Novel Non-Halogenated Flame Retardant Compounds

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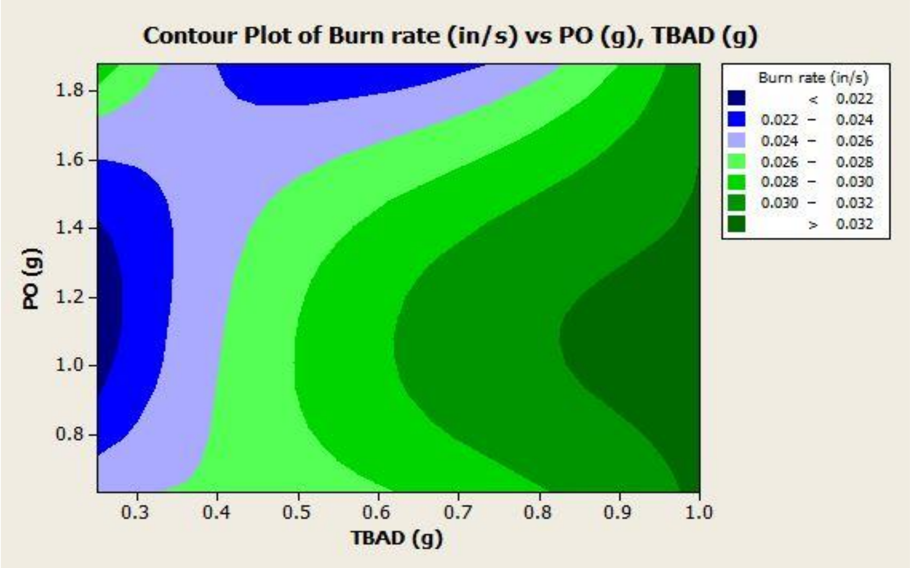
Introduction

- Halogenated flame retardants have been used in polymers for years but have environmental problems.
- Boric acid has also been used as a flame retardant but its acidity limits it applications.
- Decaborate is a non halogenated, non-acidic compound which may show promise in flame retardant applications.
- In this research work, we focused on the flame retardancy of combinations of triphenylphosphine oxide and ammonium decaborate salts, bis(tetramethylammonium) decaborate (TMAD), and bis(tetrabutylammonium decaborate (TBAD).

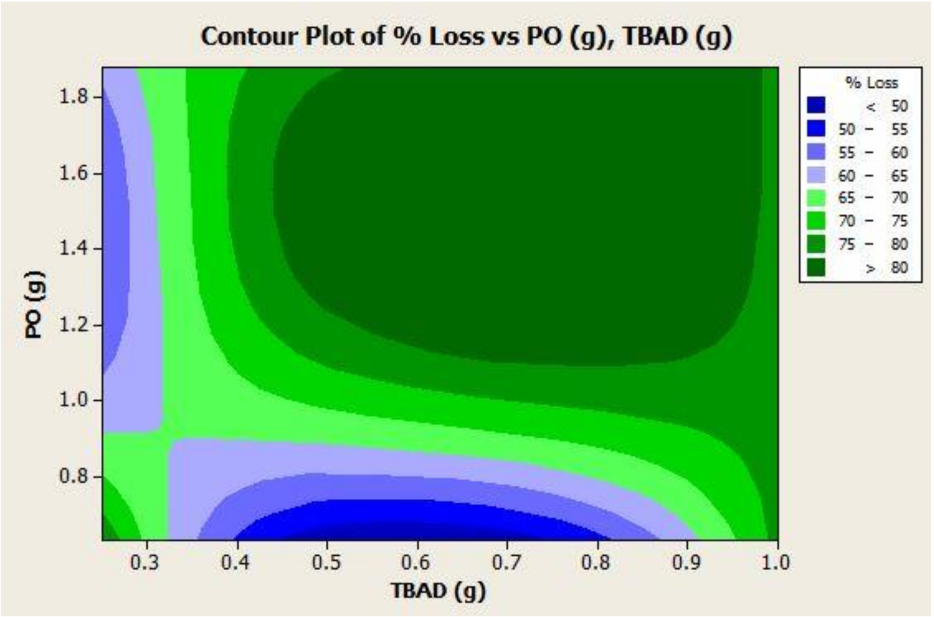
Experimental

- Bis(triethylammonium) decaborate was converted to the hydronium salt via an ion exchange column.
- The bis(hydronium) decaborate was then titrated with tetramethyl or tetrabutyl hydroxide until the solution was a pH of 7.0.
- The tetrabutyl derivative was then collected by vacuum filtration. For the tetramethyl derivative, the water was removed by distillation. The salts were then dried in a vacuum oven for 12 hours
- Varying levels of decaborate salts and phosphine oxide were combined in varying levels within a Design of Experiments and cast in polyurethane films
- Samples were then cut into strips and burned in a UL-94 Flame Chamber.
- Samples were also tested via TGA in Nitrogen to determine degradation temperature and char yields.

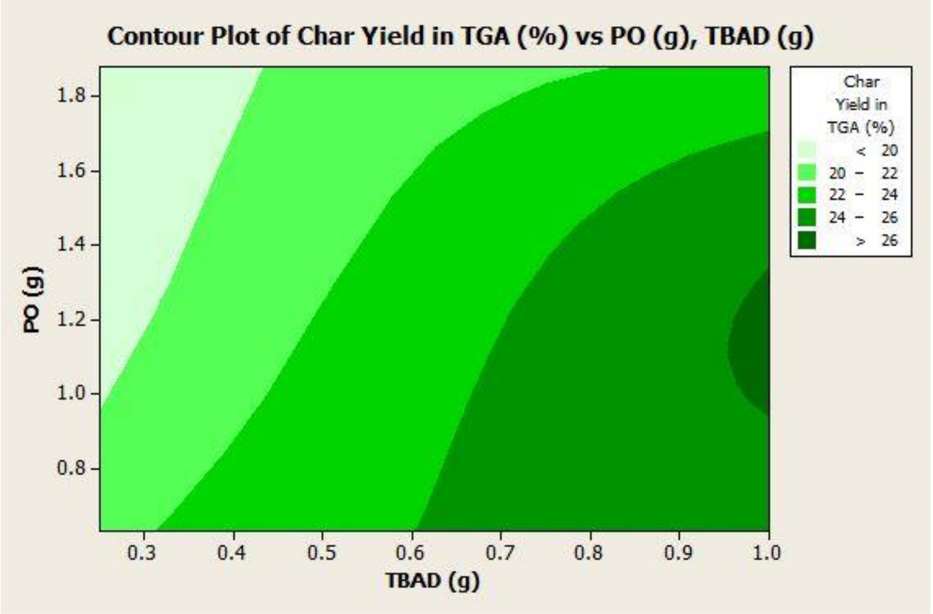
Burn Rate of TBAD Films



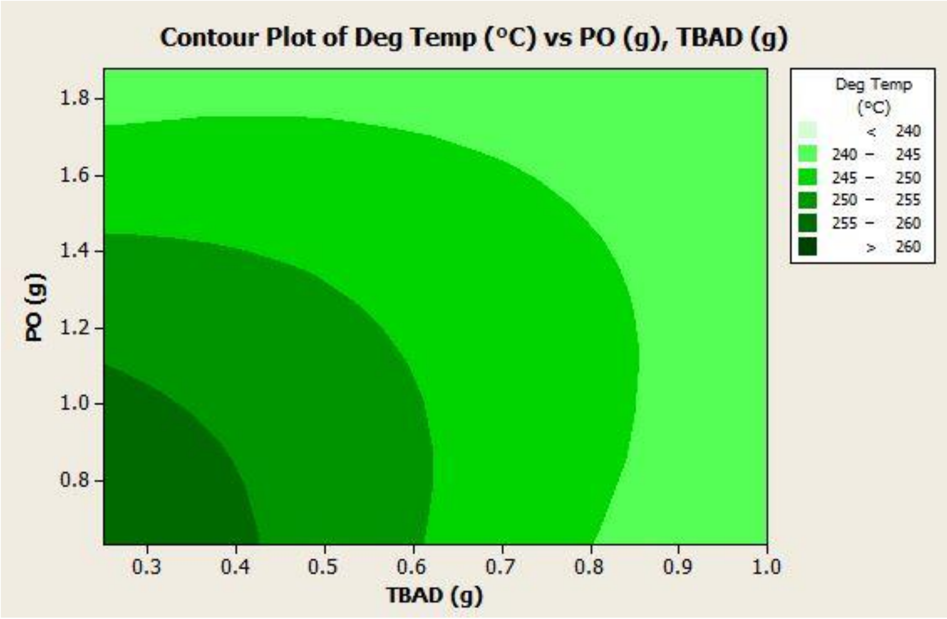
% Loss of TBAD Films



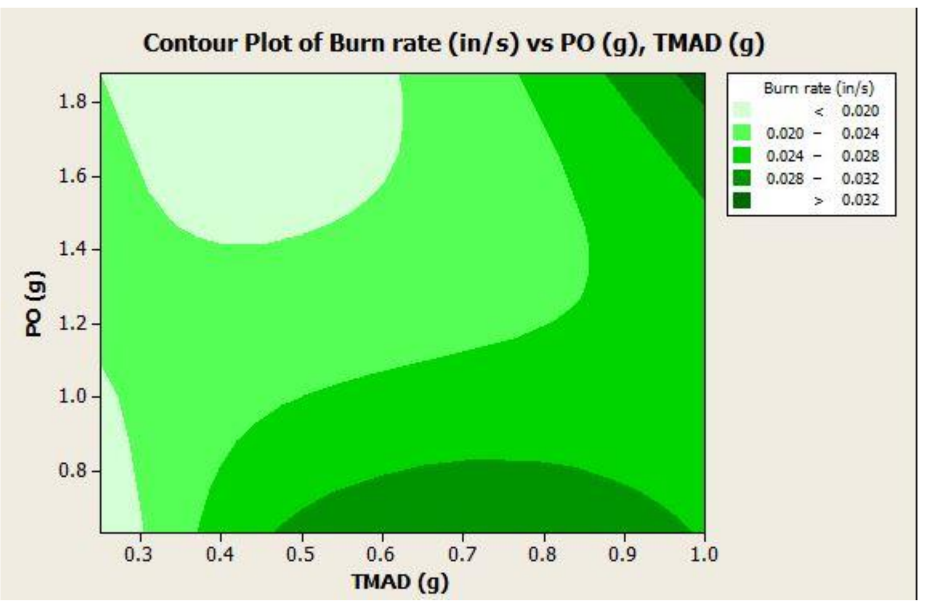
Char Yield in TGA of TBAD Films



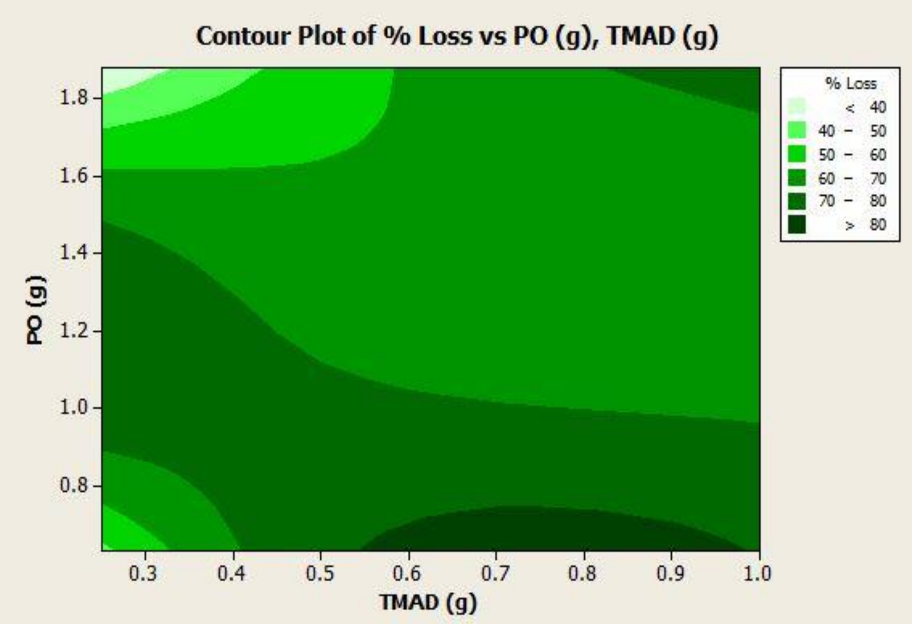
Degradation Temp. of TBAD Films



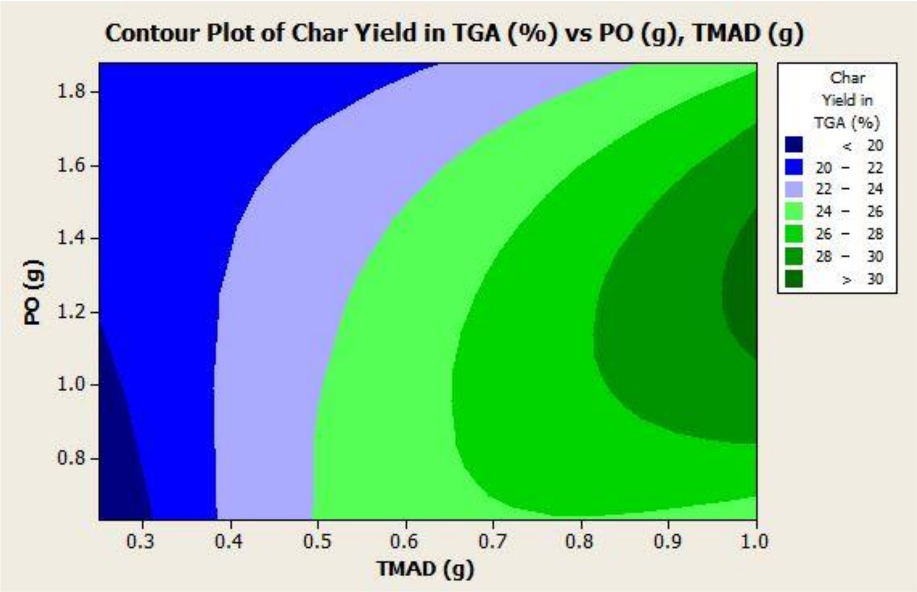
Burn Rate of TMAD Films



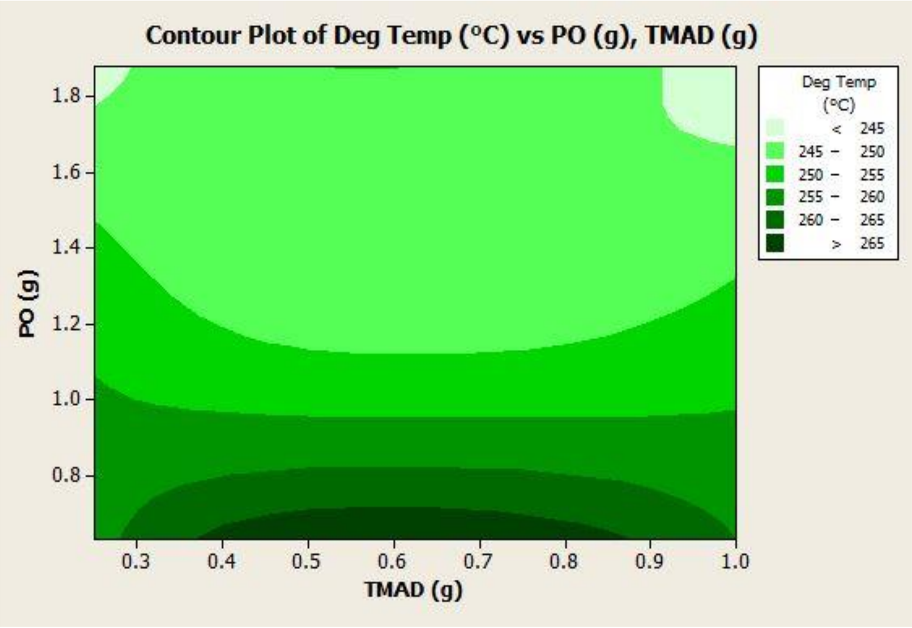
% Loss of TMAD Films



Char Yield in TGA of TMAD Films



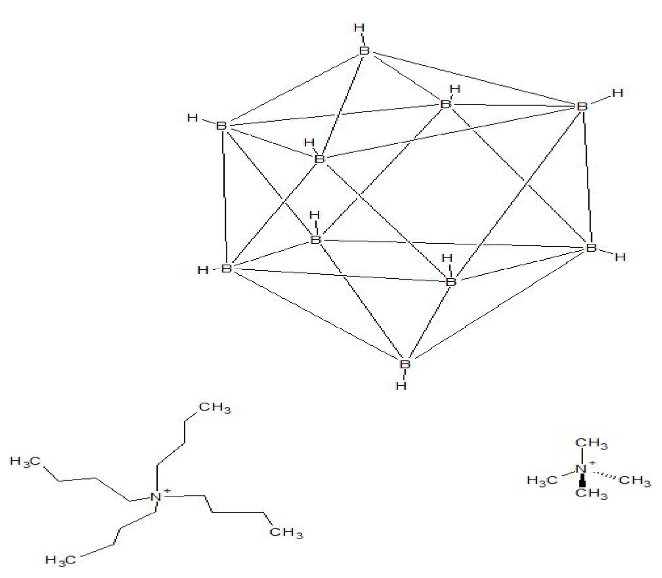
Degradation Temp. of TMAD Films



Design of Experiment Set-up

PO Level	Boron Level	PO (%)	Boron (%)
0	0	12.5	5
1	-1	18.75	2.5
0	-1	12.5	2.5
0	0	12.5	5
0	1	12.5	10
1	1	18.75	10
-1	0	6.25	5
0	0	12.5	5
-1	-1	6.25	2.5
0	0	12.5	5
0	0	12.5	5
-1	1	6.25	10
1	0	18.75	5

Decaborate Structure



Conclusion

- Various combinations of decaborate and phosphine oxide in polyurethane were cast and characterized.
- Decreases in burn rate were observed at high levels of TPO and medium levels of decaborates.
- Films loss during burn testing was minimized at low levels of TPO and medium levels of decaborate.
- Char yields increased with increasing amounts of decaborate.
- Continuing work with these materials will include characterization by cone calorimetry.

Acknowledgments

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