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Evaluating Packaging Systems for Metal Flow

Background: Since 1978, Metal Flow has been a family-owned company producing high volume, technically sophisticated custom metal components and assemblies through their deep draw process. Metal Flow would like to find a packaging system for their small muffler parts. They currently use a blue polyethylene (PE) film, the VCI and/or desiccant content of which is unknown. The corrosion inhibiting abilities of this film will be compared to VpCI-126 at 2 and 4-mil. Both products will also be used in combination with VpCI-131 foam and VpCI-146 paper.

Purpose: Evaluate and compare different combinations of VCI films, foams, and papers for protection of muffler parts from Metal Flow.

Method: ASTM D-1748 Humidity Cabinet
FTIR Spectrometry

Materials: 8 boxes of muffler parts, provided by Metal Flow
VpCI-126 blue film
VpCI-131 foam pads
VpCI-146 paper
Armor VCI Film
Perkin Elmer Paragon 1000 FTIR Spectrometer

Procedure: The following procedure was used:

1) The parts arrived pre-packaged in boxes. Parts were packaged as follows:
    a. Plain PE Film
        i. These parts were removed and used as a control.
    b. Unknown blue film (APAC) with Armor VCI paper
        i. A small sample of this film was analyzed via FTIR Spectrometry.
    c. Unknown blue film with VpCI-131 emitter
    d. Unknown blue film with VpCI-146 paper
    e. VpCI-126 film (2-mil) only
    f. VpCI-126 film (4-mil) only
    g. VpCI-126 film (4-mil) and VpCI-131 emitter
    h. VpCI-126 film (4-mil) and VpCI-146 paper
2) All parts were left as received, and all packages were placed in ASTM D-1748 humidity cabinet.
3) Packages were visually inspected periodically.
4) After 1000 hours, all packages were removed from ASTM D-1748 humidity cabinet.
5) All parts were visually inspected and photographed.

Results: The following results were found:

ASTM D-1748 Humidity Cabinet

Part	Protection	Time to Failure (Hours)
A1	None (Control)	72
B1	APAC Film + Armor VCI Paper	144
C1	APAC Film + VpCI-131	288
D1	APAC Film + VpCI-146	240
E1	VpCI-126 (2-mil)	288
F1	VpCI-126 (4-mil)	DNF*
G1	VpCI-126 (2-mil) + VpCI-131	DNF*
H1	VpCI-126 (2-mil) + VpCI-146	DNF*

DNF – Did not fail during 1000 hours of humidity testing.

FT-IR Spectrometry

1) FT-IR Spectrometry showed no sign of corrosion inhibitor compounds in the submitted blue film, nor did it show any desiccant. The film appears to be nothing more than plain polyethylene. Note: the graph for this analysis is attached.

Conclusion: The use of 4-mil VpCI-126 blue film provided drastically better corrosion protection than the currently used PE film. The addition of VpCI-131 foam and VpCI-146 paper provided additional protection to this system.

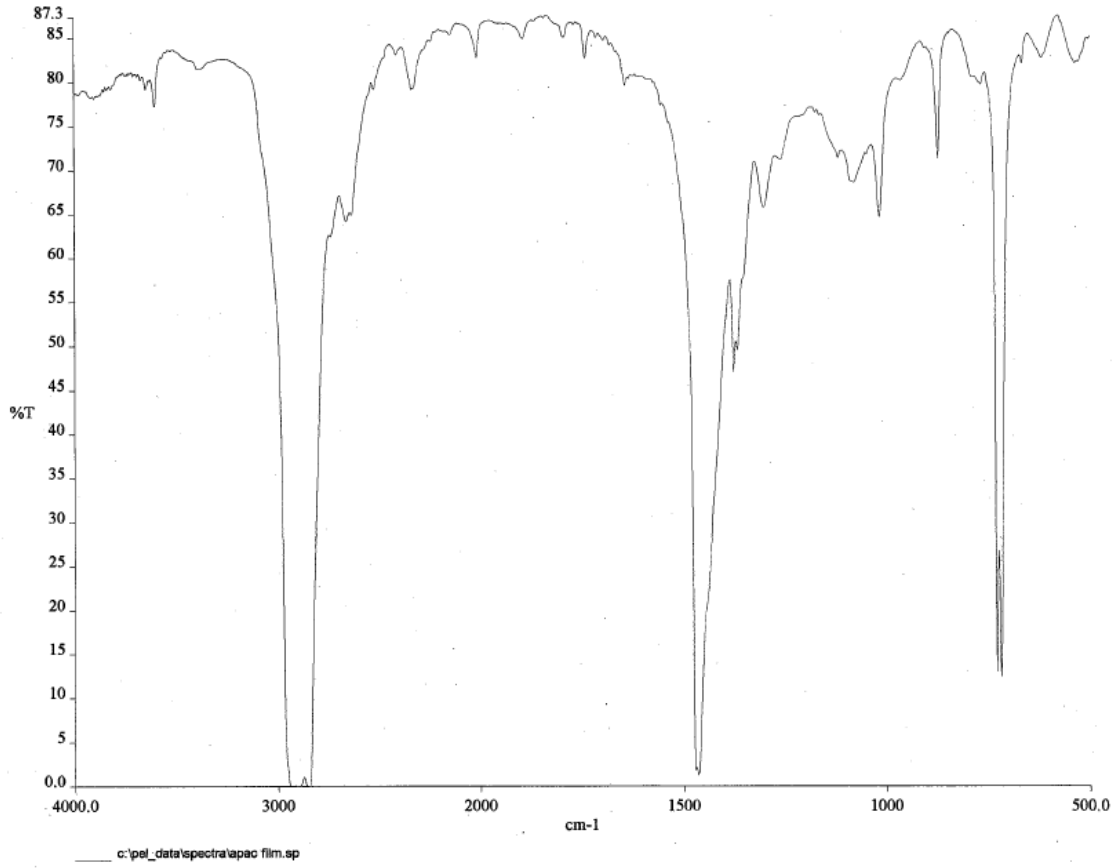

Figure 1: FT-IR Spectrum for Submitted Blue Film from Metal Flow.

Figure 2: A1, control parts after 1000 hours in ASTM D-1748 humidity.

Figure 3: B1, parts packaged in unknown blue film with Armor VCI paper, after 1000 hours in ASTM D-1748 humidity.

Figure 5: C1, parts packaged in unknown blue film with VpCI-146 paper, after 1000 hours in ASTM D-1748 humidity.

Figure 6: D1, parts packaged in unknown blue film with VpCI-131 foam pad, after 1000 hours in ASTM D-1748 humidity.

Figure 7: E1, parts packaged in 2-mil VpCI-126 blue film,
after 1000 hours in ASTM D-1748 humidity.

Figure 8: F1, parts packaged in 4-mil VpCI-126 film,
after 1000 hours in ASTM D-1748 humidity.

Figure 9: G1, parts packaged in 4-mil VpCI-126 and VpCI-146 paper,
after 1000 hours in ASTM D-1748 humidity.

Figure 10: H1, parts packaged in 4-mil VpCI-126 and VpCI-131 foam,
after 1000 hours in ASTM D-1748 humidity