SELF CLEANING PROPERTIES OF POLYMERIC FABRICS

AUTHORS:

K.V. LAMBERT - Vesl Membrane Systems
Fortitude Valley Brisbane

BALA VENKATARAMAN - Seaman Corporation, Wooster
Ohio, U.S.A.

One of the most important requirements for architectural fabric performance is the maintenance of a clean and attractive surface finish in a variety of exposures. This paper discusses research carried out by the authors on exposure samples in Brisbane, and data collected in the U.S.A.

1. INTRODUCTION

High quality polymeric fabrics for use in architectural fabric structures have been in use for over 20 years in the U.S.A. and Europe, and 10 years in Australia.

One of the most important aspects of fabric performance is the ability of the surface to remain clean under a variety of atmospheric conditions.

2. TYPES OF FABRIC

Known fabrics used in the industry for architectural structures can be broadly classified:

- Acrylic top coated PVC.
- Acrylic / Urethane top coated PVC.
- Laminated PVF film on PVC.
- Coated PVDF on Substrate.
- Top coated PVDF on PVC.
- Coated PTFE on Substrate.

The 'work horse' of the industry in terms of frequency of use and numbers of structures in the field is the acrylic top coated PVC.

There are also growing numbers of projects using PVF laminated PVC, PVDF top coated PVC and PTFE fabrics.

3. SURFACE CHARACTERISTICS

There is no recognized protocol for the classification of surface characteristics which affect cleanability. Known factors include:

- Plasticiser migration to surface.
- Chemical reactions on surface.
- Roughness ratio of surface.
- Porosity of surface.
- Electrostatic effects.

In general, the top coat finished surfaces and plain PVC have all the above factors to a greater or lesser degree.

The broadly "non plasticised" films and coatings such as PVF, PVDF and PTFE eliminate some of the above factors, namely plasticiser migration, chemical reactions and porosity.

4. STAINING TESTS

The exact nature of the staining and soiling process is not easily quantified.

Information available on various staining agents and the effects of removal agents is shown in FIG 1.

RESULTS OF STAIN TESTS ON VINYL-BASED FABRIC SURFACES

	Acrylic Topcoated Vinyl		Tedlar ® Laminated Vinyl	
Staining Agent	Cleaning Agent	Result	Cleaning Agent	Result
Alkali - concentrated	2-MEK	A,B,C	1	n/c
Mustard - mild yellow	2-toluene	A,B,C	2-MEK	n/c
Coffee - concentrated	2-MEK	A,B,C	1	n/c
Hydrochloric Acid - 20%	0	n/c	0	n/c
Spray Paint - Sears, black	1	n/c	1	n/c
Blaisdell felt pen - #1100, black	2-acetone	A,B,C,D	2-MEK	n/c
Mark-A-Lot Carter broadpoint pen	2-MEK	A,B,C	2-MEK	n/c
Xerox Toner - #5400	1	n/c	1	n/c
Silver Nitrate - N/10 Reagent	2-MEK	A,B,C	2-acetone	n/c
Gentian Violet - 1% aqueous	2-acetone	A,B,C	2-acetone	n/c
Iodine - 45% tincture	2-MEK	A,B,C	2-MEK	n/c
Mercurochrome - 2%	1	n/c	2-acetone	n/c
Nicotine - concentrated	2-MEK	A,B,C	1	n/c

KEY:

0 = dry cloth
1 = Lestoll* household detergent
2 = Solvent, as noted

A = change in gloss or colour
B = blistering
C = softening
D = special event, i.e., shadow
n/c = no apparent change in surface after cleaning

SOURCE: Tech Bulletin TD-36 DuPont Company

Figure 1. Staining Tests on Polymeric Fabrics

The staining agents are a range of daily use materials which could be applied to work surfaces.

The cleaning method ranges from a dry cloth through household detergent to solvents.

The comparison is acrylic topcoated PVC and PVF laminated PVC. Clearly the PVF film is inert and unreactive to the cleaning agents.

The information available on field tests of architectural fabrics relating to dirt pickup and staining is largely case by case examples and anecdotal data.

5. FIELD EXPOSURE DATA

In 1987, an exposure programme was undertaken by Vesl to give relative and absolute data on the dirt pickup and weathering characteristics of four different fabrics.
These included:

a)	PVF laminated PVC	(DuPont 1 mil Tedlar®)
b)	Acrylic top coated PVC	
c)	Acrylic / Urethane top coated PVC	(Seaman TS116/117)
d)	Acrylic compound top coated PVC	(Seaman PF007)

The four fabrics were welded together in 600mm wide strips and tensioned lightly into steel frames.

The frames were placed on a north inclined roof (15°) in Fortitude Valley, Brisbane.

The choice of 15° was to represent typical areas of fabric structures at a fairly low angle ie. around bases of cones and tops of arch shapes. It also provided a good weathering test sample for long term strength testing.

The environment could be regarded as moderate fallout, with relatively heavy vehicle traffic and fly ash from the Royal Brisbane Hospital boiler house being very evident on the roof at all times.

Although not heavy industrial, the exposure could be regarded as fairly typical of fabric structure exposure in metropolitan areas of Australia.

6. 24 MONTH EXPOSURE RESULTS

The programme was designed to take a panel at 24 month intervals and record the condition of the surfaces, including simulated cleaning of the panel.

The fabrics were all in the range of 8-12% translucency and would typically be used in medium to large tension structures.

Recent exposure of the panel included a high rainfall in April-May 1989, but no significant rain in the period 2 weeks before sample date. The dirt on the surfaces can therefore be regarded as 2 weeks recent fallout, plus the natural weather cycle of the previous 24 months.

Photo 1 shows the 24 month exposure before cleaning tests. The slope of the roof from right to left caused some ponding on the edge of Sample (a), and indicates the level of fallout and washdown over the period.

Photo 1: Test Panel on Roof

The lower edge of Sample (a) is uncoated ie. (bare PVC), and shows the level of soiling of an uncoated PVC compared with the PVF laminated PVC.

Photo 2 shows the same panel viewed from Sample (a) at the top and (d) at the bottom.

Photo 2: Dirt Pickup after 24 Months

In ranking the condition of the samples, Sample (a) was best, closely followed by Samples (c),(d). Sample (b) showed severe dirt pickup and discolouration.

7. SIMULATED CLEANING OF 24 MONTH SAMPLES

Typically, cleaning of a fabric structure only occurs when the owner notices dirt, and is not usually to a recommended programme.

Mild liquid detergents and high pressure spraying and sponging are the usual methods.

In order to confine the cleaned area to a defined track, sponging with clear water was adopted as the test method.

Photo 3 shows the test panel.

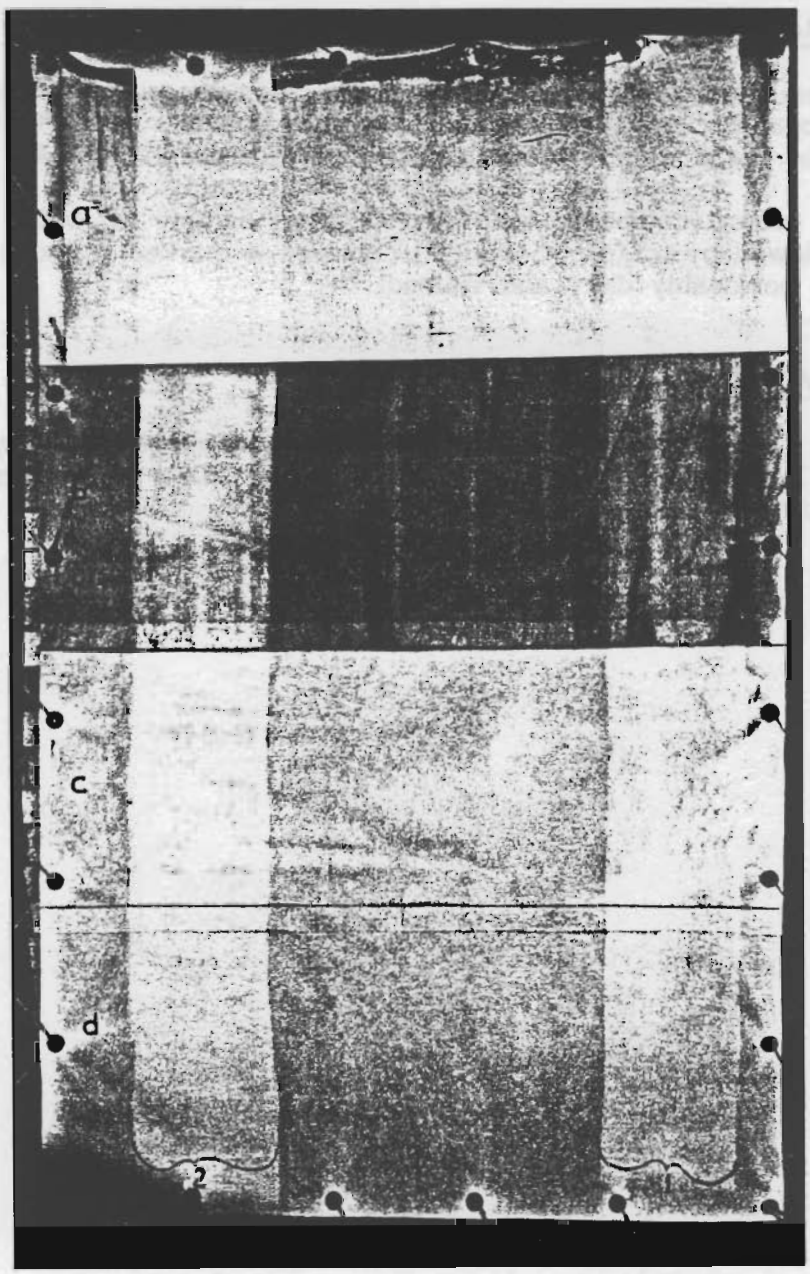

Photo 3:

Simulated Cleaning of Test Panel

Test (1)
Test (2)

A squeeze mop of sponge 250mm wide was wet and two tests conducted:

Test (1): The squeeze mop was passed once with light pressure over each test strip, rinsing after each 600mm.

Test (2): The squeeze mop was passed several times over the fabrics, rinsing several times until no improvement in appearance was gained.

Test (1) Results

The purpose of "one wipe" in Test (1) was to gauge the effect of light cleaning such as with hosing or heavy rainstorm.

The greatest effect was on Sample (a) followed by (c) and (d). The worst effect was on Sample (b) which can clearly be seen in Photo 3. Sample (a) was almost free of dirt.

Test (2) Results

The purpose of this test was to show how clean the surfaces can be made with reasonable cleaning effort, and also to show how much buildup had occurred in the 2 week/24 month period (as discussed earlier).

The least effect [compared with Test (1)] was Sample (a) which was already clean, followed by (c),(d). Sample (b) showed a marked improvement but was still quite noticeably dirty and stained.

8. 24 MONTH SAMPLE TEST SUMMARY

In putting the foregoing results in perspective, a matrix has been constructed on Photo 3, ranking the surface condition, on a scale of 0 (clean) to 20 (very dirty). This is shown in FIG 2.

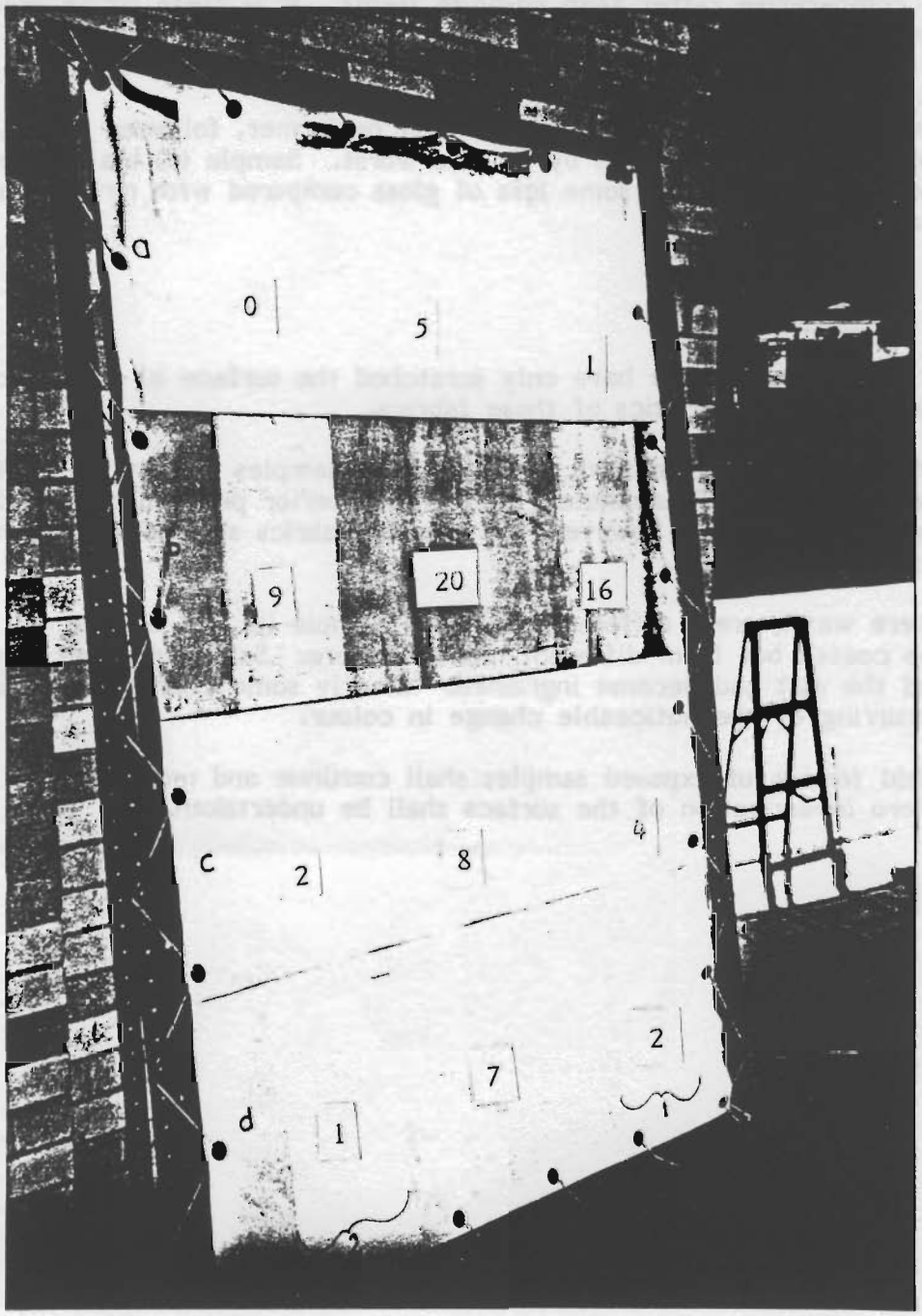

FIG 2. Ranking of surface condition 24 month exposure

The above ranking system is to a degree subjective, however it is objective in comparative rather than absolute terms. It is clear which areas of the test samples are cleaner than others, so a comparison is possible but (eg.) it is not certain that Sample (b) is 20 times as dirty as cleaned (2) Sample (c).

Overall, Sample (a) clearly is the best performer, followed by (d), then closely by (c), and Sample (b) is by far the worst. Sample (d) maintained a high gloss, and (c) showed some loss of gloss compared with new samples of like material.

9. CONCLUSION

It is certain that we have only scratched the surface of the topic of self-cleaning characteristics of these fabrics.

The broad conclusion from Vesl field test samples is that after 24 months exposure, the PVF laminated fabric has superior performance to like acrylic top coated fabrics, however, the cleaned fabrics showed far less variation (except Sample (b)).

There was a great difference between Sample (b) and Sample (c), both acrylic top coated but from different manufacturers. Sample (b) had lost all gloss, and the dirt had become ingrained. Clearly some chemical reaction was occurring by the noticeable change in colour.

Field testing of exposed samples shall continue and more detailed micro investigation of the surfacs shall be undertaken.