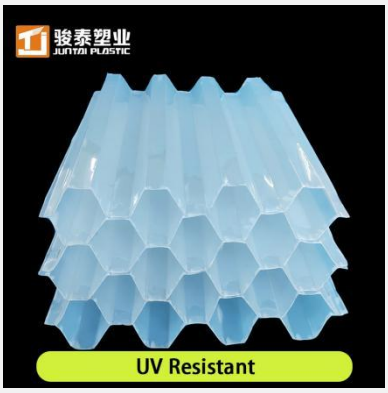
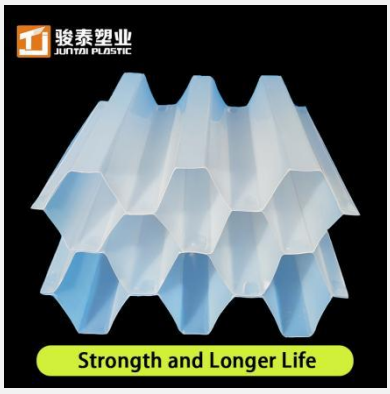
# JUNTAI Tube Settler

## Instruction For Wastewater Treatment





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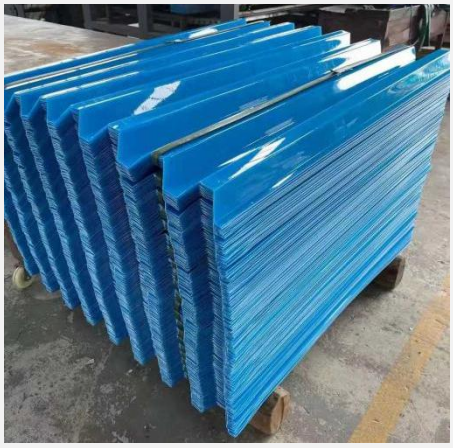
# Juntai Tube Settler Instruction for Wastewater Treatment

## CONTENT





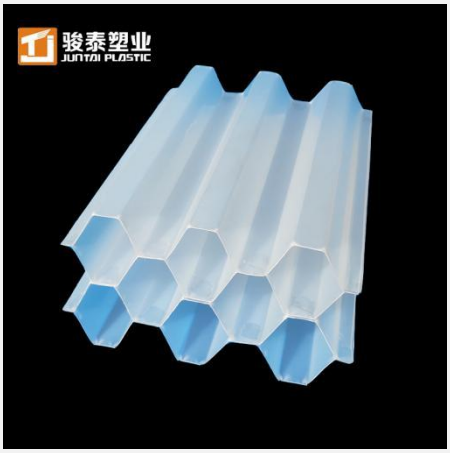
# 1. What is tube settler?

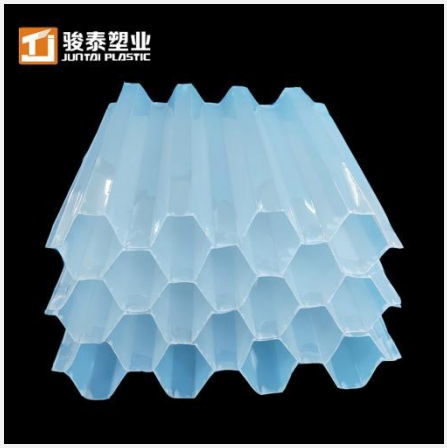
## -lamella clarifier sedimentation principle

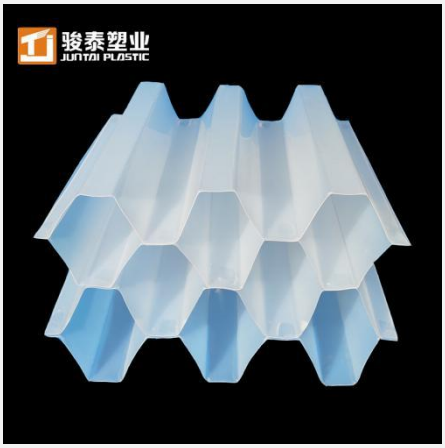
### (1) The Basic Overview

- The inclined plate (tube) sedimentation tank is an efficient combination sedimentation tank designed according to the shallow pool sedimentation theory. Also known as shallow pond sedimentation tank. Many dense inclined pipes or inclined plates are arranged in the settling area, so that the suspended impurities in the water are settled in the inclined plates or inclined pipes, the water rises and flows along the inclined plates or inclined pipes, and the separated sludge slides down to the bottom of the pool along the inclined plates (pipes) under the action of gravity.And concentrated discharge. This kind of pond can improve the precipitation efficiency by 50~60%.

The treatment capacity can be improved by 3~5 times in the same area. According to the test data of the original wastewater, the inclined tube settler with different flow rates can be designed, and coagulant is usually added when it is used. Inclined-tube precipitation water purification method is to set up an inclined tube with an installation angle of 60 degrees above the sludge suspension layer, so as to remove suspended solids, solids or frame alum formed after adding coagulant in raw water.The surface area on the bottom side of the inclined pipe accumulates into a thin mud layer, which slides back to the sludge suspension layer by gravity, and then sinks into the mud collecting hopper. It is discharged into the sludge pond by the sludge discharge pipe for further treatment or comprehensive utilization. The supernatant gradually rises to the water collecting pipe for discharge, and can be directly discharged or reused.







## (2) Characteristics of Equipment

1. Simple structure, no wearing parts, durability and less maintenance.
2. Stable operation and easy operation.
3. Less power and energy saving.
4. Save land, less investment, quick launch and high efficiency.
5. Short stay time, high precipitation effect, high treatment efficiency, low aeration intensity, and land saving, without sludge backflow.

## (3) Scope of Use

I. the removal rate of mixed wastewater containing various metal ions, Ming, copper, iron, zinc and nickel in electroplating wastewater is 90% per person;
Generally, electroplating wastewater can reach the discharge standard after being treated.

II. Coal mine and mineral processing wastewater can raise turbidity from 500-1500mg/l to 5mg/L

III. The chroma removal rate of printing and dyeing wastewater is 70-90%, and COD removal is 50-70%.

IV. Removal of a large amount of organic matter from wastewater from tannery, food and other industries, with COD removal rate of 50-80% and impurity solid removal rate of over 90%. COD removal rate of chemical wastewater is 60-70%, chroma removal is 60-90%, and suspended matter reaches the discharge standard.

## (4) The Structure Introduction

- Materials of inclined tube and inclined plate: FRP, PVC, PE and PP.
- The inclined tube section is generally regular hexagon, and the inclined plate section can be parallel plate or sinusoidal plate.
- The height of clear water area above the top of inclined pipe (plate) is 1.0—1.5m, and the height of water distribution area below the bottom is not less than 1.0—1.5m When discharging mud mechanically, the height of water distribution area should be greater than 1.6m, which is convenient for installation and maintenance.

- The Re number of the water flow in the inclined pipe (plate) is less than 500 and the fr number is 10-3-10-5.

- The designed flow velocity of inclined tube is 1.0-4.0mm/s, and that of inclined plate is 10-20 mm/s.

## (5) Installation and Use

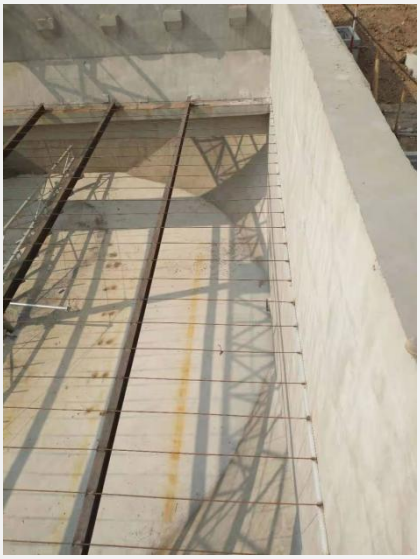
1. When installing inclined tube, glue solution or electric bonding shall be used for bonding and fixing. Parallel inclined plate is fixed with support frame, and corrugated inclined plate is fixed with through-center screw.

2. During installation, the inclined direction should not make the water flow straight at the inclined pipe (plate).

3. Regular washing and reasonable management can reduce the blockage caused by the rapid growth of biofilm.

4. Inclined tube (plate) plane shall not bear concentrated load.

5. Open flames shall not be used in areas where inclined pipes (plates) are installed.


## (6) Precipitation principle

Inclined plate and inclined tube are collectively called shallow pool sedimentation tank, which is based on the principle of shallow pool sedimentation. There is an ideal sedimentation tank with pit v, surface area a, long length, width =B, height = mouth, treated water quantity q, residence time t and sedimentation speed U0. Then v=Qt, H=Uot, Q=Uot/H=UOA. According to the sedimentation principle of shallow pond, the sedimentation efficiency is only the area of the sedimentation tank surface area, and has nothing to do with the water depth.When the volume of sedimentation tank is a fixed value, the shallower the tank, the greater the A value and the higher the sedimentation efficiency. Therefore, if the sedimentation tank is divided into n layers according to height, that is, into n shallow sedimentation units with height h=H/n, and the sedimentation depth of particles decreases from each other to H/n under the condition of constant q, the sedimentation velocity range of particles that can be completely removed in the sedimentation tank will be expanded from the original UO to the mouth uUo/n,The fraction of particles that can be removed in the settling velocity uUo also increases from u/U0 to nu/UO, so that the removal rate of suspended particles in the settling tank is increased by N times compared with the original one. Obviously, the more separated shallow layers, the higher the removal rate. This principle can be made into inclined plate or inclined tube sedimentation tank.

Inclined tube sedimentation tank adopts ethylene-propylene copolymer, glass fiber reinforced plastic or polyvinyl chloride honeycomb inclined tube, with inclination of 60℃, inclined length of 1m and inscribed circle diameter of 35-50MM, which can be changed according to water quality to achieve the best sedimentation effect. The inclined tube precipitator can be designed and processed according to the user's requirements or the test data of the original wastewater. Coagulant is usually added when it is used.It is suitable for rural areas, towns, farms, army barracks, small and medium-sized enterprises and institutions to improve drinking water quality and small-scale waste/sewage projects.

# 2. How to design and calculate the tube settler?

**-the Technical description of honeycomb tube settlers sedimentation tank**


According to the sedimentation principle, at a certain flow rate q and a certain particle sedimentation velocity u Under the condition of, the sedimentation efficiency e is proportional to the plane area a of the pool, i.e. E=U A/Q。 The pool is divided into n intervals in height, which increases the plane area of the pool, shortens the settling time and improves the settling efficiency.

Combined with the need of sludge discharge, the inclined plate is added to the inclined plate sedimentation tank, which increases the water flow area and wet area of the tank, reduces the hydraulic radius, reduces Reynolds number and turbulence of water at the same horizontal flow rate, and has good sedimentation effect.

Inclined tube sedimentation tank is a sedimentation tank in which many parallel inclined tubes with smaller intervals are installed. The sedimentation principle of inclined tube sedimentation tank is the same as that of inclined plate sedimentation tank. On hydraulic condition, the hydraulic radius of inclined tube is smaller than that of inclined plate, so Reynolds number is lower and sedimentation effect is more remarkable. Inclined tube sedimentation tank has small tank capacity and saves floor space.It has been adopted by many water plants at home and abroad and accumulated a lot of experience in operation and management. The problem is that the

maintenance and management are complicated, and the inclined plates of inclined pipes need to be cleaned and replaced regularly. Due to the short settling time of inclined plate and inclined tube sedimentation tank, attention and management should be strengthened when water quantity and water quality change during operation.When using this kind of sedimentation tank, attention should also be paid to the perfection of flocculation and the reasonable arrangement of sludge discharge.

### (1) design points of inclined plate sedimentation tank.

① There are three main water flow directions in inclined plate sedimentation tank: upward flow, lateral flow and downward flow.

② The designed particle settling velocity μ of inclined plate sedimentation tank, and the liquid level load should be determined by experiment or referring to the operation experience of waterworks under similar conditions. The designed particle settling velocity can be 0.16~0.3mm/s, the liquid level load can be 6.0 ~ 12 m/(m h), and the lower limit value should be adopted for low temperature and low turbidity water.

# 3. Tube setter design Case 1

**-Design and calculation of tube settler sedimentation tank(lamella water treatment)**

Design conditions: water consumption is 15000$m^3$/d.

The influent concentration is 280mg/L.

Sludge water content 97.50%

Effluent suspended solids concentration 30 mg / L

Design parameter:

The number of sedimentation tanks n = 4

Surface load of sedimentation tank: q = 2.4$m^3$/（$m^2$·h）

The diameter of inclined pipe is 100 mm

The length of inclined pipe is 1.0m

The horizontal angle of inclined pipe is 60°

Design calculation:

## 1. Surface area of sedimentation tank

Water consumption q = 15000$m^3$/d=625$m^3$/h=0.174$m^3$/s

Number of sedimentation tanks n = 4

Surface load $Q_0$= 2.4$m^3$/（$m^2$*h）

$$\therefore \quad A=\frac{Q}{nq_0*0.91}=\frac{625}{4*2.4*0.91}=71.54m^2$$

## 2. Plane size of sedimentation tank

$$a=\sqrt{A}=\sqrt{71.54}=8.45m, 8.5m$$

## 3. Residence time in tank

Height of clear water layer in the upper part of inclined pipe area $H_2$=1.0m

Vertical height of inclined pipe $H_3$=1.0m

$$\therefore\ t = \frac{(h_2 + h_3) * 60}{q} = \frac{(1+1) * 60}{2.4} = 50\text{min}$$

## 4. Required volume of sludge

Sludge storage time t = 24h

The influent suspended solids concentration $C_1$= 280mg / L = $0.28 \times 10^{-3}$ t/m$^3$

The effluent suspended solids concentration $C_2$= 30 mg / L = $0.03 \times 10^{-3}$ t/m$^3$

Sludge density$\gamma$=1t/m$^3$

Moisture content of sludge $\rho_o$=97.50%

$$\therefore\ V = \frac{Q(C_1 - C_2)T}{\gamma(1-\rho_0)n} = \frac{625 \times (0.28 \times 10^{-3} - 0.03 \times 10^{-3}) \times 24}{1 \times (1 - 0.975) \times 4} = 37.5\text{m}^3$$

## 5. Sludge hopper volume

A square hopper is set at the bottom. The side length of the upper area is 8.5m, the side length of the lower area is $a_2$= 1.0m, and the slope degree is 50°

$$\therefore\ h_5 = (\frac{a_1}{2} - \frac{a_2}{2})\tan 50° = (\frac{8.5}{2} - \frac{1}{2}) \times \tan 50° = 4.47\text{m, take 4.5m}$$

$$\therefore\ V_1 = \frac{h_5}{6}(2a_1^2 + 2a_1a_2 + 2a_2^2) = \frac{4.5}{6} \times (2 \times 8.5^2 + 2 \times 8.5 \times 1 + 2 \times 1^2) = 122.63\text{m}^3$$

The volume of the sludge hopper is $V_1$=122.63m$^3$.

$\because\ V_1 > V$

$\therefore$ Can meet that requirement of sludge storage.

## 6. Total height of sedimentation tank.

Ultra-high $h_1$of sedimentation tank = 0.3m.

Buffer layer $h_4$at the bottom of sedimentation tank = 1.0m.

$\therefore$ $H=h_1+h_2+h_3+h_4+h_5=0.3+1.0+1.0+1.0+4.5=7.8m$

## 7. Design of inflow tank and water distribution hole.

Strip-shaped flat-bottom grooves are adopted, and water distribution holes are arranged at equal intervals: Hole size 200mm.×200mm

Inflow tank: let the width of inflow tank be B=1.0m, and the flow velocity in the tank be v = 0.25m/s. There are two water tanks in total, and every two sedimentation tanks share one water tank, so the water depth in the tank is $h=\frac{Q}{vB}=\frac{0.174}{0.25\times1.0}=0.696m$

Average flow velocity of water holes v=0.25m/s,

Then the number of water distribution holes n. $=\frac{Q}{va}=\frac{0.174\div4}{0.25\times0.04}=4.35$, take 5.

Hole spacing l =8.5/5=1.7m

## 8. Triangle weir calculation:

The triangle weir height is 0.10m, the water depth of the triangle weir is 3/5 of the weir height, that is, h=0.06m, and the weir angle is 90°, then

$Q_0=1.4.h^{2.5}=1.4\times0.06^{2.5}=1.23\times10^{-3}\ m^3/s$

$\therefore$ $N=\frac{Q}{Q_0}=\frac{0.174\div4}{1.23\times10^{-3}}=35.$

Then $Q_{total}=1.23.\times10^{-3}\times35=0.43\ m^3/s>0.174\div4=0.0435\ m^3/s$

## 9. Check solid load.

$q2=\frac{Q.\times C_1}{A}=\frac{15000\times0.3}{8.5^2}=62.28\ Kg/(m^2\cdot d)<150\ Kg/(m^2\cdot d)$

Meet the solid load requirements.

③ Inclination angle o: It varies according to the materials and particles of the inclined plate, and it is usually 60 for the convenience of mud discharge.

④ plate distance p: that is, the distance between two inclined plates, and lateral flow inclined plate p is generally 80~100mm; The length of single-layer inclined plate should not be greater than 1.0m.

⑤ velocity v in plate: calculated according to surface load when flowing upward; The lateral flow can refer to the horizontal velocity equivalent to the horizontal sedimentation tank, which is generally 10~20mm/s; When flowing downwards, it can be calculated according to the downward surface load.

⑥ In the pool of lateral flow inclined plate, in order to prevent the water from passing through the inclined plate, a choke wall should be set, and the top of the inclined plate should be higher than the water surface.

⑦ In order to distribute and collect the water evenly, the inlet and outlet of the inclined plate sedimentation tank in lateral flow should be provided with rectifying walls. The opening rate of the rectifying wall at the inlet shall be such that the flow velocity of the through hole is not greater than the flow velocity at the outlet of the flocculation tank, so as to avoid floc breakage.

⑧ Punched pipe or mechanical sludge discharge equipment is generally used, and the design of perforated pipe sludge discharge is the same as that of general sedimentation tank.

**(2) Key points of inclined pipe process design**

① The cross section of inclined pipe is generally honeycomb hexagonal, and its inner diameter is generally 25 ~ 35mm.

② The diameter of inclined pipe is 30 ~ 40mm, the length of inclined pipe is generally about 1000mm, and the horizontal inclination angle isθ60 ° is often used.

③ The height of clear water area in the upper part of inclined pipe should not be less than 1.0 m. The higher clear water area is conducive to the uniformity of water outlet and the reduction of sunlight impact and algae propagation.

④ The height of water distribution area at the lower part of inclined pipe should not be less than

1.5m.In order to distribute water evenly, perforated wall or grid should be set at the inlet of sedimentation tank.

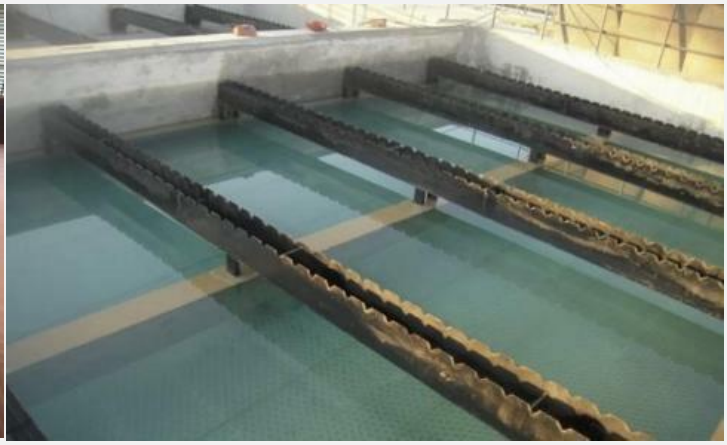
⑤ The height of the sludge area should be determined according to the amount of sediment, the concentration degree of sediment and the way of sludge discharge.The sludge discharge equipment is the same as the horizontal flow sedimentation tank, and the perforated sludge discharge or mechanical sludge discharge can be used.

⑥ The effluent system of inclined tube sedimentation tank should make the effluent of the tank uniform, and perforated pipe or perforated water collecting tank can be used for collecting water.

⑦ The liquid level load of inclined tube sedimentation zone should be determined according to the operation experience under similar conditions, which can be 5.0 ~ 9.0 $M^2/(m^2 \cdot h)$。

# 4. Tube setter design Case 2

**-Design and calculation of tube settler sedimentation tank(lamella water treatment)**



## 1. Known conditions

Treatment capacity Q = 195000 $m^3$/ D

Inclined tube sedimentation tank is divided into two groups

The settling velocity of particles is 0.35 mm / s

Rising velocity in clear water area: v = 2.5mm/s

The hexagonal honeycomb tube is hot pressed with plastic sheet, the tube thickness is 0.4mm, the edge distance is d = 30mm, and the horizontal inclination angle is 0.4mmθ=$60^0$。

## 2. Design calculation

1. The flow rate of each sedimentation tank Q: 1

Q=195000/2 $m^3$/d=97500 $m^3$/d=1.13 $m^3$/s

2. Clear water area:

A = q / v = 1.13/0.0025 = 452 $m^2$, in which the area occupied by inclined pipe structure is calculated as 3%, then the actual required area of clear water area is $a^/$= 452×1.03=465.6 $m^2$

In order to distribute water evenly, the plane size of inclined pipe area is 15.8m×The inlet area is arranged along the side of 29.5 m long.

**3. Length of inclined pipe L**

Flow rate: $V_0$= V / sinθ=2.5/sin$60^0$=2.5/0.866=2.89mm/s

Length of inclined tube: l = (1.33 $V_0$- μ sinθ)d/μcos$60^0$=(1.33×2.89-0.35×0.866)d30/0.35×0.5=607mm

Considering the factors of turbulent flow and mud deposition at the pipe end, the transition zone is 250mm

Total length of inclined pipe: $l^/$= 250 + 607 = 857, calculated by 1000mm

**4. Pool height:**

Protection height: 0.3m

Clear water area: 1.2m

Water distribution area: 1.2m

Height of perforated sludge hopper: 0.8m

Height of inclined tube: H = $l^/$sinθ=one×sin$60^0$=0.87m

Total height of pool: H = 0.3 + 1.2 + 1.2 + 0.8 + 0.87 = 4.37m

**5. Perforated wall is used at the inlet of sedimentation tank, perforated pipe** is used for sludge discharge and perforated pipe is used for water collection system. All the above calculation are the same as that of general sedimentation tank or clarifier.

**6. Recalculate the Reynolds number and sedimentation time in the tube**

$$Re=Rv_0/\xi$$

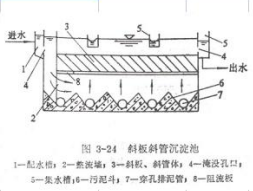
In the formula, hydraulic radius: r = D / 4 = 30 / 4 = 7.5mm = 0.75cm

Flow rate: $V_0$= 0.289cm/s

Kinematic viscosity:ξ=0.01$cm^2$/ S (when t = $20^0$C)

Re= 0.75×0.289/0.01=21.68

Precipitation time: T = l/ / $V_0$= 1000 / 2.89 = 346s = 5.77min (precipitation time t is generally between 4 ~ 8min)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Design flow | 500 | Per hour | 20.83333333 | Per second | 0.005787037 | | | | | | | | |
| Daily working hours | t= | 0.5 | Number of sedimentation tank | n= | 1 | Self-watering coefficient | 0.05 | | | | | | |
| Area of clear water area of sedimentation tank | A=Q/0.91*q= | 15.26251526 | 0.91 is the area utilization factor of the inclined plate tube | Surface load | 1.5 | The value range of "Outdoor Water Supply and Drainage Specification" is (9<=11), the actual experience is 4~6, and the rising velocity of the inclined pipe sedimentation tank is 0.4~0.6mm/s. Among them, the surface load of the inclined tube sedimentation tank is converted = the rising velocity of the inclined tube sedimentation tank x 3.6 (m3/m2.h |  图 3-24 斜板斜管沉淀池<br>1—配水槽；2—絮流墙；3—斜板、斜管体；4—淹没孔口；5—集水槽；6—污泥斗；7—穿孔排泥管；8—阻流板 | | | | | | |
| Length and width of sedimentation tank | B=A/L= | 3.052503053 | | length | 5 | | | | | | | | |
| | B Take | 3 | | take long | 5 | | | | | | | | |
| The inlet area is distributed in the length direction | Deduct invalid length 0.5m (when the length of the inclined pipe is 1m, and the angle is 60° with the horizontal) | | | | | | | | | | | | |
| Net export area | A1=(B-0.5)*L/K1= | | 12.13592233 | Inclined pipe structure coefficient K1= | 1.03 | | | | | | | | |
| Total height of sedimentation tank | H= | h1+ | h2+ | h3+ | h4+ | h5= | 4.52 | | | | | | |
| | | Protection height | Height of clear wa | Inclined tube area height | High distribution area | The height of the sludge tank | | | | | | | |
| | | 0.3 | 1.3 | 0.87 | 1.3 | 0.75 | | | | | | | |
| Inlet system | | | | | | | | | | | | | |
| Total orifice area | A2=Q/v= | 0.05787037 | | Orifice flow rate | 0.1 | | Actual flow rate | 0.080375514 | (Generally, the value is not more than 0.15-0.20m/s.) | | | | |
| Orifice size | b*l | 0.1 | 0.08 | | Number: | | | take | 9 | | | | |
| Sedimentation tank effluent | | | | | | | | | | | | | |
| Outlet hole flow rate | v1= | 0.6 | The effluent of the | Total area of perforation | A3=Q/v1 | 0.009645062 | | | | | | | |
| Number of perforations | N=A3/F= | 6 | 6 | Single orifice area | 0.00160751 | Aperture | 0.045252445 | | | | | | |
| Width of catch basin | 0.2 | Interval | 1 | Number of catch basinssump | 1 | | Holes on each si | 3 | Hole spacing | 1 | take | 1 | |
| Air loss | h1= | 0.000917431 | | Inlet resistance coefficient | 0.05 | | | | | | | | |
| Outlet main tank | width | 0.2 | Deep | Different starting point and ending point, there is a slope | | | | | | | | | |
| Water depth in tank | 0.3 | Flow rate in tan | 0.048225309 | Water slope | 0.05 | Head loss in tank | 0.25 | | | | | | |
| Total loss of effluent | 0.250917431 | | Take | 0.05 | | | | | | | | | |
| Inclined pipe of sedimentation tank | Tube length | 1 | Pipe diameter | 30 | | 0.45 | | | | | | | |
| Mud discharge system | Number of mud dra | 1 | Perforated pipe | 150 | Aperture | 3 | Interval | 1 | Total | 2 | | | |
| Top width of mud drair | 0.4 | Bottom width | 0.1m | Horizontal angle | 45 | Fighting High | 0.8 | | | | | | |
| | | | | | | | | | | | | | |
| 0.327645409 | | | | | | | | | | | | | |
| 0.0225 | | | | | | | | | | | | | |
| 0.15 | | | | | | | | | | | | | |

# 骏泰塑业 JUNTAI PLASTIC Water Treatment Product


MBBR Media
(Patent Certification)


Tube Settler

MBR Membrane

PU Bio Media


Disc Diffuser

Tube Diffuser

Ro Water Plant

MBBR Mixing

Ro Antiscalant
(Patent Certification)