PlasticForests FencePosts

FIRE STATEMENT

GENERAL COMMENTS AND SUMMARY

- Plastic Forests fence posts are composed of polyethylene (HDPE & LDPE) and polypropylene (PP) (some posts also have a steel core).
- Plastic posts, like timber fence posts made of softwood or hardwood, will burn under various fire loads. Even metal posts will melt in severe bushfire conditions.
- There is no Australian Standard for fire-rating fence posts as they are exempt.
- Studies show that the temperature required to ignite polyethylene or polypropylene is around 100°C higher than that required to ignite various woods.
- From a toxicity standpoint, the literature indicates that fires involving polyethylene are not highly or unusually toxic, and present no more of an inhalation toxicity than wood.
- Results of in-house testing with an oxy-acetylene flame torch show that although it is possible to set parts of our fence post alight, it was difficult to ignite, did not burn easily or explode.
- Critical Heat Flux tests with polyethylene and polypropylene indicate that greater heat energy is required for ignition of PE/PP (19-21 kW/m2) than wood (12kW/m2).
- Critical Heat Flux results suggest a Bushfire Attack Level rating of between BAL-19 to BAL-29.
- Polyolefins (including PE & PP) typically have similar fire resistance properties as Radiata Pine Timber

CONCLUSIONS AND RECOMMENDATIONS

- The findings suggest that although our plastic fence posts cannot claim to be fire-proof in severe bushfires (just like timber posts), they would withstand smaller grass fires and ember attack.
- Plastic Forests fence posts are recommended for internal line fencing applications, where the fuel loads within farming properties are generally controlled. We recommended installation away from high fuel load applications such as perimeter fencing next to a National Park, where there is minimal back-burning or regular fire management controls.

Low fuel levels typically found around internal farm fencing

Recycled plastic bollards have been used extensively by Australian councils for over 30 years in rural & bush applications.

GREEN GLOBE AWARDS 2018 WINNER | INSIDE WASTE AWARDS 2018 Winner Outstanding Facility Award | 200 Businesses of Tomorrow 2017 WINNER | INSIDE WASTE AWARDS 2018 Winner Circular Economy Award | 2015 Endeavour Awards WINNER MOST INNOVATIVE MANUFACTURING COMPANY

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It should be noted that the flammability and burning response of plastics is complex, with laboratory test results varying from burning in real fires and different experiments yielding different results depending on the parameters set.

"As with any testing, the tests for flammability are designed for the laboratory and quality control. In real fires plastics may behave significantly differently and the results of laboratory testing cannot predict the actual performance of a particular plastic or product."
Source: https://www.appstate.edu/~clementsjs/journalarticles/zeus_flammability.pdf

a) IGNITION TEMPERATURES

- Polyethylene and polypropylene are resistant to ignition compared with many other materials. The temperature required to ignite polyethylene or polypropylene is around 100°C higher than that required to ignite various woods.
- Tables 2.1.1, 2.1.2 and 9.1 list the approximate ignition temperatures for a range of natural and synthetic materials.

Various Materials Ignition Temperature - Table 2.1.1

Reactions to temperature exposure	
Reaction	**Temperature (Celsius)**
Wood slowly chars*	120°-150°
Decayed wood ignites	150°
Ignition temp of various woods	190°-260°
Paper ignites	218°-246°
Wool	228°-230°
Cotton	250°
Hay ignites	172°
* wood chars at a rate of approximately 30-50 mm/hour	

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Plastics - Table 2.1.2

Melting points and ignition temperatures		
Plastic	**Melting Point Range**	**Ignition Temperature**
Polyethylene ld	107°-124°	349°
Polyethylene hd	122°-137°	349°
Polypropylene	158°-168°	570°

Source: T.C Forensic Pty Ltd, various extracts https://www.tcforensic.com.au/docs/article10.html

Ignition Temperatures for Various Materials (ASTM D1929) - Table 9.1

	Flash-Ignition (°C)	**Self-Ignition (°C)**
Pinewood	240	260
Polyethylene	340	350
Polypropylene	320	350
Paper	230	230
Cellulose Nitrate	130	130

Source: NFPA (1982) Fire Facts, National Fire Protect Association. USA

b) THERMAL RESPONSE PARAMETERS (TRP) AND CRITICAL HEAT FLUXES (CHF) FOR IGNITION

The Critical Heat Flux for ignition is the lowest thermal load per unit area capable of initiating a combustion reaction (either flame or smoulder ignition).

	Thermal Response Parameters (TRP)	**Critical heat flux (CHF) kW/m^2**	
Polymer	**TRP kW. s $^{1/2}$ m^{-2}**	**(Measured)**	**(Calculated)**
PE HD	343	15	21
PE LD	454	-	19
PP	193-336	15	21

Source: https://polymerandfire.files.wordpress.com/2013/03/chapter-3-plastics-and-rubber1.pdf Table 3:9

- Polyethylene and polypropylene have a critical heat flux for ignition of 19 - 21 kW/m^2.
- This compares with a critical heat flux for ignition of wood of 12 kW/m^2 (approx)
- These results indicate that greater heat energy is required for ignition of PE/PP than wood (depending on test set-up, sample orientation, ambient temperature and heat transfer mode).

"The burning behaviour of wood is complex. However the processes behind pyrolysis, ignition, combustion, and extinction are generally well understood, with good agreement in the fire science literature over a wide range of experimental conditions for key parameters such as **critical heat flux for ignition (12 kW/m^2 ± 2 kW/m^2)** and heat of combustion (17.5 MJ/kg ± 2.5 MJ/kg). "

Source: Bartlett, A.I., Hadden R.M., and DBisby, L.A. Fire Technology 55, 1-49 (2019) Abstract "A review of Factors Affecting the Burning Behaviour of Wood for Application to Tall Timber Construction."

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c) BUSHFIRE ATTACK LEVEL (BAL) FOR BUILDINGS

A BAL is a means of measuring the severity of a building's potential exposure to ember attack, radiant heat and direct flame contact. It is measured in increments of radiant heat (expressed in kilowatts/m^2). A BAL is the basis for establishing the requirements for construction, to improve protection of building elements from bushfire attack.

- The Critical Heat Flux for Ignition of LDPE, HDPE & PP (19-21 kW/m^2) suggests a BAL rating between BAL-19 and BAL-29 (approx).
- The information suggests that Plastic Forests' fence posts could sustain "increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux between 12.5 and 19kWm^2," and "between 19 and 29kW m^2 "

BAL - Low	There minor requirements that warrant specific construction requirements
BAL – 12.5	Ember Attack
BAL - 19	Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux between 12.5 and 19 kW m^2
BAL - 29	Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux between 19 and 29 kW m^2
BAL - 40	Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux with the increased likelihood of exposure to flames
BAL – FZ	Direct exposure to flames from fire front in addition to heat flux and ember attack

Source: https://www.bushfireprone.com.au/what-is-a-bal/

d) COMBUSTION TOXICITY

Full-scale fire studies show that polyethylene under combustion is less hazardous than cellulosic material (i.e. burning wood) from a toxicity standpoint. A joint study by the Fire and Safety Research Institute in Chicago and the Dow Chemical Company found that there is:

" no substantial difference in toxicity between burning cellulose materials and burning polyethylene materials and this is sufficient basis to conclude that fires involving polyethylene present no more of an inhalation toxicity than wood"

Smoke from wood is the more toxic material when comparisons are made on a volume basis. The study showed that the primary hazards in a large scale fire situation involving polyethylene or wood are carbon monoxide and temperature.

Source: Kuhn, R.L., Potts, W.J. and Waterman, T.E#., " A Study of the Inhalation Toxicity of Smoke Produced Upon Pyrolysis and Combustion of Polyethylene Foams – Part II, Full Scale Fire Studies", Journal of Combustion Toxicology, 5, p.434 (1978) Nov.

Furthermore, a literature review of polyethylenes with an emphasis on the identification of gaseous products generated under various thermal decomposition conditions and the toxicity of those products found that:

"the toxicity of the combustion products from various samples of polyethylene are not highly or unusually toxic."

Source: Paabo M and Levin, C.L., "A Literature Review of the Chemical Nature and Toxicity of the Decomposition Products of Polyethylenes.", Fire and Materials, Vol 11, 55-70 (1987)

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e) TYPICAL FIRE RESISTANCE PROPERTIES

Typical results from Fire Hazard Tests are shown below for a range of fire resistance properties.

Property	Range for Polyolefins	Range for Timber- Radiata Pine
Ignitability Index (0-20)	13	14-15
Smoke Development Index (0-10)	3-5	3
Spread of Flame Index (0-10)	5-7	5-8
Heat Evolved Index (0-10)	4-6	5-9

Source: https://www.boeingconsult.com/tafe/fire/SmokeControl.pdf

- These results show that polyolefins (including PE & PP) typically have similar fire resistance properties as Radiata Pine Timber

ADDITIONAL REFERENCES

- Australian Standard® Construction of buildings in bushfire-prone areas - AS 3959-2009
- Fire resistance - Test methods for fire-resisting materials and assemblies. Currently, there is no test method available to assess the performance of fire-resisting materials such a plastics

Source: https://www.ballarat.vic.gov.au/sites/default/files/2019-04/Standards%20-%20Construction%20of%20buildings%20in%20bushfire-prone%20areas.pdf

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