1. Designed Wastewater Flow Rate:

Wastewater flow rate (average) = 708 persons × 0.15 m³/day = 106.2 m³/day
Wastewater flow rate (Maximum) = 106.2 m³/day × 1.2 = 127.44 m³/day
Wastewater treatment plant designed flow rate: 150 m³/day

2. WWTP Wastewater Characteristics:

A. Influent wastewater characteristics
   - BOD: 200 mg/l
   - COD: 400 mg/l
   - SS: 200 mg/l
   - Coliform: 10,000,000 CFU/100ml

B. Target effluent characteristics
   - BOD < 30 mg/l
   - COD < 100 mg/l
   - SS < 30 mg/l
   - Coliform < 200,000 CFU/100ml

3. Functional Calculation in each Process Treatments

1. Collecting /pumping tank
   A. design parameter:
      Flow rate: Q = 150 CMD
      HRT time = 3.0 hr  •  the total volume needed:
      V = 150 m³/day × 3 ÷ 24 = 18.75 m³
   B. plant calculation:
      a. tank dimensions:
         (1) L200 × W520 × H350/ D200 cm
         effective tank volume: 20.8 m³ > 18.75 m³ —— OK!
         HRT timing: 20.8 ÷ 150 × 24 = 3.3 (hr)
      b. sewage pump
         QTY = 2.0 units
         Design with 0.45 m³/min × 8mH × 2HP × 2 units (alternating operation)
2. Equalization tank
   A. design parameter:
      Flow rate \( Q = 150 \text{ m}^3/\text{d} \)
      
      \[
      V \geq \left[ \frac{Q}{T} - (K \times \frac{Q}{24}) \times T \right]
      \]
      design with \( k = 1.0 \), \( T = 12 \text{ Hrs.} \)
      
      \[
      V \geq \left[ \frac{150}{12} - (1.0 \times \frac{150}{24}) \times 12 \right]
      V \geq 75 \text{ m}^3
      
   B. plant calculation:
      a. tank dimensions:
         \( L500 \times W520 \times H350/D320 \text{ cm} \)
         Effective tank volume: \( 83.2 \text{ m}^3 \geq 75 \text{ m}^3 \)--OK!
      c. actual Detention Time
         \( DT = 83.2 \div 150 \times 24 = 13.3 \text{ (hr)} \)
      d. Equalization tank pump calculation
         water pump flow rate required = \( 150 \text{ m}^3/\text{d} \div 1440 \text{ min/} \text{d} = 0.10 \text{ m}^3/\text{min} \)
         designed with \( 0.15 \text{ m}^3/\text{min} \times 6.0 \text{mH} \times 0.5 \text{Hp} \times 2 \text{ (units)} \text{ (alternating operation)} \)
      e. mixing facility calculation
         designed with mixing flow = \( 0.02 \text{ m}^3/\text{m}^3/\text{min} \) (according to government building design code)
         air flow required for mixing = \( 0.02 \text{ m}^3/\text{m}^3/\text{min} \times 83.2 \text{ m}^3 = 1.67 \text{ m}^3/\text{min} \)
         designed with air blower flow rate = \( 2.2 \text{ Nm}^3/\text{min} (p=4000 \text{mmAq} \text{, Re-circulated and cooling vertical type roots blower, 50MM, 3HP}) > 1.67 \text{ m}^3/\text{min} \).....OK!
         There will be 16 units of \( \frac{8}{8} \text{ cm} \) coarse bubble diffuser (6 units install in sludge storage tank, 2 units in sludge return tank) which gives air flow rate per diffuser around \( 0.09 \text{ m}^3/\text{min} \).

3. Aerobic Tank (Submerged attached Growth Process) filled with \textbf{Matala}\textsuperscript{®} contact media: (estimate BOD removal efficiency: 85%)
   A. design parameter:
      Flow rate = \( 150 \text{ m}^3/\text{d} \)
      \[
      \text{BOD load} = 150 \times (200-30) \times 0.9 \times 1000 = 23.0 \text{ kg/d}
      \]
Designed BOD volumetric loading rate = 0.3 kgBOD/ m³⋅d (serina’s note: designer use fare conservative data, as from our research data, we do suggest 0.5 kgBOD/ m³⋅d at V_{media}/V_{tank} ratio=47%, and 1.0 kgBOD/ m³⋅d at V_{media}/V_{tank} ratio=60%,)

Tank volume required: 23.0 / 0.3 = 76.7 m³

B. Plant calculation:

a. tanks dimensions:
   
   (1) L250×W520×H350/ D315 cm³
   
   (2) L250×W520×H350/ D315 cm³

Matala (SM150) Contact media total surface calculation:

Matala total surface are: 150 m²/m³ × 30 m³ = 4500 m²

Matala surface loading rate: 23.0 kgBOD/day ÷ 4500 m² ÷ 1000 = 5.1 g BOD/m²⋅d

--------(OK)

b. Actual Volume:

   Tank effective volume: 81.9 m³ > 76.7 m³………OK

Design with Matala contact media filling rate: V_{media}/V_{tank} = 55%

Matala contact media total volume = (L150×W520×H350) × 2 × 0.55 = 30 m³

Total volume of Matala contact Media: 30 m³

c. Actual Detention Time

   DT=81.9÷150×24=13.1 (hr)

d. Actual BOD load

   L=23+81.9=0.28 kg/ m³⋅d

e. Air flow calculation

   aeration air flow: 1.5 m³AIR/ m³⋅V-HR(according regulation)

   total air flow required: 81.9 × 1.5 / 60 = 2.05 m³/min

f. Air Blower flow rate calculation:

   design with 2.2Nm³/min(p=4000mmAq) · Re-circulated and cooling vertical type roots blower, 50MM · 3HP) > 2.05 m³/min..OK!

   26 units of fine bubble disc diffusers, air flow rate per diffuser is around 0.08 m³/min.

g. Back Wash:

   Air back wash: 26 coarse bubble disc diffuser with 3HP Re-circulated and cooling vertical type roots blower. (air flow rate per diffuser is around 0.08 m³/min.
4. Final sedimentation tank

A. Design Parameter:

- Flow rate: 150m³/d
- Detention time: >3.0 hrs
- Surface loading rates: <25m³/m².d
- Weir Loading Rates: <50 m³/m².d

B. Plant calculation:

a. tank dimensions:
   (1) L300×W300×H350/ D310

b. Actual volume
   \[ V = 27.9 \times 0.8 = 22.3 \text{m}^3 \]

c. Actual Detention time
   \[ DT = 22.3 \div 150 \times 24 = 3.5 \text{ (hr)} > 3 \text{hrs} \quad \text{OK!} \]

d. Actual surface loading rate
   - designed surface area=9.0 m²
   - actual surface load rate =150÷9.0=16.7m³/ m².d< 25 m³/ m².d

e. Actual Weir Loading Rate:
   - Designed Weir Length=4.0 m
   - Actual Weir Loading Rate=150÷4.0=37.5 m³/ m.d< 50 m³/ m.d

f. pump in final sedimentation tank
   - QTY=2.0 units (time pre-set operation)
   - Sludge estimate quantity =1.5m³/day
   - Sludge discharge time =30 mins
   - Sludge pump capacity calculation=1.5m³/d÷30 min÷=0.05m³/min
   - Pump head required =6.0m
     - (calculated head loose : 20% from the tank depth which caused by horizontal, elbow, check valves, piping etc.)
     - Designed with water pump of 0.15 m³/min×6.0mH × 0.5 Hp×2 units(interchange operation by pre-set timing)

5. Disinfection Effluent tank

A. Design Parameter:

- Flow rate=150m³/d
- HRT= 2.0 hrs
Tank Volume required = $150 \text{m}^3/\text{d} \times 2.0 \div 24 = 12.5 \text{m}^3$

B. Plant Calculation:

a. Tank Dimensions:

(1) \( L200 \times W300 \times H350 / D250 \)

b. Effective Volume

\( V = 15 \text{ m}^3 > 12.5 \text{ m}^3 \)

c. Actual Detention Time

\( DT = 15 \div 150 \times 24 = 2.4 \text{ (hr)} > 2.0 \text{ hr} \) OK!

d. Effluent tank water pump calculation (designed with 8hrs operation)

Water pump flow rate required = $150 \text{m}^3/\text{d} \div 480 \text{min/d} = 0.31 \text{ m}^3/\text{min}$

Head required = 8m (Maximum height from bottom of the tank to the effluent outlet)

Designed with $0.4 \text{m}^3/\text{min} \times 14 \text{mH} \times 3 \text{Hp} \times 2 \text{ units (inter exchange operation)}$

6. Sludge Storage Tank:

A. Design parameter:

Designed with sludge quantity = $1.5 \text{m}^3/\text{d}$

Estimate sludge quantity reduce to 1/2 after storage and thickening, sludge storage and digest reduce the sludge quantity to 50%

Storage duration > 60 days

Volume required = $1.5 \times 1/2 \times 0.5 \times 60 = 22.5 \text{ m}^3$

B. Plant design:

a. Tank dimensions:

(1) \( L520 \times W200 \times H350 / D325 \)

b. Actual volume

\( V = 33.8 \text{ m}^3 \)

c. Actual Detention time

\( DT = 33.8 \times 0.375 = 90 \text{ day} \)