Q1: A cast iron combined sewer of 30 inch diameter (n=0.012) conveys a maximum W.W.F (Wet Weather Flow) of 380 l/s, at \( \frac{3}{4} \) of its height. The minimum D.W.F. (Dry Weather Flow) is 100 l/s, Calculate:  
- The max. D.W.F. when the pipe is \( \frac{1}{2} \) full.
- The design velocity and the slope.
- The velocity at min. D.W.F. & max. W.W.F.
- The depth of water at min. D.W.F.

![Graph showing flow vs percent of pipe]

Q2: A completely mixed activated sludge system is to be used for organic matter removal only (one sludge system). Design this system knowing the following:- microorganisms growth constants are:

\[
\mu_m = 2.5 \text{d}^{-1}, \ K_d = 0.05 \text{d}^{-1} \quad Y = 0.5 \text{mg VSS/mg BOD removed} \\
K_g = 100 \text{mg BOD/L} \quad \text{Flow} = 0.15 \text{m}^3/\text{s} = 12960 \text{m}^3/\text{d} \\
B_O = 84 \text{mg/L (Soluble)} \quad \text{required effluent} \rightarrow \text{(total BOD)} = 30 \text{mg/L}
\]

Q3: Estimate the BOD removal efficiency and effluent BOD5 of a two-stage trickling filter using the NRC formula with the following given conditions.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wastewater temperature</td>
<td>20°C</td>
</tr>
<tr>
<td>Plant flow Q</td>
<td>2 Mgal/d (7570 m³)</td>
</tr>
<tr>
<td>BOD₃ in raw waste</td>
<td>300 mg/L</td>
</tr>
<tr>
<td>Volume of filter (each)</td>
<td>16,000 ft³ (453 m³)</td>
</tr>
<tr>
<td>Depth of filter</td>
<td>7ft (2.13 m)</td>
</tr>
<tr>
<td>Recirculation for filter 1</td>
<td>= 1.5Q</td>
</tr>
<tr>
<td>Recirculation for filter 2</td>
<td>= 0.8Q</td>
</tr>
</tbody>
</table>
Q4: A) A grit channel (L = 25 m) with a cross-section as shown below, is charged with Q = 180 litres/s. Determine:
   a) The through flow time (min.)
   b) The surface charging.
   c) The axial velocity (m/s).
   d) Name the measures which are necessary for a secure separation of sand (grain size > 0.2 mm).

   ![Cross-section of a grit channel](image)

B) In order to match an increase in loading of an activated sludge plant (V = 2,000 m³) the solid matter content is increased from 3.3 g/litre to 3.5 g/litre. 250 m³ of excess sludge with a solid matter content of 6.6 g/litre have to be removed from the plant daily.

For which period of time must the excess sludge removal be set in order to achieve the desired DS content?

Q5: Answer A or B

A) Wastewater is collected from a subdivision of 98.8 acre (40.0 ha) area that consists of 480 residential units and 2.2 acres (0.89 ha) of commercial center. Each of the two pumps will be cycled, alternately, 4 times per hour. Determine the volume of wet well needed.

B) A secondary settling tank with a surface area of A = 3,250 m² has a combined water inflow \( Q_{CW} = 2 \) Q\(_{DW} = 1,000 \) litres/s. With meeting a recirculation ratio of RR = 0.5, the solid matter content in the aeration tank is DS = 3g/litre. The sludge volume is determined as SV = 300 ml/litre.

Calculate the sludge index taking into account the highest inflow (\( Q_{CW} + Q_{RS} \)), the sludge volume charging and the surface charging.

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Head of Department

Dr. MUHANED A. SH.

Examiner

Dr. ALI HADI GHAWI