Design of Sludge Treatment Facilities in Indonesia: Learning from the Past to Design a Better Future

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Authors / Acknowledgements

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Overview of Presentation

- Introduction
- Lessons learned
- Some themes and planned activities
- 85% of Indonesia’s urban population create septage
- Government to construct 200 Septage Treatment Facilities over the next 5 years.
- An additional 150+ existing IPLTUs are in need of replacement or rehabilitation
- USAID’s IUWASH (PLUS) program planning scheduled desludging

- Support regulations have been passed in many cities.

- This will cause a major increase in the sludge treatment facilities’ flows

- Aim to identify lessons learned and develop knowledge to move forward

- Building training and education
Lessons Learned

Planning

Design

Construction

Operation
Lack of standard methodologies/systems for planning

Need Everyone Involved: Owner, Operator, Consultant, Contractor

Lack of coordination between stakeholders (concept, design, construction, operation all separate activities)
Lack of Standard operating procedures

- No knowledge of septage quality
- No preparation of design narratives or calculations
- Lack of understanding of treatment processes
- Lack of consideration for hazards and ease of access and general practicality
No real knowledge in country about strength of septage: The most important design parameter!

160 samples from 8 cities taken to get initial understanding

**Septage Quality**
Sometimes Process Designs makes no sense for septage.
- Pulo Gebang – Aeration as a first step
- Medan – Imhoff Tanks overwhelmed with solids
- Bekasi – ABR or single SBR proposed

Process Flow chart makes sense, but is undersized or under utilized
- Sludge Drying Beds – 1/5th of needed size
- Anaerobic Ponds – no consideration of desludging period
Aeration as a first step: seen at three facilities and quickly proposed for others...

- Septage contains 80 times “wastewater” solids concentration
- Aeration prior to solids liquid separation is inefficient and costly
  - For 50% BOD reduction, 200m3/day, 135kW, $150,000 annual electricity
Imhoff tank aims to provide long solids retention time (>120 days) for digestion.
- For septage, design allows for 0.3 days solid retention time. Very little TSS removed.

- Also seen with ABR designs

- No understanding of hydraulics
Only one “SBR” due to budget constraints.
- Trucks fill from 8am to 10pm.
- 10pm to 4am react
- 4 to 5am settle
- 5-8 am decant

Lack of understanding of batch process

No clear operating description

No calculations

Size of tank way too large for good sludge removal at one point only
Recommended installation of a simple screen for low cost REDUNDANCY for screening plant.

Partitioned clarifiers and changed inlet and outlet details to PREVENT SHORT CIRCUITING and double settling efficiency.

Allowed for sludge removal from clarifier.

Rearranged room layout to allow access for screenings removal and disposal of sludge.

Rearranged aerator position to provide REDUNDANCY on mixing in holding tank.

Repositioning divider wall to reduce chance of settling, septicity and odor in the sludge holding tank and to increase retention time for aeration.

Partitioned aeration chamber, moved outlet, discussed outlet details and repositioned aerators to PREVENT SHORT CIRCUITING. This more than doubled the useful volume with limited cost and reduce calculated effluent BOD from 87ppm to 25 ppm.

Showed that aerators were delivering up to five times the required aeration capacity for assumed flows and loads. Gave suggestions for confirming actual requirements and determining if smaller units could provide REDUNDANCY and better FLEXIBILITY for future reduction of operation costs by up to 50%.
Sludge Drying Beds (SDBs) can separate liquids and solids.

SDBs must be designed to handle all the sludge.

Main Issues:

- Undersized in general (annual loading)
- Overloaded in short term (>20cm of sludge) – no understanding of operating strategy
Pulo Gebang - Undersized Sludge Drying Beds For Anaerobic Pond Desludging

- Current Anaerobic Pond is 125m x 20m and when the entire pond is desludged it will 2,000m$^3$ of sludge.
- There are two SDBs @ 20m x 50m (2,000m$^2$)
- When Sludge is emptied to SDBs it would create a 1m thick layer
- @ 1m the sludge will take a long time to dry
Pulo Gebang - Undersized Sludge Drying Beds

- To create a 20cm lift SDBs would need to be increased 5 times.

Diagram:
- Existing Anaerobic Pond: 125m x 20m
- Existing SDBs: 100m x 100m
- Required SDBs: 40m x 50m
- Layered materials:
  - Perforated Pipe
  - Gravel
  - Sand
  - 20cm layer
  - 1m height
We’d love to see a change in design attitudes

"Your opinions are a rephrasing of my opinions. I like that in a subordinate."

ARGUING WITH AN ENGINEER IS LIKE FIGHTING A PIG IN MUD

AFTER THE FIRST FEW HOURS, YOU REALISE THEY ENJOY IT
Construction

- Poor quality drawings
- Poor capacity contractors
- General lack of oversight likely
- **No operations staff involvement**
- Unclear responsibility after handover
Bogor

- Poor construction of Sludge Drying Beds
  - Poor quality wooden rafters
  - Cracking in Concrete
  - Poor quality plexi-glass roof material
  - “in warranty period” so no operator action
Solid/liquid separation occurs and due to incorrect pipe networks the split flows are then recombined in the ABR.
Lack of Standard operating procedures

• Lack of training for operators
• Lack of available spare parts and maintenance support for mechanical equipment
• Lack of understanding of the treatment process
• Reduction of cost at the expense of water quality
• Peripheral/Support Infrastructure Issues
Duri Kosambi & Pulo Gebang

- Operators hadn’t received training
- No users manual available
- No Spare Parts
- No local vendor support services
Bypassing Unit Processes Common

- Operators are unable to solve problems and tend to bypass processes at the detriment to water quality.

FOG on drying beds due to bypassing ABR

- Bypassing initial grit removal due to lack of wash water
- Bypassing initial grit removal due to broken mechanical equip.
Key Themes and Solutions

- **Septage is Strong, Needs Solid/Liquid Separation**
- **Systematic method for process selection**
- **O&M Manual Starts in Design!**
- **Redundancy in design. EVERYTHING must be redundant**
- **Plan phasing of treatment facility**
- **Stakeholder engagement through design and construction**
Questions and Discussion
Overview

1. Receiving
   - Grit removal
   - FOG removal
   - Coarse screen
   - Fine screen

2. Pre-Treatment
   - Sedimentation Tank/Clarifier
   - Sludge Drying Bed
   - Mechanical Dewatering
   - Anaerobic Pond

3. Primary Treatment (Solids Liquid Separation) Selection
   - Simple Separation
   - Separation with Digestion

4. Liquids Treatment Selection
   - Waste Stabilization Ponds
   - SBR
   - Activated Sludge/Oxidation Ditch
   - Chemical Disinfection (if applicable)
   - Discharge to Environment

5. Solids Treatment Selection
   - Sludge/Cake Drying Bed
   - Mechanical Dewatering
   - Thermal Drying
   - Landfill or Beneficial Use

6. Landfill disposal

Receiving and Pre-Treatment
Primary (Solids Liquid Separation)
Sneak Preview

Select Solids Liquid Separation Approach

Select Solids Disposal Route
Select Additional Volume Reduction Approach

Select Liquid Treatment Approach
Select Pathogen Reduction Approach

Check what pretreatment needed
Select Disinfection

Then draw up treatment process and step through logically
Initially Sludge Drying Beds Appropriate

- Low initial cost
- Simple to operate
- Suitable for small systems

Sludge Drying Beds No Longer Appropriate

- Area needed too large
- Install mechanical dewatering
- Use SDBs for previously dewatered sludge

System Grows: More Money and Skill
Initially facultative ponds suitable

- Low initial cost
- Limited Operating costs
- Suitable for small systems

Faculative Ponds Too Small

- Area needed too large
- Install aerators
- Make sure pond initial design suitable
Several consultants said “there is no oil and grease”

Oil and Grease have a significant chance of wrecking facilities

500ppm is a “big number” when designing processes
# Septage Quality in Different Nations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Indonesia Samples</th>
<th>United States Septage</th>
<th>Notes</th>
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<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Maximum</td>
<td>Average</td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>1,600</td>
<td>14,000</td>
<td>5,600</td>
</tr>
<tr>
<td>BOD5</td>
<td>5,500</td>
<td>15,000</td>
<td>6,500</td>
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<tr>
<td>TSS</td>
<td>22,000</td>
<td>18,000</td>
<td>13,000</td>
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Pulo Gebang - Undersized Sludge Drying Beds

- Besides creating massive SDBs what other options are there?
  - Divide Pond into smaller sections.
  - Add a mobile desludger
- Do need to still check the annual loading – good research question!

Existing Anaerobic Pond

<table>
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<th>6.6m x 62.5m</th>
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Aerators & Mixers

- Not Maintained
- Under utilized
- Located incorrectly

Aerator only operating 2 hours a day
Aerators & Mixers

- Undersized – no sizing calculations
- Care with impact of high solids concentration on mixer design
- Located incorrectly

One Aerator for large pond
Pipe Networks

- Insufficient design. Pipes are not clearly shown in many designs e.g. Malang

- Pipes need to be designed to include:
  - Regular cleanouts
  - Scouring velocity
  - Minimum 3” for solids but keep scouring velocity if possible.
  - Built to withstand vehicle traffic (if applicable)
  - Ensure inlet/outlet locations to avoid short circuiting
Problems:
- General Health & Safety Issues
- Designs need to account for poor construction and seismic conditions

Elevated Imhoff Tank is an unnecessary hazard in a seismic prone region
Site Hazards

- Truck Access routes are not well thought out.
- Trucks reversing pose a hazard to plant operators.

No vehicle access for removal of sludge. Currently dumped in the corner of lot. (Bogor and Malang)
Receiving station inlet too high, prevents trucks from passively emptying truck.

Similarly receiving station is on a slope and this prevents trucks from passively emptying truck.
Peripheral Issues – water supply, power etc

- Washwater very important for screen operation but insufficient available.
Anaerobic baffled reactor prior to liquid/solids separation will lead to rapid accumulation of solids and frequent desludging. Just like the Imhoff tank won't get digestion. Also seen at Bogor.