergence of new market opportunities. Efficiency indicators indicate a high level of labor, means and capital efficiency.Although the quality coefficient has decreased slightly, it is still kept at a high level with an increase in production volumes[10].

Improvements in Production Processes: Technological development makes production processes efficient and fast using automation and artificial intelligence. For example, 3D-Lofter technology increases product quality and strength by accurately positioning the fibers. These technologies allow real-time control and optimization of production processes.

Technological and environmental innovations in non-woven fabric production processes are of great importance in improving efficiency and quality. However, changes in market demands and technical problems require overcoming for manufacturers. Constant innovation and quality control are necessary to ensure the stability and efficiency of production processes.

The introduction of advanced technologies in the field of non-woven fabric production is of great importance in improving the efficiency of production processes, improving quality and ensuring environmental sustainability. These technologies play an important role in improving the efficiency of production processes and fulfilling goals[11].

Automation and AI technologies increase speed and accuracy in the production of non-woven fabric. AI technologies allow real-time control and optimization of production processes, which reduces errors in production processes and increases efficiency. For example, when detecting and preventing malfunctions in the production line, automatic diagnostic and repair processes are carried out using AI systems. 3D-Lofter technology provides the ability to place fibers in specific places, which increases the structural strength and functionality of fabrics. Fabrics produced using this technology provide high quality and strength. For example, in the manufacture of medical fabrics, the properties of protecting fabrics from viruses and bacteria are increased by precisely placing fibers. With the help of nanotechnology, new properties are added to woven fabrics, such as high strength, durability and protective properties. The use of nanomaterials improves the filtration abilities of fabrics, which is widely used in the medical and industrial fields. For example, fabrics created using nanofibers filter out very fine particles and have high protective properties[12].

Program results related to 3D-Lofter technology and format of code written in Matlab:

```
% LowerLimbExoskeleton:: 4 axis, RRRR, stdDH, slowRNE
% +---+--------  +---------+---------+---------+---------+
% | j   | theta     |      d  |     a   |  alpha    | offset   |
% +---+--------  +---------+---------+---------+---------+
% |  1  |      q1     |        0|     0.1 |  1.5708|          0 |
% |  2  |      q2     |        0|     0.6 |           0|          0 |
% |  3  |      q3     |        0|     0.4 |           0|          0 |
% |  4  |      q4     |        0|    0.26|          0|          0 |
% +---+---------  +-------+--------+---------+---------+
```

```
% Denavit-Hartenberg parametrlari
DH = [
    q1, 0, 0.1, pi/2, 0;
    q2, 0, 0.6, 0, 0;
    q3, 0, 0.4, 0, 0;
    q4, 0, 0.26, 0, 0;
];
robot creation
L(1) = Link([DH(1,1) DH(1,2) DH(1,3) DH(1,4) DH(1,5)]);
L(2) = Link([DH(2,1) DH(2,2) DH(2,3) DH(2,4) DH(2,5)]);
L(3) = Link([DH(3,1) DH(3,2) DH(3,3) DH(3,4) DH(3,5)]);
L(4) = Link([DH(4,1) DH(4,2) DH(4,3) DH(4,4) DH(4,5)]);

robot = SerialLink(L, 'name', 'LowerLimbExoskeleton');

% Creating a look of a robot
q = [0, 0, 0, 0]; % Initial steps
robot.plot (q);
% Dynamic analysis
% (in order to slow down the network, take into account inertia and braking forces-magan)
```

The processes of manufacturing non-woven fabrics using 3D-Lofter technology and MATLAB Robotics toolbox will have innovative solutions. Allows you to create and get a view using the above code..Preliminary results provide great opportunities in measuring productivity and quality indicators. These processes take production processes to a new level by optimizing production and applying innovative technologies.

4 Conclusion

The current state of non-woven fabric production for medical purposes has been thoroughly analyzed using the MATLAB program. The integration of advanced technologies such as automation, AI, and 3D-Lofter technology has significantly improved the efficiency and quality of the production processes. These innovations allow for precise fiber placement, enhancing the structural integrity and functionality of the medical fabrics produced.The use of biodegradable and eco-friendly materials in the production process not only meets the high standards required for medical applications but also contributes to environmental sustainability. Energy-efficient manufacturing techniques further reduce the environmental impact, making the production process more sustainable.

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