Recent Overview on Reuse and Biotransformation of Industrial Sludge into Organic Fertilizer through Vermicomposting

Presented by: Lee Leong Hwee
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1. Introduction
• Industrial sludge is one of the main by-products produced from the treatment of industrial wastewater

• Solid or semi-solid material, consisting of
  - Compounds removed from the wastewater
  - Substances added into the chemical and biological operation units
• Contains a lot of contaminants:
  ➢ Organic
  ➢ Inorganic
  ➢ Chemicals
  ➢ Microbial pollutants

• Composition may vary considerably, depending on the treatment processes

• Processing and disposal of sludge is challenging and complex
2. Formation of Industrial Sludge
• Industrial sludge is the settleable by-products generated from different treatment stages

• Can be classified into:
  ➢ Primary sludge
  ➢ Secondary sludge
  ➢ Activated sludge
  ➢ Chemical sludge

Fig 1 Sludge generation points of typical wastewater treatment scheme (Turovskiy and Mathai, 2006)
Primary sludge
- Produced from the primary treatment
- Grey in colour, strongly odorous, high percentage of organic matters
- Solid content: 2–7%

Secondary sludge
- Produced from the secondary treatment (biological treatment)
- Brownish, consisted of biological solids and biomass produced by the microorganisms, inert materials
- Solid content: 6-8%
- **Activated sludge**
  - Produced from activated sludge process in the secondary treatment system
  - Dark grey or dark brown in colour, flocculent appearance
  - Made up of a mass of microorganisms, inert materials, non-biodegradable suspended solids
  - Solid content: 0.4-1.5%

- **Chemical sludge**
  - Produced from the chemical treatment
  - Chemicals are used to remove and precipitate solids, improve sedimentation processes
  - Darker in colour, low dewatering characteristics
3. Management of Industrial Sludge
Three most common disposal methods

1. Incineration
2. Landfilling
3. Land application
Land Application

• Convenient and economic disposal alternatives

• More preferable
  ➢ Valuable source of nutrients
  ➢ Contains high organic matter content

• Reduce the use or inorganic fertilizer

• Recycling and reuse of waste are preferred for sustainable development
Problems and Issues

• Presence of pollutants and contaminants
  ➢ Threaten soil quality and crop yield
  ➢ Contaminate human food chain

• Uncontrolled application can cause
  ➢ Overfertilization
  ➢ Ammonia toxicity
  ➢ Accumulation of heavy metals in soil
  ➢ Increase soil alkalinity
  ➢ Ground water pollution
Possible way of reusing industrial sludge

• Integrating with other treatment and stabilization processes
  ➢ Volume reduction
  ➢ Odor control
  ➢ Pathogen and toxic compounds removal
Current treatment methods

• Comprises of few stages:
  ➢ Thickening – remove moisture to reduce sludge volume
  ➢ Pre-treatment or conditioning – alter the characteristics of sludge to enhance performance
  ➢ Post-treatment – stabilize and detoxificate the sludge
  ➢ Dewatering – remove all the water
4. Vermicomposting
Vermicomposting

- Natural conversion of biodegradable waste into organic fertilizer (Lim et al., 2016)
Advantages of vermicomposting process (Singh et al., 2011):
• Short Processing time
• High nutrients recovery

Benefits of vermicompost (Sim and Wu, 2010):
• Rich in nutrients
• Improve soil texture
• Improve plant growth
5. Vermicomposting of Industrial Sludge
## Vermicomposting of Industrial Sludge

<table>
<thead>
<tr>
<th>Sludge</th>
<th>Amendments</th>
<th>Earthworm</th>
<th>Observation</th>
<th>Ref</th>
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</thead>
</table>
| Paper-mill sludge       | Totato-plant debris               | E. fetida    | - 2:1 mixture ratio of tomato-plant debris and sludge  
                          - Higher proportion of tomato-plant debris showed higher amount of humic acid | Fernández-Gómez et al., 2013 |
| Pulp and paper mill sludge | Cow dung, food processing waste   | P. excavatus | - Total phosphorus increase (76.1%)  
                          - Total nitrogen increase (58.7%)  
                          - Total organic carbon decrease (74.5 %) | Sonow al et al., 2013        |
### Vermicomposting of Industrial Sludge (Continued…)

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</table>
| Pressmud sludge  | Cow dung, Jeevamirtham Azospirillum | E. eugeniae | - Increased in nitrogen, phosphorus and potassium content  
- Decreased in organic carbon and C:N ratio               | Vasant hi et al., 2014 |
| Pressmud sludge  | Cow dung                    | E. fetida  | - Increased in nitrogen, phosphorus, sodium, electrical conductivity and pH  
- Decreased in C:N ratio and potassium                   | Bhat et al., 2014   |
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<tr>
<td>Bakery industry sludge</td>
<td>Cow dung</td>
<td>E. fetida</td>
<td>- Increased in growth and reproduction of the earthworms</td>
<td>Yadav et al., 2015</td>
</tr>
<tr>
<td>Food industry sludge</td>
<td>Cow dung, poultry droppings, biogas plant slurry</td>
<td>E. fetida</td>
<td>- Increased in earthworms biomass</td>
<td>Garg et al., 2012</td>
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<tr>
<td></td>
<td></td>
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<td>- Increased in total nitrogen, total available phosphorus, total sodium and total potassium</td>
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<td></td>
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<td>- Decreased in C:N ratio and pH</td>
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6. Conclusion
• Earthworms are able to remove harmful pathogens, ingest heavy metals and mineralize nitrogen and phosphorus
• Vermicompost has high content of organic matter and nutrients
• Vermicomposting can be used to manage various type of industrial sludge
7. References
References


References


THANK YOU