MECHANICAL PROPERTIES OF VCI PAPERS

A COMPARATIVE ANALYSIS

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Executive Summary

1. The mechanical properties of the Cortec product are equivalent or superior to heavier products (Daubert, Cromwell).

2. The lightest product is the Cortec product with increasing weight for Cromwell and then Daubert. The advantages of a light product are that they cost less for disposal as well as for shipping.

3. The Cortec paper is the lightest and is the most cost effective when compared to the heavier papers.

4. The Cortec product exhibits the highest stretch value, a property critical to application where wrapping is required.

Mechanical Property

The properties of Cortec, Daubert and Cromwell VCI papers are tabulated in the attached table. Comments of each property are made with respect to their end use performance and product quality. How these properties are achieved are also noted.

Base Weight

The lightest paper is Cortec's at 32.5 pounds. The Cromwell product is slightly higher at 35.8 pounds. The heaviest product is Daubert at 41.2 pounds. It is believed that the heavy weight of the Daubert product is attributed to a heavier base paper rather than more anti-corrosion chemical deposition. This means that the Daubert product will not exhibit superior end use performance than a lighter product. With today's aim of getting more with less, lightness is highly desirable, e.g. less paper, less disposal. Also with less paper, you have less dead weight to ship. Producing a lightweight paper without losing mechanical strength has been the main focus for achieving competitiveness in today's global marketplace. We have essentially achieved this.

Caliper

Caliper represents the thickness of the product. The Cortec paper exhibits the lowest caliper, but approaches that of the Cromwell product. As long as strength and performance are not compromised, less thickness occupies less space and volume. In today's finely tuned manufacturing facilities, space saving is highly desirable. Low caliper at the same given base weight also reflects paper densification through calendering. The Cortec paper indeed is calendered to yield a smooth and dense paper matrix ideally suited for uniform coating structure and superior anti-corrosion performance. The dense matrix localizes the anti-corrosion chemicals to the directed surfaces. A porous structure will cause valuable leakage of anti-corrosion chemicals through the backside of the paper where protection is not needed.

Tear

The MD tear of the Cortec product is comparable to the higher weight of the Cromwell product. The CD tear is somewhat lower, but meets all major needs. The tear value in light of other strength values will show that this low value is not an impediment. The localization of the anti-corrosion chemicals on one surface will impart less strength to the final product than a product made by total saturation of the entire paper matrix. As indicated earlier, the localization of the chemical to one surface will yield a more effective anti-corrosion effect. So there is some trade-off.

Tensile

The tensile values (CD & MD) of the Cortec product are comparable to competitive products. However, the Cortec product exhibits a more mechanically uniform sheet as shown by a lower ratio of CD/MD. Unlike the Cromwell product, the MD value is much larger than the CD value thereby creating an unbalanced mechanical torque in the paper.

TEA

The Tensile Energy Absorption (TEA) is the energy absorbed per unit area of the specimen before breaking. Taken as a composite, Cortec's TEA is comparable to the competitive values despite being lighter weight.

Stretch

Stretch property is one of the most important properties in which the product is used for wrapping. The Cortec product is equal to the heavier Daubert product and is superior to

the Cromwell product also, which has a slightly higher weight than the Cortec product. This property alone should identify the Cortec product as "premium." The superior stretch of the Cortec product can be attributed to decurling, which functions as a pre-stretcher.

Ink Float

The product is deposited on a pool of blue ink. The rate at which the ink strikes through the paper is noted. As shown in the table, Cortec exhibits the greatest resistance to liquid penetration. This by no means indicates the product as moisture-proof. Again, the resistance to liquid penetration can be attributed to the tight formation of the paper through calendering and other paper machine parameters.

Smoothness

The smoothness of the Cortec product is comparable to that of Cromwell, but not as rough as the Daubert product. A rough surface is attributed to high fiber population of the paper surface and can create fiber contamination of the product to be protected. The smoothness of the Cortec product is attributed to the low fiber population of the paper surface and should not contaminate sensitive products such as electronic circuit boards or aerospace parts.

Abrasion

The abrasion values of the Cortec product support the high smoothness values. Note that abrasion on the VCI side which is in contact with the protected product is lowest for the Cortec product. This means less amount of material will be abraded from the Cortec product. This again illustrates the "cleanliness" of the Cortec product. This attribute alone should qualify the Cortec product as a superior electronic product protector.

Paper Properties Comparison of Competitive VCI Papers

Property	**TAPPI Method**	**Unit**	**CORTEC**	**DAUBERT**	**CROMWELL**
Basis Weight	T-410	lbs/3000 sq ft	32.5	41.9	35.8
Caliper	T-411	inches	0.0032	0.0046	0.0034
Tear - MD	T-411	gms	47.5	53.2	47.8
Tear - CD	T-411	gms	58.5	66.3	66.3
Dry Tensile - CD	T-404	lbs/inch	11.3	11.5	9
Dry Tensile - MD	T-404	lbs/inch	21.4	27.8	28.7
TEA-CD	T-494	ft-lbs/ft	3.6	3.2	2.6
TEA - MD	T-494	ft-lbs/ft	1.9	3.3	2.5
Stretch - CD	T-404	%	4.26	4.23	3.93
Stretch - MD	T-404	%	1.47	1.84	1.4
Ink Float	T-530	minutes	0.25 minute	0.01 second	0.01 second
Smooth -nonprint	T-538	Sheffield	240	302	215
Smooth - VCI	T-538	Sheffield	231	320	241
Internal Bond	T-541	ft.lbs/inch	0.165	0.133	0.154
Abrasion-nonprint	T-476	gm loss/100 rev	0.007	0.005	0.007
Abrasion-VCI	T-476	gm loss/100 rev	0.002	0.023	0.012
MD = Machine direction		CD = Cross direction	Caliper = Thickness		