Cast vs. Calendered Vinyl

Learn the differences and why to use the right vinyl in the right application. There huge differences and a quick read through this article will help you understand all the ins and outs of calendered and cast vinyls.

By Molly Waters, OEM & Strategic Alliance Specialist, Digital Imaging Avery Graphics

Whether you are new to the graphics industry or have been around for many years, you have most likely heard terms such as; cast, 2 mil, high performance, long-term, calendered, 4 mil, intermediate, short-term and economy.

It is safe to say that most people may not know the actual ingredients or manufacturing processes for these films. They do, however, know that a short-term or economy film should not be used for a vehicle wrap and that a cast or high-performance film is overkill for a point-of-purchase (POP) display that will only be used for six months to one year. This article will explain the differences between cast and calendered films as well as give examples of where each type of film would be used.

What Makes Vinyl Vinyl

Let's begin with a few of the basics on vinyl films. Most vinyl films are made from the same basic raw materials. We begin with polyvinylchloride (PVC) polymer, which is simply basic plastic, and is, by nature, relatively rigid. Other ingredients are then added to the PVC. These ingredients include: plasticizer to make the film flexible, pigment to make the desired color, and additives to help achieve specific properties such as UV absorbers to improve resistance to UV radiation, heat stabilizers, fillers and processing aids. These raw materials can be chosen from a wide range of quality levels. Of course, for a film with limited durability, often the least expensive raw materials are chosen.

Apart from the type of raw materials that are used at manufacturing, the manufacturing process and the type of plasticizer used create the main differences of vinyl films. Vinyl films can either be made by calendering or by casting. Each of these processes renders different qualities of films. Casting generally results in better quality films. The grade of plasticizer that is used to make the film flexible also greatly affects the grade of the film. Generally for pressure-sensitive adhesive films a choice is made between polymeric and monomeric plasticizers. We won't go into detail on the plasticizers in this article, but for simplicity's sake consider polymeric to be the higher grade and monomeric to be the economy grade plasticizer. The combination of these factors greatly determines the durability of vinyl films.
**Cast Films**

Cast films, also known in the industry as premium, high-performance or 2 mil are considered to be a premium product with excellent durability and conformability characteristics. The term "cast" refers to the manufacturing process of this type of vinyl. Making a cast vinyl film is a lot like baking a cake. The vinyl begins with a "recipe" calling for a list of ingredients known as the formulation. These materials are added to a "bowl" or mixing churn in a predetermined order while mixing at specific speed and for a set amount of time to ensure a complete and consistent mixture. This liquid mixture, known as organosol, is then "poured" or cast onto a moving web known as the casting sheet and is then processed through a series of ovens which allows for the evaporation of solvents. When the solvents are evaporated, a solid "film" is left behind. The film is then wound up in large-diameter rolls for subsequent adhesive coating. The casting sheet determines the texture of the film.

Because the vinyl is cast on the casting sheet in a relaxed state, this material offers very good dimensional stability. This process also allows the film to be very thin (most cast films are 2 mil), which helps with the conformability of the product. Material manufacturers recommend the use of cast films on substrates such as fleets, vehicles, recreational vehicles or boats where the customer wants a "paint-like" finish that will last a long time, usually five to eight years depending on how the film is processed.

**Advantages of cast films:**

- Shrinkage is the lowest of all vinyl films because the "casting sheet," not the film itself, is pulled through the machine. Since the film has not had any stress applied during the manufacturing process it does not try to resume or shrink back to its original form.
- Durability of cast films is generally higher than that of other vinyl films due to the manufacturing method and the raw materials used.
- Cast films can be made very thin which produces a conformable product that allows application over substrates with rivets, corrugations, and complex curves. Also, once applied, this low caliper makes the graphic less vulnerable to abrasive forces.
• Cast films also maintain their color and other properties better than other vinyl films. This results in better performance of pigments and UV absorbers.
• The manufacturing process of cast films makes it easy to run small productions of special colors to match. It is relatively easy to change color during production making color matching in small batches possible.

Calendered Films
Like cast, calendered film also gets its name from the manufacturing process. These films may also be referred to as intermediate, 4 mil, short-term or economy. Calendered vinyl is formulated with similar raw materials as cast, except that no solvents are used. The batch is mixed and heated to a molten state that resembles pizza dough. Once the film reaches this molten state it is extruded through a die and is then fed through a series of calendering rolls. These polished steel rolls progressively squeeze and stretch the vinyl into a flat sheet (similar to flattening out dough with a rolling pin). Because the film is stretched into shape, it has some degree of memory and therefore is less dimensionally stable than cast vinyl films. This means that when a calendered film is exposed to heat the film will have a tendency to shrink or pull back towards its original form. Calendered films also tend to be thicker (usually 3.2 to 3.4 mils) than cast films because of the limitations of the calendering process. Unlike casting where a textured or smooth casting sheet is used to produce the film finish, calendering implements a special finish cylinder at the end of the process while the film is still warm. This process is extremely fast and is ideal for bulk production runs. Therefore, color matching is very unattractive on these machines. However, due to its bulk production with high yields, calendered films are relatively inexpensive.

The quality of calendered films can range from economy to intermediate with durability of one to five years. These films generally are not recommended for vehicle applications because they are thicker, less conformable and less durable than cast films.
Advantages of calendered films:

- Greater production yields equals less cost
- Stiffer/thicker film equals easier handling
- Thickness of film increases resistance to abrasion

The chart below lists several attributes of cast and calendered films and how they compare to one another.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Cast</th>
<th>Calendered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durability</td>
<td>7+ yrs</td>
<td>1-5 yrs</td>
</tr>
<tr>
<td>Conformability</td>
<td>excellent</td>
<td>fair</td>
</tr>
<tr>
<td>Stability</td>
<td>excellent</td>
<td>fair-good</td>
</tr>
<tr>
<td>Gloss</td>
<td>Variable</td>
<td>None - Medium</td>
</tr>
<tr>
<td>Color Range</td>
<td>many</td>
<td>few</td>
</tr>
<tr>
<td>Product Variety</td>
<td>many</td>
<td>very few</td>
</tr>
<tr>
<td>Automotive Grade (OEM)</td>
<td>yes</td>
<td>no (may be used for some applications)</td>
</tr>
</tbody>
</table>

As with anything else, the finished product is only as good as what you put into it. This begins with choosing the right vinyl for the job. If you are doing a full vehicle wrap where you want the graphic to conform so that it looks and performs similar to paint you should choose a material with these characteristics, which would be cast film. Calendered films are ideal for applications that do not require the film to stretch or conform around contours. Examples of calendered film uses would be floor graphics, wall murals, and point-of-purchase displays.

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