

# Bellacide<sup>®</sup> 350

## Compatible with Reverse Osmosis Membranes in Oil & Gas

### Challenge

Controlling biological fouling is important in every stage of oil and gas production from the well to the refinery. Systems that utilize Reverse Osmosis (RO) membranes in oil and gas need to consider the interaction of any biocide with those membranes in terms of compatibility and efficacy. The Bellacide 350 technology is based on Tributyl Tetradecyl Phosphonium Chloride (TTPC), which is a non-oxidizing biocide treatment utilized in a variety of oil and gas applications globally that has proven RO membrane compatibility.

### Compatibility Testing

The compatibility of Bellacide 350 with Dow Filmtec<sup>™</sup> SW30HR-380 RO membranes has been extensively studied.<sup>1</sup> RO membrane coupons exposed to 100,000 mg/L TTPC for 1 hour at 25°C were assessed for morphological and chemical changes using scanning electron microscopy (SEM) and infrared spectroscopy analysis, respectively. The following are the results of these tests:

- SEM confirmed typical peak and valley morphology of the RO membrane surface was unchanged.
- Infrared spectroscopy indicated no change to the critical polyamide linkages of the RO membrane.

These results confirm that high concentrations of Bellacide 350 did not damage the RO membrane either morphologically or chemically in an accelerated lifetime type-test.

### Performance Testing

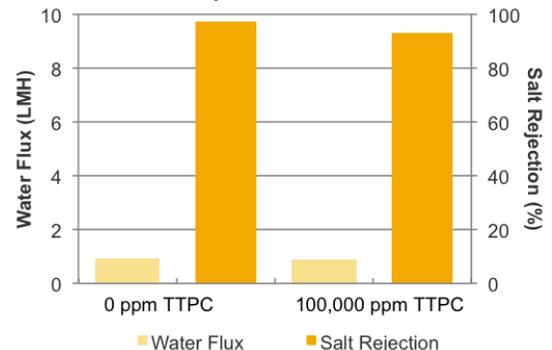
RO performance in terms of water flux and salt rejection was also evaluated using Dow Filmtec SW30HR-380 circular RO membranes (4.7 cm diameter) immersed in 100,000 mg/L TTPC for 1 hour using a stirred cell device adopting dead end filtration at 20 bars. The results of these tests can be seen in Figure 1.

The results show that there was no change in the water flux and salt rejection of the treated membranes compared to an untreated control indicating that Bellacide 350 did not affect the performance of the membrane.

In addition to having excellent compatibility with polyamide-based RO membranes, Bellacide 350 exhibits minimal passage through the membrane (99.58% rejection).

**Figure 1.**

Water flux and salt rejection of TTPC treated membrane



### Biofouling Inhibition Testing

The ability of Bellacide 350 to control biofouling was evaluated using preformed *Pseudomonas aeruginosa* biofilm on Dow Filmtec SW30HR-380 RO membrane coupons. The biofouled coupons were then placed in a drip flow reactor and continuously exposed to Bellacide 350 for 24 hours. The coupons were removed from the reactor, stained with fluorescent dyes to distinguish between live and dead cells, and analyzed using confocal laser scanning microscopy. The results are shown in Table 1.

Bellacide 350 was effective at inhibiting and removing biofilm which was evident by the reduced biofilm thickness and volume, respectively. Furthermore, the fluorescent staining demonstrated that the biofilms treated with Bellacide 350 were almost entirely composed of dead cells.

**Table 1.**

Biofilm thickness and volume after 24 hours of treatment with TTPC

Biofilm Parameter	Control	TTPC (20 mg/L)	TTPC (40 mg/L)
Thickness (μm)	23.4	13.1	6.1
Volume (μm <sup>3</sup> /μm <sup>2</sup> )	22.9	10.8	6.0

### Conclusion

Bellacide 350, based on TTPC chemistry, is a highly effective, non-oxidizing biocide compatible with standard polyamide-based RO membranes and thus is suitable for direct dosing into non-potable RO systems for the control of biofouling in oil and gas applications.

### References

1. T.-S. Kim, H.-D. Park, Tributyl Tetradecyl Phosphonium Chloride for biofouling control in reverse osmosis membranes, *Desalination* 372 (2015) 39-46.

# Bellacide® 350

Bellacide 350 is a highly effective, synergistic biocide and biodispersant for use in cooling water systems and industrial process waters. Bellacide 350 not only provides performance conscious customers with the effective prevention of microbiological slimes, but can also be used to clean heavily fouled systems.

Bellacide 350	
Typical dose in halogenated systems	25-50 ppm
Typical dose in single biocide systems	250-500 ppm
Activity	48-52%



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