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WHITE PAPER

Mutoh's Ink Durability Test Program

Factors responsible for the degradation of a print

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In this White Paper

Mutoh's Ink Durability Test Program	**Page 2**
First Test : Abrasion Resistance Test	**Page 3**
Second Test : Chemical Resistance (Colour Transfer After Rubbing)	**Page 5**
Third Test : Outdoor Durability Test of Inks	**Page 7**
Factors Responsible for Degradation of a Print	**Page 11**

Mutoh's Ink Durability Test Program

Testing the durability of an output is a very complex matter. A critical part is the evaluation of an ink's durability. Mutoh has an in-house test program to evaluate inks.

The present document intends to explain in-depth how the durability of an ink is being tested at Mutoh's chemical engineering department.

To be able to evaluate the quality of an ink, you need good outputs.

There are three main conditions for a good output:

1. The selection of media is very important. The media must give good print results in combination with a high ink coverage. Evaluation of an ink type must be done for all colours on the same type of media, because media has its own durability. Durability details can be provided by the media manufacturer.

2. As "test-objects", we use outputs of colour patches, and this with a 100 % CMYK coverage. This is the worst possible case and all possible effects are immediately visible. When testing on a printed image, there is never 100 % colour coverage and colour fading effects will be very difficult to see.

3. Before being tested, outputs are dried for at least 24 hours. Pre-printed media are carefully handled, to make sure that no fingerprints, transfer of sweat or grease can influence the ink tests.

When the outputs are prepared, the ink durability evaluation can begin.

Three different tests are done on every ink type:

1. Abrasion resistance
2. Chemical resistance (colour transfer)
3. Outdoor durability

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Test Instrument:

For testing abrasion resistance and chemical resistance, Mutoh uses a TABER Linear Abraser.

The Linear Abraser incorporates a "free-floating head" which strokes in a linear motion and can test virtually any size or shape specimen.
Adjustable settings enable the user to select stroke length, speed and load.
Interchangeable attachments can be used to convert the instrument from a Wear Tester to a Scratch Tester; a Crock Meter; or to a customised configuration.

FIRST TEST: ABRASION RESISTANCE TEST

Purpose:

Evaluate how a print will react on external factors such as: erosion, wind, sand, friction, "wear and tear", …

Test Method:

We use the linear abraser to make sure that any preprinted media is subjected to the same abrasion. The choice of abradant materials is based upon the wear the specimen material will be subjected to in actual use. The combination between a load and abradant should be run a minimum number of cycles before the end point occurs. If not, the test may be too harsh and may not correspond to normal wear.

Since there are no international standards on testing abrasion of ink on preprinted media, Mutoh chemical engineering defined a set of test parameters of which the effect corresponds as closely as possible to normal wear of preprinted media in actual use. The same test parameters were then applied to all full colour patches to be tested.

The different parameters were set as follows:

1. Abradant (Rigidity or hardness of the head): CS-10 (this is a resilient material composed of rubber and aluminium oxide abrasive particles with a mild abrasive action).

2. Load (pressure) set on the linear abraser's head: 600 g

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3. Operating speed: 25 cycles/min

4. Operating stroke lengths: 3”

5. Test duration (Number of cycles): 5 cycles

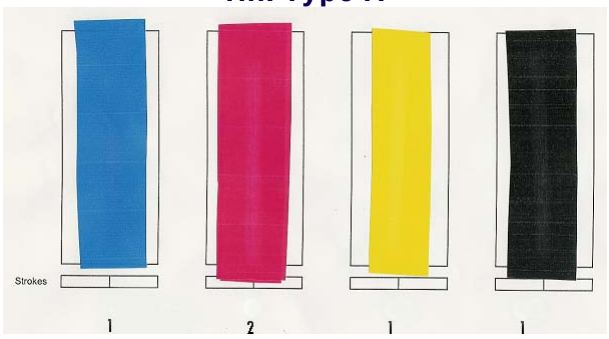
We use a uniform rating to classify the results and to be able to make objective comparisons.

Rating:

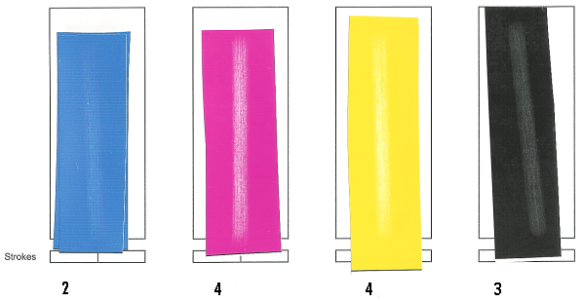
0. No damage
1. Some gloss loss, no colour loss
2. Small colour loss
3. Medium colour loss
4. Severe colour loss

Test Results – Examples :

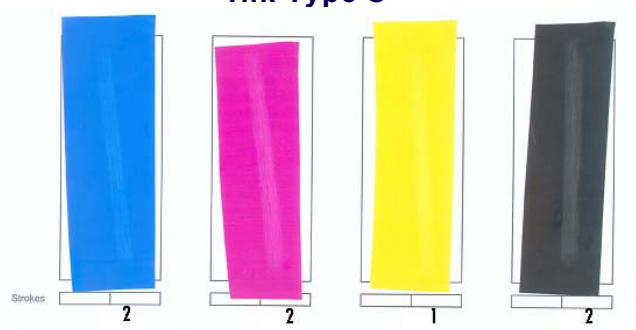
Ink Type A



Ink Type B



Ink Type C



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Conclusions :

1. Ink Type A scores better (Σ 5) than Ink Type B and Ink Type C.
2. Ink Type C scores better (Σ 7) than Ink Type B (Σ 13), but it cannot match Ink Type A (Σ 5).

SECOND TEST: CHEMICAL RESISTANCE (Colour Transfer After Rubbing)

Purpose:

Evaluate the resistance of a print towards rubbing and towards the influence of different chemical substances.

Test Method:

To test colour transfer, Mutoh's chemical engineers use the Crock Test. This test is well known in the textile industry, where it is used to evaluate colour fastness on textile products. This test is conducted in accordance with the ISO 105-X12 standard.

To perform the Crock Test, we use the Taber Linear Abraser.

On the Taber Linear Abraser, we replace the abrasion kit with the Crock Meter Kit. This kit includes a 0.625" acrylic finger, a clamp ring and crocking cloths.
For every test performed, we attach a new crocking cloth with the clamp ring on top of the acrylic finger.
The modified Linear Abraser (with the Crock Meter Kit) is a test instrument fully in conformity with the ISO 105-X12 standard.

Before every test, we wet a crocking cloth in a chemical substance and rub it over the preprinted full colour patches.

Tests are conducted using the following chemical substances:

A. Water: simulating the effects of rain.
B. Water with 10 % soap in it: simulating the effects of a car wash.
C. Acetone: this is a theoretical test to see the effects of a standard solvent (e.g. used in nail polish remover).
D. Isopropanol: simulating the effects of window cleaning fluid.
E. Diesel: simulating the effects of diesel on fleet signs.
F. Gasoline: simulating the effects of gasoline on fleet signs.

We use a uniform rating to classify the results and to be able to make objective comparisons.

Rating:

0. No colour transfer
1. Some gloss loss, no colour transfer
2. Small colour transfer
3. Medium colour transfer
4. Severe colour transfer

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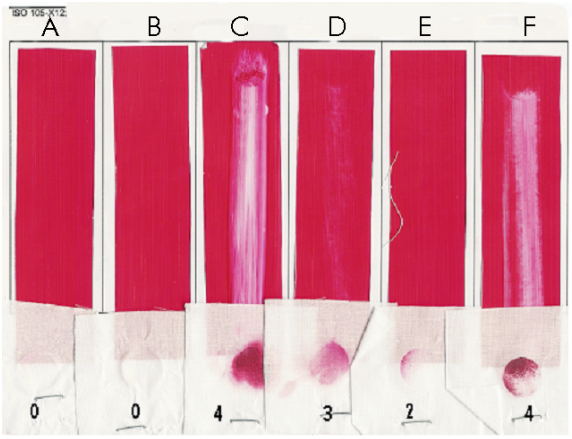
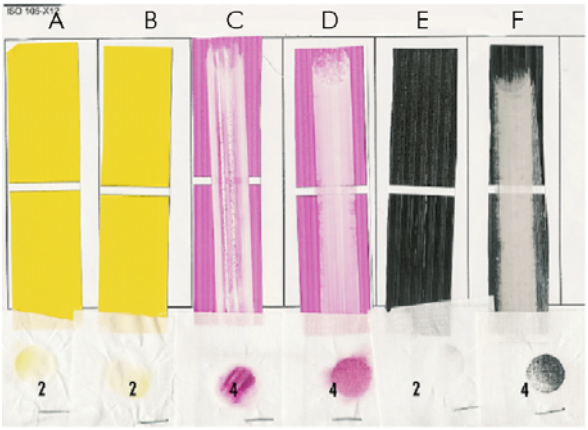
Test Results – Examples :

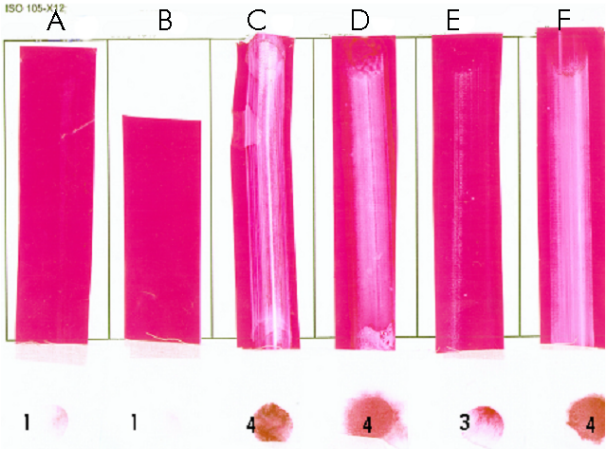
Ink Type A



Ink Type B



Ink Type c



Chemical Substance

A = Water
B = Water + 10 % soap
C = Acetone
D = Isopropanol
E = Diesel
F = Gasoline

Conclusions :

1. Tests indicate that Ink Type A outputs show a good resistance to solvents commonly coming in contact with outdoor prints (water, soap solution, isopropanol & diesel). Outputs that are used in more aggressive environments, e.g. acetone & gasoline, will need protection.

2. The application field of Ink Type B and Ink Type C is more limited. Tests indicate that both inks are vulnerable to the effect of isopropanol, which is commonly used in cleaning agents, washing streets, … Therefore, for these inks in applications where any mechanical stress in combination with wetting is involved (e.g. floorgraphics, fleet, …), lamination is strongly recommended.

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THIRD TEST: OUTDOOR DURABILITY TEST OF INKS

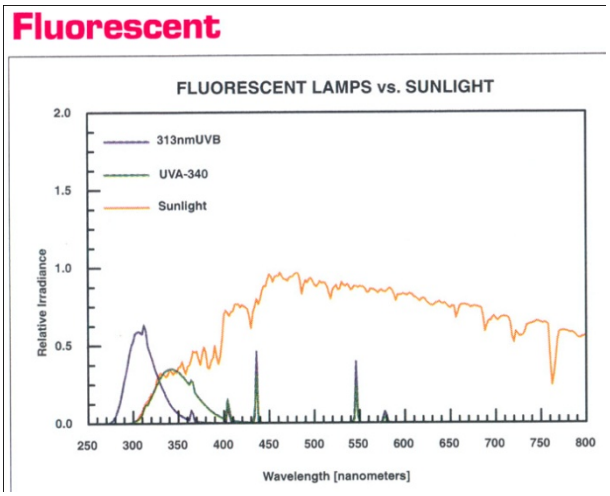
Purpose:

Evaluate the resistance of a print towards the effects of rain and sunlight.

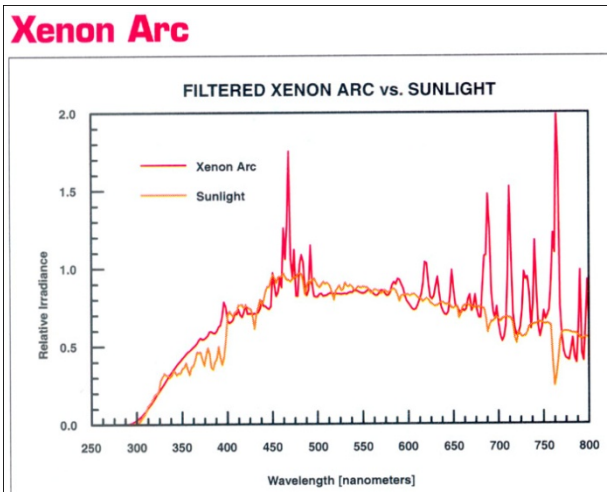
Test Method:

Instrument :

Mutoh uses a Xenon exposure system.
As you will see in below comparison (between UV - Fluorescent lamps and Xenon lamps versus sunlight), Xenon most closely matches sunlight.



UV - Fluorescent lamps are more economical light sources for simulating the relatively narrow UV ranges of the light spectrum. UV - Fluorescent lamps do not produce any of the critically visible and infrared heating effects that are caused by sunlight.



Xenon lamps produce a stable power distribution that closely matches sunlight, providing energy throughout the full spectrum, including infrared. This full spectrum offers a heating effect, especially in coloured materials, that is consistent with heating produced by sunlight. A wide range of filters is available for tailoring the spectral distribution.

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Procedure :

The full colour patches are stuck onto a metal surface and placed into the Xenon exposure system. The Xenon exposure system simulates weather conditions in an accelerated way. The samples are exposed to the effects of rain and sunlight.
The weather acceleration tests are conducted fully in conformity with the Xenon ISO 11341 standard.

Colleration of test results :

Twenty years of comparing accelerated weathering to real outdoor exposure resulted in the conclusion that 1 year outdoor exposure in Central Europe = 2050 MJ/m² (Sunlight).
(In accordance with the standard: Energy = 550 W/m² (UV & VIS = 300-800 nm)

Correlation between accelerated tests and true outdoor durability is not always as evident as it might seem. Accelerated weather tests only simulate UV radiation and rainfall. In reality, prints are also exposed to dirt, corrosion, … . Strangely enough, dirt can also act as a protection for the inks as it also blocks UV-radiation. This means that in reality one should also make the distinction between prints that are cleaned on a regular basis (e.g. fleet graphics) and banners that are hung up outdoors.

The colour balance of an image as such is not only influenced by degradation of the inks, but also by the dirt and dust particles settling down on the printed image.

In the following table you will find the correlation between the amount of hours that the test samples are exposed to the Xenon exposure system and the actual time of exposure to normal weather conditions in Central Europe.

Time in Xenon Exposure System	Actual time in Central Europe
250 h	3 months
500 h	6 months
1000 h	1 year
1500 h	1 ½ year
2000 h	2 years
2500 h	2 ½ years
3000 h	3 years
3500 h	3 ½ years

Explanation of test results :

As indicated earlier, full colour patches are used as test object for evaluating outdoor durability. Below, you can find the result for the colour patches after 250 h, 1500 h, 2500 h and 3500 hours of exposure for the different inks.
Since it is very difficult to visualize the real-life effect of fading based on 100 % colour patches, we selected a colourful image. Based on Delta E colour fading values measured on the full-colour patches after each 500 hours, we simulated the fading effects on a selected image. The results are shown below.

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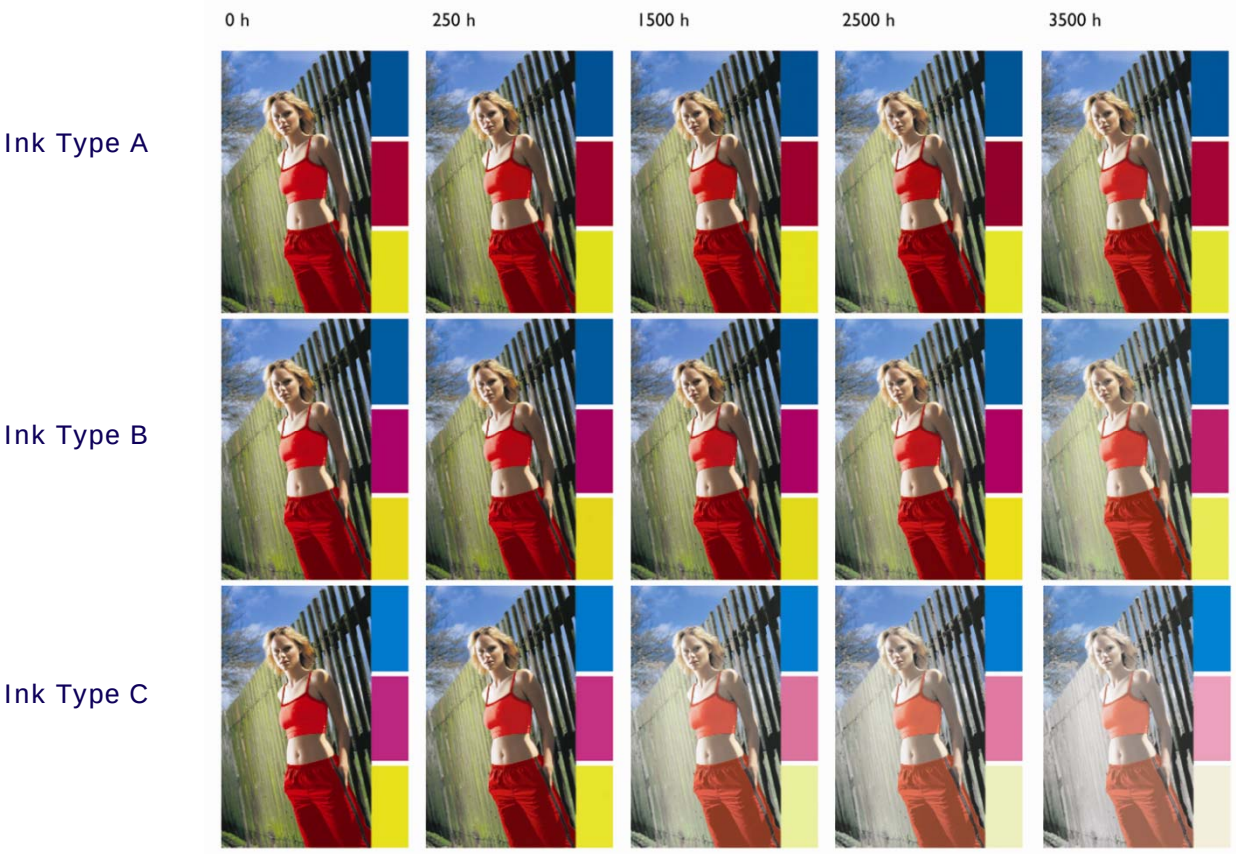
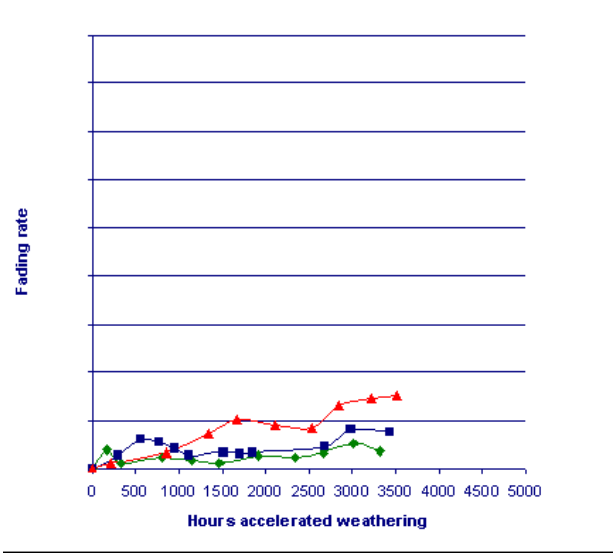
Mutoh's Ink Durability Test Program

Test Results – Examples :



CYAN colour fading :



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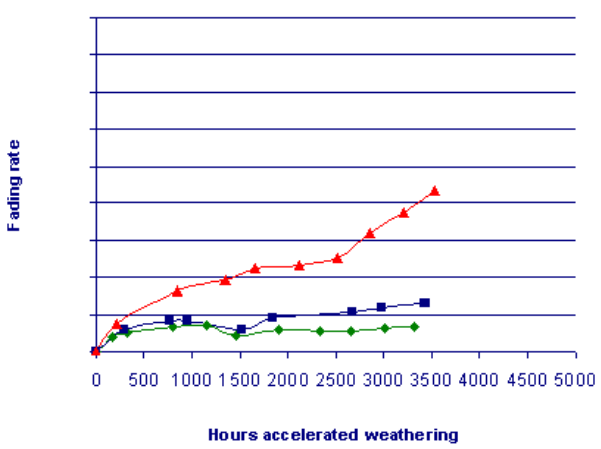
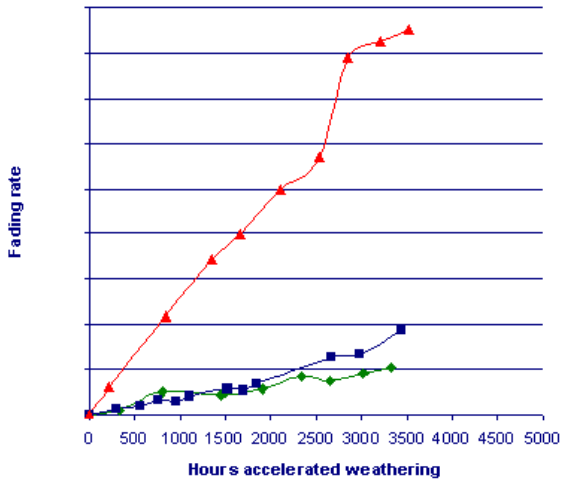
MAGENTA colour fading :



: Magenta Ink Type A
: Magenta Ink Type B
: Magenta Ink Type C

YELLOW colour fading :



: Yellow Ink Type A
: Yellow Ink Type B
: Yellow Ink Type C

Conclusions :

1. The fading rate of Ink Type C for all three process colours is fairly similar to the fading rate of Ink Type A.
   From a fading standpoint, this proves that lamination is not a must if no mechanical stress or abrasion is involved.

2. The graphs make it obvious that the Ink Type A & Ink Type C outperform Ink Type B.

3. Tests on Ink Type B show unacceptable & asymmetric fading after 1250 hours of exposure. Given the fact that for Ink Type B yellow and magenta inks are fading much more and faster than the cyan ink, the colour balance of the output is shifted quite rapidly.

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Factors Responsible for Degradation of a Print

As previously mentioned, testing the durability of an output is a very complex matter. A critical part is the evaluation of ink durability.

At Mutoh Belgium, three different tests are done to evaluate durability of an ink. These are "Abrasion resistance", "Chemical resistance (colour transfer)" and "Outdoor durability".

These tests will provide you a good indication of durability of an ink. Still, we want to point out that in 'real life' other factors will also be responsible for the degradation of the colours of your printed images:

Radiation of the sun is one of the most important factors in the degradation of outside printed media. The sun produces roughly 3 types of radiation, infrared light & visible light (not visible, not harmful for printed media), and UV-light (initiates photochemical reaction with pigmented ink which results in degradation of the colours). Main responsible for degradation of printed media is the UV-light (UVA & UVB). The higher the intensity, the larger degradation will be.

UV-light is filtered through different layers of air, clouds, … this also causes differences in the **amount and intensity of sunlight**.

Moisture is also a very important factor in the degradation process, testing is a necessity. It appears that the material is wet for approximately 8 hours a day. This doesn't always result in a chemical reaction. It causes a mechanical effect. (Moistening – Drying – M – D – M – D- …)

The higher the **temperature**, the faster degradation will be.

The **location** where a print is applied will have effect on the intensity of sunlight, moisture and temperature. Tests at Mutoh Belgium are performed in accordance with Central Europe standards. Prints on another location can be more liable to degradation of the colours. Also the **positioning** of the printed image will have effect on the degradation. Will the image be positioned Northward, Southward, … in which angle will the printed image be used (90°, 45°, …)?

Air pollution is considered to be everything which could have negative effects on all life forms under normal circumstances. That's why field-tests are performed in industrial areas, more than in rural areas.

The **media** on which the image was printed on can influence the degradation.

The **amount of ink droplets** used in the printed image will also have effect on the degradation. The more ink droplets the more resistant your image will be.

Application of the printed image. Will it be used as a window graphic, floor graphic, a vehicle graphic (in front of the car, at the rear, …), billboard, safety sign, building & construction announcement, POS display, …

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In General :

In case your printed image will be exposed to intensive mechanical stress or abrasion, or the outputs will be used in more aggressive environments or in an application where any mechanical stress in combination with wetting is involved (e.g. floor graphics, fleet, …), lamination will positively influence the life-time of the printed image.

About Mutoh Belgium

Mutoh Belgium nv are the EMEA headquarters of Mutoh Holdings Co. Ltd., Japan. Founded in 1991, the company's activities encompass development, manufacturing and distribution of CAD/CAS hardware (professional sign cutting plotters and large-format full-colour piezo printers for CAD, commercial inkjet printing and sign making applications).

For more information on Mutoh, please visit www.mutoh.eu

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