# Waterborne paints for exterior use. The connection between the resistance to blocking and the film extensibility

Alessia Matellon

*January 2020*

Wood coatings play two basic roles: one is aesthetical as they improve the surface appearance enhancing the wood substrate pattern; the other is protective since wood is sensible to water, light, micro-organisms, insects and other factors and consequently needs surface treatments in order to improve the service life of wooden products.
Speaking about coatings for exterior use, one of the main properties they must develop after drying is the extensibility of the coating film.
Wood is subject to dimensional changes in consequence of the effect of humidity and water in general. These changes vary from wood specie to wood specie, but they last for all the life of the finished product depending on the climatic conditions where it is placed.
The EN 927-1 standard contains a guideline to classify paints and varnishes for outdoors in function of the final destination of the finished product.
The classification of the product as “stable”, “semi stable” or “non-stable”, is determined by the dimension variability allowed (see table 1). For example, garden furniture and windows need such a significant dimensional stability, as minimum movements are allowed.

| End-use category | Permitted dimensional movement of wood | Typical, non-exclusive examples of end-use categories |
|---|---|---|
| Non stable | Free movement permitted | Overlapping cladding, fencing, garden sheds, open cladding ventilated rain screen |
| Semi stable | Some movement permitted | Tongue and groove cladding, sound absorbing barriers, timber framework |
| Stable | Minimum movement permitted | Joinery such as windows and doors, shutters, garden furniture |
| **NOTE**: **These examples are for demonstration only. Some wooden constructions will overlap these categories.** | | |

*Table 1. Classification by end use given by the EN 927-1 standard.*

However, a real sealing with stiff and impermeable coatings could represent a risk. In fact, it is important that during all the life of the finished product the coating film maintains a certain flexibility allowing a certain dimensional change of wood due to accidental factors or in consequence to prolonged humid or dry periods.
This flexibility can avoid or reduce the formation of possible cracks, which may cause, as well as aesthetical defects, the loss of that protection the wooden product needs.

Another important property the applied coating must possess is the blocking resistance.

*Definition of* **blocking**: *unwanted adhesion between two surfaces, at least one of which has been coated, when they are left in contact under load after a given drying period.*
*(Source: CEN/TS 16499)*

Let’s imagine opening the window shutters after a particular hot day and to force such elements because they are interlocked. After the opening you find also a slight damage on the surfaces which were in contact: this means blocking.

# Waterborne paints for exterior use. The connection between the resistance to blocking and the film extensibility

Alessia Matellon

These two properties of the coatings, the ability to follow the movements of wood (extensibility) and the resistance to blocking, tend to be opposite and therefore a certain compromise is required in the formulation of these products: a highly flexible coating, usually shows some problems with blocking resistance and vice versa.

I have recently studied this controversial effect, even if it is not a new subject being frequently considered in the formulation and testing of exterior wood coatings.

Three different waterborne top-coat products have been studied. They were produced combining three different resins, varying the relative amount. The resins used had same MFT (minimum film-forming temperature), but different extensibility behaviour; the compositions contained the same additives.
We called "A" the medium flexible resin; "B" the most flexible resin and "C" the less flexible one.
In the following table a scheme of the formulation is reported:

| | Resin content (%) | | |
|---|---|---|---|
| | Formula 1 | Formula 2 | Formula 3 |
| Resin A | 40 | 40 | 45 |
| Resin B | | 21 | |
| Resin C | 21 | | 16 |

*Table 2. Formulation scheme.*

Liquid products have been applied at 300 μm wet film thickness. For the extensibility test the products have been applied by the use of a film applicator on PET plates and for the blocking resistance test by spraying on poplar plywood panels.

The extensibility test was carried out on bone shaped specimens according to ISO/DIS 37: 2015-07, S2, by a dynamometer equipped with a video extensometer at 100 mm/min speed. The specimens have been conditioned at 20±5 °C e 65±5% r.h. for a period of 28 days. The mean values of 10 specimens have been calculated.
The blocking test was carried out according to EN 927-10 as follows:

- Three couples of 150x50 mm specimen coupled with the contact of the coated face;
- After 24 hours form the final coat at 23±5°C e 50±5% r.h. and after 5 days at 50±5 °C in oven;
- A 1N/cm$^2$ load was applied on the piled specimens.

| | Mean elasticity modulus (MPa) | Mean elongation at break (%) | Blocking at 50°C |
|---|---|---|---|
| Formula 1 | 479 | 16 | a1-d2 |
| Formula 2 | 537 | 45 | a1-d4 |
| Formula 3 | 551 | 68 | a2-d3 |

*Table 3. Test results scheme.*

# Waterborne paints for exterior use. The connection between the resistance to blocking and the film extensibility

Alessia Matellon

*Blocking results key*:
*a=effort necessary for detachment;*
*d=visual evaluation of the faces after detachment.*

*0=no adhesion of the specimens/no defects are visible*
*1=slight adhesion of the specimens, no effort necessary for detachment/slight surface changes (e.g. change of gloss or colour)*
*2= slight adhesion of the specimens, slight effort necessary for detachment/moderate surface change*
*3=blocking- strong adhesion of the specimens/considerable surface changes*
*4= blocking- strong adhesion and maximum effort needed to detach the specimens/considerable surface changes and slight film tear-off*
*5= blocking- Specimens have adhered together, impossible to separate them by hand/considerable surface changes or impossible to evaluate because of the adhesion of the specimens.*

The test has been focused on two parameters: the elongation at break (as percentage) and the elasticity modulus (called also Young modulus in MPa, being the ratio of strain and deformation).
Only the results of the blocking test at 50°C after 5 days from the last coat application have been considered because the test carried out at room conditions was the same for all the variants (a0; d0).

The results show the big influence of the kind of resin used for the formulations.
While the Young modulus is similar for the three formulas, a significant difference has been observed for the elongation at break.
The formula n. 3, showed the lowest resistance to blocking since a flexible resin is prevalent.
On the contrary, the formula n.1 is the best in blocking resistance but the film seems to be the less flexible.
In conclusion this little study has clearly shown the inversely proportional behaviour between the extensibility property and the blocking resistance of the coating films.
Moreover, it is interesting to note how the reference standards give objective evidences that might be useful for coating manufacturers on the formulation of the products in line with market needs.

I would like to warmly thanks the company Nuova Sivam S.p.A. and their collaborators for the formulations supplying and for the sharing of the information related to the products.

**For info**:
Alessia Matellon
+39 0432 747232
matellon@catas.com