Case study of anti-fog film installation
to prevent fogging on cabinet glass door
Anti-fog coatings are not new, but in the past they would lose their effectiveness over time and require reapplication. The film in the picture (on the photo of the sample) has a new type of coating that is bonded to a polyester film, which makes it much more durable. Water and cleaning products will not wear it down, although oil or grease will eventually ruin it.

Anti-fog coatings have hydrophilic properties, which means that the surface tension is changed such that any water on the surface doesn’t bead up and create fog; instead, the water simply slides off.

Typical applications include sport and safety visors, deli display cases, instrument display lenses and car windows. Consider the convenience of glass shower doors that resist water spots and are easier to clean because the water just sheets away.

The Anti-Fog Film is applied on the inside of freezer doors (retro-fit) and prevents the freezer doors from fogging up when shoppers open the cases. As a result, the standard door heating (which inefficiently tries to prevent the 'fogging up') can be switched off, which in turn accomplishes a significant energy saving.

Anti Fog Film is a special film, which can be applied to glass or plastic and is guaranteed to give clear vision through the applied area.
Examples of uses for Anti Fog Film

1. Bathroom mirrors, shower doors

Anti fog film can be applied to bathroom mirrors or shower doors in hotels or resorts to eliminate the steaming up of mirrors and door to give clear vision through the applied area.

Before applying anti-fog film

After applying anti-fog film
2. Refrigerated display cases in shops

The picture below shows the anti-fog film applied to the freezer glass doors to prevent fogging on it. In this way, customers can see the products inside clearly and the owner can save money from saving energy of anti-fog heater.

The Anti-Fog Freezer Film is an important innovation in the area of refrigeration. According to a particular coating, it efficiently and steadily impedes the glass of the freezer from fogging. Doors which are equipped with Anti-Fog Film are always perfectly transparent and the shoppers have a clear vision to the offered merchandise – even immediately after closing.
The test on the freezer glass door before applying anti-fog film

This study was done by testing under the conditions at temperature setting -20°C, Ambient Temperature 26.0°C and humidity 49% RH

Before applying Anti-Fog Film, that have fog up on the glass doors of the freezer after opening the doors, the shoppers who want to buy frozen products do not have clear vision to the merchandise: Customers need to wait approximately 60 seconds after closing the door, to have a clear view to the merchandise.
The test on the freezer glass door after applying anti-fog film

The 1st Test on January 26th, 2010

The study was done under the conditions at temperature setting -20°C, Ambient Temperature 26.2°C, humidity 48%

After applying anti-fog film, the doors of the freezer unit stay clear longer without the formation of fog after opening the doors.
The 2nd Test on January 26, 2010

The study was done under the conditions at temperature setting -20°C, Ambient Temperature 26.4°C, humidity 48% and Door heater was turned off.

After applying anti-fog film, the doors of the freezer unit stay clear longer without the formation of fog after opening the doors. By detaching the glass heating system of the freezer casing, energy savings of more than 35% can be achieved.
Energy Consumption of Freezer (at -20 °C)

1. Energy Consumption Before Applying Anti-Fog Film (Door Heater On)

| 1.1 Average Power Consumption (Heaters) | 0.162 kW |
| 1.2 Average Energy Usage per day       | 3.89 kWh |

2. Energy Consumption After Applying Anti-Fog Film (Door Heater Off)

| 2.1 Average Power Consumption (Heaters) | 0.11 kW |
| 2.2 Average Energy Usage per day       | 2.54 kWh |

3. Average Energy Saving and Cost Saving After Applying Anti-Fog Film

| 3.1 Average Power Consumption Saving  | 0.056 kW |
| 3.2 Average Energy Usage Saving per day | 1.36 kWh |
| 3.3 Total Energy Usage Saving per year (365 day) | 496.4 kWh |
| 3.4 Total Cost Energy Saving per year (365 day) (Average electricity rates 3.50 Baht/kWh) | 1,737.40 Baht |
| 3.5 Reduction in Energy Usage         | 35 %     |

Conclusion

In summary, anti-fog film seems like a promising technology. With the exception of de-lamination, anti-fog films can prevent fog and sweat from accumulating on the door. They allow the amount of anti-sweat heater use to be reduced or eliminated. These are all features which ultimately save energy while helping to keep visibility through the doors, shopper safety and product sales in the clear. The anti-fog film causes considerable savings on the energy consumption of freezer units in for example supermarkets. By detaching the glass heating system of the freezer casing, energy savings of more than 35% can be achieved. By using the film, doors of the freezer units stay clear longer without the formation of fog after opening the doors.
Remark

This study, conducted under controlled environment test conditions, shows the potential of anti-fog film to reduce or eliminate the need for the anti-sweat heaters on and around the doors, anti-fog films to compare total case energy consumption, anti-fog film performance, product temperature stability and door fog clearing times. The anti-fog film causes considerable savings on the energy consumption of freezer units in for example supermarkets. By detaching the glass heating system of the freezer casing, energy savings of more than 35% can be achieved. By using the film, doors of the freezer units stay clear longer without the formation of fog after opening the doors.

If uncontrolled environment temperature and humidity differences between the inside of the case and the ambient conditions can cause sweating on the glass surface as a result of condensation build up.

Anti-Fog Film Installation both inside and outside the glass door stay clear without the formation of fog after opening the doors.

Anti-Fog Film Installation inside the glass door but the outside was not installation. That cause the condensed water was on the outside of the glass door

This can be resolved by Anti-fog film installation inside and outside. This will help to prevent condensate outside the glass doors. Case at higher temperatures and humidity and a sufficient quantity to cause the condensate.
Project References

Renaissance hotel (Sukhumvit)

Before applying anti-fog film

Anti-Fog Film was applied on the freezer doors at Renaissance hotel (Sukhumvit)
INSTALLATION INSTRUCTION FOR ANTI-FOG FILM

Tools Required
Plastic bottle with atomizing sprayer filled with soap solution, lint-free wipers, tape measure, straight-edge ruler, single edge razor lade cutter or utility knife, four to six-inch rubber squeegee, and transparent tape.

Surface Preparation
Spray glass or plastic surface with wetting agent (dilute soap solution). Be sure surface is wet when film is applied to glass. Turn off equipment that might blow dust onto the application surface. Thoroughly clean the surface to remove dirt and other contaminants. Use a scraper or razor blade to remove any loose or rough particles. Pay particular attention to edges and corners where there may be dirt build-up. After cleaning, squeegee the surface dry, and collect any residual liquid with a lint-free wiper.

INSTALLATION INSTRUCTIONS

Step 1 - Cutting the Film
Measure the area to be covered. Film should be cut to shape prior to installation. Do not try to laminate over bevels. Leave 1/8” (3mm) between film edge and frame.

Step 2 - Wetting the Application Surface
Using the sprayer, apply the soapy water solution generously to the application surface until beads of moisture appear on the surface. The solution will act as a lubricant and will not ultimately affect the clarity of the film. If the surface becomes dry before film application, repeat the spraying operation.

Step 3 – Then separate and discard release liner
To separate, it may be helpful to apply cellophane tape to both sides at a single corner and pull apart. Adhesive may appear cloudy when exposed. Clarity will return when installed. To remove the release liner from a very large piece of film, place on wetted surface, with anti-fog side down. This will allow you to strip the release liner without creasing the film. The assistance of a second person may be helpful.
Step 4 - Placing the Film on the Application Surface
Thoroughly wet exposed adhesive with wetting agent. Place the wetted adhesive side on the wet application surface, lining up the factory edge with a straight surface edge. Carefully position the film so that it overlaps the remaining sides. Be sure to handle the film carefully to avoid wrinkles and creases. Both water and air bubbles will be smoothed away during the squeegee process, but creases cannot easily be removed.

Step 5 - Removing Water and Air Bubbles
Spray the entire surface of the film with a soapy water solution to act as a lubricant during the squeegee process. Squeegee the film surface, starting in the middle and working first towards the top and then the bottom. Using short strokes, next squeegee from the center, alternating towards the left and then right sides, beginning from the top-center of the film surface, working progressively down to the bottom of the application surface. Do not go all the way to either side or edge at this time. Apply enough pressure to remove all of the water and air bubbles. Do not try to squeegee the far edges or corners until they have been trimmed.

Allow film to dry overnight or longer. If milky blotches are seen, film is not dry. Allow to dry further. Do not try to trim film unit thoroughly dry. Then use new, sharp razor blade.

Treatment
The Anti-Fog Freezer Film is characterised by easy and uncomplicated treatment.

- About one or two weeks after installation, the technical adjustment of refrigeration can be implemented.
- Approximate three or four months after installation, the glass needs to be cleaned to eliminate residuum of the liquid used during installation.
- Every three to six months the glass needs to be cleaned. The appropriate cleaning equipment (cleaner and cleaning tissue) is included in delivery

Film surface may be cleaned with glass cleaner and wet paper towel whenever necessary. Never use abrasive windows cleansers or pads.
For bathroom mirror installation-every three months or so clean with strong kitchen degreaser (Mr. Clean, Fantastik, Formula 409) to remove build-up of household oils that settle on film surface.
To remove film, slide a razor blade under one corner and peel slowly. If traces of adhesive remain, remove with warm water or rubbing alcohol.
Visgard LTF Film may be laminated to any flat or cylindrical substrate to prevent the formation of vision obscuring fog on freezer door glass. Visgard LTF Film has an optically clear adhesive with a water-clear, protective release liner to protect the adhesive treatment until ready for lamination. There is also a water-clear protective masking on the anti-fog treated side to protect the film during installation.

1. Physical Description:
Available in 2 mil and 4 mil (50 and 100 micron) thicknesses, the true film thickness of the polyester base is actually slightly thinner than the nominal gauge. The adhesive and release liner and masking thickness is additional to the thickness of the base film.

<table>
<thead>
<tr>
<th>Appearance:</th>
<th>Crystal clear and colorless. The removable masking is also clear and must be removed.</th>
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<tbody>
<tr>
<td>Visible Light Transmission:</td>
<td>90%</td>
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<tr>
<td>Tear Strength (initial):</td>
<td>4 mil – 8.4 lbs. (3.8 kg)</td>
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<tr>
<td>Heat Tolerance:</td>
<td>300°F (148.8°C)</td>
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2. Anti-Fog Coating:
The anti-fog is a patented polymer coating which prevents fogging under all temperature-humidity conditions, even after extended immersion in water or repeated cleanings. The Visgard treatment is extremely hydrophilic which causes water droplets to spread, rather than form beads which appear as fog. Although it absorbs moisture, the coating does not dissolve in water, so it will not smudge when wet. Visgard Film is not adversely affected by commercial glass cleaners, detergents, alcohols and gasoline. It will not discolor from exposure to sunlight or heat.

3. Scratch Resistance:
Rubbing lightly with #0000 Steel wool will leave only a few scratches on the Visgard surface. Occasionally, fine scratches will appear but will heal when warmed slightly or when moistened, or after simply standing at room temperature for 15 min. to 20 min.
VISGARD® LTF 200CR ANTI-FOG FILM
TECHNICAL INFORMATION SHEET

The following data were obtained using a Taber abrader with a CS10F wheel and 500g load, according to ASTM D1044:

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<thead>
<tr>
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<th>100 cycles</th>
<th>500 cycles</th>
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<tbody>
<tr>
<td>Uncoated polyester</td>
<td>20% (approx.) Δ haze</td>
<td>66% (approx.) Δ haze</td>
</tr>
<tr>
<td>Visgard coated polyester</td>
<td>5.6% Δ haze</td>
<td>25.5% Δ haze</td>
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</tbody>
</table>

Falling sand abrasion was performed according to ASTM D968 using 3 kg standard Ottawa sand:

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<tbody>
<tr>
<td>Uncoated polyester</td>
<td>30% (approx.) Δ haze</td>
</tr>
<tr>
<td>Visgard coated polyester</td>
<td>1.49% Δ haze</td>
</tr>
</tbody>
</table>

Visgard is superior to all other formable hard coats in Taber abrasion tests and comparable to most non-formable hard coats on flexible substrates. In the falling sand test, Visgard outperforms all other hard coats tested. Bayer abrasion test yield ratios range from 2.5 at 6μ coating thickness to over 6 at 15μ thickness.

4. Anti-Fog Tests:
Test # 1 – The test surface is immersed in distilled or deionized water for 1 hr. and allowed to dry for at least 1 hr. It is then placed face down over a container of warm water (112°F/50°C) so as to completely cover the opening. Visgard coatings may exhibit a ring of condensation as the coating hydrates, but will remain clear thereafter. The test is complete when sufficient moisture has condensed to form large water drops.

Test # 2 – The test surface is immersed in distilled or deionized water for 24 hours, removed and allowed to dry for at least 1 hr. The sample is then cooled in a refrigerator to approximately 40°F (4°C) and withdrawn to a test chamber containing ambient air at 70°F (21°C) and 70 to 80% relative humidity. Material coated with Visgard will remain free of fog indefinitely.

Untreated plastics or glass will fog within seconds. Inferior anti-fog coatings may fog immediately, or remain clear for a short time until they become saturated. Visgard passes ASTM and DIN test for resistance to fogging.
5. Pressure Sensitive Adhesive (PSA):
An optically clear adhesive recommended for use with pressure roll laminating machinery or by professional installers familiar with the handling of adhesive films. Adhesive bonds immediately to glass and plastics. Minimum peel strength approx. per lineal inch after adhesive aging over glass. Increases slightly after 5 to 10 days. Adhesive bond strength will be reduced after extended immersion in water, but bond will re-strengthen on drying. Non-yellowing.

Adhesive bond strength:

- Acrylic/polycarbonate: Approx. 15 oz/in.
- Glass: Approx. 6 oz/in.
- Tack: Approx. 0.20 lbs/ft²
- Sheer Strength: Approx. 200 hours

Minimum application temperature: 30°F (-1°C)

6. Installation With Laminating Machinery:
A clean room environment is recommended when applying Visgard LTF Film with a pressure laminator. If a clean room is not available, dust may be removed with an ionized air gun connected to a supply of compressed air. A film lamination that is free of contamination may be easier to accomplish in two steps. First, laminate a tacky material to the substrate. Then as a second step peel the tacky material as the sheet enters the nip in such a way that the time of exposure to contaminated air is minimized.

7. Installation by Hand:
Where laminating machinery is not available or not practical, Visgard LTF Film may be installed by hand using a wet application technique. For pressure sensitive adhesives, a dilute detergent solution is required to prevent premature "grab" which will trap pockets of air or water. The preferred detergent is 1.0% Chemwet 29 (Chemcor, Inc., Chester, NY) in distilled water. Filter before use. This detergent allows the film to be positioned and then locked in place with light force so it will not shift when squeegee pressure is applied.

Install on a clean (very important) surface which flat, or curved in one dimension only. With the diluted detergent solution, spray the surface to be treated. Separate the release liner from film with cellophane tape attached to the front and back of a single corner. Spray the film surface with detergent solution (so squeegee glides) and apply pressure with a rubber squeegee to evacuate liquid from beneath the film. Use overlapping strokes to prevent trapping pockets of water or air. If milky blotches appear, excess water remained after squeegee. The water will dry in time, and blotches and any distortion will disappear.
8. Care Instructions:
Treated surfaces may be cleaned with household glass cleaner (such as Windex®) and a sponge,
tissue or paper towel. Do not use cleaners which contain moisturizers, abrasives, strong acids, or
caustic substances.

Remove any oily contamination with a grease cutting cleaner, such as Fantastik® or Formula 409®.

To remove film, slide razor blade beneath one corner and lift slowly. Peeling too fast will cause
adhesive to remain on the glass surface. If traces of adhesive do remain, remove with hydrocarbon
solvents (hexane, heptane, mineral spirits) or glycol ethers (Dowanol PM). Rubbing alcohol (50-70%
isopropyl alcohol) can also be used. Plastics should be tested first for solvent sensitivity.

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Formula 409® is a registered trademark of The Clorox Company
Windex® is a registered trademark of the S.C. Johnson & Son, Inc.

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