Sludge is removed from the primary and secondary treatments. After removal, sludge is dehydrated and must be disposed of by an authorised company. The final used of sludge depends on the chemical and biological contents, as happens with waste in general.

Waste produced is classified as:
- Toxic and Dangerous Hazardous Waste (corresponding to Residuos Tóxicos y Peligrosos – RPTs).
- Municipal Solid Waste and Non-Hazardous Waste (corresponding to Residuos Sólidos Urbanos - RSUs).

Usually sludge is classified as Hazardous Waste.
SLUDGE TREATMENT

- Sludge treatment
  - Thickening
    - Thickener (10-15%)
      - Aerobic
      - Anaerobic
  - Stabilization/digestion
  - Dehydration
    - Drying beds (40-45%)
    - Band filters (35-40%)
    - Vacuum filter (20-30%)
    - Press filter (60-70%)
    - Centrifuge (20-30%)
    - Driers (80-90%)
  - Final disposal
    - Incineration
    - Controlled dumping
    - Landfill
    - Sea discharge
    - Compost and vitrification
Sludge from the secondary treatment is also thickened after removal. The mechanism is flotation.

Thickening by sedimentation was performed for sludge produced in the primary treatment (note the different design).
SLUDGE THICKENER: BAFFLE
Anaerobic digesters at the bottom of the image, gasholder in front.
ANAEEROBIC METABOLIC PROCESS

ACIDOGENESIS (FERMENTATION)

ACETOGENESIS

METHANOGENESIS

Symbiosis
The relief valve on top of the digester prevents an increase of pressure exceeding design values. Some space for the gas is allowed at the top of the dome.
• Closed systems (No O2)
• $\tau_r$ (anaerobic) > $\tau_r$ (aerobic)
• $C_m$ (anaerobic) > $C_m$ (aerobic)
• $T^e$ (anaerobic) ≥ $T^e$ (aerobic)
• Sludge production ↓
• Biogas production
### Parameters of a High Load Anaerobic Digester

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t_{residence} ) (h)</td>
<td>10-30 h</td>
</tr>
<tr>
<td>( [SS_v]_{input} ) (%)</td>
<td>40 - 70 %</td>
</tr>
<tr>
<td>SSv Reduction</td>
<td>30-60 %</td>
</tr>
<tr>
<td>( Q_{sludge} ) (m³/h)</td>
<td>( \frac{SS_{sludge}}{Q_{sludge}}/24 )</td>
</tr>
<tr>
<td>( SS_{v sludge} ) (kg/d)</td>
<td>( SS_v = SS_{sludge}[SS_{input}]/100 )</td>
</tr>
<tr>
<td>( V_{digester} ) (m³)</td>
<td>( V_{digester} = t_{residence}Q_{sludge} )</td>
</tr>
<tr>
<td>( C_{SSv} ) (kg/m³/d)</td>
<td>( C_{SSv} = \frac{SS_{sludge}[SS_{input}]}{V_{digester}}/100 )</td>
</tr>
<tr>
<td>( \phi_{inner} ) (m)</td>
<td>( \phi_{inner} = \sqrt{\frac{V_{digester}}{\left(\pi H_{free}/4\right) + \left(\pi H_{back}/4\right)}} )</td>
</tr>
</tbody>
</table>
LOW LOAD
DISCONTINUOUS
REACTOR

- $t_{RH} = t_{RS}$ (30-60 days)
- Mass load (Kg COD/m³/d): 0.4-1.6
- There are no mixing devices. Small turbulence created by the gas bubbles produced.
- Raw liquid enters through the digestion area.
- Feeding influent must include anaerobic bacteria (manure).
- A foam layer is formed at the surface favored by the ascending gas that carries sludge and floating mat.
- Digested sludge and supernatant is periodically purged.
- 57-85 l/hab sludge 1<sup>st</sup> + 113-170 l/hab sludge 1<sup>st</sup> + active sludge.
- Free reactor volume = approx 50% total digester volume.
Gasholder sometimes called gasmeter.
<table>
<thead>
<tr>
<th>Process</th>
<th>Energetic Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumping</td>
<td>10-20%</td>
</tr>
<tr>
<td>Primary sedimentation</td>
<td>2-5%</td>
</tr>
<tr>
<td>Active sludge</td>
<td>30-70%</td>
</tr>
<tr>
<td>Sludge processing</td>
<td>10-50%</td>
</tr>
<tr>
<td>Electricity, monitoring, controls</td>
<td>1-3%</td>
</tr>
<tr>
<td>Disinfection</td>
<td>1-3%</td>
</tr>
<tr>
<td>Odor control</td>
<td>1-2%</td>
</tr>
</tbody>
</table>
• Flocculants may be needed to enhance thickening
• The image shows the proportioner
DEHYDRATION:
BELT FILTER
DRY SLUDGE
• Sludge is stored temporarily.
• Disposal must be performed by an authorized company.
• Sludge may be hazardous waste!