ASSESSMENT T-STRIPE

for T-STRIPE Ltd.
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1. Goal

Goal of this assessment is to study the principles behind the T-STRIPE window heating system, its structural-physical effects as well as energy consumption and influence on room climate.

2. Constraints

To ensure realistic simulations the variants are being limited to 2 different window types. These types correlate to T-STRIPE's current main field of application.

1. Ceiling-high window (i.e. patio door) without radiator nearby
2. Skylight (at 45°) without radiator nearby

The criteria for the windows were as follows:
U_{Glass} = 1,1 W/m²K - double-glazed windows
U_{Frame} = 1,6 W/m²K - plastic frame
Psi $_{Bezel}$ = ~0,06 W/mK, spacer: Aluminium
Filling: Inert gas filling

All calculations use heat transfer coefficients of glass pane and window frame according to ÖNORM EN ISO 10211, ÖNORM EN ISO 10077 or ÖNORM B 8110-2:
Alpha inside= 7,7 W/mK equalling Rsi= 0,13 mK/W
Alpha outside= 25 W/mK equalling Rse= 0,04 mK/W

Measurements regarding the skylight are the same for all simulations in order to accommodate differences in vertical and angular installation.

Preface:

All results are based on the assumption that a hygienic airflow is being maintained at all times. Possibilities of air flow and airings dropping under the hygienically necessary limit are not being considered.

Solar irradiation is not being factored into the calculations. This results in calculations that are neutral to specific window orientations and coinciding energy costs or radiation factors. Convective energy passing is subject to a multitude of conditions and never a uniform constant, especially not when T-STRIPE is being applied. For this assessment the information provided in ÖNORM B 8110-2 - for instance the heat transfer coefficient - are being used. **Due to these simplifications the simulations illustrate a 'worst-case' scenario'.**

3. Calculations regarding the heat bridge effect

To illustrate the very principles behind T-STRIPE we calculated the heat bridge effect in the 'ANTHERM' software. Surface temperatures and modifications caused by T-STRIPE were of prime interest. The results for these calculations are valid for both window types, since in both cases the calculations only illustrate a certain point in time accompanied by a distinct outdoor temperature.

3.1. Assumptions

Temperatures:

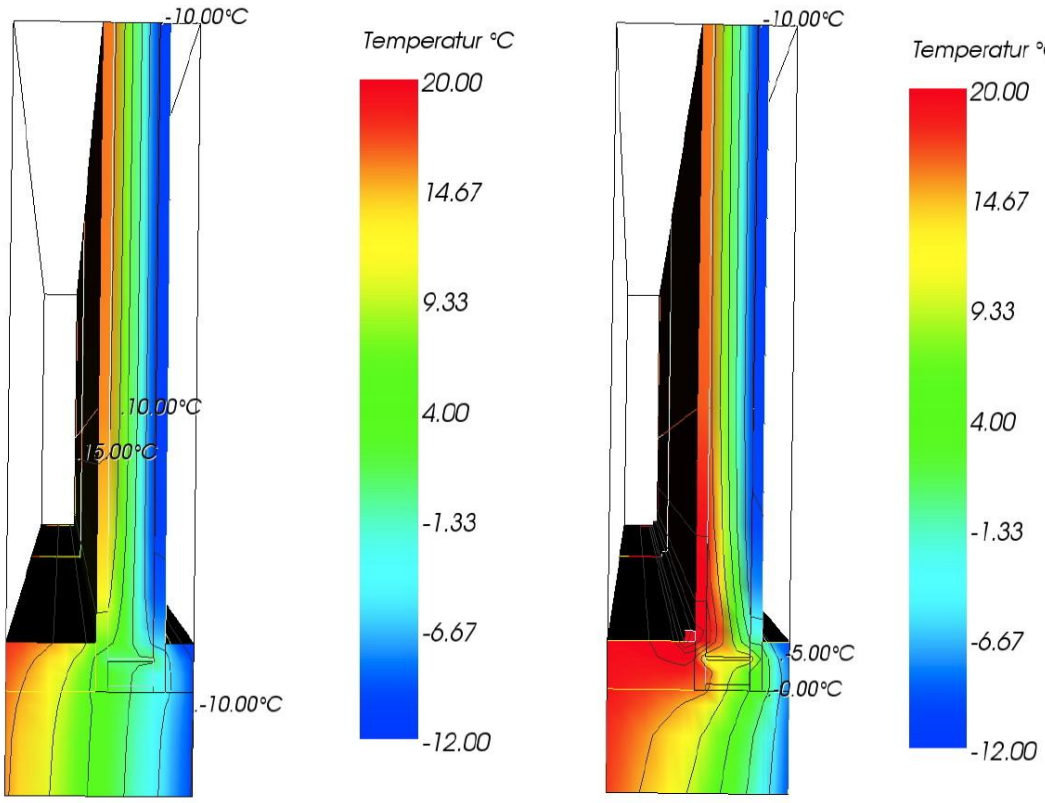
Calculations regarding the heat bridge effect assume an indoor temperature of 20°C and an outdoor temperature of -12°C (standard design temperature for construction parts without storage mass in Vienna) and -1,6°C (average temperature of construction parts during January). In regards to condensate, results of simulations with very low temperatures are considered more important.

Materials:

Designation	**Application**	**Heat transmission**
		W/mK
Glass	Glass panes	1
Gas fillung	Gas filling between panes	0.0178
Sealant	Sealant beneath spacer	0.4
PVC frame	Window frame PVC	0.1
Zeolite	Core material - spacer	0.13
Aluminium	Cladding material - spacer	200

3.2. Results of the simulation at -12°C outdoor temperature

Without T-STRIPE the lowest measured temperatures on the inside surface of the window pane were seven (7°) degrees along the edges of the pane. With T-STRIPE the lowest recorded temperature on the glass surface was sixteen (16°) degrees in the middle of the window pane. During these tests the T-STRIPE heating element itself reached a temperature of 38.9 degrees.

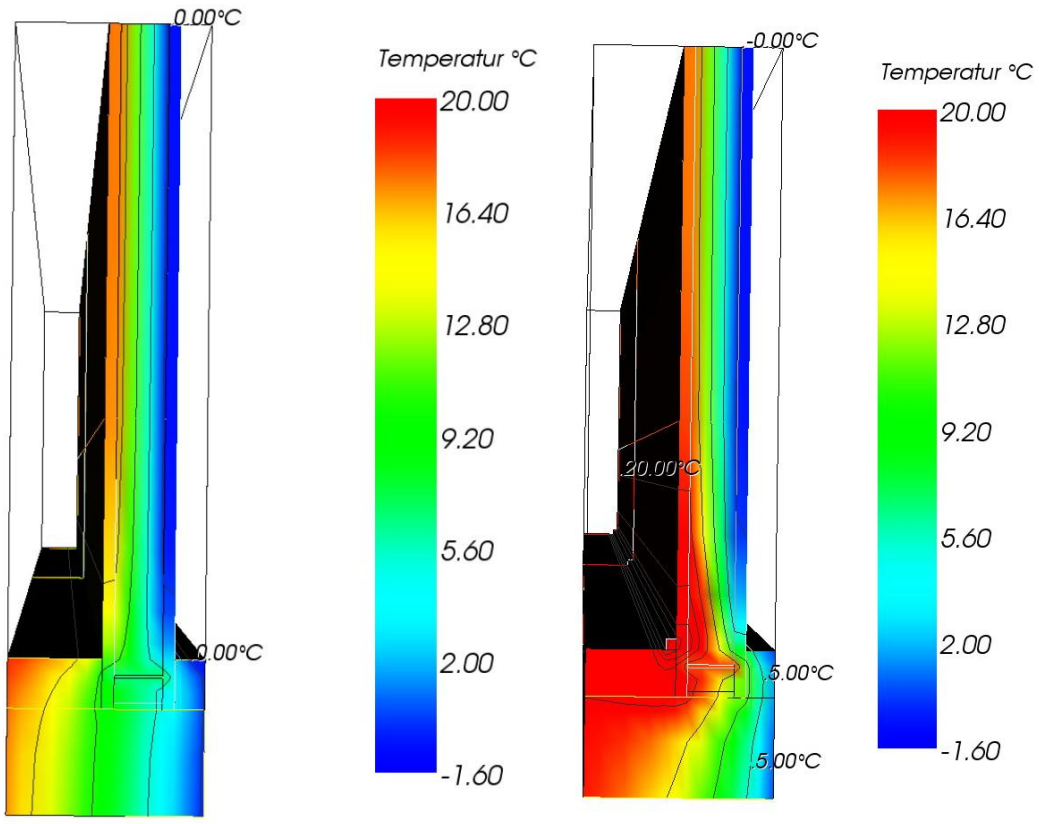


Ausgangsvariante "T-STRIPE" Variante

Isothermendarstellung bei TAussen= -12°C

3.3. Results of the simulation at -1,6°C outdoor temperature

Without T-STRIPE the lowest measured temperatures on the inside surface of the window pane were twelve (12°) degrees along the edges of the pane. With T-STRIPE the lowest recorded temperature on the glass surface was seventeen and a half (17.5°) degrees in the middle of the window pane. During these tests the T-STRIPE heating element itself reached a temperature of 42.7 degrees.



3.4. Main findings

The simulations clearly show the difference in surface temperature of the window pane along the window frame. By using the T-STRIPE heating system the temperature factor f_{RSI} can be raised significantly.

	Value	Limit for Condensation	Limit for Mold
Without T-STRIPE	0.59	>=0.69	>=0.71
With T-Stripe	0.88	>=0.69	>=0.71

By using T-STRIPE both limits for mold and condensation are being surpassed, **effectively preventing any condensation or mold from occuring!**

Due to the significant raise in surface temperature along the window frame the increase in warm air flow contributes to an overall increase in surface temperature of the window pane.

The simulations have also shown how much of the thermal energy spent contributes to room climate and temperature:
63.2% of thermal energy will be reflected back into the room, while 37.6% dissipate outdoors.

T-STRIPE therefore contributes to the heating of the room since window panes reflect parts of the thermal energy.

4. Comparison between different methods of condensate prevention

In order to reduce the risk of condensation along the edges of the window frame the following methods are considered viable:

- Reduction of relative humidity by increasing airflow
    - Excess humidity can be released
    - Condensate cannot be ruled out
    - Energy consumption dependent on type of heating
    - Up to a certain temperature possible increase in comfort
    - Increase in air quality indoors

- Increase of indoor air temperature
    - Manipulation of the dew point
    - Condensate cannot be ruled out
    - Energy consumption dependent on type of heating
    - Up to a certain temperature possible increase in comfort

- Installation of T-STRIPE
    - Condensate can be prevented upon correct calibration
    - Electric power consumption
    - Increase in comfort since the surface temperature of the window pane is being raised