

A brief discussion on the development of rubber single-screw extrusion dewatering unit with dual-support

Wu Dan

(Dalian Rubber & Plastics Machinery Co. LTD., Dalian 116036, Liaoning, China)

Abstract: This paper introduces the research and development principles and working mechanisms of a dual-support rubber single-screw extrusion dewatering unit. It enumerates the main performance indicators of the unit, provides a detailed analysis of the structure and technical highlights of its main components, and comprehensively discusses the electrical control system of the entire machine.

Key words: dual-support structure; rubber single screw extrusion dewatering unit; synthetic rubber; structure; technical points

Classification number: TQ330.46

Article number: 1009-797X(2026)04-0001-05

Document code: B

DOI: 10.13520/j.cnki.rpte.2026.04.001

In the early 1940s, the United States developed a standard production process for the post-treatment of synthetic rubber. In the late 1950s, mechanical extrusion dewatering machines began to replace vacuum drum dewatering. In the early 1960s, another significant advancement was made, namely the introduction of mechanical drying methods. The key equipment for high-performance post-treatment production lines is primarily provided by French and Anderson Form in the United States, and WE in Switzerland. The rubber single-screw extrusion dewatering machines from French and Anderson in the United States are typically placed horizontally, with the screw achieving a high compression ratio through diameter and pitch changes, and are generally of a combined type. The water content in the material is controlled by adjusting the size of the cone opening during discharge. The rubber single-screw extrusion dewatering machines from WE in Switzerland are usually placed at an incline, with the screw achieving a high compression ratio through a twisted cage and diameter changes, and are supported at both ends. The water content in the material is controlled by adjusting the size of the discharge opening during discharge.

The rubber single-screw extrusion dewatering unit is primarily utilized in the drying process of synthetic rubber post-processing production lines. It serves as a crucial equipment in the post-processing of synthetic rubber due to

its numerous technical key points, broad applicability, high performance index requirements, and high degree of automated linkage control.

After more than 70 years of development, China's synthetic rubber industry has embarked on a path combining independent technological development with the introduction of world-leading technologies, and has become an important industry with a relatively complete product system and high annual output. However, key post-processing equipment for high-performance synthetic rubber still relies on imports, which are expensive and have long procurement cycles for spare parts. To address these issues, Dalian Rubber & Plastics Machinery Co., Ltd. (hereinafter referred to as "Dalian Rubber & Plastics") has organically combined its years of experience in the research, development, and manufacturing of rubber extruders and rubber machinery. Based on the technological requirements of synthetic rubber processes, it has integrated advanced technologies from similar imported equipment and independently developed the "double-support form rubber single screw extrusion dewatering unit". This article introduces

Biography: Wu Dan (1975-), with a bachelor's degree, is a senior engineer primarily engaged in the research, development, and design of membrane equipment and synthetic rubber post-processing production lines. She was awarded the First Prize for Technological Invention by the China Petroleum and Chemical Industry Federation in 2021.

its research and development principles, working principles, main performance indicators, structural and technical highlights, and the electrical control system of the entire machine.

1 R&D principles of rubber single-screw extrusion dehydration unit

(1) Ensure technological progressiveness to meet the process technology requirements of synthetic rubber.

(2) High degree of automation, suitable for integrated control of the entire production line.

(3) The economy is relatively good, with the cost controlled at half of the price of imported equipment.

(4) High safety, energy-saving, and environmental protection.

2 Main performance indicators and structural features

2.1 Operating principle

The main motor provides power to drive the input shaft of the reduction gearbox to rotate. Utilizing a specific reduction ratio, a fixed speed is output, thereby driving the screw directly connected to the output shaft of the gearbox to rotate. The rotation of the screw facilitates conveying, compression with a high compression ratio, and mixing with specific pins, which squeezes out the water in the rubber compound and completes the removal of free water. The dehydrated rubber compound is pushed to the front end of the screw and cut by a cutter directly connected to the front end of the screw. The cut rubber particles are fed into the next process along a chute by their own weight. In the granulation system, the adjustment template and the fixed template are fitted together. The rotation power of the adjustment template is provided by a screw elevator, which rotates along the center of the fitting to adjust the aperture ratio of the template. The cutter is coaxial with the screw and does not require power drive, rotating at the same speed as the screw, thus achieving the cutting function.

2.2 Main performance indicators

(1) Properties of colloidal particles at the inlet of the unit:

Actual water content: 50%~60%;

Temperature: 80~90 °C;

Outline dimensions: 3~15 mm;

Other properties: unchanged.

(2) Properties of rubber particles at the outlet of the unit:

Actual water content: 8% ~ 12%;

Temperature: <100 °C;

Other properties: Unchanged.

2.3 Main structural features and technical highlights

The double-supported rubber single screw extrusion dewatering unit mainly consists of a main motor, a coupling, a reduction gearbox, a reduction gearbox lubrication system, an extrusion system, a pelletizing system, etc. (see Figure 1). Its characteristics are as follows:

(1) The unit adopts a structural form supported by double-end bearings.

(2) The screw and barrel are integrally welded.

(3) The template adopts a dual-piece assembly method, with one piece fixed and the other adjustable for rotation.

(4) The cutting blade is of a non-powered, plate-type design.

(5) All key components are made of stainless steel materials, supplemented by special heat treatment and hardening processes.

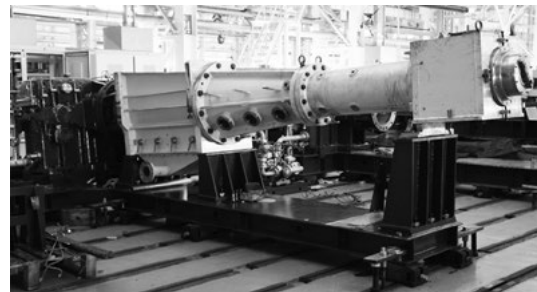


Figure 1 Double-supported rubber single screw extrusion dewatering unit

2.3.1 Main motor and coupling

The motor used is a three-phase asynchronous motor, with threaded holes on the frame for adjustment; the coupling used is an elastic pin coupling with a modular structure, and the elastic element is made of non-metallic material.

2.3.2 Reduction gearbox

It is mainly composed of a box body, a main shaft, gears, bearings, seals, etc. (see Figure 2). Its characteristics include compact structure, small footprint, strong load-bearing capacity of gears, and high transmission accuracy. The technical points

are as follows:

- (1) Integrated split structure.
- (2) All gear types shall be helical gears.
- (3) The gear material is high-quality low-carbon alloy steel, with surface hardening treatment and a precision level of 6.
- (4) The safety factors of all gears reach 1.5.

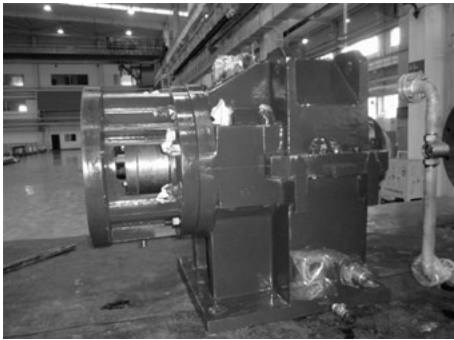


Figure 2 Reduction gearbox

2.3.3 Reduction gearbox lubrication system

It primarily consists of a pump, heat exchanger, filter, pipeline, and detection components. Its characteristics include compliance with ANSI design standards (see Figure 3), and the technical highlights are as follows:

- (1) An independent lubrication station is adopted, with one pump in operation and the other as standby, and interlocked for automatic start-up.
- (2) A manual dual filter with a filtration accuracy of 25 μ m is adopted.
- (3) Pressure and temperature control components are installed on the lubricating oil pipeline to achieve control interlocking and real-time monitoring.

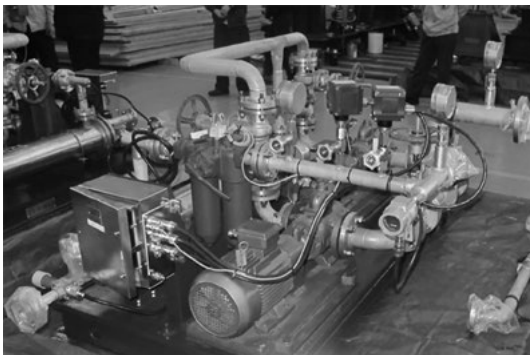


Figure 3 Reduction gearbox lubrication system

2.3.4 Extrusion system

It primarily consists of a screw, a feeding device, a

feeding section barrel, a compression section barrel, and an extrusion section barrel (see Figure 4).

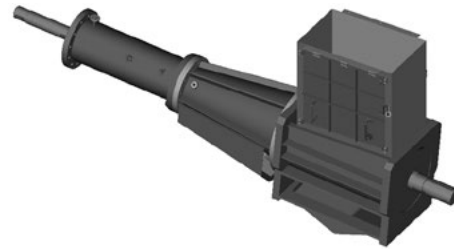


Figure 4 Extrusion device

2.3.4.1 Screw

It mainly consists of leads with equal spacing and equal depth, equal spacing and unequal depth, and unequal spacing and unequal depth (see Figure 5). The spiral part of the compression section is equipped with an inverted material slot, which features a large compression ratio and repeated material extrusion. The technical points are as follows:

- (1) Adopting a welded structure, the spiral rib is formed by sequentially welding spiral blades together.
- (2) The screw rod is supported at both ends.
- (3) The sealing at the end of the screw adopts a reverse thread and a skeleton oil seal.
- (4) The main shaft and spiral blade are made of stainless steel.



Figure 5 Screw

2.3.4.2 Feeding device

It mainly consists of the main frame, feeding door, sieve plate, gas collection hood, etc. Its characteristics include safety, reliability, and non-blocking, ensuring that gas is collected uniformly. The technical highlights are as follows:

- (1) Adopt a structure with both sides open for easy cleaning of the rubber compound.
- (2) The door is equipped with a safety switch that is interlocked with the host machine for control.
- (3) The material is stainless steel.

2.3.4.3 Feeding section barrel

It is mainly composed of a cylinder, flange, grating mesh, water collector, etc. (see Figure 6). Its characteristics include

a welded structure and two "drawers" that can be pulled out like Johnson screens, allowing a large amount of water to be discharged outside the cylinder. The technical points are as follows:

- (1) Below, there are two drawable drainage grilles that can be disassembled and assembled separately.
- (2) The barrel is equipped with a safety switch that can be interlocked with the host machine for control.
- (3) All external parts are equipped with reinforced rib structures.
- (4) The end face adopts a rabbet type to ensure positioning and sealing between the machine barrels.
- (5) All materials are stainless steel.

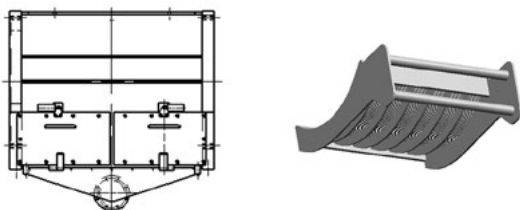


Figure 6 Feeding section cylinder

2.3.4.4 Compression section barrel

It is mainly composed of a cylinder, flange, sieve plate, collection cover, etc. (see Figure 7). Its characteristics include a conical welded structure, with reinforcing ribs welded on the outside, and detachable Johnson screens on the lower side and bottom surface to discharge a large amount of water out of the cylinder. The technical points are as follows:

- (1) Adopt welded structure.
- (2) The barrel is provided with pin holes.
- (3) The inner hole is provided with uniformly distributed longitudinal grooves.
- (4) The end face adopts a seamless joint design to ensure positioning and sealing between the machine barrels.
- (5) All materials are made of stainless steel.

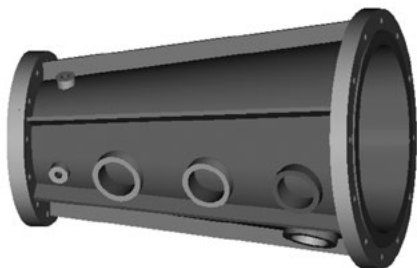


Figure 7 Compression section cylinder

2.3.4.5 Extrusion section barrel

It mainly consists of the cylinder, jacket, flange, etc. (see Figure 8). Its characteristics include the adoption of a welded jacket structure, where steam is passed through the jacket to preheat the cylinder and control its temperature. The technical points are as follows:

- (1) Structural characteristics of the extrusion section barrel.
- (2) The cylinder is provided with pin holes.
- (3) There are connection holes for temperature and pressure sensors on the flange near the machine head.
- (4) The inner hole is provided with uniformly distributed longitudinal grooves.
- (5) All materials are stainless steel.

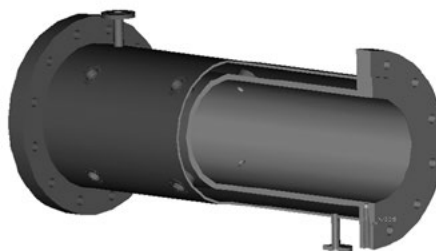


Figure 8 Extrusion section barrel

2.3.5 Granulation system

It mainly consists of a template adjustment device and a cutting blade device (see Figure 9).

The template adjustment device utilizes a direct-coupled reducer transmission pair to drive the rotation of the adjustment template. The magnitude of the rotation is monitored by a displacement sensor connected to the transmission pair's lead screw, enabling online adjustment of the aperture ratio of the two templates.

The cutting device primarily consists of a granulation box, a moving template, a fixed template, a cutter head, cutting blades, etc. The granulation box adopts a welded structure. The cutter head is directly connected to the screw shaft via a flat key, and the cutting blades are secured to the cutter head with screws. The adjustment template and the fixed template are fitted onto the center of the screw shaft. Both templates have the same number and size of holes. When the screw shaft rotates, it drives the cutter head to rotate, achieving the granulation effect. The surfaces of the core components are all hardened.

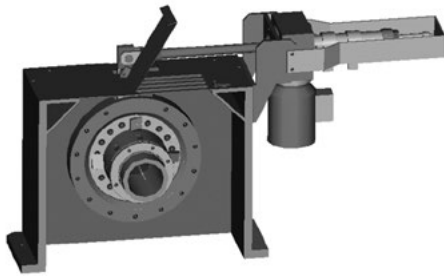


Figure 9 Pelletizing system

2.3.6 Electrical control system

The control system utilizes control technologies such as PLC program control, PROFIBUS bus technology, remote I/O, Ethernet access, and human-machine interface, along with dual-redundancy main control technology. The parameter setting is simple and easy to operate.

A network-based control structure is adopted, where the operation status of the unit is monitored and controlled by the operator station in the control room or the on-site operation cabinet. The control system of the unit utilizes PLC, and data exchange between the operator station in the control room and the PLC is conducted via Ethernet. PROFIBUS communication is employed between the PLC master and slave stations, between the PLC and the on-site operation cabinet, and between the PLC and the drive cabinet. The PLC cabinet is equipped with a Modbus communication module, enabling data to be provided to the supervisory DCS system through Modbus communication.

The touch screen displays various important parameters (speed, current, opening, temperature, pressure, etc.) and indicates whether there are faults in the slave stations,

facilitating maintenance.

The unit is equipped with a safety status monitoring interlock. The unit is not allowed to start up before it meets the startup conditions (displayed on the main console). During operation, if the process conditions are not met, the unit will automatically shut down and trigger an alarm, with corresponding indications displayed on the human-machine interface.

The unit is equipped with an industrial computer. It can display and set important parameters of the unit during operation, and can also store historical operation data for future analysis and use. The storage function of alarm records allows for future viewing, fault analysis, and maintenance and repair.

3 Conclusion

Currently, "Dalian Rubber & Plastics" has produced multiple sets of "double-support form rubber single screw extrusion dewatering units" and delivered them to users for use. Through formal production and operation, it has been proven that the determination of main technical performance parameters, the design of some device functions and electronic control systems, etc., are reasonable and advanced, capable of reaching the contemporary international advanced level. They have replaced imported products, offering good economic efficiency, high safety, energy conservation, and environmental protection. This has formed a double-support form rubber single screw extrusion dewatering and extrusion unit with independent intellectual property rights, which has become the company's new product and also a new economic growth point for the company.