# Dendritic polymers as oil spill dispersants: Effectiveness and toxicity compared to Corexit 9500A

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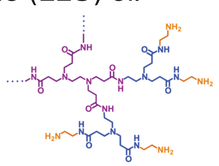
## Introduction

We hypothesize that crude oil can be dispersed using dendritic polymers. Our objective is to compare dendritic polymers to Corexit 9500A (the dispersant used in the BP oil spill) taking effectiveness and toxicity into consideration.

## Materials

- Hyperbranched polyethylenimine polymer, (HyPEI) with several molecular weights (1.2, 1.8, 10, 70, and 750 kDa)
- Corexit 9500A
- Louisiana light sweet crude (LLS) oil
- *Synechocystis* sp.
- *Dunalliela* sp.



Amine-terminated HyPEI branches

## Methods

### *Dispersant performance*

- Premix the oil and polymer(or dispersant) at different DOR for 24 hours
- Add 20 ul premix to 12 ml artificial seawater, mixing at 200 rpm for 30min
- Settle for 15 min
- Collect 3 ml water sample from bottom of vials
- Extract dispersed oil in water sample with 1.5 ml dichloromethane (DCM)
- Test the absorbance at 340nm

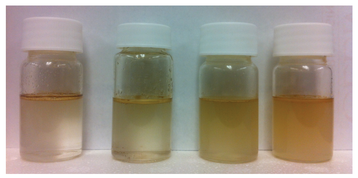
### *Interfacial tension*

- Premix as in performance test
- Pendent drop and the axisymmetric drop shape analysis (ASDA) technique, Easy Drop@kruss
- Graph interfacial tension change with time

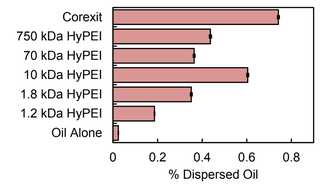
### *Algal growth inhibition*

- Subculture two algal speceis in culture tubes with 10 ml media
- Add combinations of oil premixed with dispersant at various DORs into triplicate tubes.
- Grow under 12-hr light/dark cycle
- Measure absorbance daily at 685 nm

## Dispersion performance results

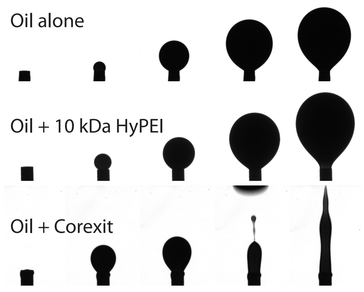


Left to right: oil, oil + 1.2 kDa HyPEI, oil + 10 kDa HyPEI, and oil + Corexit in water. Photo taken after mixing and standing 5 minutes. Qualitatively, the hyperbranched polymers disperse oil, though not as well as Corexit.

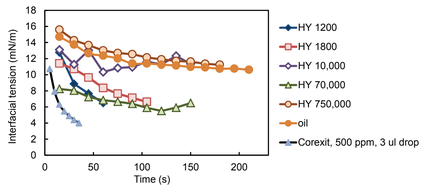



Effectiveness measurements with 1:50 dispersant:oil ratio (DOR) show that Corexit is best. Hyperbranched polymers have roughly increasing effectiveness with molecular weight, but the 10 kDa size bucks the trend.

## Interfacial tension results

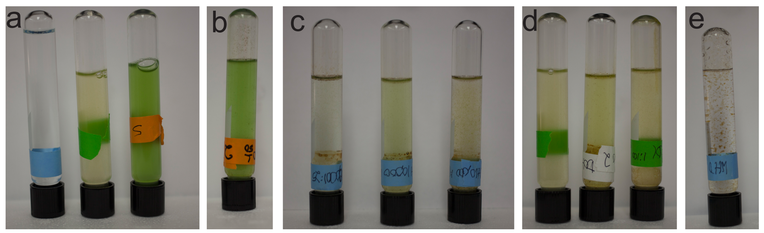



Video stills from interfacial tension experiments with oil alone, 10 kDa HyPEI, and Corexit. HyPEI did not cause the dramatic drop breakup that Corexit caused, indicating HyPEI uses a different mechanism than interfacial tension modification for its dispersion capability. (See the videos by scanning the QR code at the bottom right of the poster).



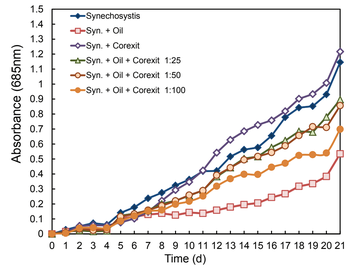

Even a low concentration of Corexit is effective at reducing interfacial tension, but the hyperbranched polymers are less effective; no clear trend with molecular weight is observed.

## Algal growth inhibition photos

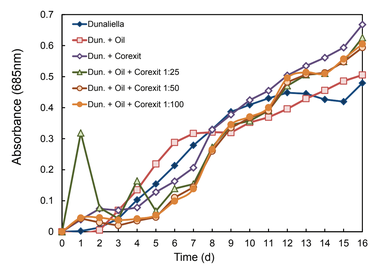



a. Water, Dunalliella alone, and Synechocystis alone
b. Synechocystis + oil + 10 kDa HyPEI 1:50
c. Dunalliela + oil + 10 kDa HyPEI at three DORs: 1:25, 1:50, 1:100.
d. Dunalliela alone, Dunalliela + oil + 750 kDa HyPEI 1:100, and Dunalliela + Oil + Corexit 1:100
e. Oil + 1.2 kDa HyPEI 1:25.

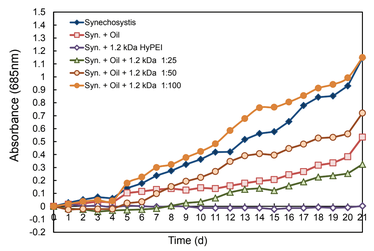
## Algal growth inhibition results



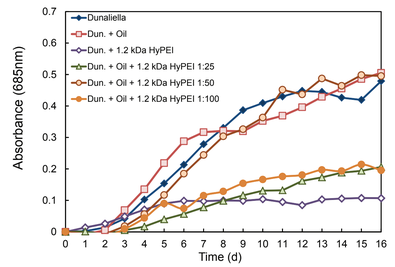

Synechocystis with Corexit. Corexit protected Synechosystis from oil contamination. Corexit alone did not seem to have an adverse effect on algal growth.



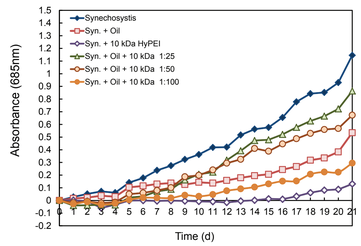

Dunaliella with Corexit. Corexit or oil seem to have no adverse effect on algae growth.



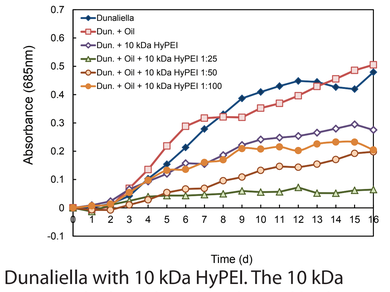

Synechocystis with 1.2 kDa HyPEI. 1.2 kDa seems to be a threat for algal growth. The higher the DOR, the greater the threat. 1.2 kDa HyPEI's toxicity reached its climax when it was applied alone without any oil.



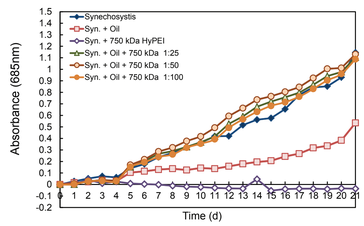

Dunaliella with 1.2 kDa HyPEI. The 1:50 DOR appears protective of algal growth. (Though in this set there was high variability in the other DORs).



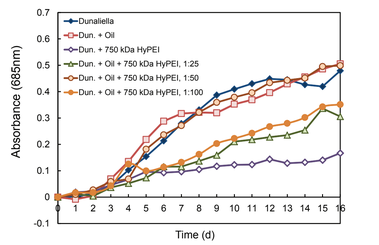

Synechocystis with 10 kDa HyPEI. 10 kDa seems to be a threat for algal growth, but the higher DOR, the less the threat. Only 1:100 showed higher toxicity than oil. 10 kDa HyPEI's toxicity reached its climax when it was applied alone without any oil.




Dunaliella with 10 kDa HyPEI. The 10 kDa HyPEI and oil combination showed higher toxicity than oil or 10 kDa HyPEI alone and the toxicity of the combination increased with the DOR.




Synechocystis with 750 kDa HyPEI. 750 kDa HyPEI posed a greater threat and showed higher toxicity when it was applied without oil. But when it was mixed with oil, it seemed to have no adverse effect on algae growth. (70 kDa results were similar).




Dunaliella with 750 kDa HyPEI. The 750 kDa HyPEI alone showed the highest toxicity and the toxicity of the oil and 750 kDa HyPEI combination was higher at DOR of 1:25 and 1:100, but showed no effect at DOR of 1:50.

## Conclusions

- Hyberbranched polymers, especially 10 kDa, were effective at dispersing oil, though not as effective as Corexit 9500. HyPEI did not decrease interfacial tension as well as Corexit.
- Corexit addition mitigated algal growth inhibition by oil. Some HyPEI polymers did the same, though the polymers alone often greatly inhibited growth.

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This research is funded by U.S.EPA-Science To Achieve Results (STAR) Program
Grant # RD835182

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