

HARSH ENVIRONMENT LABEL CONVERTING

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More and more converters are expressing an interest to participate in the "harsh environment" labeling marketplace. Without question, the high value-added for these engineering intensive applications usually mean higher profit margins. This paper will strive to address some of the operational differences between labels bound for harsh environment applications versus more traditional labeling applications such as prime labels, and other "ordinary" labels and tags.

First and foremost, applications definition, i.e. how and where the label will be used, is imperative. Most harsh environment labeling opportunities arise in the middle of someone else's manufacturing process. That is, these labels generally end up on raw materials and WIP, rather than on finished goods destined for "sitting on a shelf". Unlike making carton labels and the like, where trial and error is the accepted *modus operandi*, harsh environment opportunities almost always require extensive field testing. Since the specially engineered label media is comparatively much more expensive, the testing protocols require a high initial success rate, in order to keep trial costs as low as possible. **Please call Polyonics' Customer Service Department for a free reprint of the article "Industrial Labeling", which discusses many of these issues.**

For the sake of this discussion, let's define what we mean by a typical "harsh environment" application. In the "good old days", many thought that a harsh environment was "…six-months outdoor exposure in South Florida". While that may be extreme, many of today's UV stabilized polyesters and many PVC films will survive this for reasonable amounts of time. We'll define a harsh environment as that in which conventional substrates (such as paper, polyester, and the like) fail. For example, an environment in which the label is exposed to temperatures in excess of 500° F, (260° C); or, exposure to solvents and cleaners/degreasers commonly found in the manufacturing processes associated with printed circuit boards; or, exposure to Skydrol® hydraulic fluid and brake fluids found in the aircraft industry; and, of course, combinations of the above Obviously, the label needs to be printed, and the print needs to survive these same exposures as well..

There's "good news and bad news". Although the applications are difficult to address, the technical risks somewhat greater, and the materials generally more expensive, the competition is less fierce than in other staid, more mature market areas. Of the some 3,500-4,000 converters in the US, we estimate that less than 10 % are actively addressing these types of industrial labeling needs.

The small size of the label (usually) and the large cost of the media are the primary reasons for running at a slow speed. High performance label materials are much more expensive than traditional paper and the more ordinary synthetic films, such as polyethylene, or so-called "polyolefins". In fact, the higher the performance required usually means the higher the cost. For example, PEI (polyetherimide) and PEN (polyethylene-napthenate), each a so-called "polymeric" material, respectively exhibit higher temperature resistance than PET (polyethylene terephthalate). Polyimide film (most commonly sold under the Dupont trade name – Kapton®) exhibits temperature resistance even up to 1,000 ° F, for a few seconds. As shown in the table below, the enhanced temperature resistance means much higher costs than paper labels:

Labeling Media	Relative Cost
Paper	1
Generic PET	4-5
Specialty Polyesters	10-15
Polymerics	20-30
Polyimides	60-100
Ceramics	90-200

The label converting world has focused on two things over the past few decades – wider web widths and faster line speeds. The harsh environment label manufacturer needs to focuses on two things – narrower webs, and possibly slower converting line speeds.

A very common size thermal transfer printable label may be a 4" x 6" AIAG format. The large size of the label lends itself to high speed converting, because the label is relatively large compared to the area of the waste matrix. However, the most common size of a polyimide printed circuit board label is 1.25" x .30". Since it is common practice to allow the standard 0.125 gap between labels, the waste matrix area becomes more significant when compared to the label area. This smaller size demands that we slow down our presses to avoid losing labels with the matrix. Due to the cost parameters shown above, a lost polyimide label equates to lost profit at a very high rate, when compared to a lost paper label.

From another perspective: the higher the cost of material becomes as a percent of the total cost, the more important MATERIALS COST and YIELD become when compared to work center and labor rates, based solely on the run speed of the equipment. More to follow on this point in a moment.

A top coating is used because of the necessity of printing on these high performance films. The top coating must provide color (usually white, but not always), a gloss or matte surface, opacity, print receptivity and chemical/heat resistance. Although these films are unusually tough to cut, relative to polyester,, the addition of abrasive pigments, whiteners, and other colorants (typically TIO_2 - Titanium Dioxide) changes the requirements for die-cutting.

While it is a common conception that paper dies burst and film dies cut, *"It Ain't Necessarily So"*. Even filmic dies have a bursting component to their performance. Given the abrasiveness of the topcoat and the toughness of the film, what does the converter choose? A sharp die will cut better but dull quicker and a coated die will last longer but doesn't start as sharp.

When a die cuts (bursts) through the label and adhesive of the pressure-sensitive sandwich it tends to fracture the bond between the adhesive and the release coating on the liner. The fracture may extend into the label as much as 1/8". When you are cutting a label that is only .3" wide to begin with, the die cutting process itself may remove the label from the liner. This is the prime reason for cutting at a very slow speed.

From an operational standpoint, there are many pointers and "tricks of the trade" we have learned over the year. . **Polyonics has published several Technical Memos called "tooling tips" which are available to you at no charge.**

However, a couple of noteworthy "rules of thumb" are appropriate for this discussion. First, specially hardened, tooling is available for these engineered and often abrasive materials, including for top-coated, pressure sensitive polyimide. Second, magnetic tooling has been used successfully for short runs, as have steel ruled dies in conjunction with hot stamp/flat bed cutting equipment. Finally, many successful operations actually dedicate up to three engraved tools for high volume, standard label sizes: one die running, one die waiting and one out being re-sharpened. **It is imperative to never allow the tool to become dull, when cutting these specialty materials, especially at these small sizes.** Since die wear is of concern when converting polyimide films, make sure not to overlook this cost in your quotes.

OK…we've discussed a bit about materials cost, yield, and special tooling…but what about "slow speed"? In most cases polyimide films are converted at "jog speed". This is between 35 and 50 feet per minute on flexographic presses.

By now, you are probably asking yourself, "How do I make any money running that slow?"

When quoting polyimide labels we must step back from our traditional way of costing a job. We are no longer basing our quotes on throughput/machine hour. This is fine if we are running 20" wide at 500 feet/minute. But we are now running polyimide, 4" wide at 50 feet/minute. The same rules do not apply because the materials are up to 100 times more expensive. Scrap generation at high speed means "MEGA-scrap", at high cost !!.

Let's compare running a paper label at 20" width at 400 feet/minute to running a polyimide label 4" wide at 50 feet/minute. In one hour:

Paper will produce 5,760 msi in finished labels.

$$\frac{20\text{"(width)} \times 400\text{'(per minute)} \times 12\text{"(inches per foot)} \times 60 \text{ (minutes per hour)}}{1000 \text{ in}^2 \text{ per msi}} = 5{,}760 \text{ msi}$$

Polyimide will produce 144 msi in finished labels.

$$\frac{4\text{"(width)} \times 50\text{'(per minute)} \times 12\text{"(inches per foot)} \times 60 \text{ (minutes per hour)}}{1000 \text{ in}^2 \text{ per msi}} = 144 \text{ msi}$$

Let's use a common method of quoting these jobs:Selling price equals three times materials cost.quote the job at "three times material cost". If paper P-S costs you $.25/msi your quoted price is $.75/msi. Let's assume that the polyimide costs you $ 30.00 per msi (yes, that's correct….no typographical error), then you would be tempted to quote $ 90.00 per msi, on the finished labels. You probably will get very little business. **HOWEVER**, you **can** sell the finished labels at $ 60.00 per msi (that, too, is very realistic). The first scenario generated $ 4,320 in revenue (what about scrap??), while the second case generated $ 8,640. The profit contribution in case 1 was $ 2,880, while in case 2 it was $ 4,320. Labor and overhead are the same, so profitability of the machine hour was much larger in case 2.
If you base your pricing on the traditional "throughput per machine hour" basis, you wmay be totally missing harsh environment labeling opportunities.

By changing your thinking to profit contribution per machine hour, you can quote more highly engineered specialty materials and actively and **PROFITABLY** compete in the harsh environment labeling arena.

These specialty labels, such as polyimide, are often printed on-site, and on-demand.. Some labels are pre-printed for batch application on site. The most common form of printing is thermal transfer printing. At Polyonics, we have dedicated hundreds of man-hours of testing to evaluate ribbons and label material combinations suited for these types of applications..Moreover, engineering test kits are available to you at no charge, to help you define the label/ribbon combinations which will work for your customers.

For additional information on harsh environment labeling materials, go to our web page:

www.polyonics.com.

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