



Significance of Raw Material in u-PVC Profiles
for
High Quality Weathering Results



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Raw material specification in u-PVC profiles

uPVC is extensively used around the world as the "new age" building material. It looks elegant and can be cut to suite different architectural styles

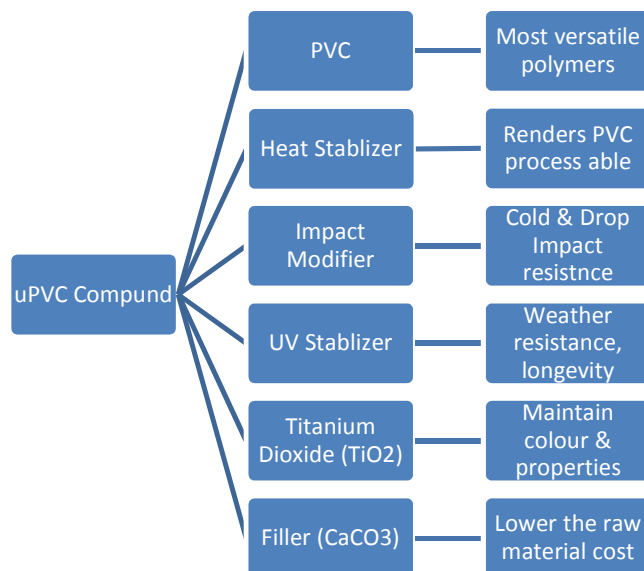
What is uPVC ?

UPVC is based on polyvinyl chloride (PVC), one of the most versatile polymers found in the century. PVC today finds application in almost all facet of our life, from daily use to highly sophisticated lifesaving applications. UPVC is prepared with a special formulation in which modifiers and stabilizers are added to polyvinyl chloride (PVC) making it rigid and suitable for use as window frames.

UPVC (where 'U' stands for unplasticized) is one of the most preferred window framing material across the world. The material comes in a range of color, is low maintenance and offers benefits which no material so far has matched.

uPVCprofiles contain the following components

- Major part is PVC Compound – Petroleum by product and salt
- Heat Stabilizer
- Impact Modifier
- UV Stabilizer
- Titanium Dioxide (TiO₂)
- Color Pigment
- Lubricant & Processing Aids



Dry Blend (Formulation Mix)

- It is in powder form
- Mixture of PVC and additives in desired ratio
- It is made without adding any plasticizer, we called it as uPVC blend (Unplasticized)

Stabilizer

- The job of Stabilizer is to heat degradation, so that compound can be formed in a product before degradation takes place
- Stabilizer in profile extrusion is used mainly to process the pvc through the hot hostile environment of the extruder.

Filler Caco3

- Normally Caco3 is used in PVC compounds to lower the raw material cost of finished goods
- Extruder barrel and screw wear are affected by the amount & particle size of the Caco3
- Caco3 serves no useful purpose in PVC except to reduce compound cost and act as filler

Tio2

- Whiteness and tone
- Achieve brilliant aesthetics
- Durability for lasting protection
- To achieve opacity in non-weather able compounds
- UV Protection in weather able compound & to achieve given colour

Processing Aids

- The most common processing aids used with PVC are acrylic polymers
- A process aid can reduce or increase melt viscosity, increase frictional heat & reduce uneven dir flow. In a compound, it promotes fluxing and acts like an internal lubricants.

What is Weathering Test in u-PVC profiles ?

- **Weathering phenomenon:**

All materials located outdoors are exposed to direct or indirect sunlight which partially consists of UV radiation. If an unpigmented PVC part is exposed to UV light, this radiation soon damages the molecular structure of the PVC, thus causing yellowing and a deterioration in its mechanical properties.

If the sufficient pigment (TiO₂) is added in the PVC formulation then TiO₂ pigments absorb the high radiation of UV Light and they control the PVC degradation due to which uPVC profile maintains its color stability, brightness & surface finish for a longer outdoor exposure.

System companies always focus on that part and for this they take care in selection of raw material & evaluation of profile properties as per norms.

As a system company profile have also selected below listed world leader companies with their grade name for supply of Titanium dioxide for uPVC profile production in India to ensure better UV properties.

KRONOS EUROPE
HUNTSMAN CORP.

KRONOS 2220
RTC-30

designed for Hot climate
designed for Hot climate

- **Weathering types:**

Two different types of weathering tests are used for evaluation of weathering resistance of uPVC profile against harmful UV Radiation.

Outdoor Weathering Test

The most meaningful results from weathering tests can be expected only when the test objects are exposed to conditions which approximate the actual stresses in practice. Outdoor weathering tests can, however, be very time-consuming and, in some cases, last up to 10 years.

Outdoor exposure is the only way to study the weathering behaviour of a PVC compound under real ambient conditions. In this context, the samples are generally positioned to face south at an angle of 45°, thus exposing them to maximum sunlight, fluctuating temperatures by day and night, precipitation and harmful gases, such as Ozone and SO₂.

Arizona & Florida are such locations where worst atmospheric conditions are applied on the product surface like warmest temperature over earth, humidity & pollutants during outdoor exposure.

In the above said locations profile has tested their product against outdoor weathering resistance so the Quality of product gets more strength among other profile suppliers.

Many profile companies in India have not tested their formulation as per above criteria of outdoor exposure due to unavailability of technical details but in profine we have tested our formulation as the outdoor exposure of window formulation is the best possible way to guarantee the discoloration resistance.

Accelerated Weathering Test

Processes which employ radiation in the wavelength range below 400 nm (UV-A), and which are more intense than sunlight and guarantee adequate humidity, are suitable for the accelerated weathering of PVC pigmented with Titanium Dioxide (TiO₂). The degradation of the polymer matrix is accelerated by radiation below 315 nm (UV-B).

As in practice uPVC profiles show discoloration due to cracking of bonds between PVC molecules due to photo degradation caused by harmful UV radiation of sun light.

Due to photo degradation of PVC molecules uPVC profile gets yellow and also the mechanical properties get low.

During accelerated weathering test we can apply more severe condition in test chamber over profile specimen to evaluate that formulation used for profile production is approved and can protect PVC molecules from photo degradation caused by UV radiation.

Depending on the task & test standard various types of Accelerated weathering test are available-

1. Xenon Arc / Carbon Arc Weatherometer
2. Xeno Test
3. Sun Test CPS+

As per System Company and with enriched experience, profine Germany has facility for Xenon Arc/Carbon Arc Weatherometer for in-house evaluation of profile sample for any changes in raw material to strengthen the end product Quality. For product certification, samples are passed through Xeno Test with severe climatic condition in coordination with most trusted institutions of Germany & UK.

- **Radiation dose exposure time for accelerated weathering & required test results**

Scope

Below is the procedure to calculate the duration of the exposure needed to assess resistance to moderate (M) and severe (S) climates to be used for artificial weathering.

Calculation

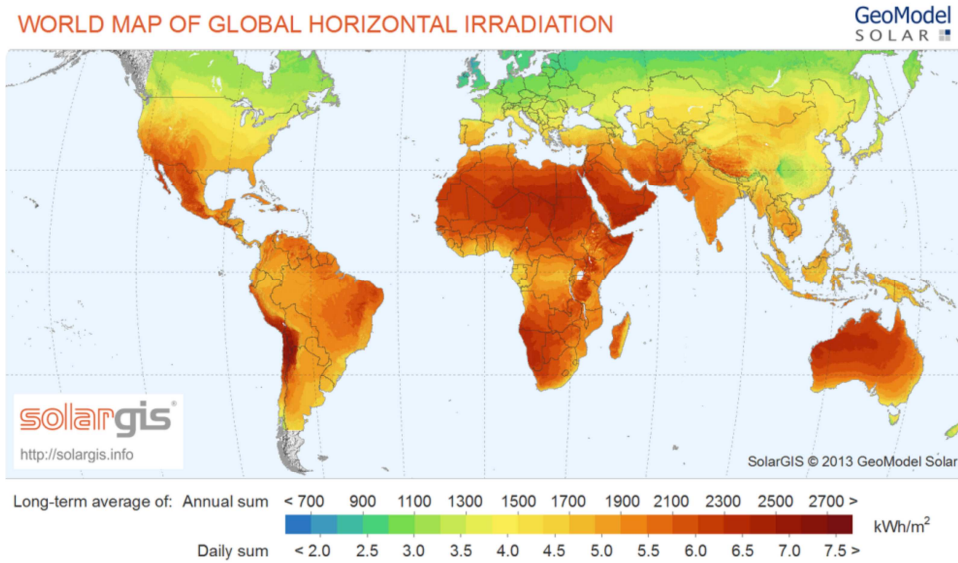
The climatic zones are classified in terms of the annual solar energy falling on a horizontal surface and the average temperature of the warmest month per year.

For the purpose of this calculation the following assumption is made on the annual solar energy:

- For moderate climate the amount of solar energy is estimated at 4GJ/m2/Year
- For severe climate the amount of solar energy is estimated at 6GJ/m2/Year

Other factors

- Radiation doses for the wavelength range between 300 nm - 800 nm
- 60% of total solar energy
- 67% correction factor for higher summer temperatures



	EN12608	EN12608
	Moderate	Severe
Long term average (kcal/cm ²)	94.65	142.83
Long term average (kLy Langley)	94.29	142.29
Long term average (kWh/m ²)	1100	1660
Long term average (GJ/m ²)	3.96	5.98
Radiation doses (GJ/m2) 1 year	1.59	2.40
Radiation doses (GJ/m2) 5 years	7.96	12.01
Exposure time (hrs) 1 year equivalent	804	1213
Exposure time (hrs) 5 years equivalent	4020	6067

Test Parameter & Target Results

Test Procedure-

Artificial weathering according to (DIN) EN 513 ,procedure 2 (simulation of a severe climatic Zone S) up to an irradiation dose of 12 GJ/m² in the wave length range between 300 nm - 800 nm.

Weathering device	-	XENO TEST BETA LM
Light Source	-	Xenon Arc
Black standard temperature	-	65 +/- 3 C
White standard temperature	-	45-50 C
RH%	-	65 +/-5%
Spray cycle	-	6 min water spray ,114 Min Dry cycle

Target Results

- **Colorimetric Assessment**

As per DIN EN ISO 11664-4 ,colour distance delta E* between weathered and un-weathered sample shall not be larger than 5 and colour distance delta b* shall not be larger than 3

- **Visual Assessment**

As per DIN EN 20105-A02 by using grey scale weathered sample should reach the fastness grade 3

- **Resistance to Weathering**

As per DIN EN ISO 179-1/1fA:2010-11 after weathering charpy notched impact strength of weathered sample shall not drop more than 40% compared to the value of the un-weathered samples.

Raw Material Specification & Role of Tio₂

Due to photo degradation of PVC molecules from UV Radiation unpigmented or usage of less superior grade of pigment, product face discoloration issue and also their mechanical properties get low.

While using superior grade of pigment the pigment particles act as barrier between pvc molecule and sunlight, also pigment particles reflects some harmful radiation so they save product Quality in terms of color stability, brightness and smooth surface of product.

Better/superior Grade of TiO₂ have the below listed properties to show maximum UV properties against outdoor Exposure

- Opacity for reliable hiding power: TiO₂ pigments helps to optimize their light scattering performance to deliver excellent opacity.
- High Amount of UV Screening to block harmful UV radiation.
- Very High resistance to discoloration
- Exceptionally good weathering Resistance
- Excellent dispersibility
- Very Good Rheological properties

Profile face listed defects on usage of inferior pigment (TiO₂) grade:

- Inferior grade of pigment (TiO₂) saves product life for shorter time interval but after this pigment particles get degrade and they also increase photo-degradation in uPVC profile which causes discoloration in out door exposure.
- Inferior grade of pigment (TiO₂) or low quantity in formulation shows degradation on profile surface which is called “**CHALKING**” which leads to slow discoloration and low gloss in profile and also the surface gets rough during out door exposure.
- If uPVC profile is Lead stabilized then pigment particles react with Lead metal and generate grey/pink spots on profile surface which is called as “**pinking phenomenon**”

System companies liked profine which have vast experience in stabilizer product never use Lead based stabilizers for producing uPVC profiles.

In profine we use Ca-Zn based stabilizers which are more compatible with pigment (TiO₂) so that they never produce byproduct which initiate photo degradation in PVC. Hence the profiles are more resistant to UV radiation and perform well in out door exposure.

Why Koemmerling as Most Preferred brand in India?

A short overview that why Koemmerling is superior among other products and serve for long in terms of Functionality & Quality.

- Selection of Raw material based on detailed R&D.
- R&D selection is based on profile internal Raw material typical specification which is passed by only well balanced raw material producer.
- Self evaluation on Raw material quality before it is used in production of final product.

- Well set up in-house weather-ometer station to find the product out door performance with optimized pigment (TiO₂) doses.
- Strong formulation control to maintain the raw material support in the final product.
- Analysis of Raw material content in final product after fixed time interval so the final product always maintain Quality at user end.
- Weathering evaluation of product in artificial & out door weathering exposure way of testing.
- All products produced as per norms of EN12608 but even after this profine has internal guidelines for raw material approval so there is double check system on product Quality.
- Profine brand are certified by world's leading certification agencies for trust in services.

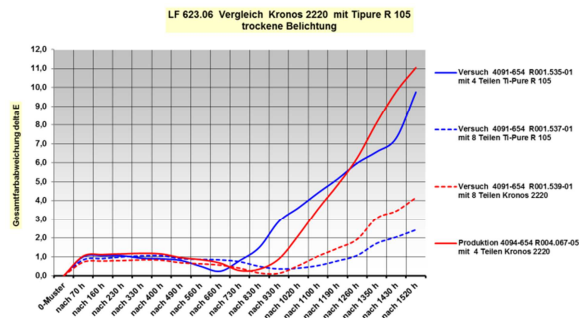
SKZ Germany - largest plastics institute in Germany, which offers practical solutions - tailored exactly to customer requirements. For more than 55 years serve as a partner for plastic industries.

BSI UK – The world's leading certification institute for implementation of Quality management system

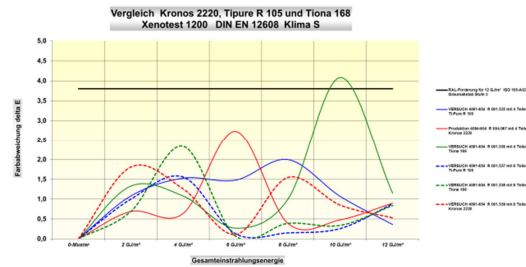
- In addition, as profine we also have self certification for our product system, where we are evaluate our own product by self R&D set up. Thus we are more confident on product quality during outdoor exposure.
- As a system company profine fulfills all the aspects of customers by self evaluating their product . We are doing third party certification only for customer prospects as with our own set up we are able to deliver Quality products to the end user by knowing & removing the product defects.

Procedure of raw material selection

- Raw material is checked based on profine internal specification.
- All the raw material is tested for mechanical & chemical evaluation.
- Profile produced with new raw material is passed through internal evaluation of weatherability and graphical representation is recorded for product quality parameters as per below



GRAPH -1

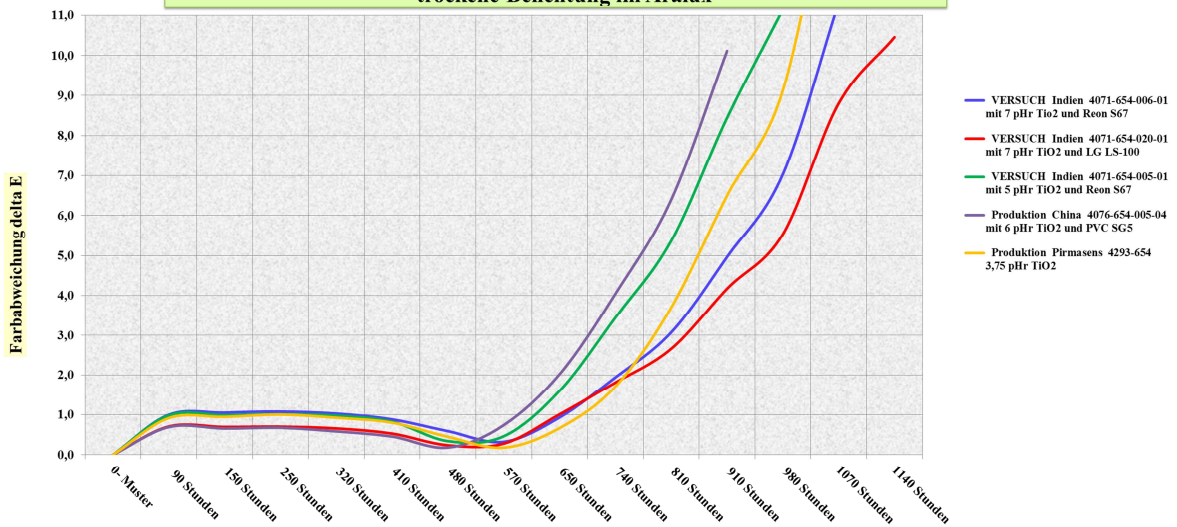


GRAPH-2

Significance of Graphs:

- In Graph-1 profile sample are passed through Aralux weathering test ,with different Titanium grade profile samples.
- The only superior grade of titanium di-oxide is selected based on weathering performance to guaranteed the Discoloration stability of profile.
- In Graph -2 profile sample are passed through Xenon Beta test ,with different Titanium grade profile samples.
- The only superior grade of titanium di-oxide is selected based on weathering performance to guaranteed the Discoloration stability of profile.

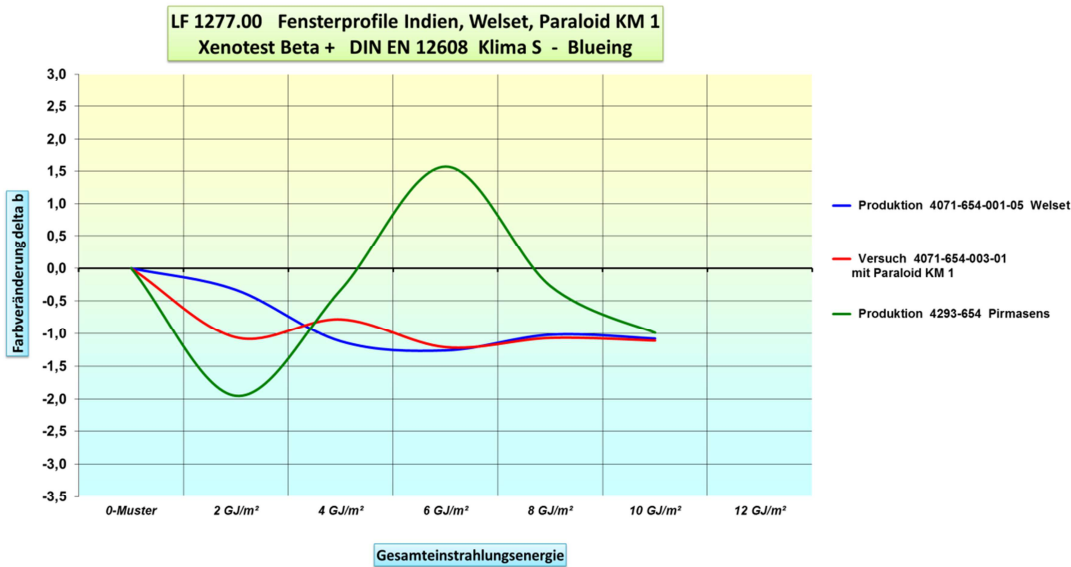
**Laborauftrag LF 1335.00 Extrusion Indien, LG LS 100, Calplex OT, Formolon
trockene Belichtung im Aralux**



GRAPH-3

Significance of graph:

- In Graph -3 New grade of PVC Resin are tested under Aralux weathering test ,to judge the end product weathering stability.
- New grade of Raw material are tested in comparison to standard formulation & also with respect to Germany based formulation & only after getting equivalent results the Raw material grade are used for profile production.



GRAPH-4

Significance of graph:

- In Graph-4 ,Raw material are tested for Xeno Test as per DIN EN 12608 for weathering stability of profile sample produced with new grade of Raw material.
- Profile sample tested in comparison to standard raw material and German compound and after getting equivalent weathering results or more superior test data then only new grade are inserted in the profile production.

External Evaluation or Third party certification of Product Quality for Koemmerling tested profiles:

As a system company profine has it's in-house strength for product certification to maintain product internal Quality beyond customer expectation. To fulfill the end user requirements we have certified our product every year with external sources to show the product superiority in terms of weathering resistance & color fastness and we have achieved superior results among other suppliers due to well controlled formulation.

See the below results from SKZ Germany for accelerated weathering

- Color fastness – as per EN12608 ,color fastness in terms of delta E* <5 and delta b* <3
Profine sample tested for 6000 hours and get the outstanding results among all Indian competitors and product show out standing stability.

Colour coordinates	Sample as supplied	Sample after weathering	Colour distance
L*	94.9	95.0	0.1
a*	-0.8	-0.7	0.1
b*	1.1	0.7	-0.4
Colour distance ΔE^*_{ab}			0.4

- Weathering resistance – as per EN ISO 179-1/1fc the charpy impact of weathered sample should not fall more than 40% compared to un-weathered sample.

Profine sample tested for 6000 hours and fall in charpy impact strength was even negligible among other profile company due to well maintained formulation.

Samples corresponding to DIN EN ISO 179-1/ 1fA (notch base radius 0.25 mm)				
reference sample (unweathered)		weathered sample		amendment %
\bar{x}	s	\bar{x}	s	
72.6	0.4	71.5	0.6	-1.5
10 x non-break (N)		10 x non-break (N)		

\bar{x} = mean value s = standard deviation

- Visual assessment – As per EN ISO 20105-A02 the weathered product should not show value below 3 when measured on grey scale.

Profine sample easily achieve fastened grade 4-5 which is show that product not passed for any discoloration issue even after 6000 hours severe UV radiation exposure.