1) Choose a broad topic, narrow down and confirm your topic as early as possible 2 months before comprehensive viva

2) Confirm the list of prominent journals for your research topic

3) Collect literatures (minimum 50 papers) without missing any relevant papers but without any irrelevant papers

4) Chapter-wise Filtration / grouping / develop files for each chapters

5) Paraphrase the conclusions from literatures chapter-wise

6) Critical review of literatures, together with summary table

7) Find, evaluate and confirm the gap in research as YOUR original, non-plagiristic, non-obvious

8) Conceptualise your research gap

9) Hypothesize your Research Concept

10) Experiment YOUR OWN research hypothesis

11) Prove the Hypothesis with your own data interpretation,

12) Address and hold this as your own proven research hypothesis

13) Add your new hypothesis with the existing knowledge domain in your area, Let your PhD students re-SEARCH

14) Title your name on your proven hypothesis
Internal referencing:

“The development of single stage anaerobic digester in to two stage is to separating hydrolyser and methanisers independently gained much attention in the recent past specifically to prevent NH3 toxicity (Parkin and Owen 1986; Bhattacharya et al., 1986; Alvarez J.M 1987; Anglidaki et al., 1993; Anderson et al., 1994; Anglidaki et al., 1998a; Alvarez et al., 2000)”. 
The enzyme hydrogenase consists of two subunits and interacts with NADH on the cytoplasmic side and protons on the periplasmic side of the cell membrane. Hence, the important bioprocess parameters to ensure proper fermentative biohydrogen production have been reported as below:

- Optimum pH and ORP control (Yu et al., 2002)
- High organic loading rate with short HRT (Kim et al., 2004)
- Selection, pre-treatment and gradual acclimatization of digester seed inocula (Horiuchi et al., 2002)
- Optimum NADH/NAD+ ratio (Mohan et al., 2008)
- Optimum butyrate/acetate ratio (Wang et al., 2006)
- Avoiding solventogenesis and methanogenesis (Hawkes et al., 2002)
- Optimum Fe-only, Ni-Fe hydrogenase enzyme activation for hydrogenesis and methanogenesis separately. (Lay et al., 1999; Hans et al., 2005)
Summary on mixing;

Many previous researchers have emphasized the importance of adequate mixing to improve the distribution of substrates, enzymes and microorganisms throughout the digester (Parkin and Owen, 1986; Chapman, 1989; Lema et al., 1991). For instance, et al (1992) described that This was supported by et al (1992), et al (1993) et al (1995). However, those informations on the effect of the intensity and duration of mixing on the performance of anaerobic digesters are contradictory. Several studies indicated that a lack of sufficient mixing in low solids digesters dealing with municipal waste resulted in a floating layer of solids (Diaz and Trezek, 1977; James et al., 1980; Stenstrom et al., 1983). Chen et al. (1990) concluded higher methane yield in the case of a 4.5 m3 digester under unmixed conditions than continuously mixed conditions. Similar results were also reported by et al (2002); et al (2006). However, Ben-Hasson et al. (1985) observed 75% lower methane production rate using the dairy cattle manure under continuously mixed conditions than the unmixed conditions. Contrary to this, Ho and Tan (1985) revealed that the higher gas production for a continuously mixed digester than for an unmixed digester fed with palm oil mill effluents, whereas Hashimoto (1983) found higher biogas production from beef cattle wastes under continuously mixed conditions than under intermittent mixing conditions. Similarly, Dague et al. (1970), Mills (1979) and Smith et al. (1979) suggested an intermittent mixing yields better efficiency of anaerobic digesters over continuous mixing.
Preparing and Tabulating the review of previous findings to understand the gap in research

- It has been observed that very rapid mixing disrupts the structure of flocs inside a biological reactor which disturbs the syntropic relationships between organisms, thereby adversely affecting the reactor performance (Whitmore et al., 1987; Dolfing, 1992; Stroot et al., 2001). However, there is no clear information available in the literature about the threshold limits of digester mixing, other than a power input of 0.20–0.30 HP/1000 cu ft (5.26–7.91 W/m$^3$) is suggested by the US EPA for efficient digester mixing (US EPA, 1979). These contrary findings reported in the literatures about the effect of mixing on the process performance of anaerobic digesters emphasize the need for an extensive research on mixing and hydrodynamics studies. Therefore, the present study was designed to evaluate the performance of digesters having three different modes of mixing,—biogas recirculation, impeller mixing, and compared with unmixed conditions.
Hydrogen and methane production potential of different solid wastes (HP).

Liu et al., (2001) experimented which the H2 production potential using the household solid wastes fermentations observed 43mlH2/gm of VS added and 250 mL per gram of VS removed using 2 days HRT in the first stage.

Kim et al (2004 and 2006) have concluded that the specific H2 production potential of food wastes was higher than that of sewage sludge. The maximum specific H2 production potential of 122.9mL/gm of carbohydrate COD was found in the waste composition of 87:13 (of food waste in to sewage sludge). Lay (2000) observed 1600l/m3 / day of H2 yield and 1.2 LH2/gm Starch COD/d. The H2 production of rice winery waste water using mixed anaerobic culture was observed as 1.33 LH2/gm VSS.d and HPR was 1.37mol-2.14 Mol/Mol of hexose. Okamoto et al (2000) observed the H2 production potential of cabbage, carrot, and rice were 26.3 -61.7mL/g VS, 44.9 – 70.7 mL/gm VS, and 19.3 – 96 ml/gm respectively. The general engineering parameters and the Biohydrogen yield potential have been well documented.
<table>
<thead>
<tr>
<th>S.No</th>
<th>Author (Year)</th>
<th>Type of Waste</th>
<th>Opt. pH</th>
<th>OLR (gm/L RV/day)</th>
<th>Opt. HRT (Days or Hrs)</th>
<th>Opt. Temp (°C)</th>
<th>Hydrogen Production Potential</th>
<th>H2 (%)</th>
<th>CO2 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Archer (1986)</td>
<td>Brewery effluent</td>
<td>6.8 – 7.1</td>
<td>2 – 12 kg/d</td>
<td>15hrs</td>
<td>NA</td>
<td>100ppm</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>2</td>
<td>Lay et al (1999)</td>
<td>OFMSW</td>
<td>5.0</td>
<td>10</td>
<td>20 days</td>
<td>37</td>
<td>140 – 180 mL/gm TVS</td>
<td>55</td>
<td>21</td>
</tr>
<tr>
<td>3</td>
<td>Okommoto et al., (2000)</td>
<td>OFMSW</td>
<td>7.0</td>
<td>4</td>
<td>20 days</td>
<td>25</td>
<td>Cabbage =26-61 Carrot = 44.8 - 70.7 Rice = 19.3 - 96 Egg =2.6 - 7.1 Meat = 2.5 – 7.7 Chicken =3.6 - 10.2 Fat =4.4 – 11.1</td>
<td>Cabbage 33.9- 55.7, Carrot = 27.7- 46.8 Rice 44 - 45</td>
<td>NA</td>
</tr>
<tr>
<td>4</td>
<td>Lay (2000)</td>
<td>Starch</td>
<td>4.7 – 5.7</td>
<td>6g/l/d (starch)</td>
<td>17 hrs</td>
<td>34</td>
<td>1.29l/gm of starch</td>
<td>60</td>
<td>32</td>
</tr>
<tr>
<td>5</td>
<td>Chen et al. (2001)</td>
<td>Glucose and Sucrose</td>
<td>6.7</td>
<td>20gm/l/d</td>
<td>13.3</td>
<td>35</td>
<td>Glucose 1.63 Sucrose 4.45 M of H2/M</td>
<td>24</td>
<td>NA</td>
</tr>
<tr>
<td>S.N</td>
<td>Author (Year)</td>
<td>Type of Waste</td>
<td>Opt. pH</td>
<td>OLR (gm/L RV/day)</td>
<td>Opt. HRT (Days or Hrs)</td>
<td>Opt. Tem (°C)</td>
<td>Hydrogen Production Potential</td>
<td>H2 (%)</td>
<td>CO2 (%)</td>
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<tr>
<td>7</td>
<td>Yu and Fang (2002)</td>
<td>Dairy waste water</td>
<td>4.0</td>
<td>8 g/l/d</td>
<td>12</td>
<td>30</td>
<td>0.62-1.48 l/l/d</td>
<td>58</td>
<td>38</td>
</tr>
<tr>
<td>8</td>
<td>Logan et al., (2002)</td>
<td>Sucrose, Molasses, Lactate, and Cellulose</td>
<td>6.0</td>
<td>20 g/l/d</td>
<td>20 hrs</td>
<td>NA</td>
<td>4,8,4,2,4 M/Mole of glucose, sucrose, potato starch, lactate, and cellulose respectively</td>
<td>60-64</td>
<td>NA</td>
</tr>
<tr>
<td>9</td>
<td>Wu et al (2003)</td>
<td>Sewage Sludge sucrose</td>
<td>5.8 – 6.8</td>
<td>20 g/l/d</td>
<td>2 – 6 hhs</td>
<td>35</td>
<td>2.67 M/m of sucrose</td>
<td>60</td>
<td>NA</td>
</tr>
<tr>
<td>10</td>
<td>Gomez et al., 2006</td>
<td>Slaughter house solid waste + OFMSW</td>
<td>5.5</td>
<td>12</td>
<td>3 and 5days</td>
<td>34</td>
<td>52.5 to 71.3 mL/gm VSf</td>
<td>25-27</td>
<td>NA</td>
</tr>
<tr>
<td>11</td>
<td>Krupp and Widmann</td>
<td>Sewage sludge</td>
<td>5.5</td>
<td>2-14</td>
<td>5 days</td>
<td>35</td>
<td>140 mL/gm VS</td>
<td>44-52</td>
<td>NA</td>
</tr>
</tbody>
</table>
Suggestions to ensure that you are not duplicating work which some other researcher has already done

- Check with your supervisor
- Check with a recent and oldest review paper of your topic
- Previous Ph.D theses - back references
- International Conferences proceedings
- Check citation index, and confirm depth of work of each authors
- Sometimes, inevitably another researcher may publish similar work in the meantime.

- In that case find a way at last to conclude something different from your work, which some one has not attempted to conclude, change your data analysis strategy and find new reasons for your conclusions to prove originality of your’s research work.
Writing a research paper

- **Abstract**: Maximum 150 words, (see journal specification)
- **Key words**: Maximum 7 to 8 words
- **Introduction**: Maximum 3-4 pages A4
- **Materials and Methods**: 3-4 pages A4
- **Results and Discussion**: 4-5 pages A4
- **Conclusion**: 150 to 200 words
- **Graphs** (Elsevier 6 to 8 graphs) 3-4 pages
- **References**: 2 pages (30 references for original research 55 to 72 references for review paper)
- **Total pages**: 14-25 pages A4 (Short communication 14 pages) Better to read the specification of journals.

Acknowledgement

References 30 to 40
WRITING A PhD THESIS

- Synapsis: 2 or 3 pages.
- Organisation of the thesis, Chapter 1 depicts, chapter 2 depicts, chapter 3 depicts
- Introduction: 5% of whole thesis
- Aims and objectives: Minimum 2 pages
- Scope of the study: Minimum 3 pages
- Literature review: 25%-30%
- Materials and methods: 15 to 20% of
- Results and discussion: 25 to 30%
- Conclusion: 5 to 10%
For an international standard of writing one must have completed INTELLIGENCE ENGLISH LANGUAGE TESTING SYSTEM (IELTS UK) OR TEST OF ENGLISH AS FOREIGN LANGUAGE (TOEFL).

All unit of expressions as million, billion, trillion no Crores and Lakhs, - DIMENSIONLESS AND DIMENSIONAL ANALYSIS, COBERSION FACTORS ETC.,

mg/l should be mg.L\(^{-1}\) kg.d\(^{-1}\) kg.m\(^{-3}\).d\(^{-1}\)

Internationally adoptable methodology

Internationally followed grading of fonts for titles chapters, subtitles, sub-sub titles and the text, list of figures, nomenclature, Abbreviations.
COMPOSING THE TITLE

- SHORT AND SWEET TITLE
- HOW MUCH TIME OUR PARENTS WOULD HAVE TAKEN TO TITLE OUR NAME
- ATTRACTIVE TITLE RELEVANT TO THE PAPER
- Wrong/irrelevant topic/ Titles for a Project /paper :
- ATTRACTIVE SHORT TITLE IS NEEDED
- Not more than two and half lines
- Title should directly convey your paper or the proposal
- Titling is really an art, see movies titles are how attractive that’s why few movies are still remembered not only with title but also with contents
Suggestions to link continuity of the words using

- Eventually,
- Consequently
- Apparently
- Subsequently
- Interestingly
- Nevertheless
- Contrary to this
- Supporting to this
- Therefore,
- However, For instance, In addition to this, In view of this

EVERY LINE SHOULD BE LINKED WITH OTHER LINE (No terminated and hanging sentences)

EVERY PARAGRAPH END SHOULD MAKE THE READER TO IMAGINE NEXT PARAGRAPH

EVERY END OF THE CHAPTER SHOULD GIVE THE IDEA FOR THE READER WHAT COULD BE THE LIKELY NEXT CHAPTER
Synopsis Writing?

- Synopsis: Eight to 12 equal paragraphs in 2 to 3 pages 46 to 72 lines (University specific)
- 1st paragraph: Background of the thesis
- 2nd Paragraph: Why this topic? Need and Scope of the research
- 3rd Paragraph: Aims and objectives
- 4th Paragraph: Methodology About the experiment/modelling/surveying work

FIRST PAGE OVER

- 5th, 6th Paragraph: Results, with similarities, $r^2$ values, linearity
- 7th Paragraph: Interesting conclusions of the thesis
- 8th Paragraph: Conclusions and recommendations

SECOND PAGE OVER

DEMONSTRATE MINIMUM 6 NEW TAKE HOME MESSAGES FOR EVERY READER
This paper describes what.....

Need for this paper

Application of this paper

The batch and CSTR experiment was conducted ..... Under what conditions.

interesting results and the observed lower or higher results that are attributed due to why? R² values, consistent/corraborated

Interestingly the paper concludes that.....

This paper recommends....what.
This paper describes the impact of OLR and HRT on the performance of anaerobic digester producing hydrogen and methane from leather solid wastes using two stage and a single stage anaerobic CSTR. Many hydrodynamics, chemodynamics and microbial dynamics parameters govern the bioprocess performance of an anaerobic digester. These parameters were investigated in the present study to find out the optimum conditions required for high H₂ and CH₄ yield. The experiment was conducted at mesophilic conditions. The pH minima (2.3) was observed at high OLR, whereas, the pH maxima (8.8) was observed at low OLR. This is attributed due to high accumulation of organic acids in the former and the lower accumulation in the later. Consequently, the high accumulation of organic acids was conducive to an acidic pH favoured to minimise the ammonia in the digester. This high accumulation of organic acids was also corroborated well with the high acid forming microbial populations. A high r² (0.9) value observed between pH and ammonia confirms that ammonia toxicity is the major problem in the anaerobic digestion of protein rich waste water. Interestingly, the pH 5.5 yielded maximum H₂ which was contrary to the results reported already. This is attributed due to a maximum synthesis of organic acids particularly butyric acids essential for the production of H₂ at this pH, contrary to the results reported elsewhere. The paper concludes that -------. Further, the paper recommends .........................

Key words: hydrodynamics, microbial dynamics and chemodynamics, dispersion number,