HOT
Process For Environment

HOT (Chengdu) Industries Co Ltd

H-TBS Coal Slurry Separator (Hydrosier)

About HOT

HOT (Chengdu) Industries Co Ltd (former HOT Mining)a national high-tech enterprise, is committed to providing the resource industry with services from exploration to pit closure, including consulting and design, core equipment supply, intelligence, and "one-stop" engineering technical service.

HOT has successfully applied the latest technology to mining and mineral processing practice, such as XRT Intelligent Ore Sorter, X-ray Coal Ash & Moisture Analyzer, XRF Pulp Grade Analyzer, Dynamic Density Control for Dense Medium Process, Intelligent Grinding Efficiency Optimization System and other mineral processing intelligent equipment and intelligent process control system.

ABOUT Our Services

1. Pre-Feasibility Study, Feasibility Study, Concept Design, Engineering Design, Project Budget for Coal Preparation Projects;

2. Equipments and Spare Parts——Fans, Cyclone, Centrifuge, Filter Press, spiral, kinds of crushers, TBS,etc;

3. Operations for CHPP;

4. Intelligent System for Mining and Coal Washery;

5. Materials Handling System & Express Train/Truck Loadout System.

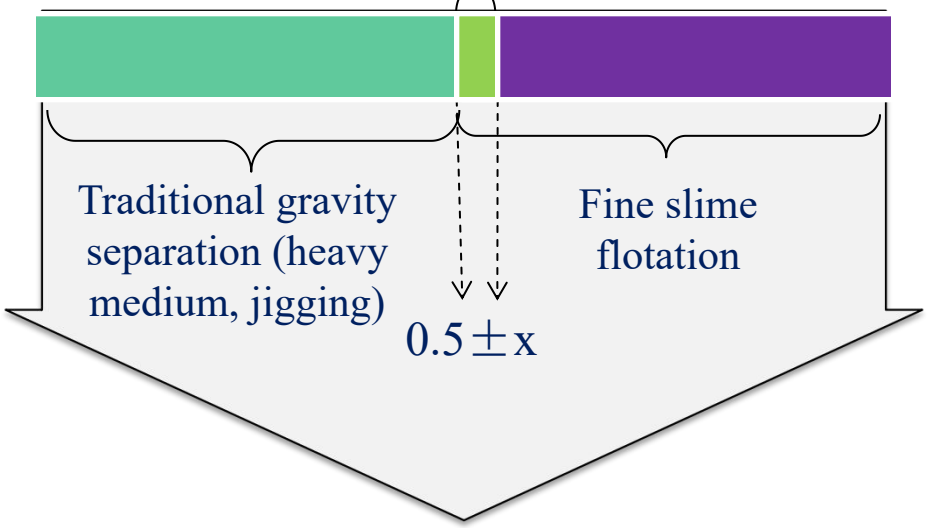
TBS Coal Slurry Separator

Traditional **Gravity Separation - Flotation** Process

Coarse slime sandwiched in the middle cannot be effectively separated

affecting the quality and yield of the final cleaned coal

and damaging the economic benefits of the coal preparation plant

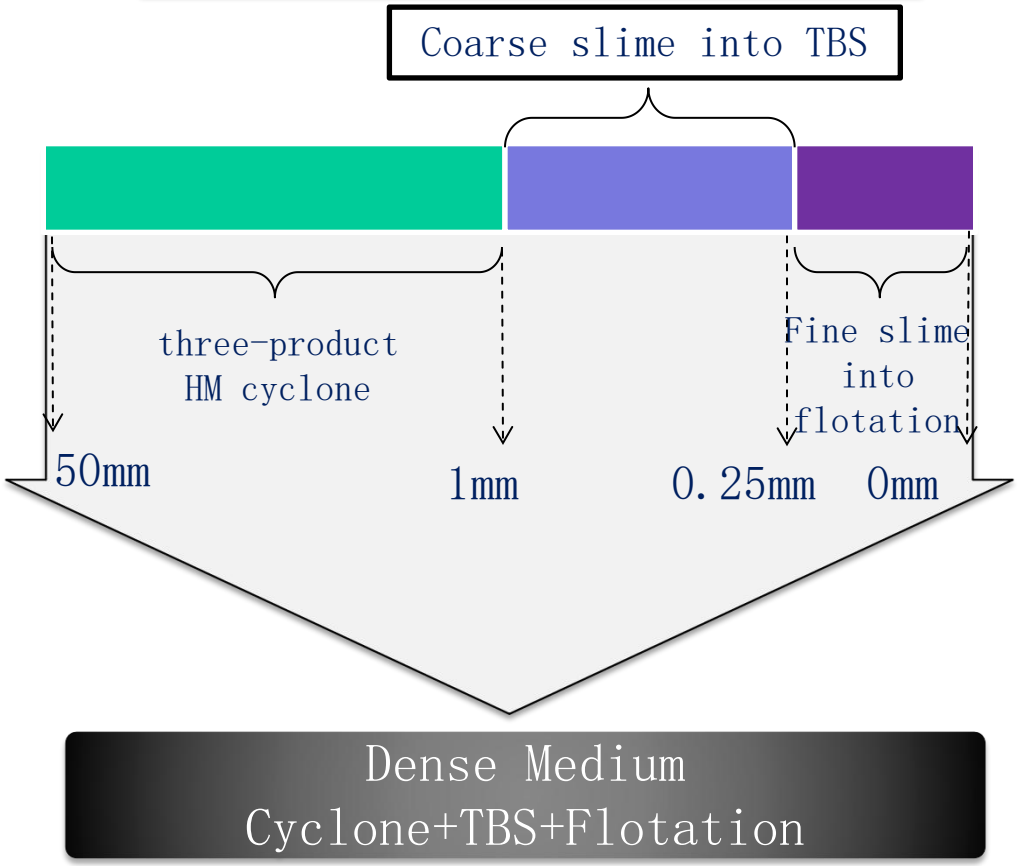


- Although many processes such as shaking table, spiral separation, water medium cyclone and so on can be used to treat coarse coal slime, either due to **the limited effect or the high processing cost**, they have not achieved satisfactory results.
- In recent years, the emergence of new **Teetered Bed Separator** has attracted much attention.

Dense Medium Separation+Flotation

- Teetered Bed Separator, in short form, TBS.
- The first TBS made in the United States was introduced into China and put into operation in September 2005 at Xima Coal Preparation Plant of Shenyang Coal Industry (Group).

TBS Production Process of Xima Coal Preparation Plant of Shenyang Coal Industry (Group)



Dense Medium Cyclone+TBS+Flotation

Introduction - TBS Advantages and Problems of Imported TBS

TBS Advantages:

- Wide sorting granularity（3-0.15mm）
- Adjustable separation density（1.3-1.8g/cm^3）
- No need to add heavy agents and chemicals.

Problems of Imported TBS:

- Inadequate pertinence to the nature of incoming materials.
- Equipmnet price is too high.
- Technical and after-sales services are not timely.
- Long parts supply cycle (generally 6 to 8 weeks).

Introduction——HOT H-TBS Series Teetered Bed Separator Prototype

Working Principle: The interference bed separator is a kind of interference sedimentation separation equipment that **uses the rising water flow to generate turbulence** in the cylindrical tank. Due to the different density and particle size of feed particles, the settling speed of particles is different.

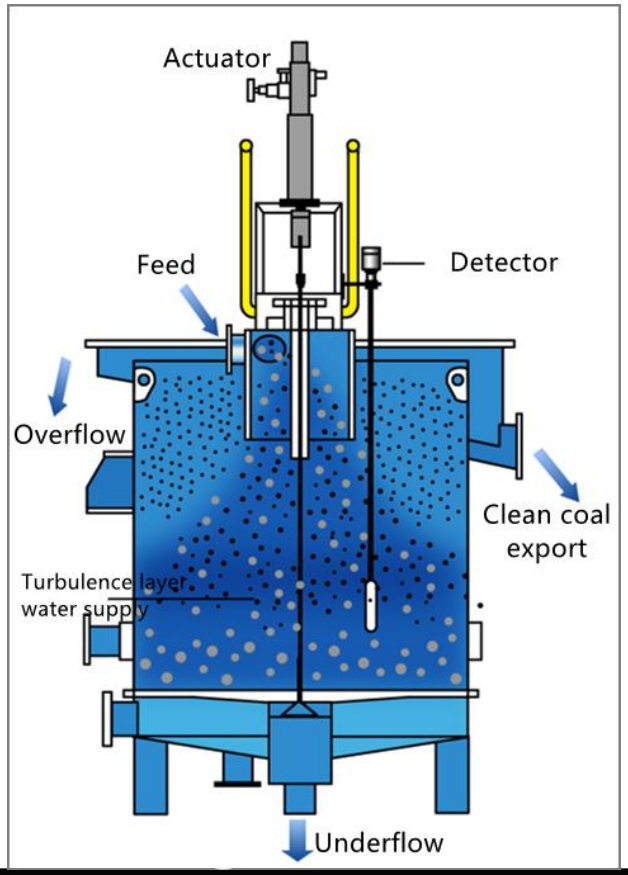


Figure 2-1 Working principle of interference bed separator

The role of rising water flow provides conditions for particle separation:

- When the **falling speed of feed particles is equal to the rising water flow speed,** he particles are suspended in the separation equipment forming a separation bed;
- When the **feed particle speed is less than the rising water flow speed**, the particles are carried to the overflow under the action of the rising water flow and become **concentrate**;
- When the **feed particle velocity is greater than the rising water velocity**, the particles move downward, pass through the separation bed, become **tailings**, and discharge from the underflow port, thus realizing the effective separation of concentrate and tailings.

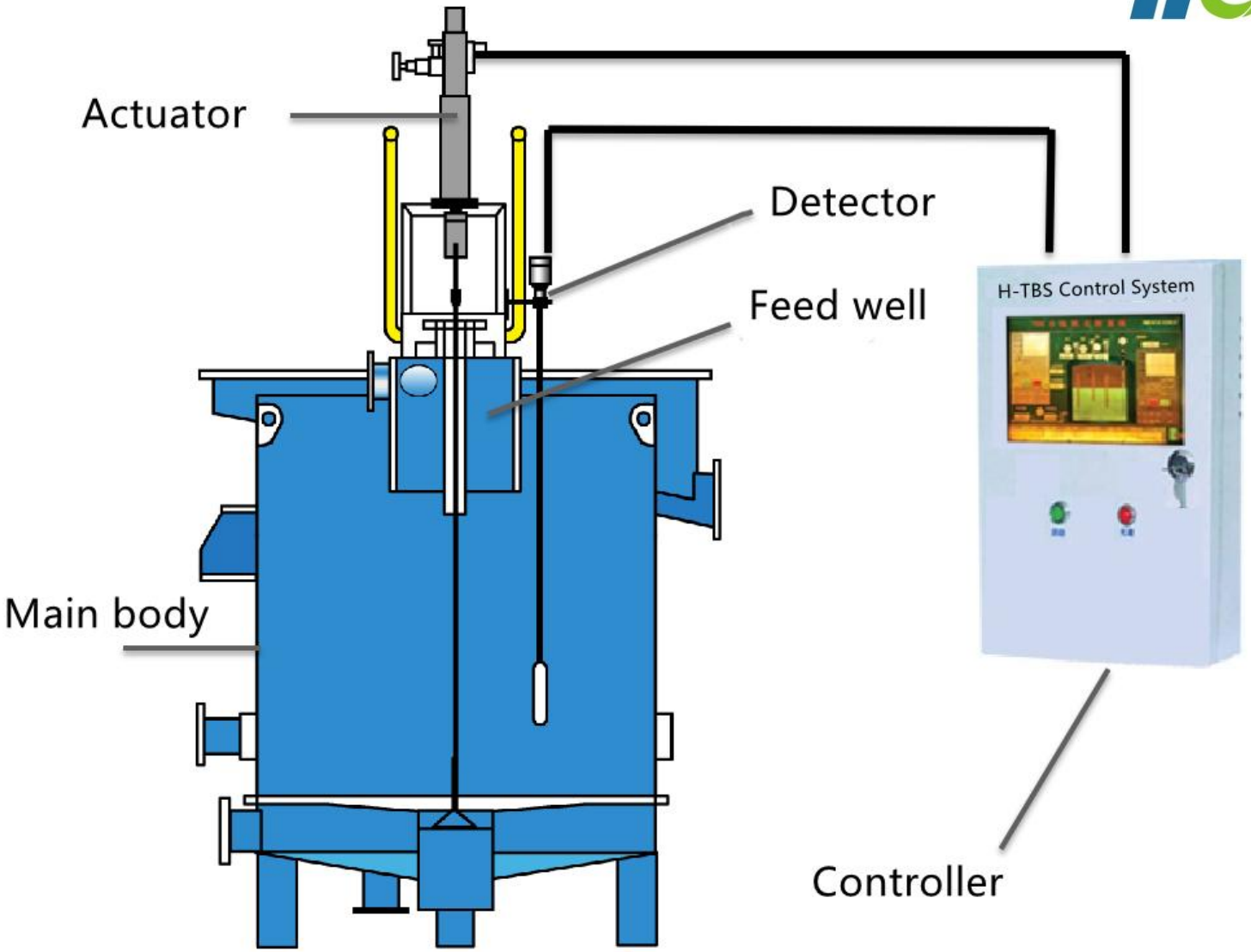
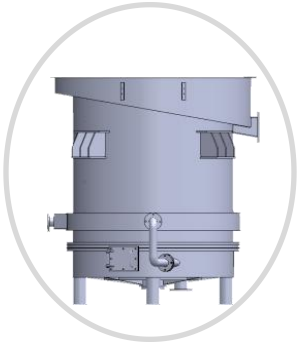


Figure 2-2 Schematic diagram of H-TBS Series Teetered Bed Separator



Mainbody

- The **actuator** is composed of actuator, connecting rod device, shuttle valve and valve seat. The core of the actuator is the actuator.
- H-TBS series interference bed sorter uses **electro-hydraulic actuator**.

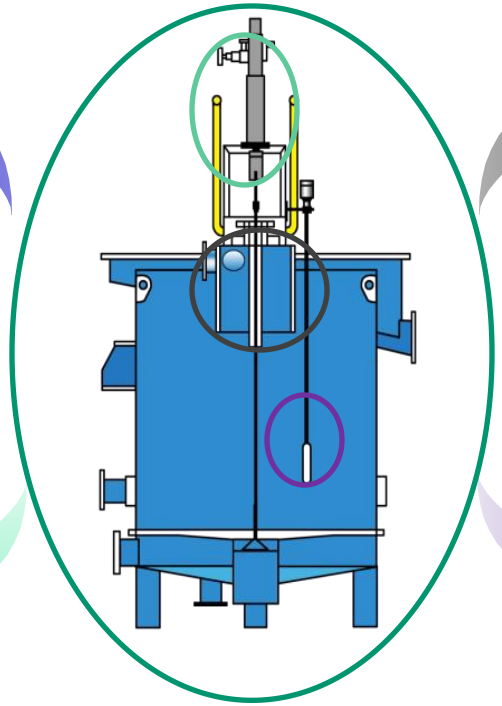
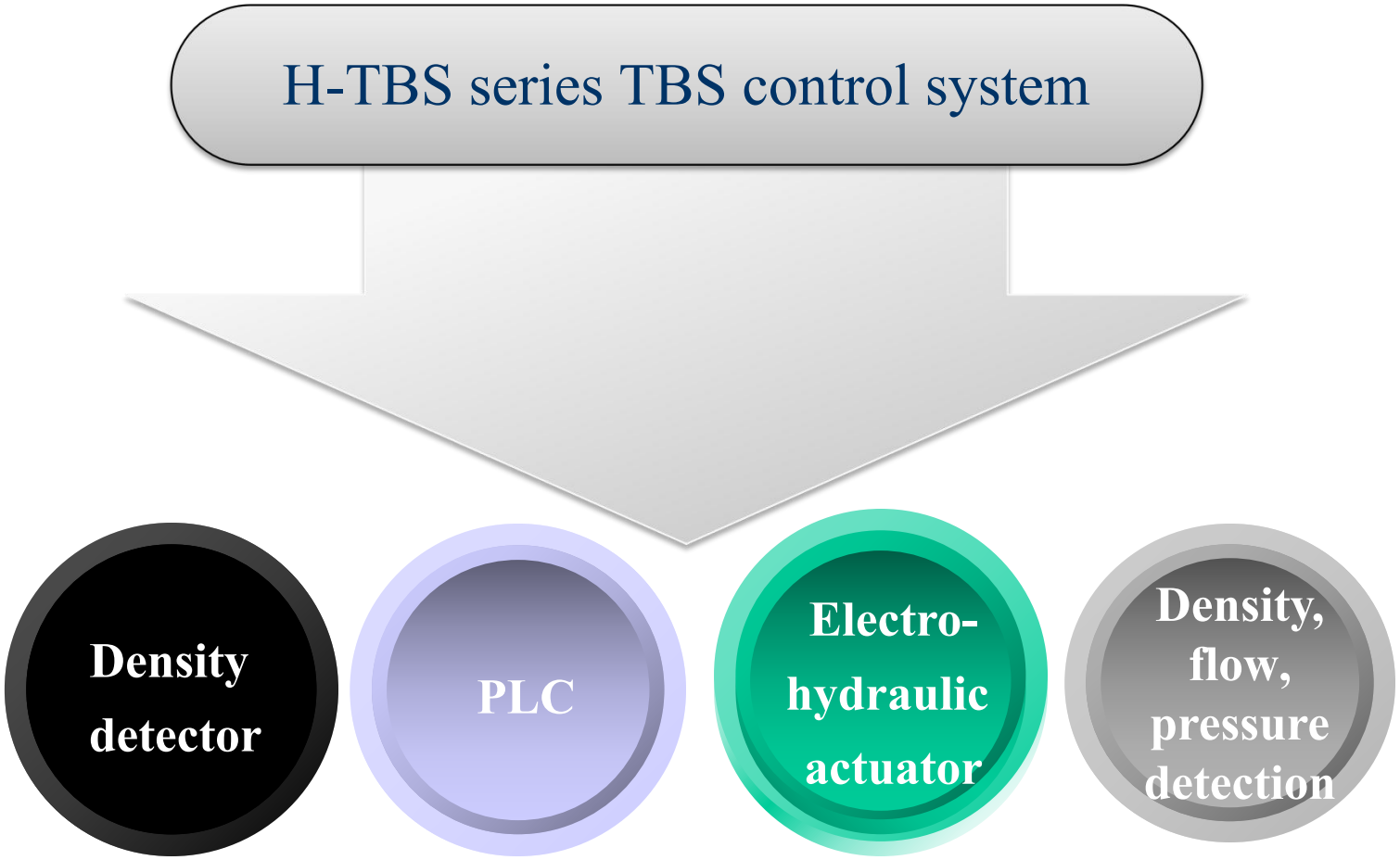


Figure 2-2 Equipment structure composition of H-TBS series TBS

- The material enters the feed shaft along the direction of **scroll involute;**
- The feed well evenly feeds the feed into the interference bed separator, and the feed well is lined with wear-resistant corundum (composition AL2O3) to increase the service life.

- Detector, also known as sensor, is located in the middle of the sorting bed. The density of the turbulent bed in the interference bed separator is different, and the pressure is also different.
- The H-TBS series interference bed sorter uses the density detector produced by Germany Endershaus Company.

Equipment Structure - Control System



Equipment Structure - Control System

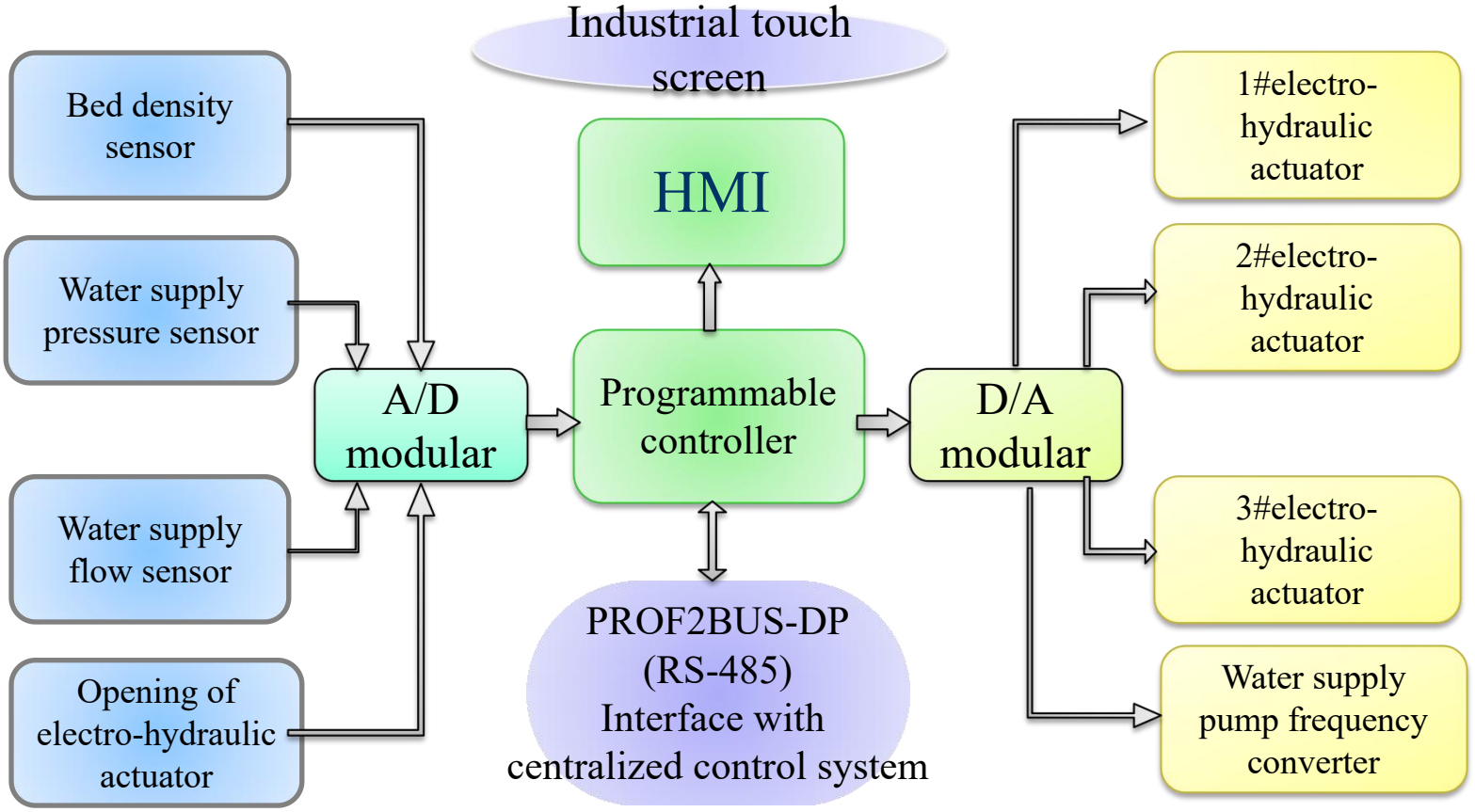
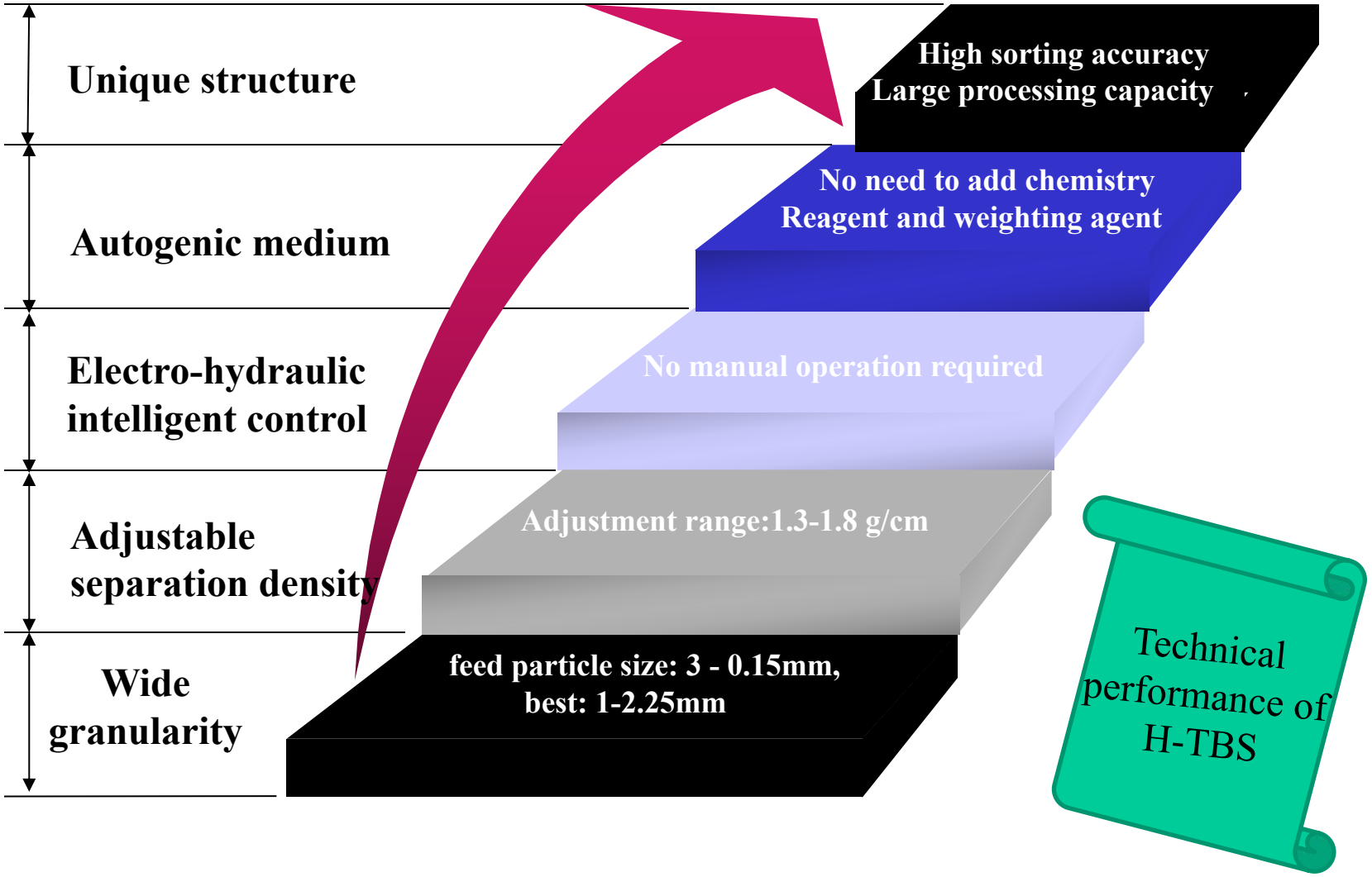


Figure 2-3 PLC control system block diagram of H-TBS series TBS

2.3 Technical characteristics and performance of H-TBS

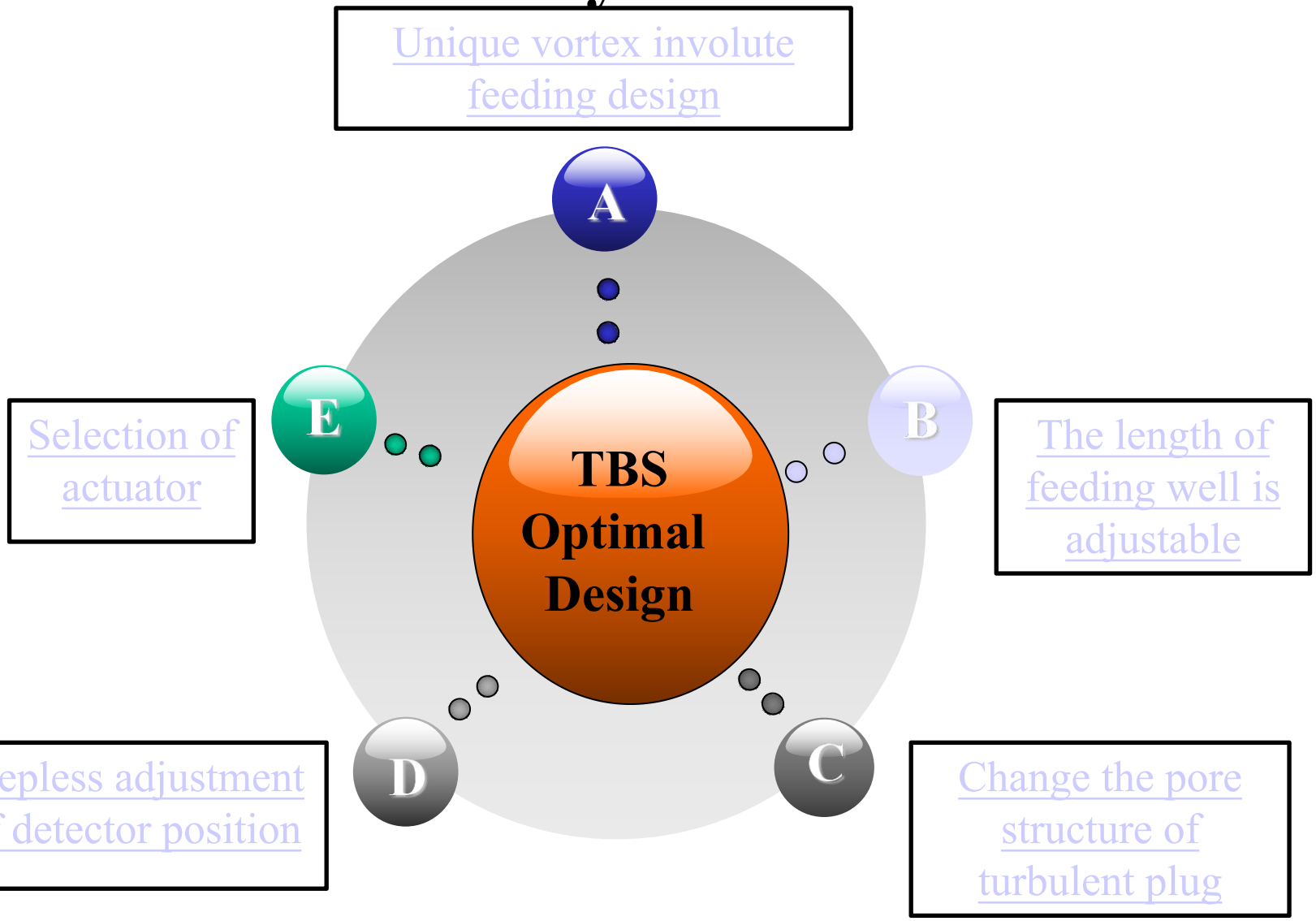


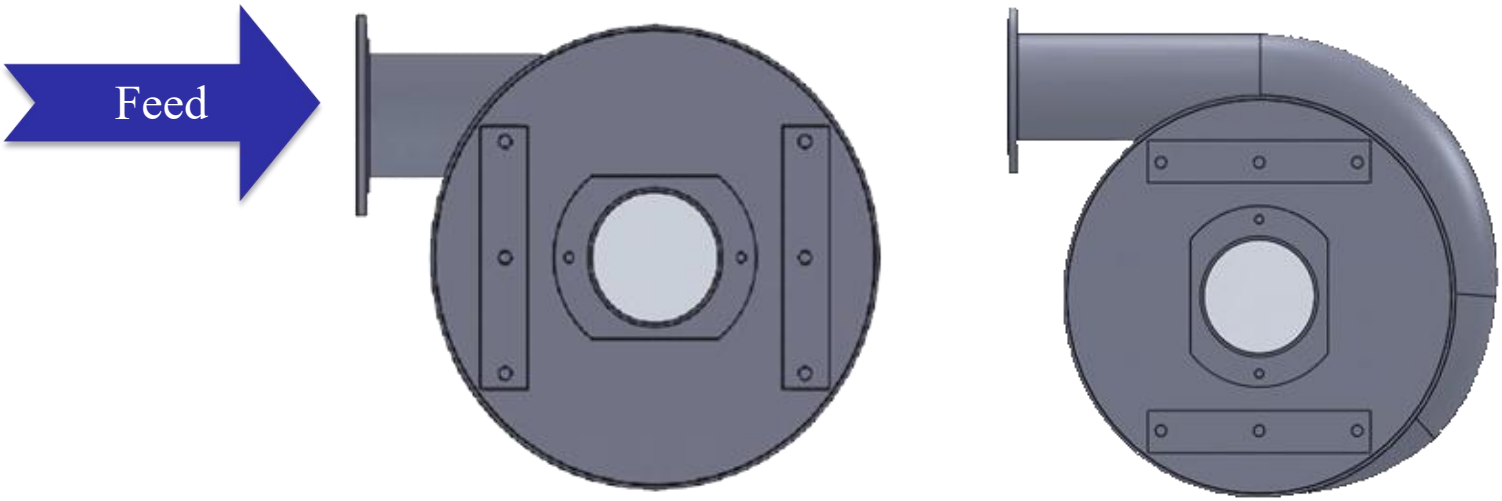
Technical Parameters of H-TBS

Table 2-1 Technical Parameters of H-TBS

Model / Diameter	H-TBS-1800	H-TBS-2100	H-TBS-2400	H-TBS-3000	H-TBS-3600
Box diameter(mm)	1800	2100	2400	3000	3600
Process capacity(t/h)	50-60	70-80	90-100	110-130	140-160
Feed size(mm)	1-0.25	1-0.25	1-0.25	1-0.25	1-0.25
Feed concentration(%)	45-50	45-50	45-50	45-50	45-50
Rising water volume(m^3/h)	50-60	70-80	80-90	90-100	110-120
Rising water pressure(Kpa)	70	70-100	70-100	70-100	80-110
Bed density(g/cm^3)	1.3-1.8	1.3-1.8	1.3-1.8	1.3-1.8	1.3-1.8
Actuator type	Electrohydraulic	Electrohydraulic	Electrohydraulic	Electrohydraulic	Electrohydraulic
Number of tailings discharge outlets	1	1	3	3	4
Actuator power(Kw)	0.55×1	0.55×1	0.55×3	0.55×3	0.55×4

3.1 Optimal design of high-efficiency TBS



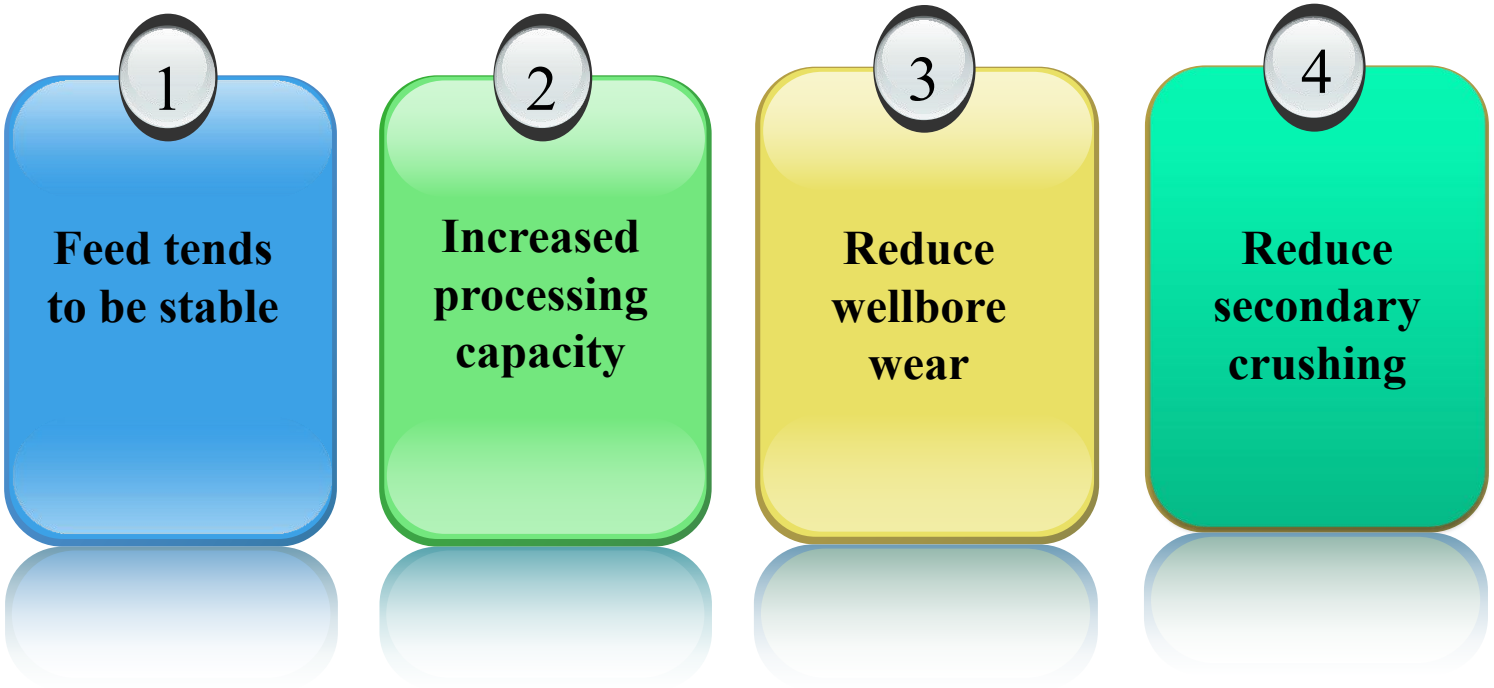


Top view of feed shaft in tangent direction

Top view of vortex involute feed shaft

Fig. 3-1 Involute Feed Shaft

Compared with the tangent method, the scroll involute feeding method has the following advantages:



A. Optimized design - adjustable length of feed well

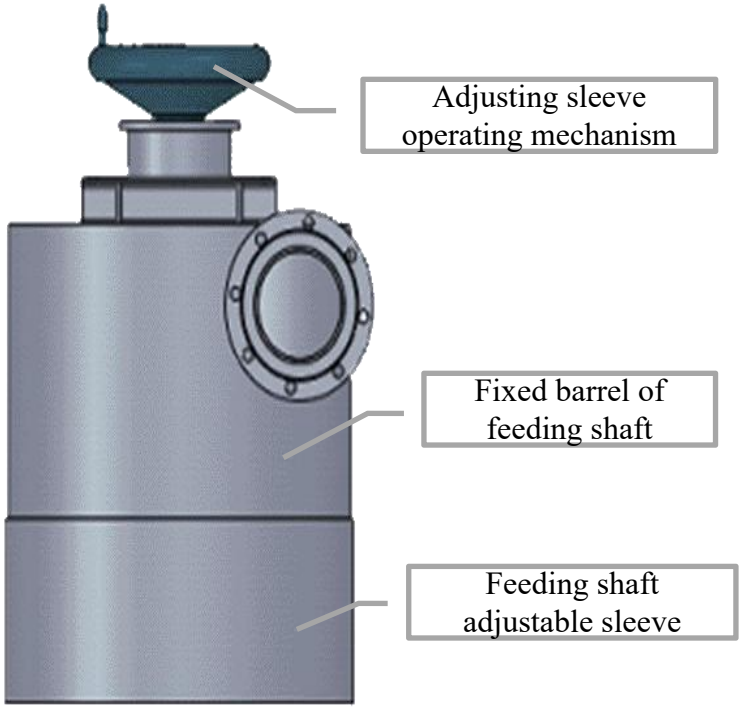


Figure 3-2 Schematic diagram of feeding shaft length adjustable mechanism

The length of the feed well directly **affects the separation time and separation effect of the material.**

The length of feeding pipe set for this test is:

- L_1=140mm;
- L_2=270mm;
- L_3=500mm;
- L_4=600mm;

- **When the feed concentration C=300g/L and the water volume Q=81mL/S remain unchanged**, See Table 3-1 for the relationship between the length of feed pipe and product quality and sorting effect:

B. Optimized design - adjustable length of feed well

Table 3-1 Comparison of feeding tube length and sorting effect

Length（mm）	Ash content（%）	Quantity efficiency（%）	Imperfection（I）	Possible deviation（Ep）
140	15.12	95.26	0.133	0.076
270	12.80	91.31	0.151	0.072
	12.37	90.18	0.186	0.081
	1.80	89.65	0.192	0.084

From the experimental results, it can be seen that under the condition that some process adjustment factors remain unchanged, the effect of feed pipe length on the separation effect is quite obvious.

C. Optimal design - change the pore structure of the turbulent plug

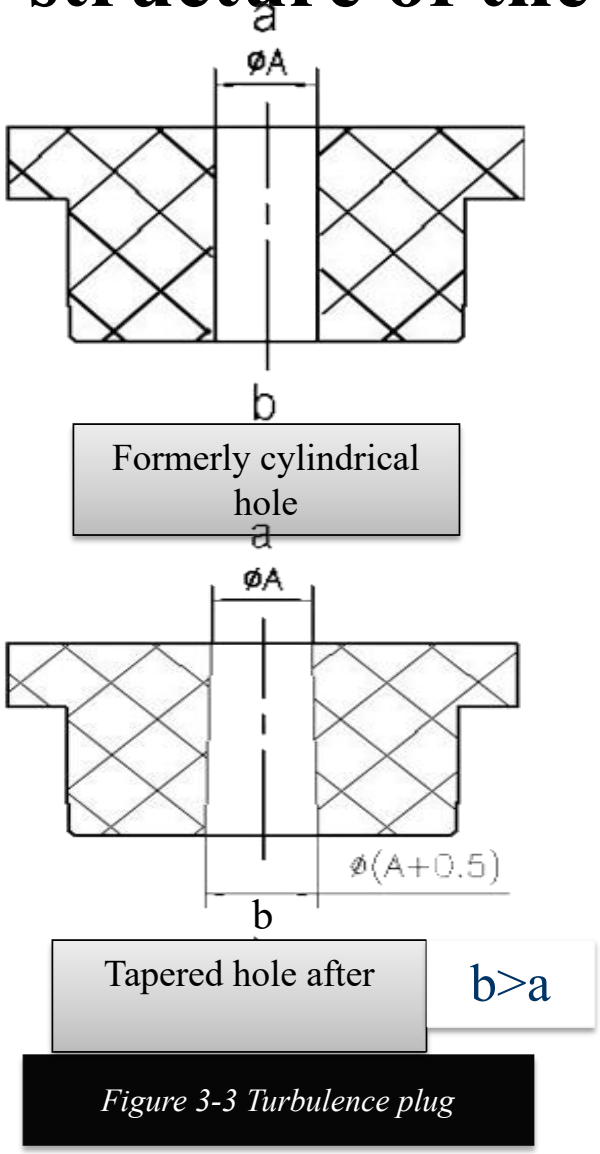


Figure 3-3 Turbulence plug

- In order to solve the problem of turbulence plug plugging, **the vertical hole of turbulence plug is changed into a conical hole.**
- **In normal production,** the rising water flows from b to a, a<b, and the material particles at the end of a are easily impacted by the rising water, and then participate in the separation.
- **After stopping,** the materials in the interference bed will gather at the top of the turbulence plug under the action of gravity;
- **Due to the small hole diameter at the top of the turbulent plug and the large hole diameter at the bottom,** even if the material enters the turbulent plug hole, the rising water can easily lift the material in the trapezoidal hole and **maintain a good penetration rate.**

D. Optimal design - infinite adjustment of detector position

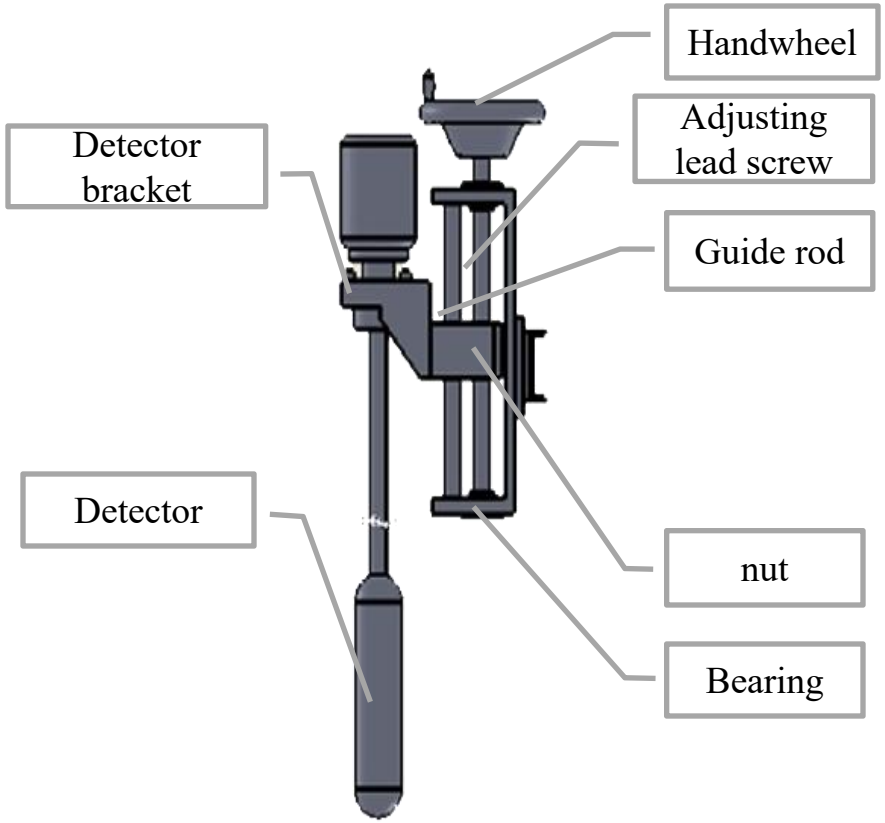
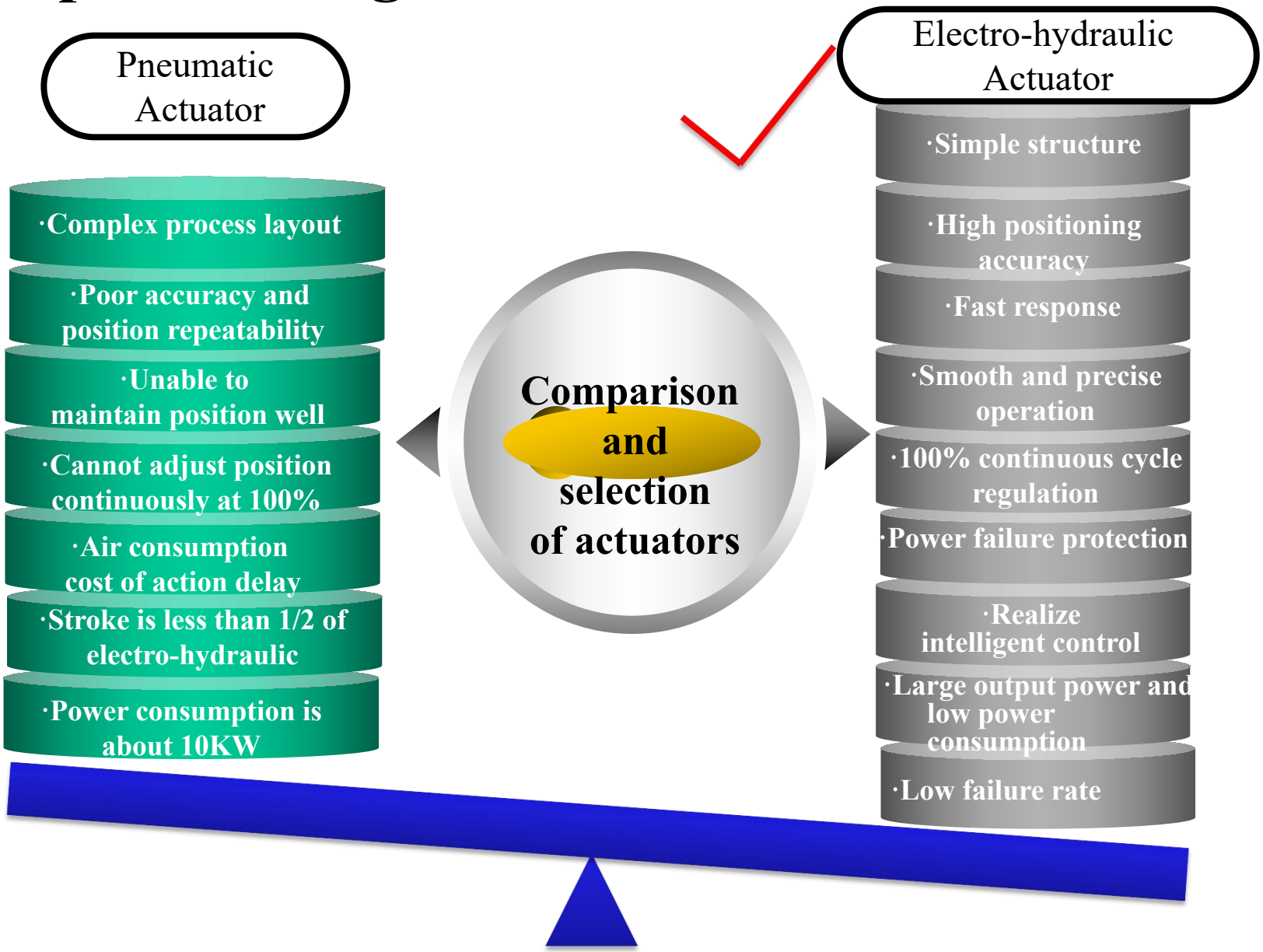
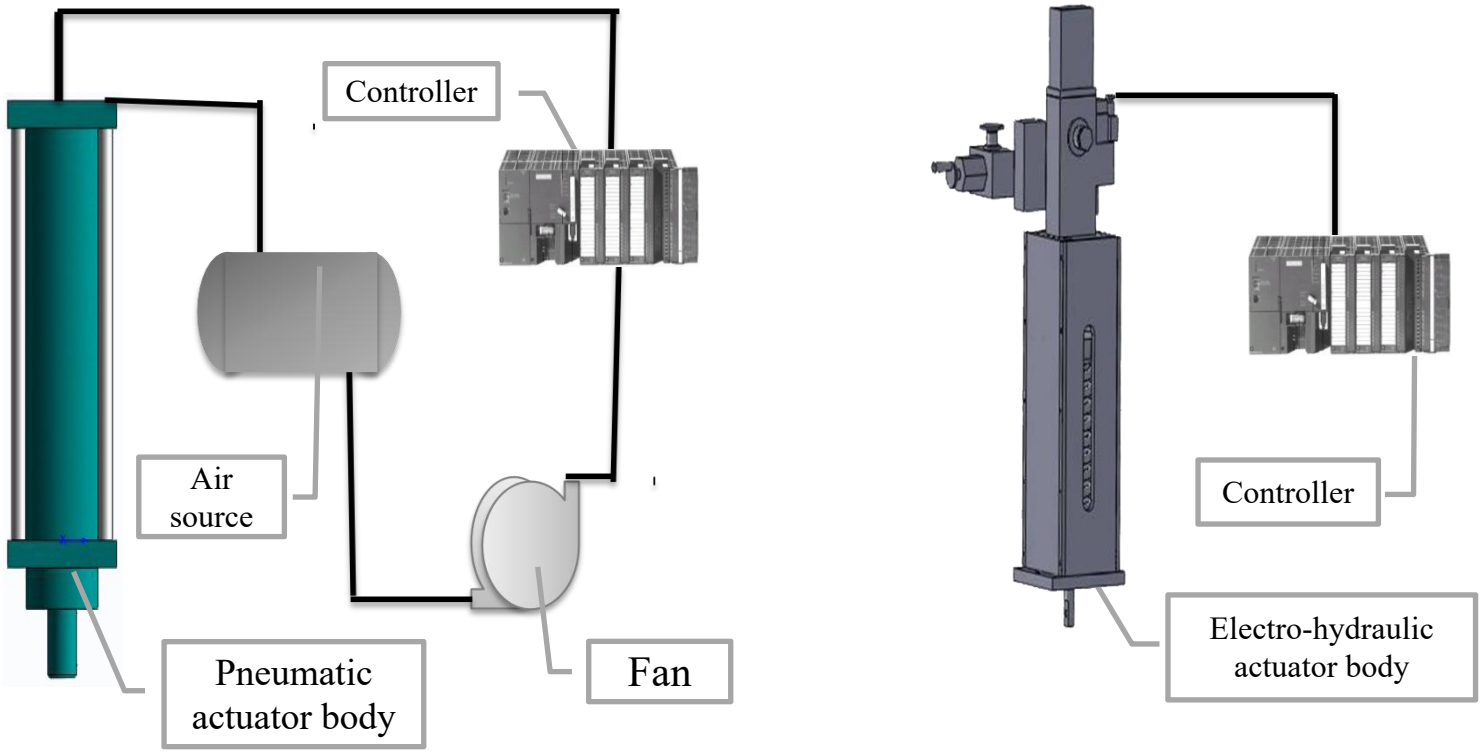


Fig. 3-4 Detector adjustable mechanism

- The position of the separation bed of the interference bed sorter is determined by a variety of factors. Placing the detector **at the position that best represents the separation density** of the bed can also transmit accurate signals to the actuator.
- See Fig. 6 Detector adjustable mechanism:
- During commissioning, the detector is placed in the middle of the interference bed sorter. **In actual operation, the detector is gradually adjusted to the best position according to various indicators and then locked.**

E. Optimal design - selection of actuator





Complex pneumatic actuator layout process

Simple electro-hydraulicactuator layout process

Figure 3-5 Schematic diagram for comparison of process layout of pneumatic and electro-hydraulic actuators

3.2 Optimal design of H-TBS series process system

Optimization design of process system		
Feeding system of TBS	Water supply system of TBS	Eliminate siphonage in water supply pipe

3.2

1 **Feeding system** of TBS

2 Water supply system of TBS

3 Eliminate siphonage in water supply pipe

The feed particle size range is generally: 3-0.15mm

The best particle size range is from 1 to 0.25 mm, i.e. 4:1

Select a classification cyclone efore TBS

Domestic multi-selection classification hydrocyclone group

Large-diameter hydrocyclones are often selected abroad

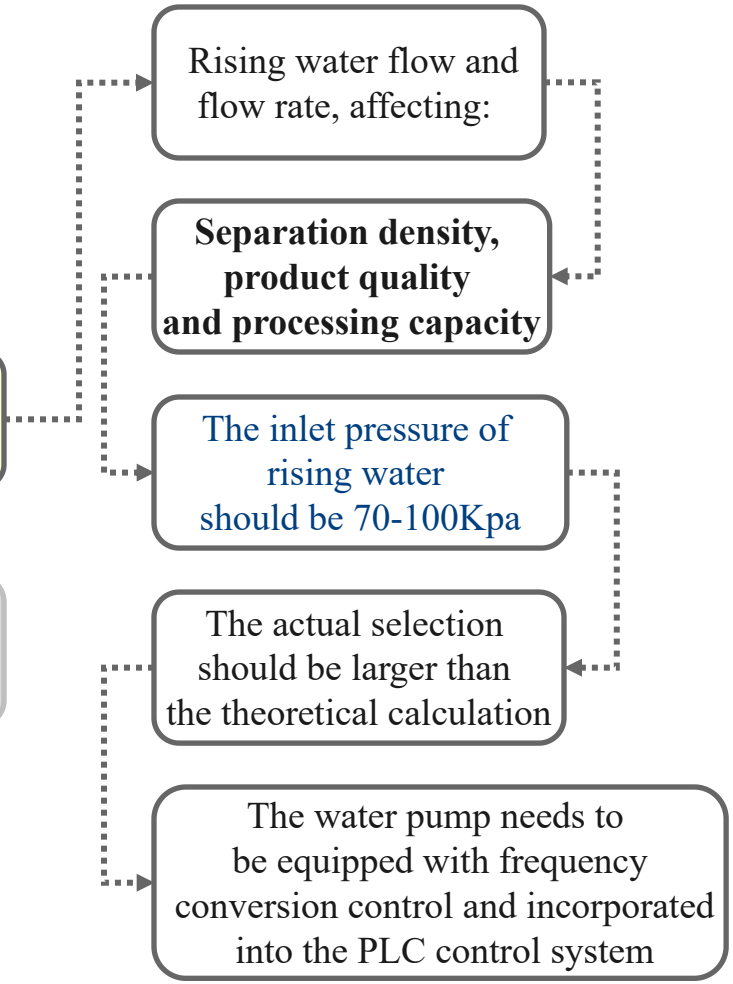
However, the processing capacity and grading granularity shall meet the TBS requirements

3.2

1 Feeding system of TBS

2 **Water supply system** of TBS

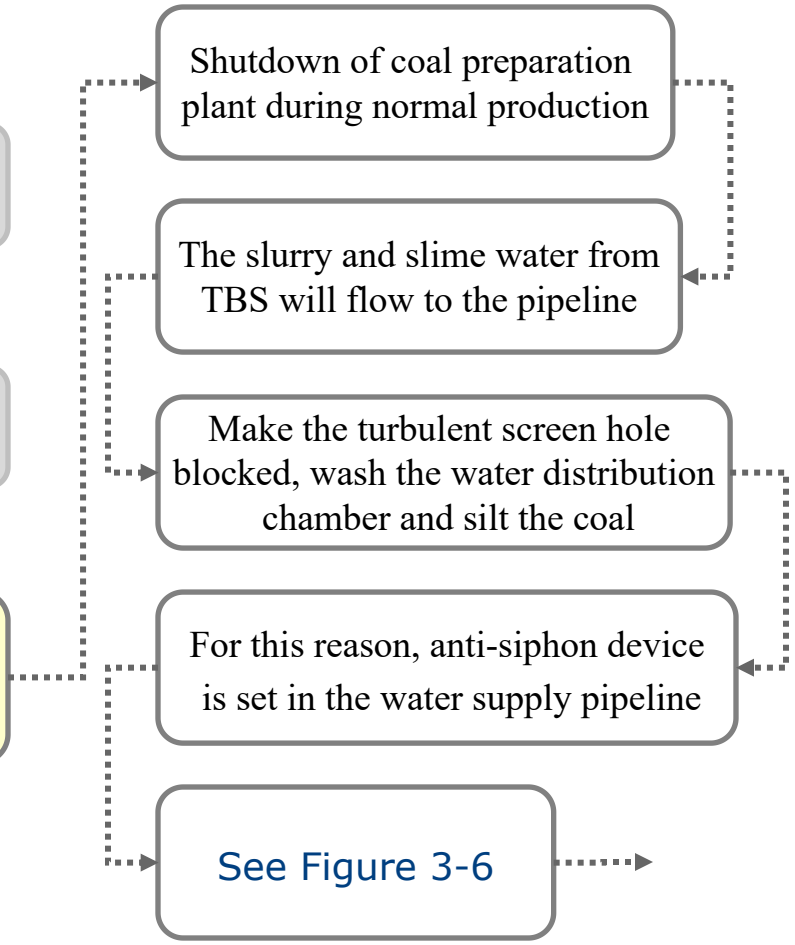
3 Eliminate siphonage in water supply pipe



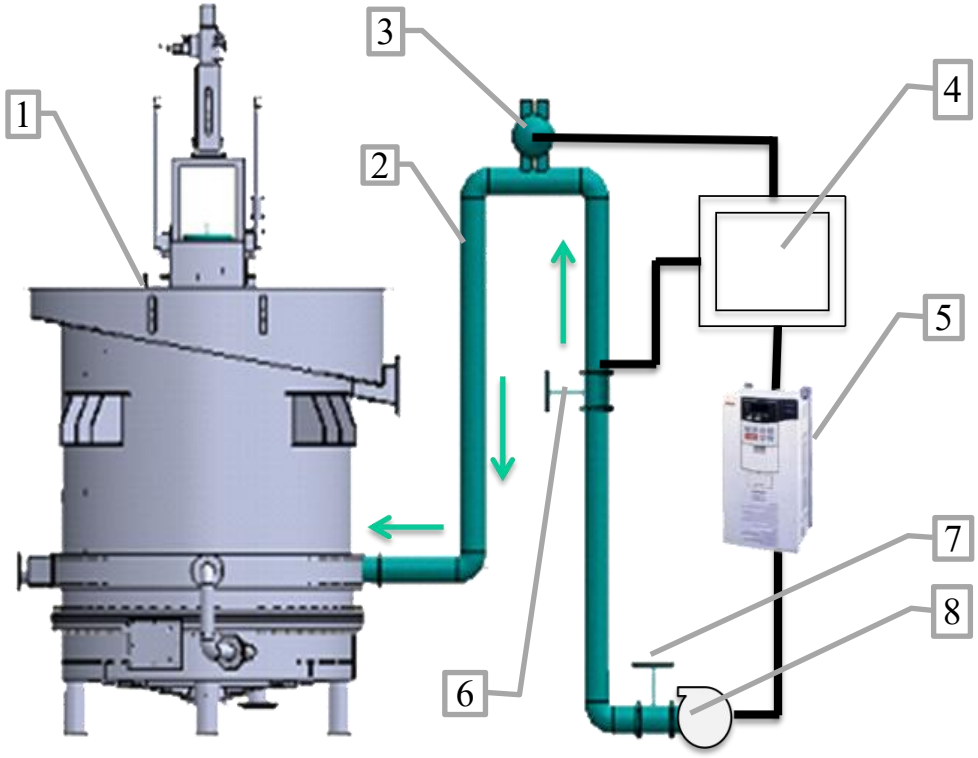
1 Feeding system of TBS

2 Water supply system of TBS

3 **Eliminate siphonage in water supply pipe**



Eliminate siphonage in water supply pipe

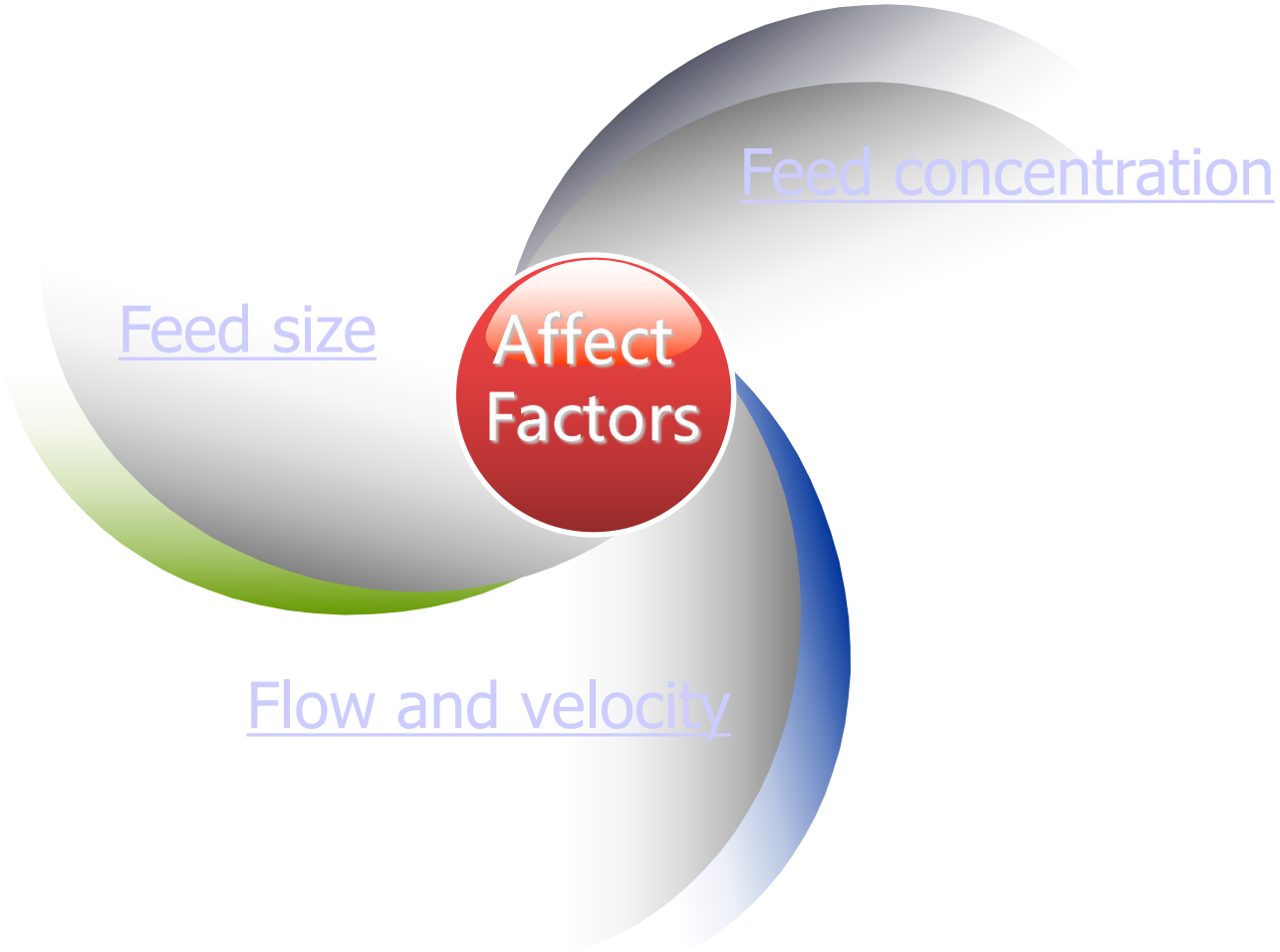


1 - interference bed 2 - pipeline 3 - exhaust valve 4 - controller 5-frequency converter 6-check valve 7-regulating valve 8-water pump

Figure 3-6 Anti-siphon Structure

- **After the water pump is shut down,** the water stop valve is closed and the exhaust valve is opened at the same time, which interferes with the fact that the slurry in the bed tank is at the same atmospheric pressure as the slime water in the pipeline, and the siphonage phenomenon in the pipeline is eliminated, and the opportunity for the turbulence plug hole to be blocked and the rising water distribution chamber to accumulate slime is significantly reduced.

3.3 Main factors affecting the separation effect of TBS



3.3 Main factors affecting the separation effect of TBS

1. **Feed size**
2. Feed concentration
3. Flow and velocity

The feed particle size range is generally: **3-0.15mm**

The best particle size range is : 1 - 0.25 mm, i.e. 4:1

If the particle size is too wide,

It is easy to make high-density fine-grained materials enter the overflow and pollute the concentrate

Make low-density coarse materials **lose concentrate** in underflow

3.3 Main factors affecting the separation effect of TBS

1. Feed size
2. **Feed concentration →**
3. Flow and velocity

- Production capacity
- Sorting process
- Product quality
- Product recovery rate
- See Table 3-2

Feed Concentration

➢When the **depth of the feed pipe and the flow rate are constant**, the effect of the feed concentration on the effect of the interference bed.

Table 3-2 Effect of Different Feed Concentrations on the Separation Effect of Interference Bed Separator

Feed Concentration（g/cm³）	Product ash（%）	Quantity efficiency（%）	Imperfection（I）	Possible deviation（Ep）
200	12.18	83.58	0.192	0.084
300	12.06	82.24	0.262	0.081
400	11.97	81.91	0.186	0.077
500	12.31	82.40	0.241	0.087

➢ It can be seen that when the feed concentration is **400 g/cm3**, the ash content, I value and Ep value of the product are the lowest.

3.3 Main factors affecting the separation effect of TBS

1. Feeding system of TBS

2. Water supply system of TBS

3. **Flow and velocity**

- High water flow and high ash content of concentrate
- High quantity efficiency
- I, Ep value is low
- The rising water velocity is proportional to the rising water flow
- Inversely proportional to the cross-sectional area of the interference bed

➢ **Special water** shall be selected for the rising water on the interference bed, that is, circulating water without impurities and with low concentration. If it is too high, add water for dilution:

The concentration of rising water should not be higher than 25 g/L.

4 Application Cases

The H-TBS-3000 TBS developed by HOT (Chengdu) Industries Co Ltd. was put into use in the dense medium workshop of **Hongyang No. 3 Coal Preparation Plant (new plant) of Shenyang Coal Industry (Group) in June 2008.**

Hongyang coal preparation plant of No. 3 Coal Mine is a coking coal preparation plant with a design capacity of **5.0Mt/a**, in which the design capacity of the new plant is 2.2Mt/a, and the design capacity of the old plant is 2.8Mt/a. The selected coal is lean coal, with a slime content of more than 35%. 1-2.25mm coarse coal slurry is divided into **32.35%**

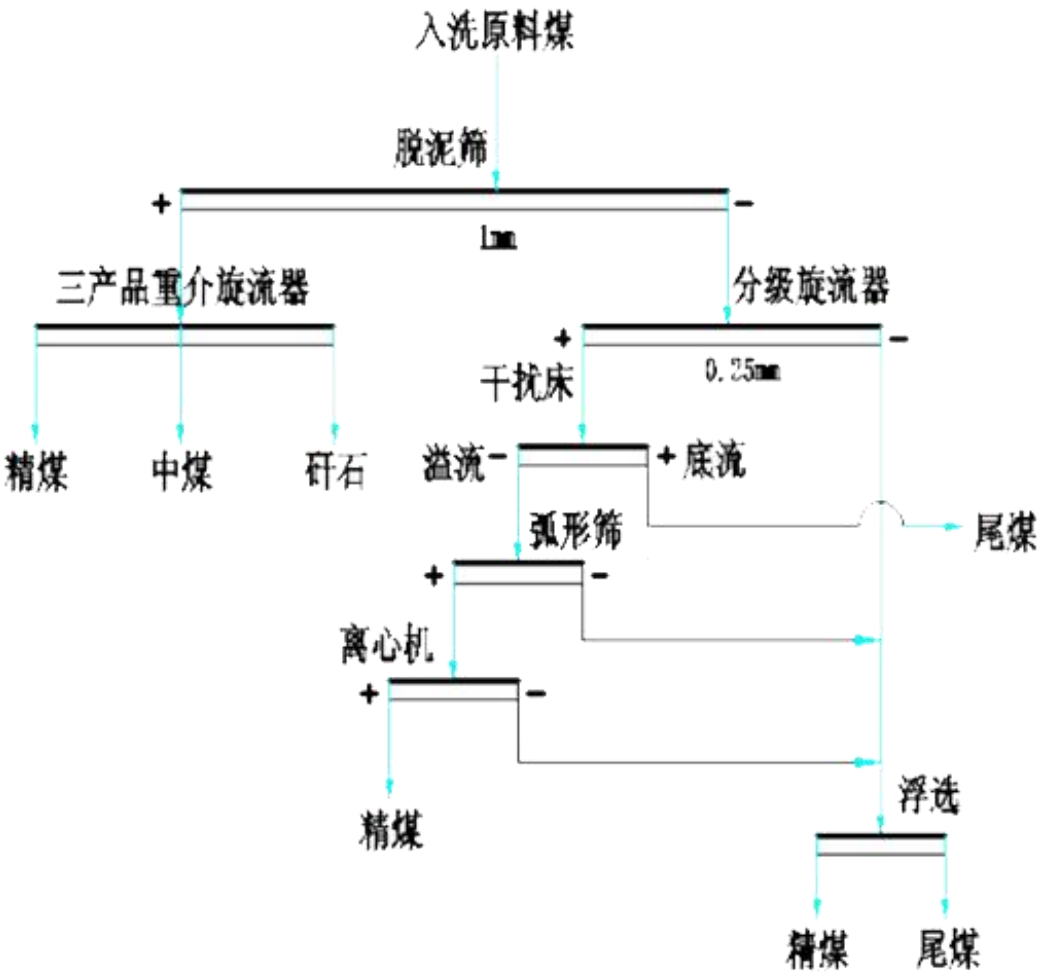


Figure 4-1 Coarse slime separation process diagram of Hongyang No. 3 Mine

- The coal preparation plant of Hongyang No. 3 Mine adopts a new coal preparation process of **dense medium cyclone+teetered bed separator+flotation**.

- See Figure 4-1 for details:

- **The main products** are Grade 8 and Grade 10 refined coal for smelting, which is used as coking refined coal for Angang Steel and Benxi Steel, and middling coal for nearby power plants or civil use.

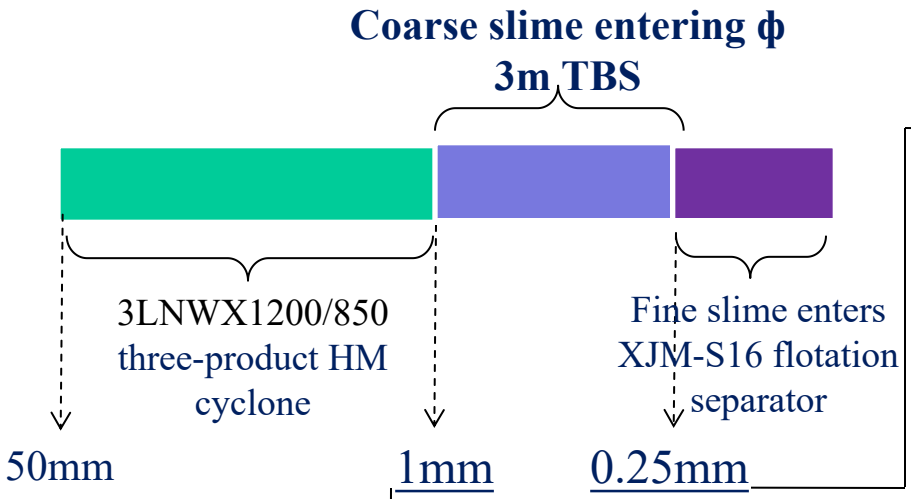
Application Case - Basic Operation of TBS

The production practice for more than one year shows that using XGR-3000 interference bed separator to separate the coarse slime of 1-2.25mm can not only separate the qualified eight-class clean coal products, but also reach 62.40% of tailings ash, and the quantity efficiency is more than 90%.

Table 4-1 Process parameters of interference bed separation bed in Hongyang No. 3 Mine

TBS Specification（mm）	Feed Size（mm）	Feed Concentration（%）	Sorting Density（g/cm³）	Rising Water Volume（m³/h）	Water Gage（Kpa）	Imper-fection（Ep）	Possible Deviation（I）
φ3000	1-0.25	50	1.49	80	70	0.0625	0.127

Application Case - Basic Operation of TBS



Improve **lower limit of feed**

Improve the effect of dense medium separation

Reduce fine slime in heavy medium

Reduce the content of high ash and fine particles in clean coal

Increase the proportion of dense medium separation and **improve the yield of clean coal**

Reduction of upper limit of flotation feed size

The feed quantity is reduced, and the reagent consumption is significantly

Clean coal recovery increased by 1-2 percentage points

The annual income can be increased by 33 million yuan

Reduce drug consumption and save more than **1 million yuan annually**

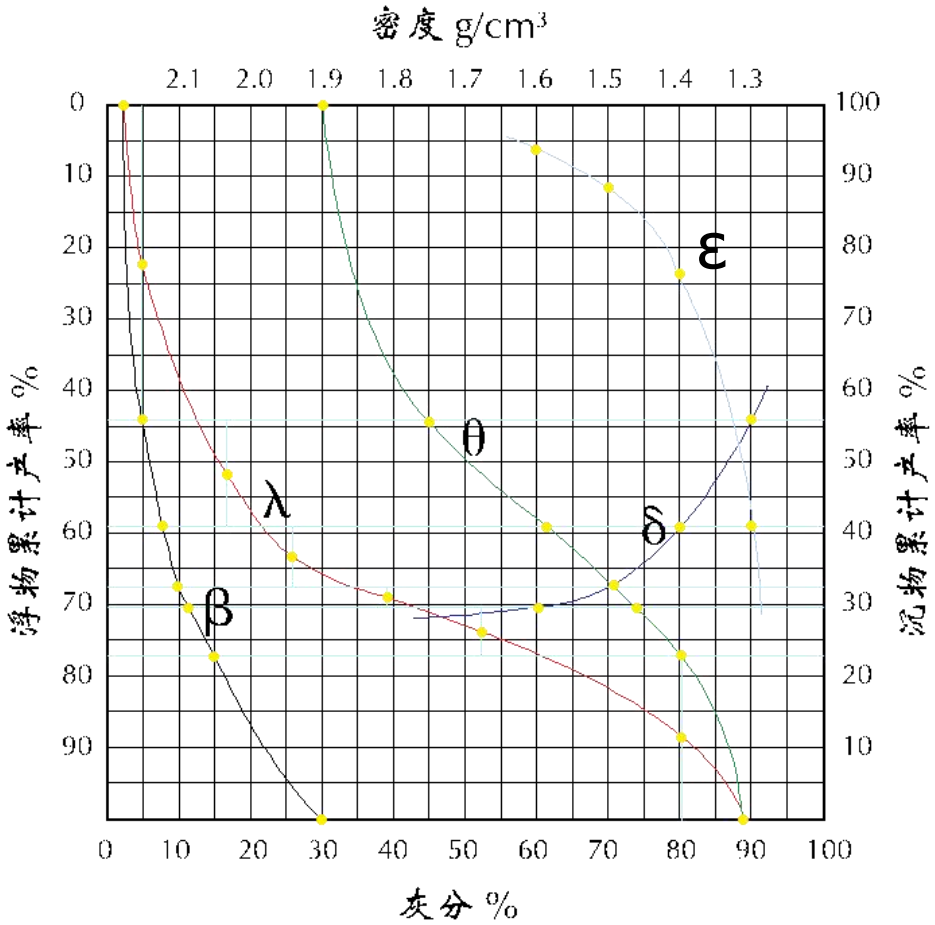
An annual increase of 34 million yuan in comprehensive economic benefits

TBS and supporting equipment investment is **less than 3 million yuan**

Application Cases - Application Effect of TBS

Table 4-2 1-2.25mm flotation and sedimentation test of Hongyang No.3 Coal Preparation Plant

Density level（g/cm³）	Average density（g/cm³）	Clean coal			Tail coal			Allocation rate（%）
		Productivity（%）	Incoming materials（%）	Ash content（%）	productivity（%）	Incoming materials（%）	Ash content（%）	
1	2	3	4	5	6	7	8	9
<1.3	1.25	74.88	41.85	3.81	0.08	0.03	4.91	0.07
1.3~1.4	1.35	15.32	8.51	14.58	0.14	0.06	14.70	0.7
1.4~1.5	1.45	6.17	3.43	24.27	2.33	1.04	26.53	23.26
1.5~1.6	1.55	2.43	1.34	37.88	7.17	3.18	34.94	70.35
1.6~1.8	1.7	1.21	0.67	65.10	20.45	9.09	47.75	93.13
>1.8	2.1	0	0	0	69.83	29.29	70.88	100
Tptal		100	55.33	8.29	100	44.47	62.40	



1~0.25 mm washability curve of coal preparation plant of Hongyang No. 3 Coal Mine

According to the 1~0.25 mm washability curve, the theoretical yield is 61.31% when the ash content is 8.29%, then the separation efficiency is: $\eta=\gamma 2/\gamma 0=55.53/61.31 \times 100\%= 90.58\%$

According to the washability curve, when the given ash content is 10%, the theoretical yield is 67.40%, and the theoretical separation density is 1.49 g/cm3.

Advanced TBS technical indicators：

（Ep=0.0625

I=0.127

η=90.58%）

When the ash content of raw ore is 32.35%, **the product quality index is qualified:**：

(Ash content of concentrate: 8.29%;

Tailings ash content: 62.40%)

Reasonable process parameters：

(separation density 1.493 g/cm3;

Rising water volume 80-100m3/h;

Water inlet pressure 70-80Kpa)

H-TBS has achieved obvious results in separating **coarse slime (1-2.25mm)** from Hongyang No. 3 Mine.


http://www.sykdtd.com

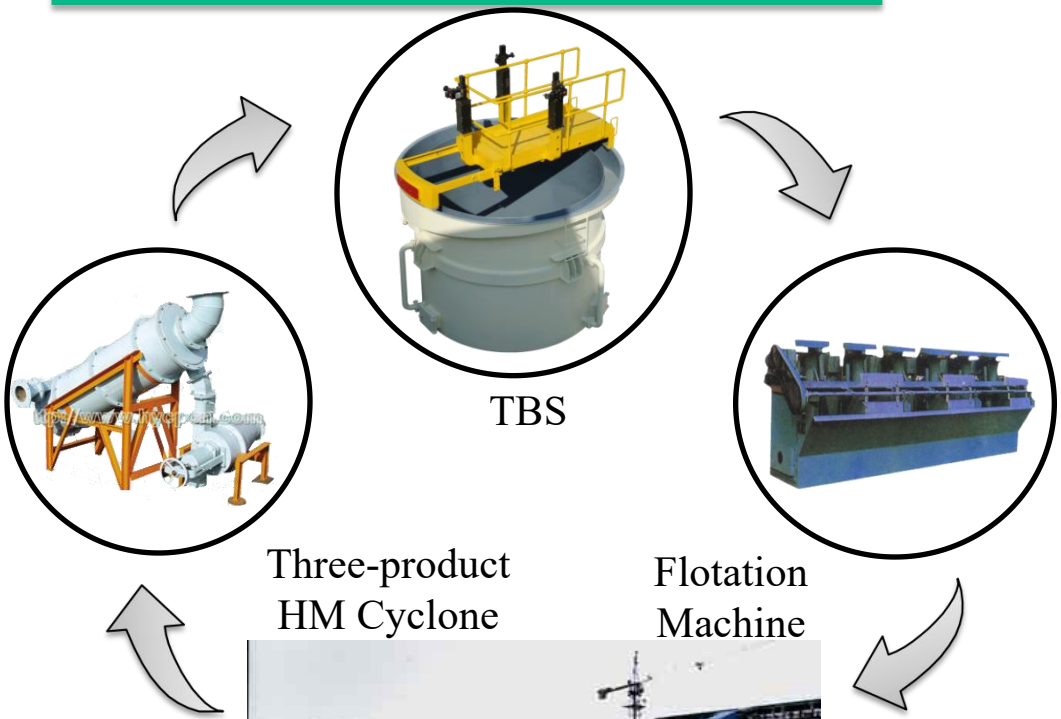
4 Application Cases

Five sets H-TBS-3000 TBS developed by HOT (Chengdu) Industries Co Ltd. was put into use in the dense medium workshop of **Ukhaa Khudag (UHG) Coking Coal Washing Plant, Mongolian Mining Corporation during 2007-2020.**

Mongolia UHG coal preparation plant has a total processing capacity of **15 Mt/a** and is divided into three modules, each of which is 5 million tons. The selected coal is high-quality coking coal. The HTBS-3.0 coarse slime interference bed separator has a separation granularity of **2-0.3mm** and separation efficiency of **>94%.**

5 Application Prospect

Historic breakthrough in coal preparation process design



In **2005**, Handan Design Institute independently adopted the combined process of **three-product dense medium cyclone+TBS+flotation** for the first time in China, which was successfully used in Xuzhou Zhangshuanglou Coal Preparation Plant!

5 Application Prospect

Ideal equipment for coarse slime separation

Coarse slime separation has always been a difficult problem that the coal preparation industry pays close attention to and is committed to solving. The application of TBS in the coal preparation process makes people see the ideal coarse slime separation equipment.

Although there are also slime dense medium cyclone and spiral separator to separate coarse slime, the TBS still has obvious advantages in comprehensive comparison.

5 Application Prospect

➢ **It is matched with spiral separator to improve quality and reduce ash**

The minimum separation density of the **TBS** can reach 1.3 g/cm3. If the light products of the spiral separator are washed again with the interference bed separator, high-quality clean coal products can be obtained.

Thanks

HOT
Process For Environment

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