Parameters for removing sulfur from Dibenzothiophene using ultrasonication system and biodesulfurization microbes

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Introduction:

The Problem ➡ Sulfur removal from oil

- A promising **"Eco Technology"** is to employ Biodesulfurization (BDS), a process where:
  - the bacteria (liquid phase) are mixed with oil at ambient temperature and pressure and remove selectively, the organosulfur components from oil fractions
  - without degrading the carbon skeleton of the compounds.

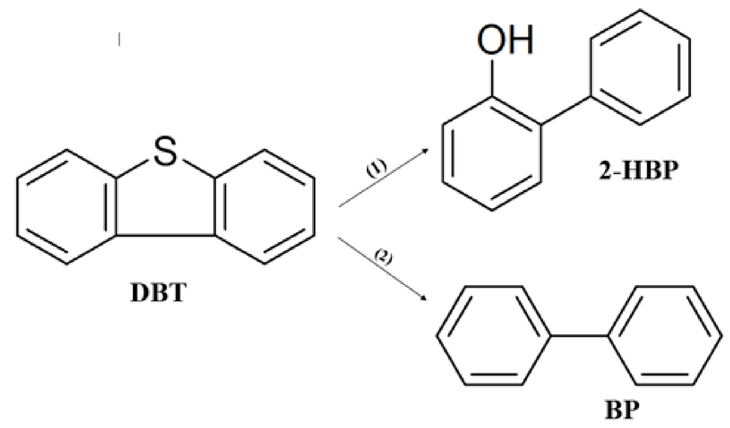
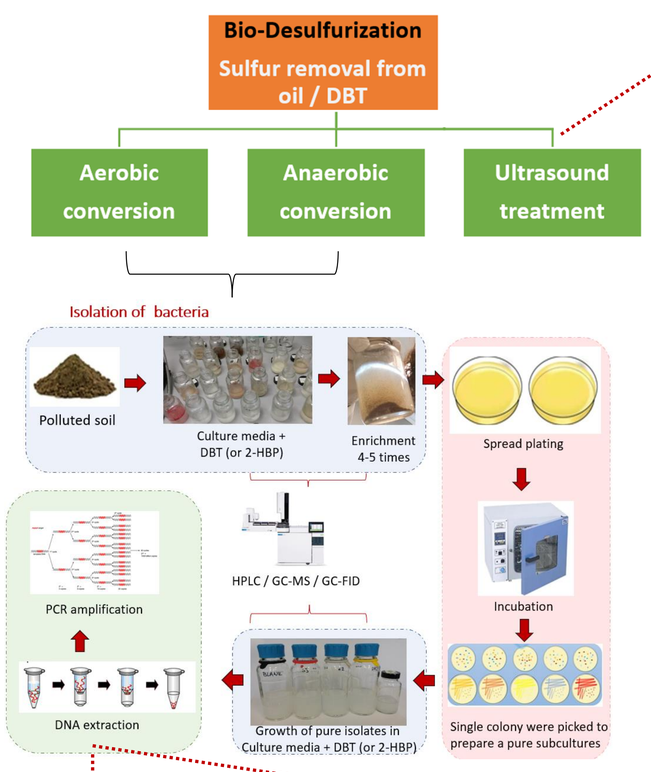


Figure 1. Desulfurization pathways: (1) aerobic microorganisms, and (2) anaerobic bacteria.

Materials and methods:



Ultra-sonication and Biodesulfurization

Fig. 4. Electronic system; front view,

(A) High intensity ultrasonic system for removing sulfur from DBT

A circular unfocused ultrasonic transducer operating at **28 KHz** was used (Fig. 4)

	Samples	Solution	Concentration	Temperature (ºC)	Time (min)	kHz	Parameter measured
1	DBT	Aqueous	250ppm	25; 70	30; 60	28	DBT (GC-FID)
2	DBT	Heptane	300 ppm	25	30; 60	28	DBT (GC-FID)

Isolation of aerobic bacteria

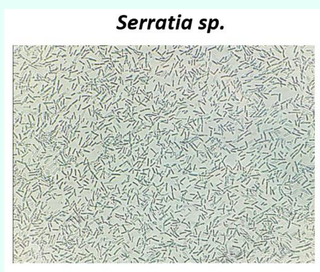
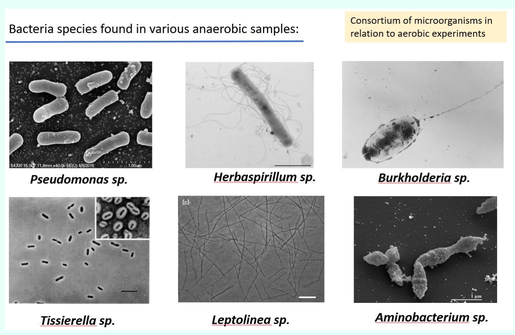


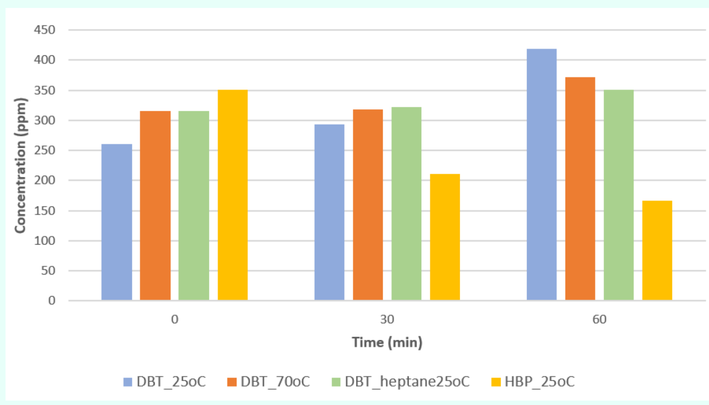
Figure 2. Picture of the detected microorganism *Serratia sp.*

Figure 3. Picture of the detected microorganism *Burkholderia sp.*

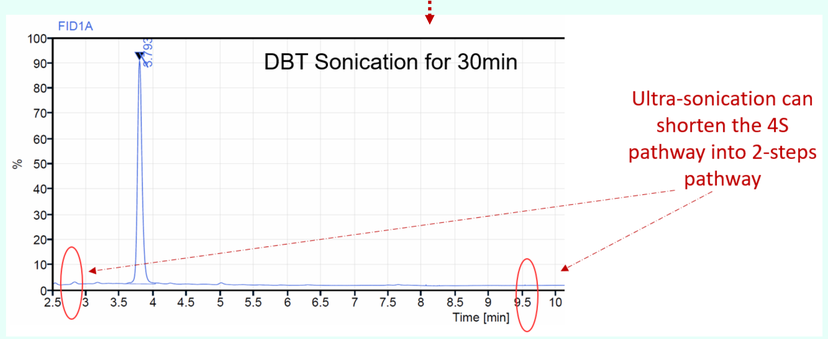
Isolation of anaerobic bacteria



Results:

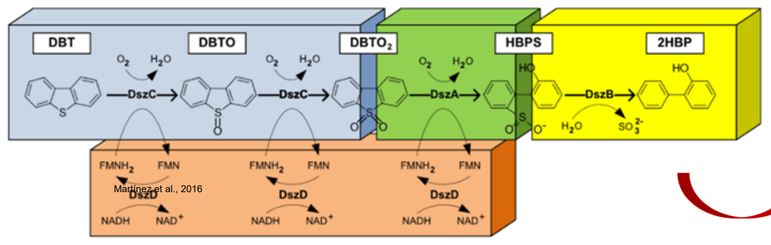


- An increase in DBT concentration is observed in both temperatures that were performed.
- On heated (T=70ºC) experiment there is a lesser increase of DBT concentration
- Decrease of 2-HBP concentration



Conclusions:

1. Sonication may enhance DBT solubility in an aqueous solution resulting in better performance through the 4S pathway
2. Through sonication process temperature is increased which may affect the solubility of the studied organic compounds



3. Ultra-sonication → from 4S pathway to 2-steps pathway

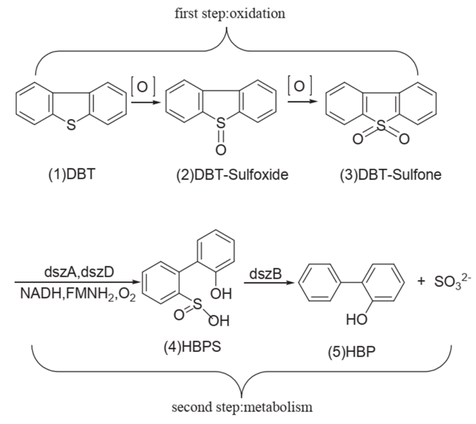


Fig. 5. The pathway of biodesulfurization of DBT by ultrasonic pre-oxidation [where [O] represent O· and ·OH and H_2O_2] (Yi et al., 2019)

References

- Kilbane, J.J., 2017. Biodesulfurization: How to Make it Work? Arab. J. Sci. Eng. 42, 1–9
- Martínez, I., El-Said Mohamed, M., Rozas, D., García, J.L., Díaz, E., 2016. Engineering synthetic bacterial consortia for enhanced desulfurization and revalorization of oil sulfur compounds. Metabol. Eng. 35, 46-54
- Stylianou M., Vyrides I., Agapiou A., 2021. Oil biodesulfurization: A review of applied analytical techniques, Journal of Chromatography B: Analytical Technologies in the Biomedical and Life Sciences, Volume 11711, 122602
- Yi, Z., Ma, X., Song, J., Yang, X., Tang, Q., 2019. Investigations in enhancement biodesulfurization of model compounds by ultrasound pre-oxidation. Ultrason. Sonochem. 54, 110–120. doi:10.1016/j.ultsonch.2019.02.009

Acknowledgments

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