Application of high frequency needle punching machine in the filament geotextile needle punching production line

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Contents

1. Research and development background
2. The structure of high frequency needle punching machine
3. Technical innovation of high frequency needle punching machine
4. The technological process of the filament geotextile needle punching production line
5. Application of high frequency punching machine in the filament geotextile production line

1. Research and development background

A. Needle Punching

- In the production of non-woven fabrics, the main key equipment in the needle punching production line is the needle punching machine, and the needle punching frequency affects productivity and quality of the nonwoven fabric.

- In the case of the same noise, amplitude and no oil leakage, stroke frequency is an important index to measure the technical level of needing punching machine .

- At present, frequency of common needle punching machine is less than1000 strokes/min, which is mainly used for producing leather base fabrics, automobile interior materials, garment accessories, etc. As usual, for producing filament geotextiles and asphalt base felts, frequency of common needle punching machines is not more than 900 strokes / min, and the noise and vibration are beyond the national standards.

- Due to the high capacity and fast speed of preparatory machine (>10 m/min), the conveying speed and frequency of the punching machine unit is required to be fast. Otherwise, advance stroke is too large, then needles will be broken. Generally, the advance stroke cannot be greater than 10 mm/needle.

1. Research and development background

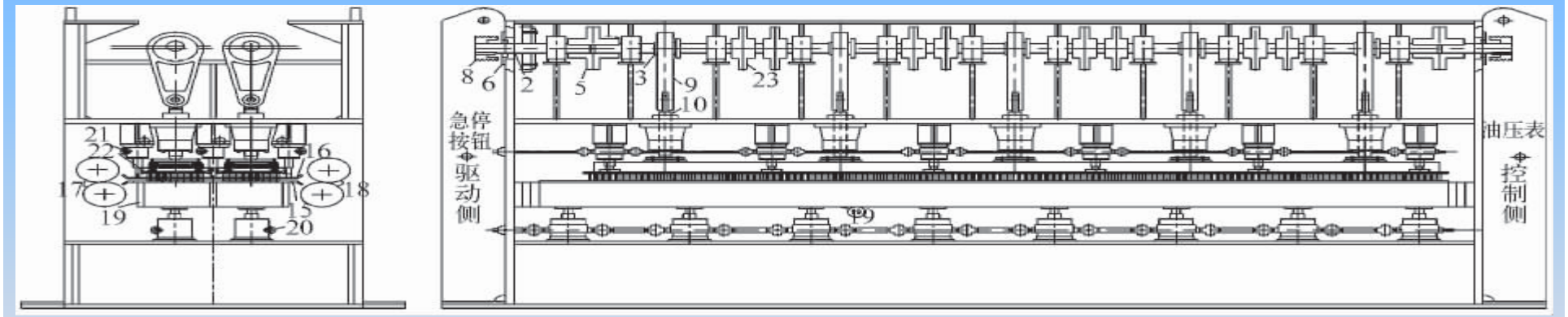
B. Filament geotextile felt

- The filament geotextile is the water-permeable synthetic filament material which is formed by needle-punching or weaving from synthetic filament fibers. It is a basic material used in the Civil engineering infrastructure construction.
- Compared with short-fiber geotextiles, filament geotextiles have the characteristics of small surface density, high breaking strength and high bursting strength. They have been widely used in railways, highways, sports venues, dams, hydraulic structures, tunnels, and beaches, reclamation, environmental protection and other infrastructure construction fields.
- With the continuation and deepening of China's infrastructure construction, filament geotextiles have developed rapidly in recent years, so the demand for high-frequency needle-punching machines has increased greatly, which is the right time to develop high-frequency needle-punching machines.

2. The structure of high frequency needle punching machine

A. The structure of common needle punching machine

- Generally, a large diameter *eccenter + through shaft* is adopted , which has large rotation inertia;
- One-piece frame is adopted. Machine frame is relatively short and the weight of the whole machine is light;
- The diameter of input roller or output roller is small and connected with the frame.



1—main shaft; 2—half shaft; 3—taper sleeve; 4—main shaft bearing block; 5—flywheel coupling;
6—half shaft bearing block; 7—pulley wheel; 8—balance wheel; 9—needle beam connecting rod;
10——push rod; 11—push rod guide sleeve; 12—needle beam; 13—needle board; 14——needle;
15——Bed plate; 16—stripper plate; 17—input roller; 18—output roller; 19—bottom board;
20——shock absorber; 21—stripper plate spiral lifter; 22—air clamping; 23—dynamic balance wheel

The above factors limit the improvement of the needling frequency of the ordinary acupuncture machine, and are also the problems to be considered in designing the high frequency needling machine.

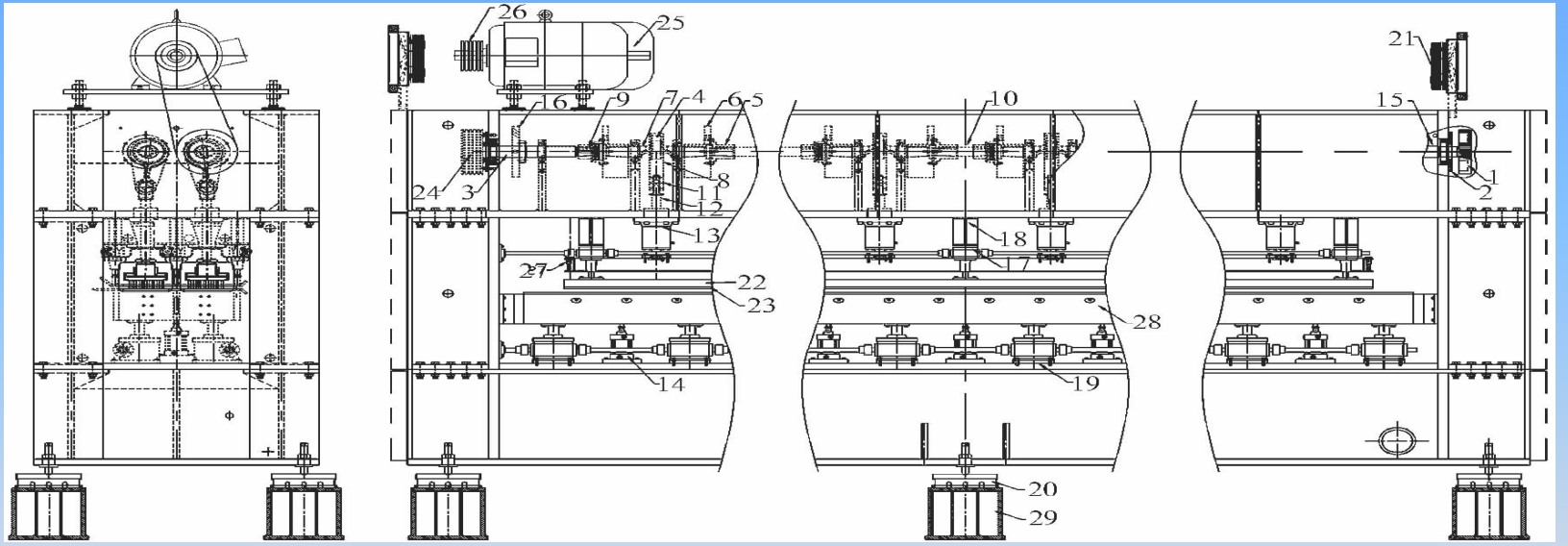
2. The structure of high frequency needle punching machine

B. The structure design of high frequency needle punching machine

- High frequency needling machine needs to solve the problems: the unbalance of high speed rotation and the thermal deformation of parts and components.
- Coupling is adopted, with automatic compensation function, low noise and less heat generation.
- An eccentric mechanism is adopted, the eccentric mechanism is connected by a flexible connection coupler to achieve the required width.
- The inertia of the crankshaft eccentric mechanism is small.
- The layer machine frame is adopted, so machine is high stability. The diameter of input roller or output roller is large, and the vibration of machine does not affect the operation of the conveying roller.
- Small outer diameter of the connecting rod bearing and the crankshaft bearing in the headstock, which is suitable for high speed (high frequency).

2. The structure of high frequency needle punching machine

2.Structure design



1—balance wheel; 2—half-shaft bearing block; 3—drive side half shaft; 4——bearing block;
5—flywheel coupling; 6—(crankshaft) coupling flywheel; 7——crankshaft; 8——needle beam connecting rod;
9—coupler; 10—Coupling; 11—pin shaft; 12—push rod; 13——push rod guide sleeve; 14——cylinder;
15—control side half shaft; 16—gear; 17——lifter; 18——50# lifter bracket; 19——80#lifter;
20—shock absorber; 21—radiator; 22—needle beam; 23——needle board; 24——main pulley12B5;
25—main motor; 26—motor pulley; 27—needle pin; 28——bottom board; 29——machine feet

3. Technical innovation of high frequency needle punching machine

The equipment has made technological innovation in the aspects of mechanical overall structure, material selection, component selection, processing technology and processing precision, automatic control and so on.

① A three-layer frame welded with high-quality thick carbon steel to increase rigidity and load carrying capacity. The frame is specially shaped and tempered by a special tempering furnace, so that each component s of machine are precision machined by a large five-axis machining center at a time.

② It adopts automatic forced lubrication system and unique guide structure (with tin-base alloy on the inner wall of the sliding sleeve), and uses a high-speed linear oil seal specially made in Western Europe. 3 years guarantee NO Oil-Leakage on the main shaft and push rod(s).

③ The screw rod and worm of the lifter for the bedplate and the stripper plate are special processing, so that the screw rod has no axial and radial bounce during the lifting process. Finally, the rigidity and impact resistance of the bedplate and stripper plate are improved.

④ The needle beam is one section, which is precision machined with aluminum alloy material to achieve light weight, high strength and ensure the synchronization of the needle board.

⑤ Polyurethane (PU) layer is casted on the needle board which is adopted a lightweight and high-strength magnesium alloy material by extrusion forming. Air clamping needle board for easy needle board change.

3. Technical innovation of high frequency needle punching machine

⑥ a). The thickness of the bed plate and stripper plate is respectively 12mm and 10mm. All of them are made of manganese alloy material with plated hard chrome after polishing. The surface of plates is not rust. The gap between the stripped plate and the bed plate is within 0.1mm after coincided.

b). "Three plates" are drilled by CNC machine , and the alignment error is ≤0.5mm;

c). The bed plate and the stripper plate can be lifted by electric-controlling separately. There are precision detection of the encoder, special scale display (including needle track) and automatic limit anti-collision device.

d). The inlet side of the stripper plate has a special structure to avoid blocking the fiber web.

It also can reduce drafting .

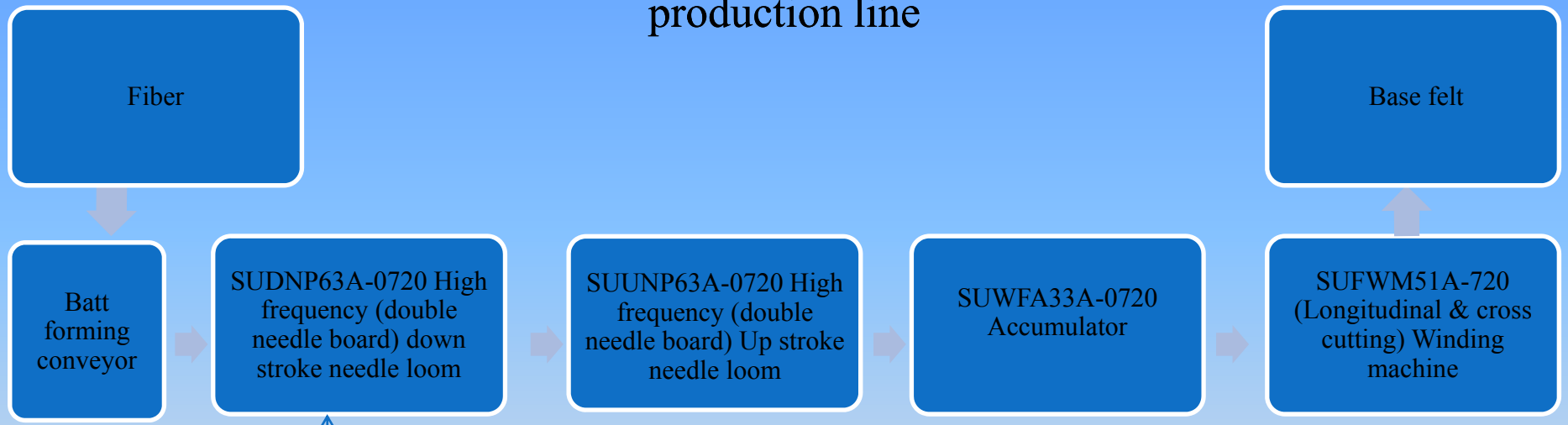
⑦ In the middle vertical window, an organic glass dust barrier is installed. The jog button for controlling the lifting of stripper plate and bedplate is installed next to the operation side window. The position is convenient for one person to jog and observe the lifting condition of the "three boards" at the same time.

⑧ Crankshaft structure is adopted, which can be operated at high frequency with low vibration and low noise.

⑨ Automatic control system is adopted. The operation screen can display all of process parameters of the needle-punching machine.

⑩ Linkage control: Two needle-punching machines are controlled by the drafting automatic adjustment device to prevent the fabric from falling or over-drafting. Each machine unit can be controlled separately or synchronously , so that simultaneous synchronization of the entire line to ensure uniform fabric quality.

4、 The technological process of the filament geotextile needle punching production line



- The 1st needle-punching machine is the pre-needling machine, adopts a high-frequency down stroke. Its purpose is to initially strengthen the filament fiber layer.
- Including: 1. compressing the thickness of the fiber layer, pre-reinforcing and entanglement of the fiber
- 2. eliminating the static during transporting of the web, to
- minimize the damage to the fiber
- 3. absorbing the dust generated in the needling process.

- The 2nd needle punching machine adopts a high frequency up stroke to enhance the entanglement of the filament layer
- including: 1. increasing the breaking strength of the fabric layer.
- 2. increasing the fabric density and making the fabric with better dimensional stability.

4、 The technological process of the filament geotextile needle punching production line

Technical parameters

1. Needle density ——related to the breaking strength, breaking elongation, density of the needle fabric, and surface condition of the fabric.

$$\text{Needle density (needle/cm}^2\text{)} = \frac{\text{Stroke frequency (stroke/min)} \times \text{Numbers of needles (needle/meter)}}{\text{Average transportation speed (meter/min)} \times 10000}$$

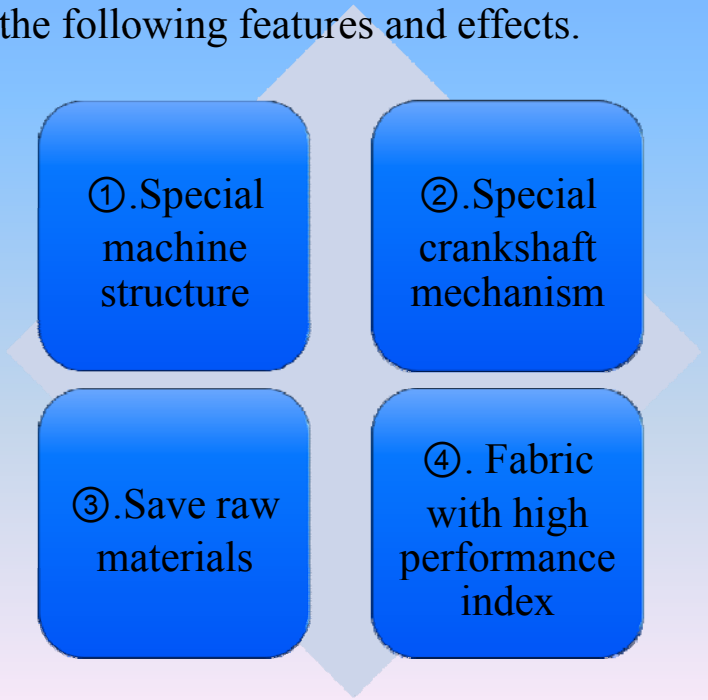
2. Needle depth——Related to the fiber raw material of the product, the quantity of the product.

The depth of punching of the pre-needle loom is 10mm, and the depth of the main needle loom is 7mm~8mm. The density of the needle, aperture of the stripper plate , the needle type and the strength of the fabric should be considered.

3. Drafting ratio ——In the operation , the speed of output is faster than the speed of the input. The ratio of the two speeds is called the drafting multiple. If the drafting ratio is too large, the needle will be broken. Different fabric with different draw ratio, which is related to the performance index. For example, the draft of the geotextile felt need large .

5. Application of high frequency punching machine in the filament geotextile production line

The high frequency needling machine has the following features and effects.



The filament geotextile needle punching production line has been applied to the production of polyester filament geotextiles and asphalt base felt.

①. Special machine structure

- When a polyester filament weight >200 g/m², the needle punching machine has low vibration, low noise, less heat generation, and no shaking.
- When the 215g / m² polyester filament product is produced at a needle punching frequency of 1500 strokes/min, the push rod has no oil leakage phenomenon.
- Temperature rise < 25 ℃, noise < 88 dB, machine energy consumption < 35KW·h.

②. Special crankshaft mechanism

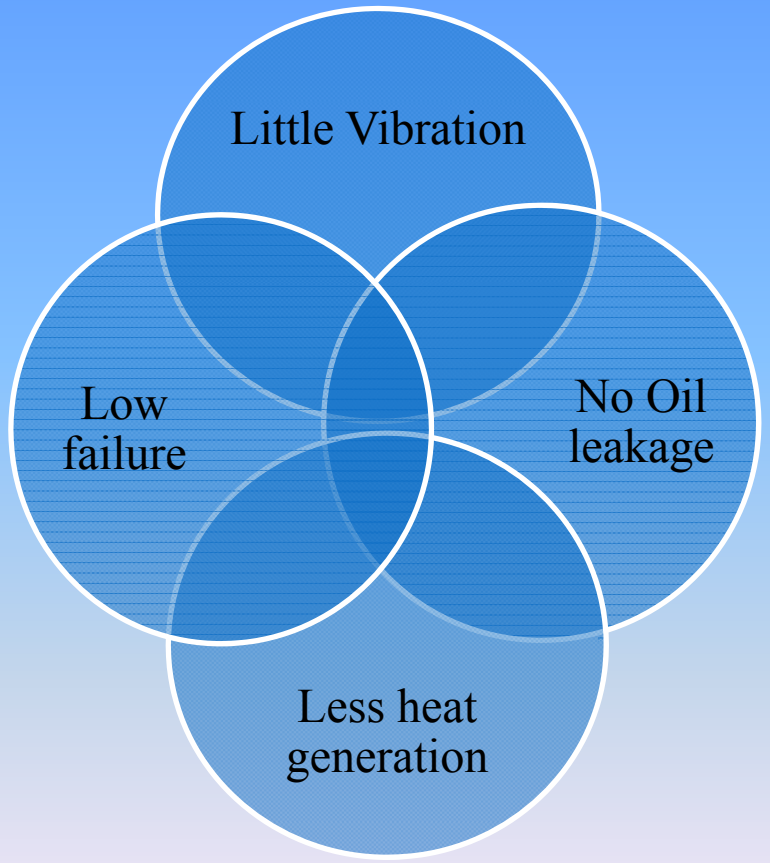
- It can adapt to high frequency during up to 1500~1600 strokes/min, small stroke quantity (about 8~12mm) and no broken needle, low failure rate, liner speed up to 12~18m/min or more, meet high production capacity requirements.

③. Saving raw materials

- The physical properties such as breaking strength, extension and thermal stability of the 200g/m² fabric are better than those of the similar products of 215g / m², which can save raw materials (slices) 7.5%. According to the line speed of 12m/min and the width of 6.8m, 1760 kgs of raw materials can be saved every day.

④. Physical property index

- Polyester filament geotextile and asphalt base felt have smooth surface and good air permeability.



Advantage of our high frequency needle punching machine

Our high frequency needle punching machine is high performance and the best choice for the filament geotextile production line.

Take advantages of 5-Axis Machining Center and focus on technical research to make a Ultra High-Frequency needle punching machine. Improve the frequency of needle punching machine to 2200-2400strokes/min

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Thank you!