Flammability of acrylonitrile–butadiene–styrene/poly(vinyl chloride) blends; limiting oxygen index data

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A strong positive correlation exists between the flammability of acrylonitrile–butadiene–styrene (ABS)/poly-(vinyl chloride) (PVC) blends and the amount of PVC present.

(Keywords: limiting oxygen index; polymer blend; poly(vinyl chloride))

Although the oxygen index method[1] has been used since the 1960s for determining polymer flammability, it has been criticized in recent publications because it does not give results which correlate with flammability data produced from 'real fire' scenarios[2–4]. Many laboratories, however, use the technique on a daily basis to evaluate the effects of additives on polymer flammability.

In a series of recent publications[5–8] we have reported in detail the effects of adding some iron(III) compounds on flammability and smoke generation in polymers. Careful examination of the limiting oxygen index (LOI) data that we have published reveals a striking feature which we did not notice earlier, and in this note we report on this.

The data in *Table 1* summarize the earlier LOI values for acrylonitrile–butadiene–styrene (ABS)-rich ABS/unplasticized poly(vinyl chloride) (UPVC) blends with increasing PVC concentrations for formulations containing between 1 and 10 parts per hundred (phr) FeOOH (basic iron(III) oxide).

Table 1 Limiting oxygen index values for ABS/PVC blends containing FeOOH

Formulation (phr)				
ABS[a]	PVC	FeOOH	$\bar{x}$LOI[b]	$\bar{x}\delta$LOI[c]
95	5	1–10	26.16±0.44	7.86
90	10	1–10	28.56±1.36	10.26
85	15	1–10	29.96±0.74	11.66
80	20	1–10	30.68±0.22	12.88
75	25	1–10	32.12±0.45	13.82
70	30	1–10	33.6±0.20	15.30

[a] 100 phr ABS LOI = 18.3
[b] Mean LOI value for each formulation having 1, 2.5, 5, 7.5 or 10 phr FeOOH present
[c] Mean change in LOI value for each formulation having 1, 2.5, 5, 7.5, or 10 phr present, compared with the LOI value (18.3) for 100 phr ABS

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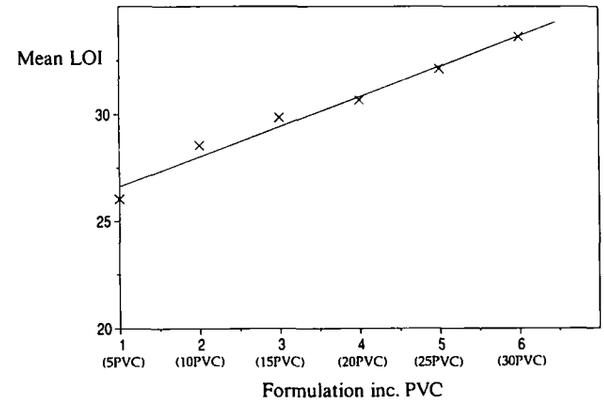

Figure 1 Mean LOI *versus* ABS/PVC/FeOOH formulation

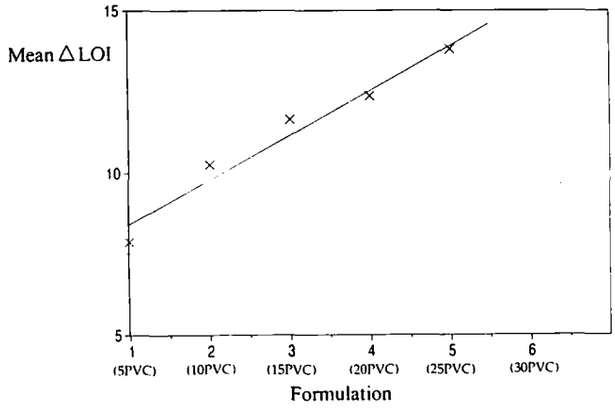

Figure 2 Mean δLOI *versus* ABS/PVC/FeOOH formulation

Plotting values of the mean LOI and mean δLOI against the formulation range for which the LOIs were determined gives 'straight line' relationships with very high correlations ($r = 0.98$). *Figure 1* shows the plot for

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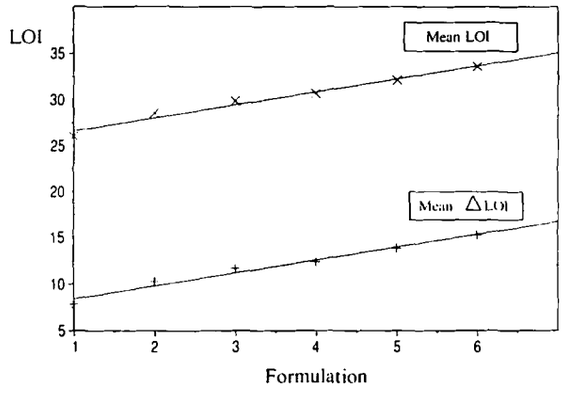

Figure 3 LOI *versus* ABS/PVC/FeOOH formulation

the mean LOI, *Figure 2* the plot for the mean δLOI and *Figure 3* shows both plots.

It would appear that in these polymer blends flammability (as determined by oxygen index) is dependent *only* on PVC concentrations in the formulation and not to any great extent on the amount of iron compound present. Increasing concentration of halogen in polymers is known to reduce their flammability: unplasticized PVC has an LOI value of 49 and polytetrafluoroethylene (PTFE) has an LOI value of 95. The HX released during combustion interferes with the radical chain mechanism taking place in the gas phase. The high energy HO$^\bullet$ and H$^\bullet$ radicals which promote burning are removed by the halogen and are replaced by low energy X$^\bullet$ radicals[9]. In these blends of ABS and PVC, increasing PVC in the blend has the effect of reducing the flammability.

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