SOLAR KEYMARK SCHEME RULES

ANNEX L. Coloured glazing families for flat plate collectors

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Background
Some manufacturers offer coloured glass (different procedures are possible) to be used as collector covers. Different technologies are available (printing, dying, coating, etc.). To use these glasses in Solar Keymark Collector families the following procedure is proposed to be adopted as part of the Solar Keymark Scheme rules:

Coloured glazing families – Flat plates

1.) General Rules
If the manufacturer produces the same collector with coloured cover glasses (i.e. the only difference between two collectors is the colour of the glass) the collectors can be considered as the same subtype (within the same collector —family) under the following conditions and procedure. The procedure is applicable to any colouring technology, however only one colouring technology can be used within one family. Independent of the colouring technology the glass structure must be the same within the whole family.

2.) Step1: Determining the range of solar transmission of the covers

2.1 Coloured Glass: The solar transmission of at least two glasses shall be measured using a simple device as described in Figure 2. The two samples shall represent the highest solar transmission τ_{max} and the lowest solar transmission τ_{min} of the family. If for any reasons it is not evident which samples represent minimum and maximum solar transmission, then additional samples shall be measured. The results shall be reported in a test report together with photographs of the measured samples. The manufacturer shall provide a description of the range of colours, and the test lab shall confirm in the test report that the measured transmission values cover that range of colours.

2.2 Printed pattern glass: If the coloured coating itself is considered as non-transparent and "transparency" is achieved by printing dot patterns (or any other regular patterns), then the maximum allowed coverage factor κ shall be defined where

$$\kappa = \frac{Printed\ area}{Complete\ area}$$

Examples: κ = 1 means that the whole surface is printed κ = 0 means that there is no printing at all. κ = 0.3 means that 30% of the surface is covered by some colour.

The transmission of a sample with κ = max using the darkest available printing (e.g. black) shall be measured using the device described in Figure 2 to give the minimum solar transmission of the family τ_{min}. Furthermore, the transmission of a sample with κ = min using the lightest (e.g. white) available colour shall be measured to provide the reference maximum solar transmission τ_{max}. The measured transmission values shall be reported in the test report. The shapes of the printed pattern shall be described in the test report together with the maximum coverage factor κ.

2.3 Edge coloured glass:

For edge colouring (i.e. the glass is only coloured in the edge region) the transparent area A_T of the collector is determined:
- For clear edge colouring, a simple geometrical consideration is appropriate.
- For soft edge colouring a reasonable geometrical consideration to determine a virtual A_T shall be defined by the test laboratory. A suitable approach would be to determine the area $A_{T,Clear}$ where there is no colour at all ($A_{T,Clear}$=Red dashed line in Figure 1, middle), then to define $A_T = (A_{T,Clear} + A_{T,Unprinted})/2$, where $A_{T,Unprinted}$ is the transparent area of the collector when using a glass without any printing.

In all cases the transparent area A_T shall be reported and explained in a test report.

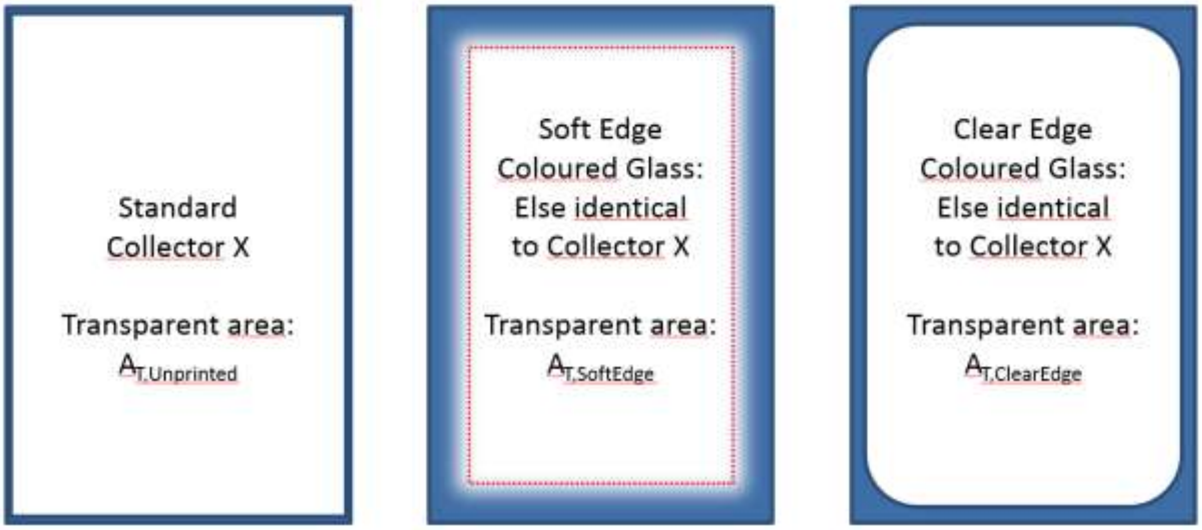


Figure 1, Edge Printing: Left: unprinted.
Middle and right: typical examples of edge coloured glasses

The minimum transmission $\tau_{min} \leq 1$ is defined using these areas:

$$\tau_{min} = \frac{A_T}{A_{T,Unprinted}}$$

If the transmission of a certain edge printing pattern has to be defined for a family of different collector sizes A_i, or for a family of different edge printing shapes, then the transmission shall be defined as the minimum value of all the sizes/shapes of the family: $\tau_{min} = min(\tau_{min,i})$.

3.) Step 2: Building families

Case A: The coloured glasses are extending an existing Solar Keymark certificate of collectors with uncoloured glass (family or single collector), meaning that there are already a valid performance test result for uncoloured transparent glass and a passed durability test available. A representative collector of the existing family is produced using the glass with the lowest measured solar transmission τ_{min}. No random sampling is required. This collector is tested for Exposure (ISO 9806:2017, Clause 10 under the same climate class as already certified) and shall not show any major failure according to Clause 17 of the ISO 9806:2017.

One of the following procedures shall be used to determine the thermal performance parameters:

<u>Procedure A1</u>: The thermal performance parameters applicable for the whole family are recalculated using the following formula

$$\eta_{0,colour} = \eta_{0,Keymark} \frac{\tau_{min}}{\tau_{max}}$$

where τ_{max} is usually the transmission of the unprinted glass (for edge printing $\tau_{max} = 1$).
All other performance parameters including IAM and thermal capacity remain unchanged.

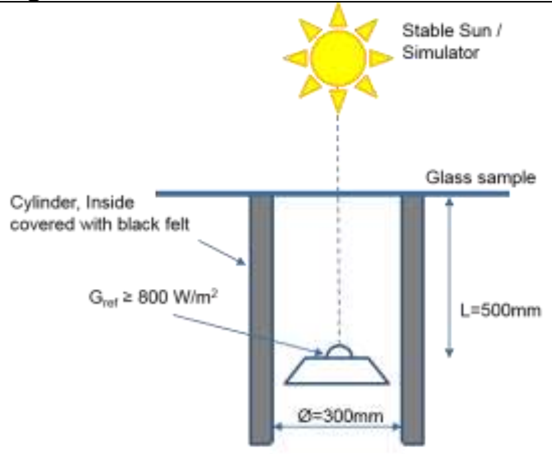
OR

<u>Procedure A2</u>: The thermal performance parameters are measured on a sample collector, which shall have the same size as the collector that was used to determine the performance data for the existing Solar Keymark. This collector model is rebuilt using the glass with the lowest measured solar transmission τ_{min}. The measured collector performance parameters are then the thermal performance parameters for the whole family.

For both procedures, the incidence angle modifier and heat capacity parameters are not measured again but can be taken from the existing Solar Keymark family.

Case B: New Solar Keymark, no collector measurements are available and the colour of the glass is the main family characteristics. In this case, a collector with transparent cover with the lowest measured transmission τ_{min} has to be tested as follows (ISO 9806:2017):
- Thermal performance measurement
- Incidence angle modifier
- Heat Capacity
- Exposure
- Final inspection

A second collector with transparent cover with the highest measured transmission τ_{max} has to be tested as follows (ISO 9806:2017):
- Complete durability
- Final inspection

<table>
<tr><td>Figure 2</td><td rowspan="2">The transmission of the glass sample shall be measured under very stable irradiance conditions, by preference in a solar simulator. For this measurement a simple device made of a cylinder coated inside with black felt. Inside the cylinder a pyranometer is placed centred and perpendicular to the sample plane. The indicated dimensions shall be used. The light source and the pyranometer shall fulfil the requirements of collector performance measurements according to the ISO 9806. The measurements shall be accomplished by a test laboratory having an accreditation for collector testing according to ISO9806. Without glass sample the measured irradiance G_{Ref} shall be ≥ 800 W/m^2.</td></tr>
<tr><td>
</td></tr>
<tr><td colspan="2">Measurement procedure:
1.) The irradiance is measured without glass sample: $G_{ref,1}$
2.) The sample is placed on the test rig and irradiance is measured again: $G_{sample,1}$
3.) Repeat these two steps three times.
By preference, different places on the glass sample shall be tested.
For building families of collectors using coloured glass, the transmission τ is then defined as.
$$\tau = \frac{G_{sample,1} + G_{sample,2} + G_{sample,3}}{G_{ref,1} + G_{ref,2} + G_{ref,3}}$$</td></tr>
</table>

4.) Registration of coloured Glass

Coloured glasses can be registered to simplify the procedure for other producers of collectors. In addition to the determination of the transmission (Step 1) and in accordance with Case B, two collectors shall be manufactured. One using the glass with τ_{min} and one τ_{max}. Both collectors shall be tested for Exposure (ISO 9806:2017) and final inspection. Furthermore the Standard Stagnation Temperature of the two collectors shall be determined, the higher of the two is the maximum application temperature T_{max} of the glass type. The results must be approved by the Solar Keymark Network.

A collector manufacturer wishing to use such coloured glass can use a simplified procedure if the coloured glass is extending an existing Solar Keymark certificate of collectors with uncoloured glass (family or single collector), similar to Case A above. If the measured Standard Stagnation temperature of the Solar Keymark collector is higher than T_{max}, the thermal performance parameters applicable for the whole family are recalculated using the following formula

$$\eta_{0,colour} = \eta_{0,Keymark} \frac{\tau_{min}}{\tau_{max}}$$

All other performance parameters including IAM and thermal capacity remain unchanged.
The incidence angle modifier and heat capacity parameters are not measured again but can be taken from the existing Solar Keymark family. No other tests required. This procedure can be used to extend an existing family or to make a new family with coloured glass only.