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Is There Room for Innovation in Tackling Reservoir Souring?

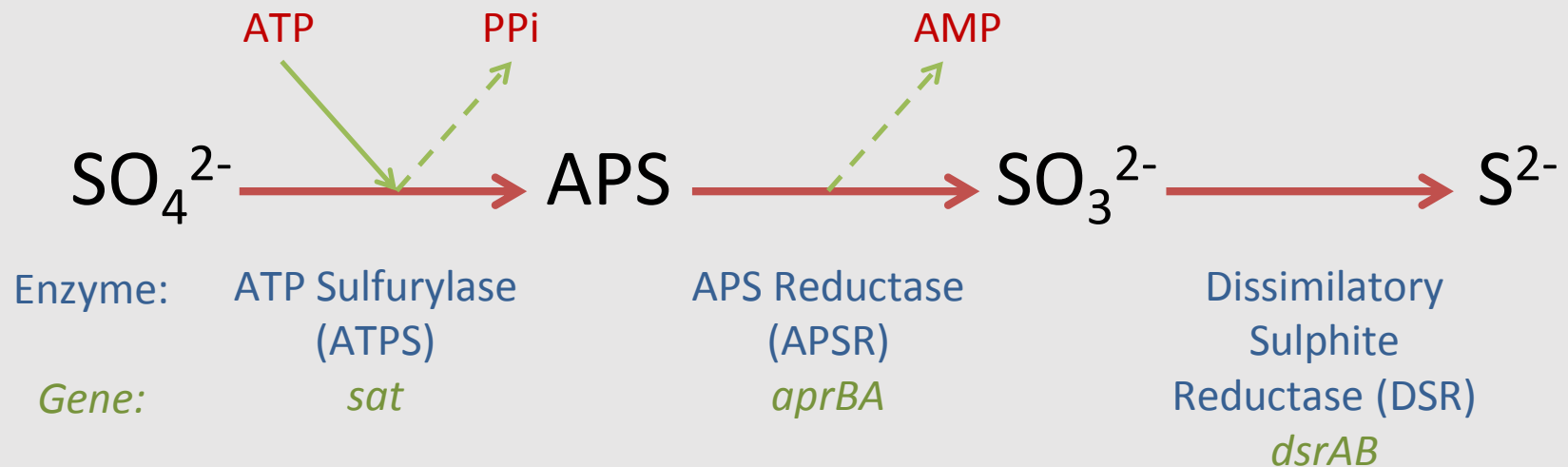
Richard Johnson, ISMOS-6

6th June 2017

Identifying Reservoir Souring

- H_2S can increase due to changes in water cut, pH, temperature, salinity and production from new areas. This needs to be taken into account when identifying increases in H_2S (kg/day).
- Source can be determined using sulphur isotope distribution (^{34}S to ^{32}S).

Reservoir Souring Mechanisms



Johnson, R. J., Folwell, B. D., Wirekoh, A., Frenzel, M., & Skovhus, T. L. (2017). Reservoir Souring— latest developments for application and mitigation. *Journal of Biotechnology*. In Press.

- H_2S generation from sources other than sulphate.
- Limits of microbial growth continuously being pushed further.

Modelling Reservoir Souring

Factors to Consider

Carbon Sources

Sulphate

Salinity

Temperature

N + P availability

pH

Pressure

Mitigation Options

Gas Lift

Fluid Flow

Reservoir Scavenging

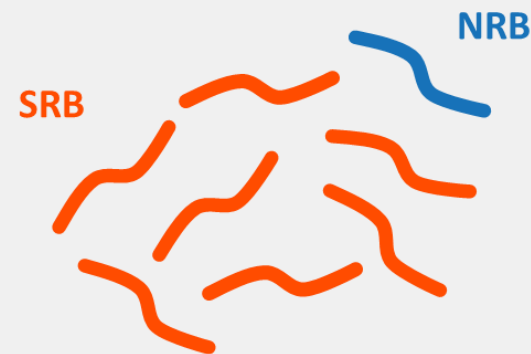
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Mitigating Reservoir Souring - Biocides

- Most biocides used for corrosion control.
- Many unstable under reservoir conditions.
- Some laboratory studies on biocide effectiveness.
 - Jones, C. R., et al. (2010). Extending performance boundaries with third generation THPS formulations. In CORROSION 2010. NACE International.
 - Xue, Y., & Voordouw, G. (2015). Control of microbial sulfide production with biocides and nitrate in oil reservoir simulating bioreactors. *Frontiers in microbiology*, 6, 1387.
- Little published data on field effectiveness.
 - Littman, E. S., & McLean, T. L. (1987). Chemical control of biogenic H₂S in producing formations. In SPE Production Operations Symposium. Society of Petroleum Engineers.
 - Talbot, R. E., Larsen, J., & Sanders, P. F. (2000). Experience with the use of Tetrakis(hydroxymethyl)phosphonium Sulfate (THPS) for the control of downhole hydrogen sulfide. In CORROSION 2000. NACE International.

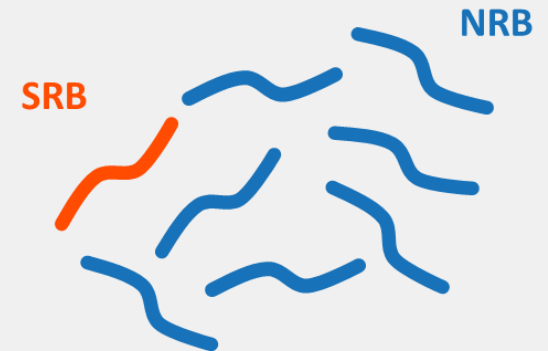
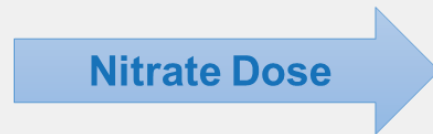


Mitigating Reservoir Souring - Nitrate



Sulphate → Sulphide

Nitrate → Nitrite



Sulphate → Sulphide

Nitrate → Nitrite

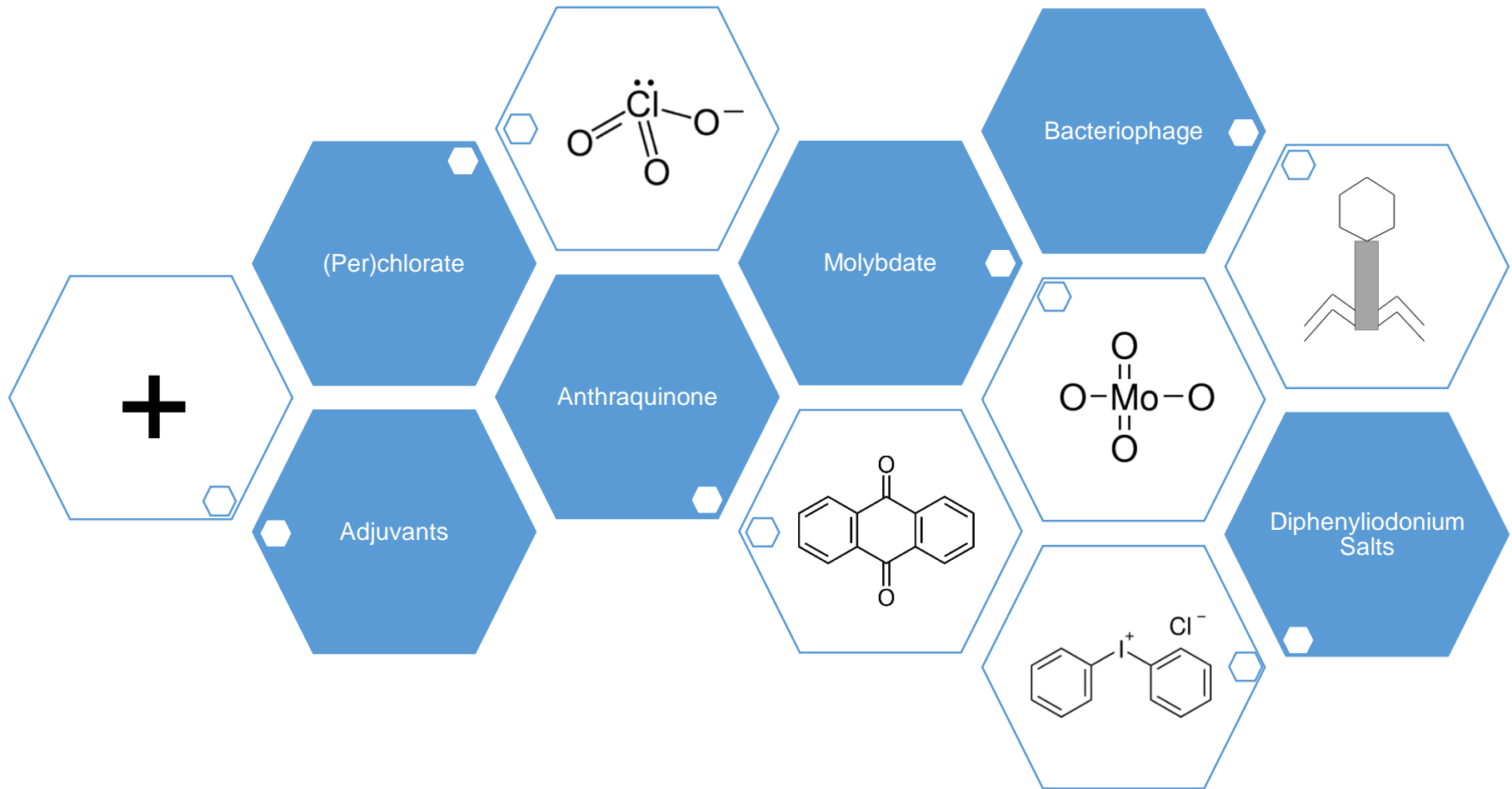
- Generally unpredictable at field scale
 - Potential for increased corrosion
 - Long term efficacy

Mitigating Reservoir Souring – Sulphate-Removal

- Used for scale control since 1988.
- Laboratory data showing effectiveness.
- Used offshore particularly for high risk facilities.
 - McElhiney, J. E., Burger, E. D., Maxwell, S., Davis, R. A., & Walsh, J. M. (2008, January). Adoption of a process to prevent souring associated with seawater waterflooding in the Ursa-Princess fields, deepwater Gulf of Mexico. In SPE International Oilfield Corrosion Conference. Society of Petroleum Engineers.

- Some sulphate remaining, utilised by SRP.
 - Robinson, K., et al. (2010). Reservoir souring in a field with sulphate removal: a case study. In SPE Annual Technical Conference and Exhibition. Society of Petroleum Engineers.

Mitigating Reservoir Souring – Novel Options



Conclusions

- Not all increases in H₂S are the result of microbial activity.
- Reservoir souring should be thoroughly evaluated at exploration and appraisal stage.
- New inhibitor chemistries are in development and are needed to mitigate against reservoir souring.
- Nanofiltration membranes are decreasing in cost but the size and weight of sulphate-removal units (SRU) still make them expensive for widespread use. Smaller SRUs could help limit souring but sulphate is still present.

Acknowledgements



Oil Plus

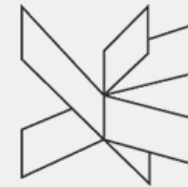
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