جلسه ۱۰:

تفصیه مقدماتی

درس: مهندسی تصفیه آب و فاضلاب

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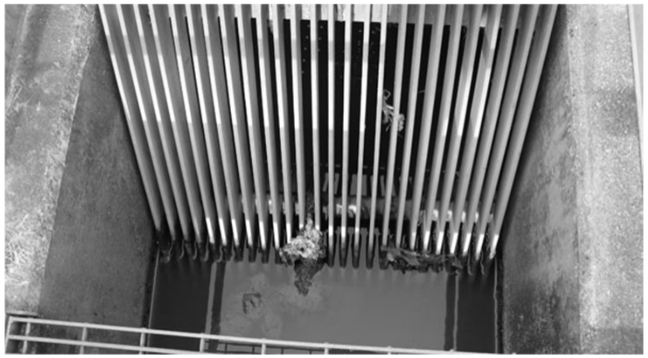
عملیات مقدماتی

- ایستگاه پمپاژ
  - باید از عمق زمین بالا کشیده شود
  - به ارتفاعی برده شود که بقیه تصفیه خانه گرانشی عمل کند
- تصفیه مقدماتی
  - حذف جامدات تصفیه ناپذیر
  - آماده سازی فاضلاب به منظور افزایش راندمان واحدهای پایین دستی و حفاظت از آن ها

Preliminary treatment

- بسیار بعید است که منبع آب آن قدر تمیز باشد که فقط با یک گندزدایی ساده بتوان آن را آماده استفاده کرد و معمولا چندین عملیات واحد برای تصفیه آن نیاز است
- به عملیات واحدهایی که در اکثر تصفیه خانه ها به چشم می خورند و قبل از هر کاری (حتی قبل از ضدعفونی کردن) مورد استفاده قرار می گیرند تصفیه مقدماتی گفته می شود
- ثابت سازی جریان equalization معمولا بعد از تصفیه مقدماتی صورت میگیرد به این دلیل به می خواهیم آب باکیفیت تر را ذخیره کنیم

اسکرین میله ای Course Screen / Bar Screen



Racks / Screens

Nomenclature of racks and screens

Type	Typical opening	Typical use
Trash racks	40–150 mm	To prevent logs, stumps, and large heavy debris from entering treatment processes. Principally used in combined sewers ahead of pumping units. In WWTPs, frequently followed by coarse screens.
Bar racks or coarse screens	6–75 mm	To remove large solids, rags, and debris. Typically used in WWTP.
Fine screens	1.5–6 mm	To remove small solids. Typically follows a coarse screen.
Very fine screens	0.25–1.5 mm	To reduce suspended solids to near primary treatment level. Typically follow a coarse screen and/or fine screen. May be used when downstream processes do not include primary treatment.
Microscreens	1μm–0.3 mm	Used in conjunction with very fine screens for effluent polishing.

پویانمایی اسکرین میله ای

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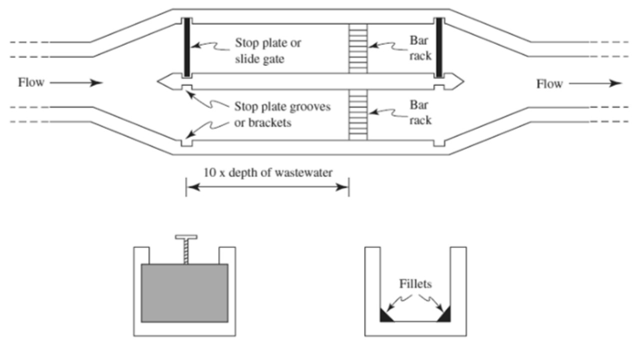
طراحی اسکرین میله ای



طراحی اسکرین میله ای

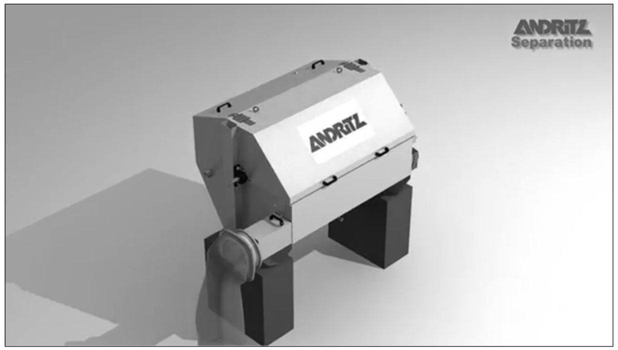
- برای سرویس کردن، هر اسکرین را باید بتوان ایزوله کرد
- باید تعداد اسکرین ها به گونه ای باشد که در اوج جریان، یک standby داشته باشیم
- بهترین سرعت برای ورود آب به اسکرین ها مابین 0.4m/s و 0.9m/s است (حد پایین برای جلوگیری از ته نشینی در کانال، و حد بالا برای جلوگیری عبور ذرات از اسکرین)
  - برای تنظیم جریان و سرعت باید کانال مناسب طراحی شود
  - می توان از معادله منینگ استفاده نمود

نمونه اسکرین

اسکرین ظریف

- انواع مختلفی دارد
- بعد از اسکرین میله ای قرار میگیرد تا ذرات کوچک تر را بگیرد
- سرعت خطی آب قبل از اسکرین ظریف میبایست حتما بین 0.3-1.4m/s و ترجیحا بین 0.6-1.2m/s باشد
- از آن رو که سرعت خطی بیشتر از اسکرین میله ای است، شاید لازم باشد ابعاد کانال تغییر کند
- به مراتب بیش از اسکرین میله ای جرم می گیرد

نمونه اسکرین



نمونه اسکرین

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Advantages and disadvantages of types of fine screens

Type of screen	Advantages	Disadvantages
Band (center feed)	Minimal screenings carryover	Channel must be widened at screen; perforation prone to clogging with grease
Bar	Multiple cleaning elements	Not as efficient as other screens
Drum	Minimal screenings carryover Low headloss	Perforation prone to clogging with grease
Step	Handles grease	High headloss; shallow or wide channel required

Characteristics to consider in selecting a fine screen

Screen type	Typical range of openings, mm	Capture[a] efficiency	Hydraulic capacity	Deep channel suitability	FOG[b] suitability
Band, perforated—center feed	1–10	High	Good	Suitable	Poor
Bar	2–15	Low	Very good	Suitable	Suitable
Drum	0.2–6	High	Very good	Not suitable	Poor
Step Screen®	1–6	Medium	Good	Suitable	Suitable

[a]Assessed at low range of openings
[b]Fats, oils, and grease

تخمین افت هد

$$H_L = \left(\frac{1}{2g}\right)\left(\frac{Q}{CA}\right)^{1/2}$$

H_L = headloss, m
Q = flow rate through the screen, m^3/s
g = acceleration due to gravity = 9.81 m/s^2
C = coefficient of discharge for the screen
A = effective open area of submerged screen, m^2

- برای یک اسکرین تمیز، می توان به عنوان تخمین C=0.6 استفاده نمود

Example

- Design a coarse screen system for a water treatment plant. Use two smooth concrete channels, one on duty and one on stand by.
- The flow of water is 37,000 m^3/day on average. Leave some space on top of the water, in case there is a surge.
- The water flows due to gravity, with a channel slope of 0.0002 m/m
- (Use the Microsoft Excel "Solver" tool)

Answer

- The value of *n* in the manning equation is reported in the tables. n = 0.013
- Also we know that:

$$Q = \frac{37,000\ \text{m}^3/\text{d}}{86,400\ \text{s/d}} = 0.4282\ \text{m}^3/\text{s}$$

- We need to make some assumptions; so we will try a channel width of 1.1 m

Answer

- Since we don't want the velocity of the water to be too low or too high in the channel, we'll try to design the system so that it is 0.6 m/s during average flow.
- If the velocity falls under 0.4 m/s during low water inputs, then sedimentation will occur in the channel and cleaning is required (this is common)
- With the assumption of 0.6 m/s our first guess for the depth of the water in the channel becomes:

$$A = \frac{Q}{v} = \frac{0.4282\,\frac{m^3}{s}}{0.6\,\frac{m}{s}} = 0.717\ m^2 \quad \rightarrow \quad D = \frac{A}{w} = \frac{0.717\ m^2}{1.1\ m} = 0.65\ m$$

Answer

- So, our first guess for the cross section of the channel becomes: 0.65 x 1.1 = 0.717 m^2
- Here, we can use the Manning equation to find the velocity of such a channel with the designated slope:

$$v = \frac{1}{n} R^{2/3} S^{1/2} \qquad \text{where:} \quad R = \frac{(W)(D)}{W + (2D)}$$

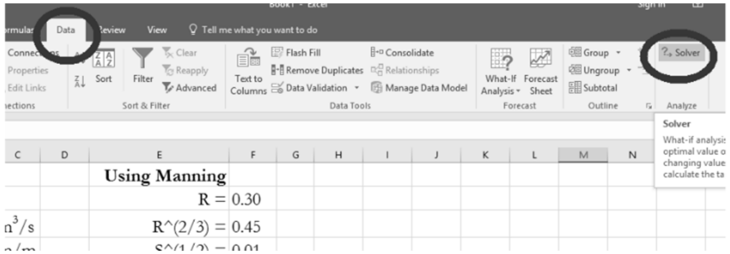
- After finding the real velocity that would result from such as channel with such a slope, we need to iterate (change the assumed depth) until the velocity calculated from Q/v becomes the same as the one calculated from Manning

Answer

- Before any iterations:

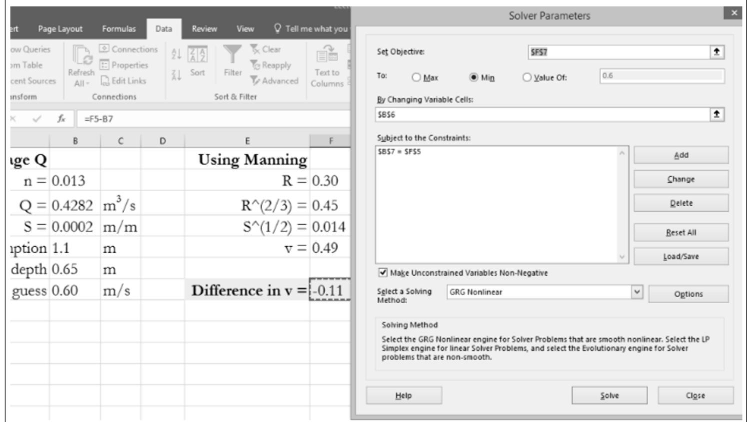
	A	B	C	D	E	F	G
1	**For average Q**				**Using Manning**		
2	n =	0.013			R =	0.30	
3	Q =	0.4282	m^3/s		R^(2/3) =	0.45	
4	S =	0.0002	m/m		S^(1/2) =	0.014	
5	Width assumption	1.1	m		v =	0.49	m/s
6	Guess for depth	0.65	m				
7	v based on guess	0.60	m/s		**Difference in v =**	-0.11	

Answer



• If you have not yet loaded the solver add-in, you need to do so in order to use it: https://support.office.com/en-us/article/Load-the-Solver-Add-in-612926fc-d53b-46b4-872c-e24772f078ca

Answer



Answer

• After solver optimization:

	A	B	C	D	E	F	G
1	**For average Q**				**Using Manning**		
2	n =	0.013			R =	0.32	
3	Q =	0.4282	m^3/s		R^(2/3) =	0.47	
4	S =	0.0002	m/m		S^(1/2) =	0.014	
5	Width assumption	1.1	m		v =	0.51	m/s
6	Guess for depth	0.7649	m				
7	v based on guess	0.51	m/s		**Difference in v =**	0.00	

• We see that under such flow conditions, the velocity is almost at the lower limit, so we must either designate a different width, or accept that the channel needs to be cleaned periodically due to sedimentation in low flow

Homework

• Solve the previous example at home, by altering the dimensions and slope, in order to obtain a velocity less prone to sedimentation

• Keep in mind that after you have solved the problem, add about 60 cm to the final channel depth, just in case there is a water surge!