The use of low molecular weight Polyethylene in HMA

1. What is a HMA?

A hot melt adhesive (HMA) is a thermoplastic compound that is applied in its molten form. It forms a bond with the substrate it is applied on and cures by cooling. The main advantages of a HMA are:

- No volatiles
- Fast setting
- Low penetration of substrate
- Water insensitive

A typical HMA consists out of an equal amount of polymer, a tackifying resin and a low molecular weight polyethylene (PE).

The packaging industry is the main market for HMA particularly box assembly, and case and carton sealing. These processes take place at a high speed and require the HMA to act fast.

The functions of the low molecular weight PE are:

- Viscosity reduction during manufacturing of HMA and during application.
- Increase the blocking temperature of HMA to prevent agglomeration during transport
- Affect the performance of the HMA:
  - Heat resistance ie the ability of the bond to withstand elevated temperatures
  - Quick setting times require for high speed packaging lines

2. Performance testing in hot melt adhesive formulation

Trecora Chemical used the services of an independent laboratory to benchmark the performance of Trecora Chemical's waxes with other commercially available waxes used in the hot melt adhesive industry.

2.1 HMA formulation

A standard formulation was used for this evaluation, which composed of:

EVA copolymer (28% VA level)	30%
Rosin ester	49.7%
Irganox 1010 (anti-oxidant)	0.3%
Wax	20%

2.2 Waxes evaluated

The waxes evaluated were:

- FT1 – A hard Fischer-Tropsch wax with a high crystallinity and low viscosity.
- FT2 – A hard, high molecular weight Fischer-Tropsch wax
- Micro – A microcrystalline wax that is used in industry to improve the flexibility of the adhesive.
- PE wax – A synthesized high molecular weight polyethylene wax
- Trecora CWP500E – A crystalline, high melting point HDPE wax
- Trecora HMA-1 – A narrow cut HDPE wax

2.3 Performance Tests and results

2.3.1 Viscosity at 177 °C (cP)

One of the main reasons waxes are used in hot melt adhesives is to reduce the viscosity of the blend. The viscosity comparison is shown in Figure 1

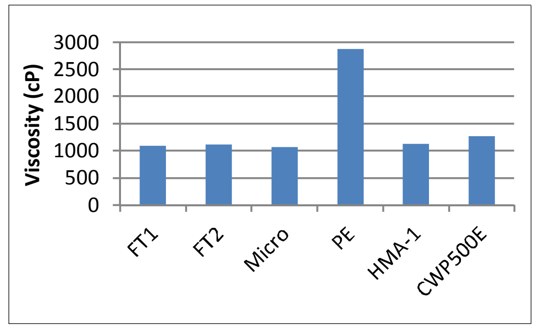
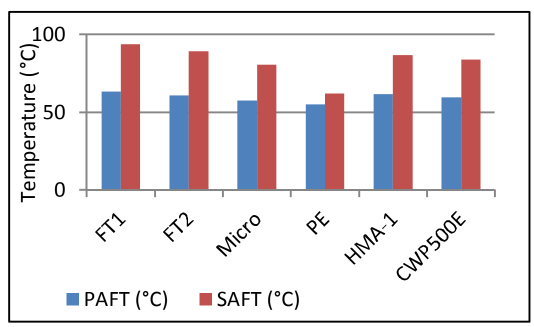


Figure 1: Viscosity comparison at 177 °C

2.3.2 Heat Resistance

The heat resistance is determined by measuring the shear adhesion failure temperature (SAFT) and Peel adhesion failure temperature (PAFT). Both tests involved measuring the temperature at which the adhesive bond fails under shear and peel stress when subjected by increasing temperatures in an oven. The results are depicted in Figure 2.



2.3.3 Cloud Point (°C)

The cloud point gives an indication of the compatibility of the system. An incompatible ingredient will settle out at a certain temperature in the HMA blend. A lower cloud point indicates better compatibility. Figure 3 depicts the cloud point analysis.

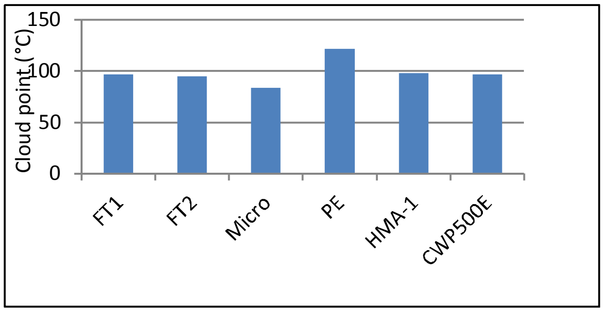


Figure 3: Cloud point (°C)

2.3.4 Mechanical Properties

The elongation (%) and tensile strength of the HMA were determined on an Instron tensile tester by casting dogbone samples. The results are depicted in Figure 4.

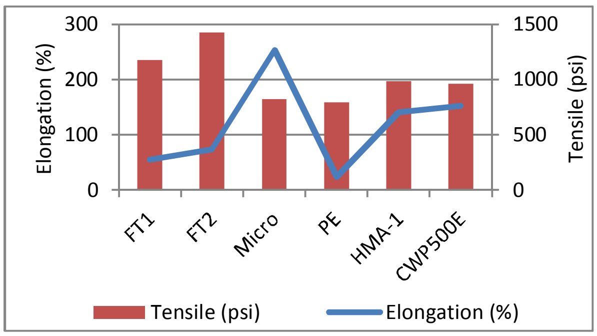


Figure 4: Mechanical properties

2.3.5 Thermal Stability

The thermal stability was measured by the change in viscosity when the HMA samples were placed in a forced air convection oven at 177 °C for 100 hours. The percentage change in viscosity results are depicted in Figure 5.

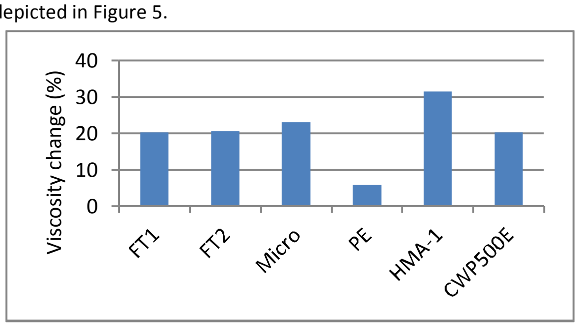


Figure 5: Percentage change in viscosity after 100h at 177 °C

2.3.6 Speed of set

Table 1 summarizes the comparative set speed when compared to FT1, which was given a set speed of "Fast".

Table 1: Speed of set comparison

	FT1	FT2	Micro	PE	CWP500E	HMA-1
Speed	Fast	Very fast	Medium	Med Fast	Med Fast	Med Fast

2.3.7 Bonding test

Bonding tests were performed on a white corrugated substrate. This substrate is standard in industry and estimated to be harder than average to bond. The amount of fiber tear was used as an indication of the quality of bond formed. It was categorized into the following:

FFT = Full fiber tearing bond (85-100%)

PFT = Partial Fiber tearing bond (50 – 84%)

SFT = Slight Fiber Tearing bond (20 – 49%)

NFT = No Fiber Tearing bond (0 - 19%)

The results are shown in Table 2.

Table 2: Bonding results on white corrugated substrate

	FT1	FT2	Micro	PE	HMA-1	CWP500E
-20°C	NFT	NFT	NFT	NFT	NFT	NFT
0 °C	NFT	NFT	NFT	NFT	NFT	NFT
25 °C	SFT	NFT	SFT	SFT	SFT	PFT

3 Discussion

The most striking aspect observed was that the Trecora waxes had a longer open time (almost like a micro), but the set speed was still fast. Also the mechanical properties of the Trecora waxes were superior to the other waxes tested. The elongation was far greater than that of the FT waxes and other PE wax tested.

The bonding performance of all of these products was about the same with an edge to the two waxes from Trecora.