

Investigating Environmental Factors Influencing the Biodegradation of Heavy Oil in the Natural Environment

Shakir Ali¹, Young-Cheol Chang¹ *¹ Course of Chemical and Biological Engineering, Muroran Institute of Technology, Hokkaido 050-8585, Japan

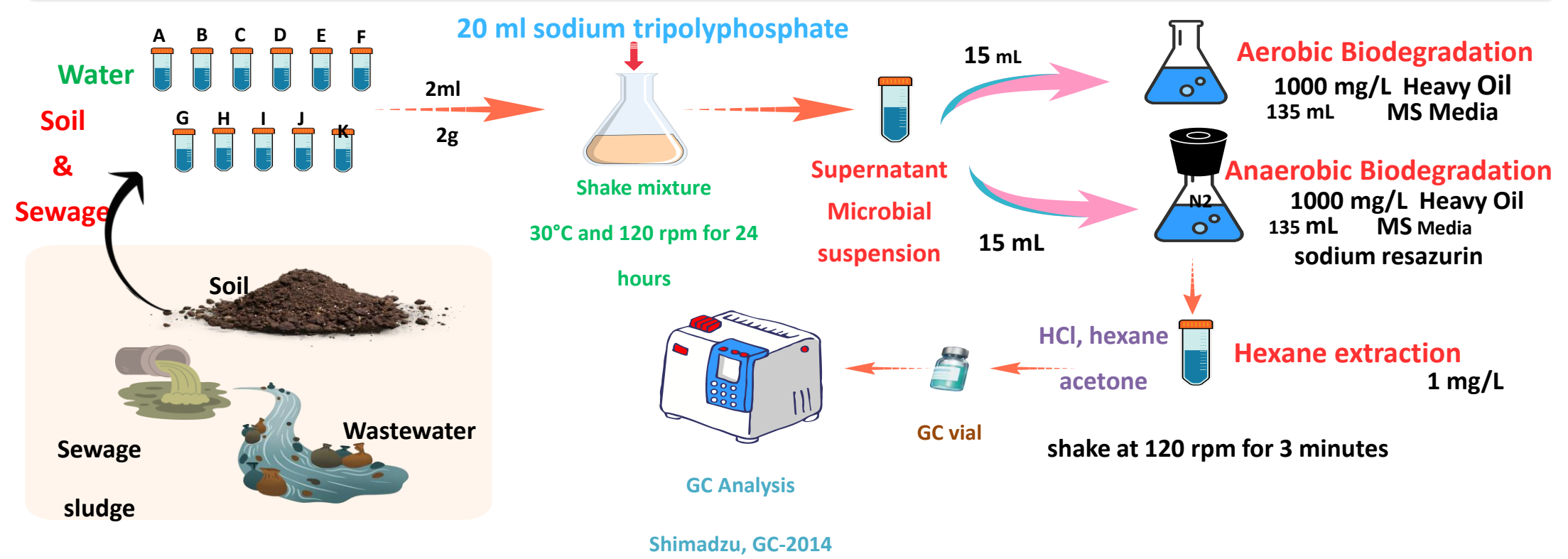
INTRODUCTION & AIM

The **complicated** hydrocarbon structure, high molecular weight, and **great viscosity** of heavy oil make it a major **environmental problem**.

The biodegradation of heavy oil in the natural environment is influenced by various factors such as the **diversity and abundance of microbiota**, **pH**, **temperature**, **oxygen availability**, and other environmental factors

In this study, we aimed to investigate the biodegradability of heavy oil using the **microbial community** of **soil** and **water** under **aerobic** and **anaerobic** conditions.

METHOD



RESULTS & DISCUSSION

GC Analysis of Heavy Oil Biodegradation

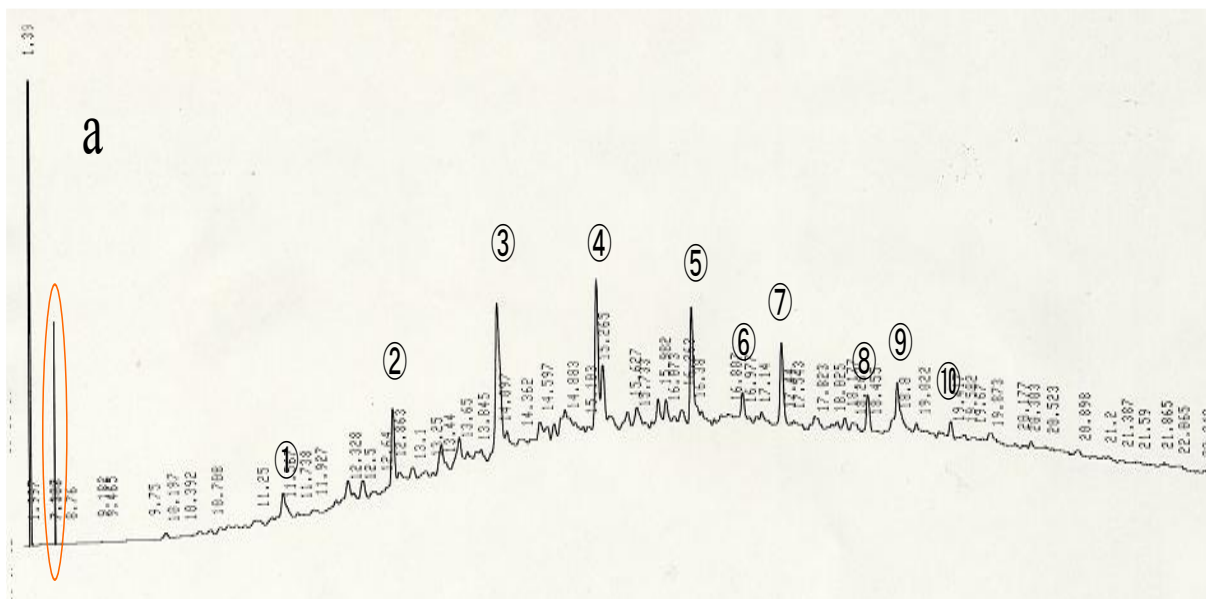


Figure 3. GC Analysis of Heavy Oil (Control peaks)

Presence or Absence of Heavy Oil Peaks after Biodegradation in Aerobic Conditions

Sample	Peak (1)	Peak (2)	Peak (3)	Peak (4)	Peak (5)	Peak (6)	Peak (7)	Peak (8)	Peak (9)	Peak (10)
A	○	○	○	○	○	○	○	○	○	○
B	○	○	×	×	○	○	○	○	×	○
C	○	○	×	×	×	×	×	×	×	×
D	○	○	×	×	×	×	×	○	×	×
E	○	×	×	×	×	○	×	×	×	×
F	○	○	×	×	×	×	×	×	×	○
G	○	○	○	○	○	×	○	○	×	○
H	○	○	○	○	○	○	×	○	×	×
I	○	○	○	○	○	○	×	○	×	×
J	○	○	○	○	○	○	×	○	×	○
K	○	○	×	×	×	○	○	○	○	○

Presence or Absence of Heavy Oil Peaks after Biodegradation in Anaerobic Conditions

Sample	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A	×	×	×	×	×	×	×	×	×	○
B	×	×	×	×	×	×	×	×	×	○
C	×	×	×	×	×	×	×	×	×	×
D	○	×	×	×	×	×	×	×	×	×
E	×	×	×	×	×	×	×	×	×	○
F	○	×	×	×	×	×	×	×	×	○
G	×	×	×	×	×	×	×	×	×	○
H	×	×	×	×	×	×	×	×	×	×
I	×	×	×	×	×	×	×	×	×	×
J	×	×	×	×	×	×	×	×	×	×
K	×	×	×	×	×	×	×	×	×	○

Aerobic Biodegradation of Heavy Oil by Water and Soil Microbial Community

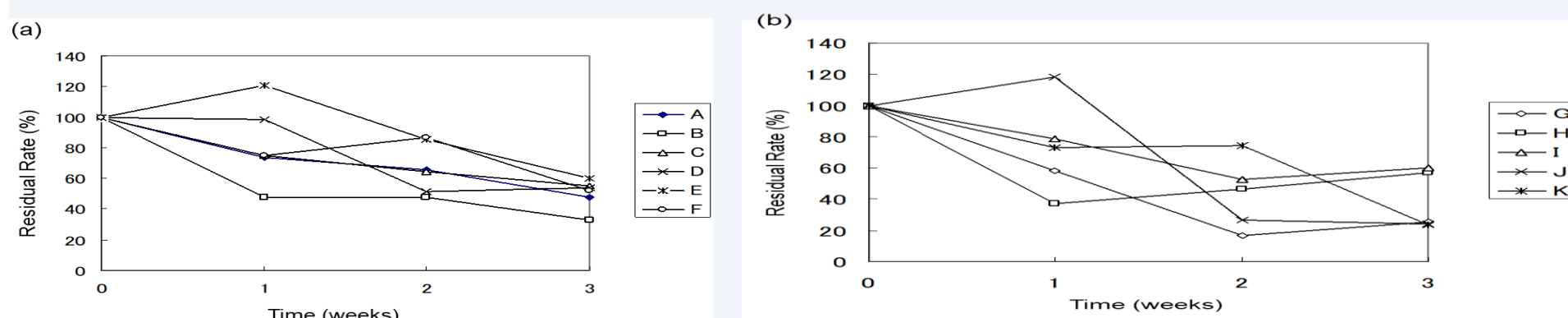


Figure 2. (a) Aerobic Biodegradation Test Results of Heavy Oil (Water Sample), (b) Aerobic Biodegradation Test Results of Heavy Oil (Soil Sample).

Anaerobic Biodegradation of Heavy Oil by Water and Soil Microbial Community

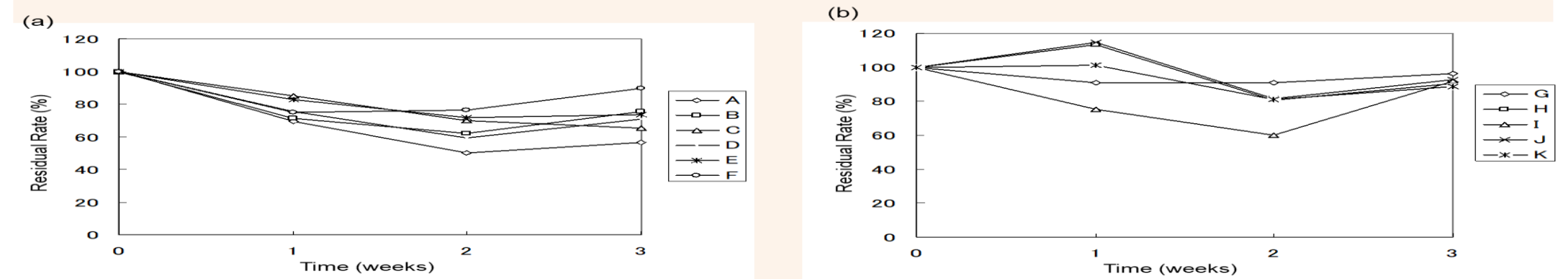


Figure 7. (a) Anaerobic Biodegradation Test Results of Heavy Oil (Water Sample), (b) Anaerobic biodegradation test results for heavy oil (soil samples)

Effect of Microbial count (CFU) on Biodegradation of Heavy oil in Aerobic conditions

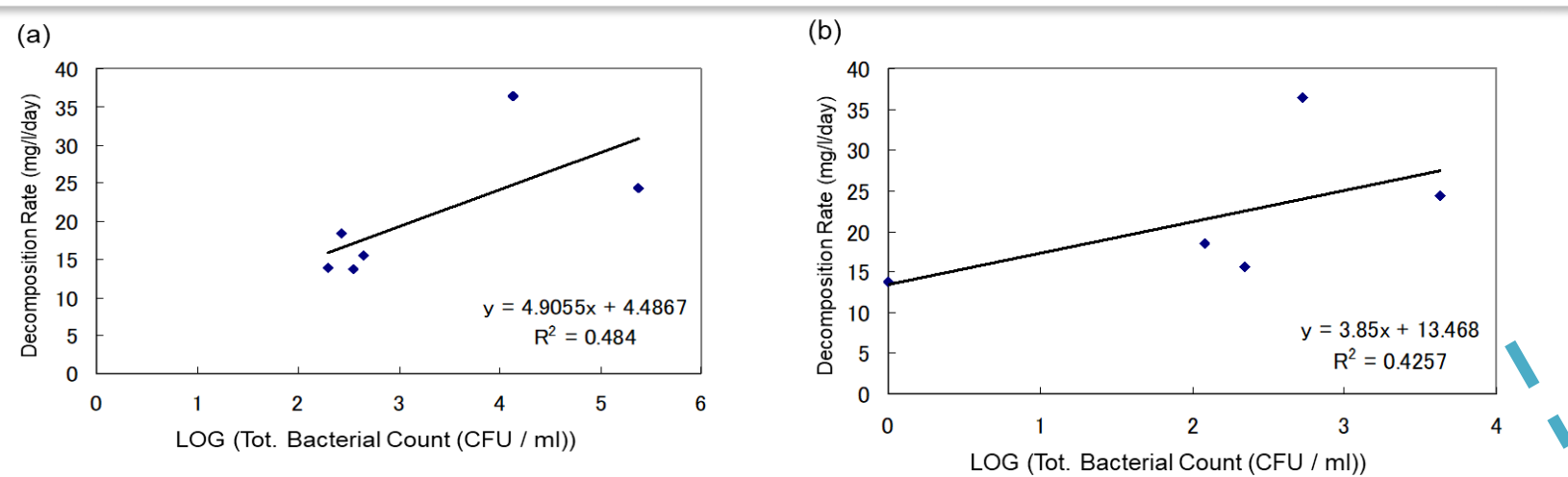


Figure 4. (a) The Correlation Between Biodegradation Rate of Heavy Oil and Total Microbial Count in Water Samples Under Aerobic Conditions; (b) Correlation Between Biodegradation Rate of Heavy Oil and Heavy Oil-Degrading Bacteria Count in Water Samples Under Aerobic Conditions

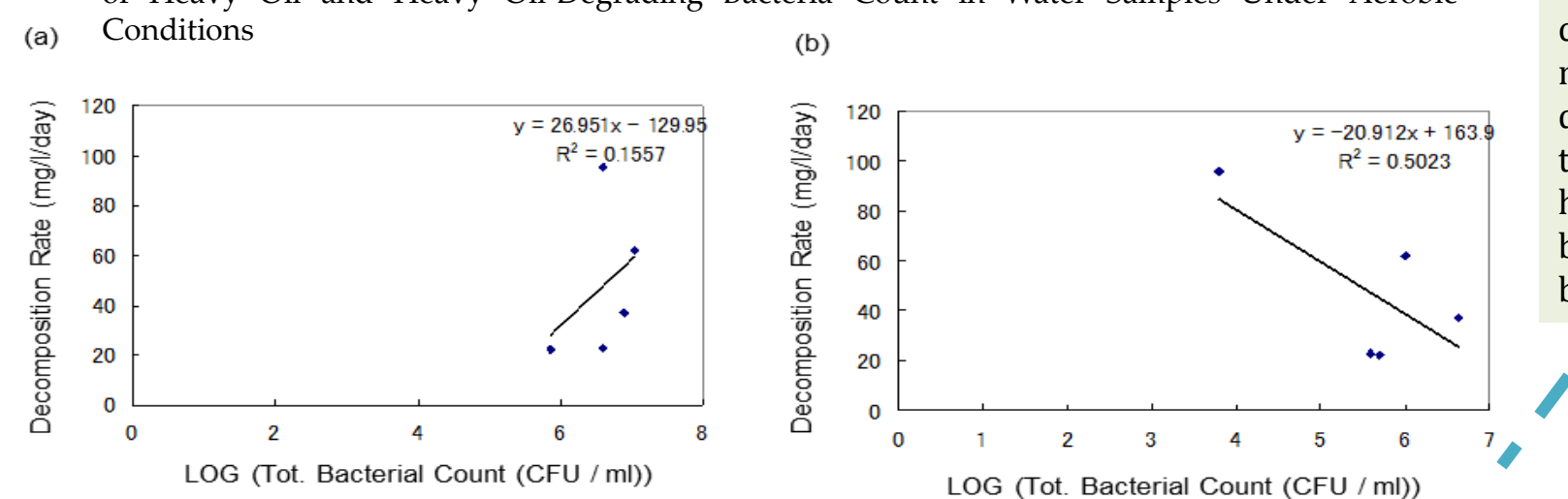


Figure 5. (a) Correlation Between the Biodegradation Rate of Heavy Oil and the Total Bacteria Count in Soil Samples Under Aerobic Conditions; (b) Correlation Between Biodegradation Rate of Heavy Oil and Oil-Degrading Bacteria Count in Soil Samples Under Aerobic Conditions.

Although no clear linear statistical relationship was found, the correlation between initial microbial populations and degradation performance revealed that higher counts of heterotrophic and oil-degrading bacteria generally enhanced biodegradation.

Effect of Microbial count (CFU) on Biodegradation of Heavy oil in Anaerobic conditions

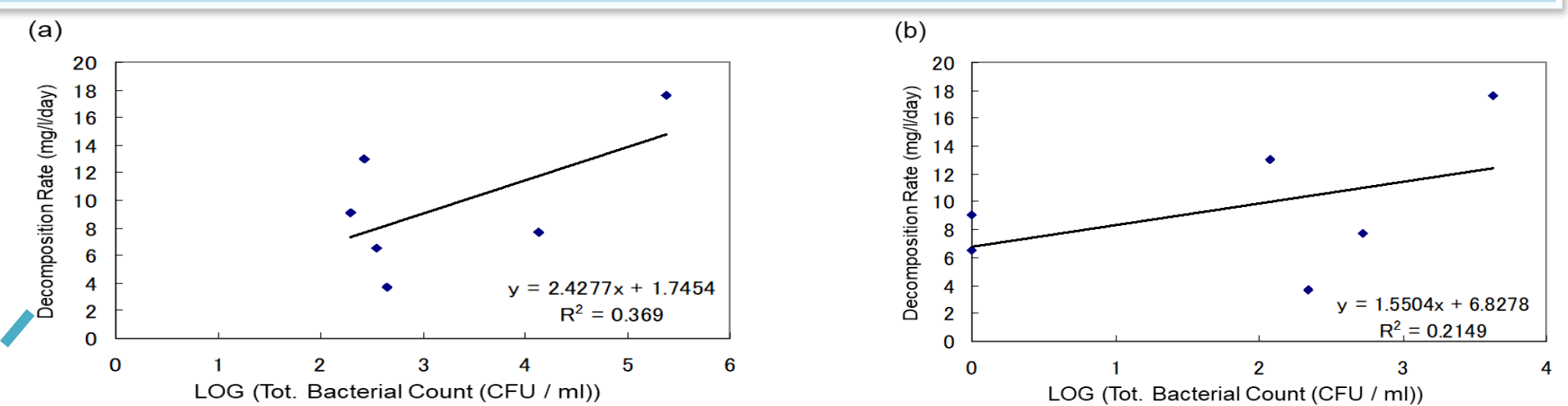


Figure 8. (a) Correlation Between Degradation Rate of Heavy Oil and Total Bacterial Count in Water Sample Under Anaerobic Conditions; (b) Correlation Between Degradation Rate of Heavy Oil and Heavy Oil-Degrading Bacteria Count in Water Sample Under Anaerobic Conditions.

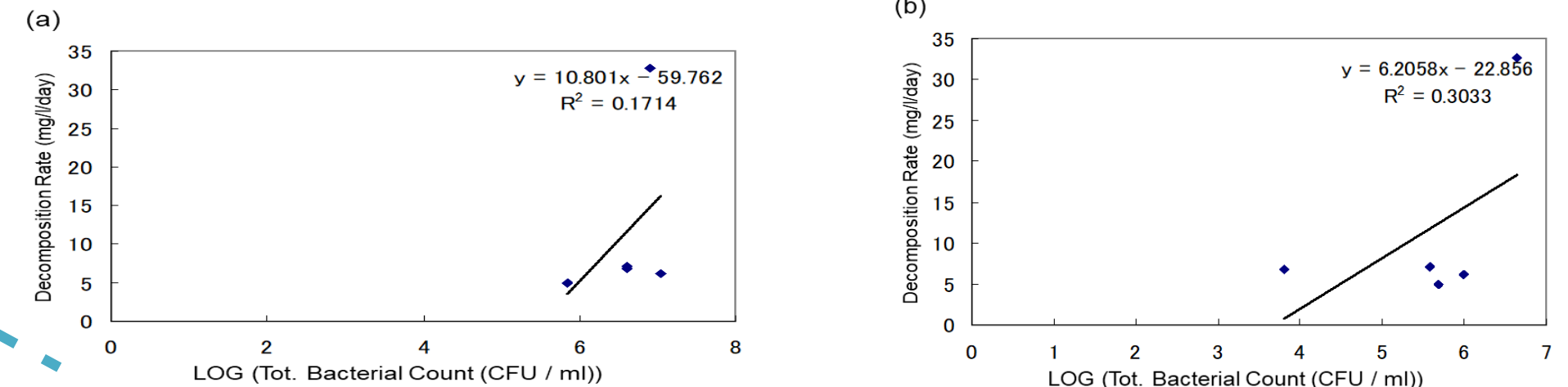


Figure 9. (a) Correlation Between Degradation Rate of Heavy Oil and Total Bacterial Count in Soil Sample Under Anaerobic Conditions; (b) Correlation Between Degradation Rate of Heavy Oil and Heavy Oil-Degrading Bacteria Count in Soil Sample Under Anaerobic Conditions.

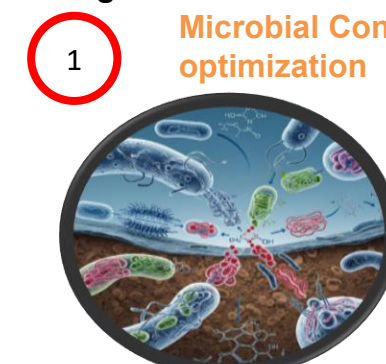
CONCLUSION

Heavy oil biodegradability is **higher in soil under aerobic conditions** compared to water, while under **anaerobic conditions**, it **decreases**. **Microbial source** and **oxygen availability** influence heavy oil degradation. **Future studies** should focus on **enhancing microbial activity and hydrocarbon degradation in aquatic systems**. Bioremediation using **microbial consortia** is **effective for heavy oil contamination**, and maintaining aerobic conditions through aeration could improve cleanup.

FUTURE WORK / REFERENCES

Limitation

Despite efficient biodegradation, some peaks remained undegraded.



Combination of Bioremediation and other remediation technologies

Use of Novel Bio-stimulant Methods