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Testing Results for Thermo-Shield wall coatings

and their Implementation into **DK-Solar Simulation Tools**

Part 1 of 2: Analysis

Start of test: August 2nd, 2002. Final Report (in German) march 3rd, 2004

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Final Report from Siegfried Delzer (English translation, June 2004)

Testing goal

Testing the dynamic behavior of the wall coating Thermo-Shield in comparison to conventional materials such as wood, plaster and regular wall paints. Before testing, scientific considerations and practical insights did not lead to a coherent physical model.

Testing Method

Two different testing methods were developed:

1st: DK (Delzer Kybernetik) dynamic testing

Probes consisting of different materials and with different surfaces were placed in an airtight and insulated chamber. The probes ceded moisture condensing on the cooling surface and consecutively evaporating when heated. The dynamic behavior of the probes in delivering and absorbing moisture on their surface as well as conveying moisture in the depth of the probe material influences the moisture level in the chamber. Measured are the courses of relative moisture and of temperature. All test runs were performed in a reproduceable manner. Therefore, the results of the test runs with different materials can be directly compared and evaluated. This testing method comprehends the complete dynamic behavior of the probes: Mass, heat accumulation, heat conductance, moisture absorption and moisture transport. With this testing method, temperature and relative moisture are variable: Defined heat energy is at first withdrawn from the process and added thereafter. Withdrawing heat energy cools the chamber and air moisture condenses on the cooling surface. Moisture delivered from the probe lowers relative moisture in a slower manner. The same effect occurs in the reverse manner while heating. Probes with an active surface will show a lower initial moisture increase in the chamber. Probes with a high moisture conductance will show a lower moisture variation.

2nd: DK (Delzer Kybernetik) static testing

These tests were also accomplished in an airtight and insulated chamber. In the chamber, water is evaporated over a defined surface. Moisture and temperature are measured over time. At test end, the quantity of evaporated water and weight increase of the probes are measured and interpreted in association with the dynamic test results.

A normal plywood plate was used as comparative reference. It provided for all tests performed stable and well reproduceable values. All test runs were performed in parallel with two different testing chambers. To eliminate differences in the testing and measuring equipment, all tests were performed with swapped probes for a second time.

Overview of test runs performed for result interpretation

Test run 5
2 chambers with plastic plates
a) with Thermo-Shield coating
b) with untreated surface
Test run 6
2 chambers with plywood plates
a) with Thermo-Shield coating
b) with untreated surface
Test run 7
2 chambers with plywood plates
a) with Thermo-Shield coating
b) with CAPA (Caparol) normal paint
Test run 8
2 chambers with plywood plates
a) with Thermo-Shield coating
b) with CAPA (Caparol) normal paint
Test run 9
2 chambers with plywood plates
a) with Thermo-Shield coating
b) with CAPA (Caparol) normal paint
Test run 10
2 chambers with plywood plates
a) with Thermo-Shield Exterieur coating
b) with Thermo-Shield Interieur coating
Test run 12
2 chambers with plywood plates
a) with Thermo-Shield Exterieur coating
b) with Thermo-Shield Interieur coating

General Results

Thermo-Shield has a substantially greater surface-activity in comparison to all other materials tested.

This effect proves evident in short time dynamics: Is moisture brought to the chamber, the relative moisture level raises at the beginning slower than in the reference chamber.

Test run 5 with 2 plastic plates shows only the surface effect. This for the reason, that plastic can absorb and deliver only a negligible amount of moisture. The plastic plate with Thermo-Shield coating shows a remarkable lower relative moisture level.

Test run 6 (Test 2) with painted and non painted plywood demonstrates, how relative moisture at first increases much slower (surface effect) and thereafter faster, compared to the untreated plate. Reason: slow-down

effect for diffusion. It is surprising, how Thermo-Shield raises surface activity. An untreated plywood plate has, compared to normal paint, a very raw surface. Just by appearance and estimation, a contrary effect would be expected.

The fast moisture absorption and -delivery provides for the first 20 to 30 minutes a clear advantage. Illustration: Taking a shower in analogical outfitted surroundings might demonstrate this effect.

Steam permeability from and to wall materials is given, but not as fast as for example with untreated surface or normal paint covered walls.

To dry out materials, the course of action is extremely slow, but in any case sufficient. For the case of heavy and short cycle moisture variation at high air moisture levels, the moisture transport to the inside of the material should be delayed. This effect compares to the low-pass filter effect in electronics and electrics: high frequency is filtered out and only slow and controllable effects are of evidence.

This effect is important for inside wall coatings, and of even higher importance for external wall coatings. This is validated with the test runs 10 and 12. In both tests, short- and long-term dynamics of Thermo-Shield Interieur is better. Reason is the somewhat inferior moisture permeability of Thermo-Shield Exterieur. This leads to somewhat higher relative moisture in the testing chamber.

The difference between Thermo-Shield Interieur and Thermo-Shield Exterieur is marginal compared with the differences to the other tested materials. This result had to be expected, since the basic materials are the same. The differences in formulation ameliorate obviously both materials for their intended use.

Implementation of the test results into DK-Solar Simulation Tools

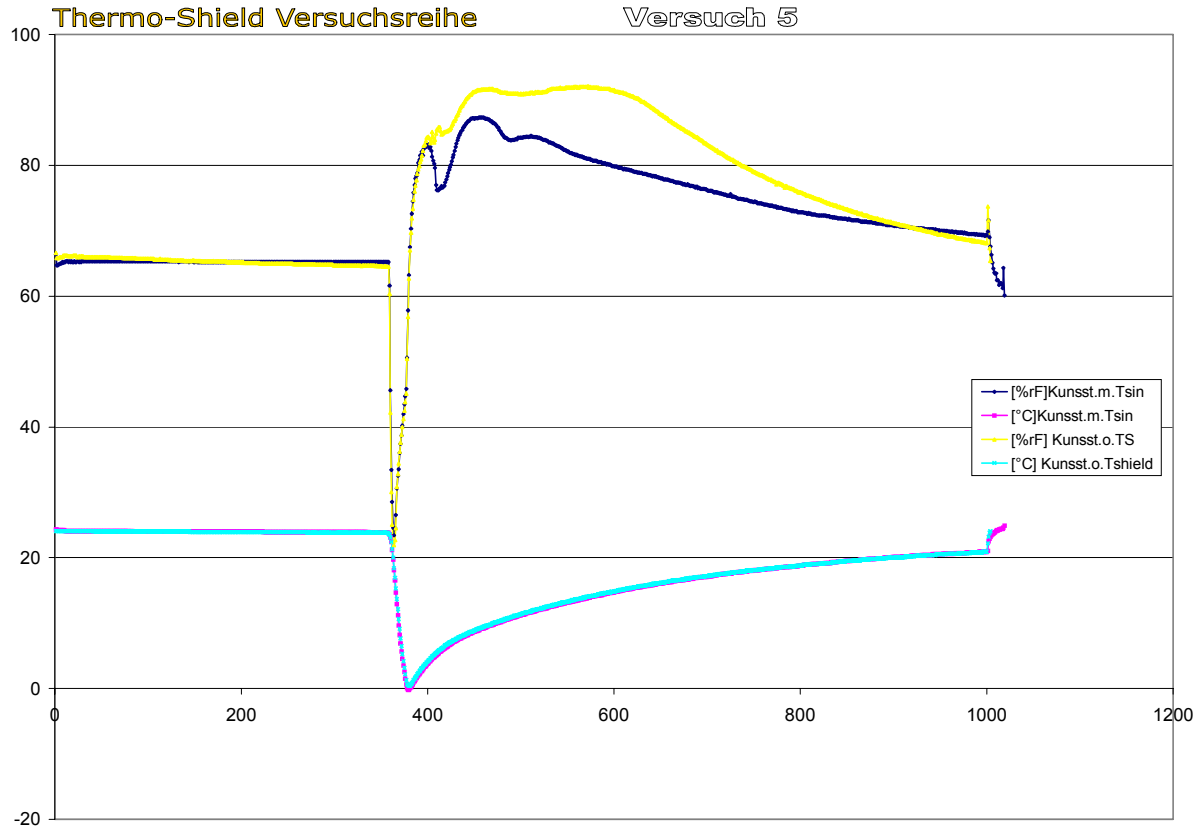
The test results of the dynamic behavior of Thermo-Shield and other wall materials served as input to the dynamic **DK-Solar** Simulation Tools. This constantly extended and ameliorated software tool for the optimization of buildings is in use since 1984. In the year 1992, the originally for industrial use developed module for air vapor- and condensation dynamics has been integrated and validated.

As rule of thumb, comparative simulation with DK-Solar is resulting in 10 to 15%energy savings. This for buildings in Central Europe climate conditions.

Analysis of graphs resulting from DK-Solar simulation runs

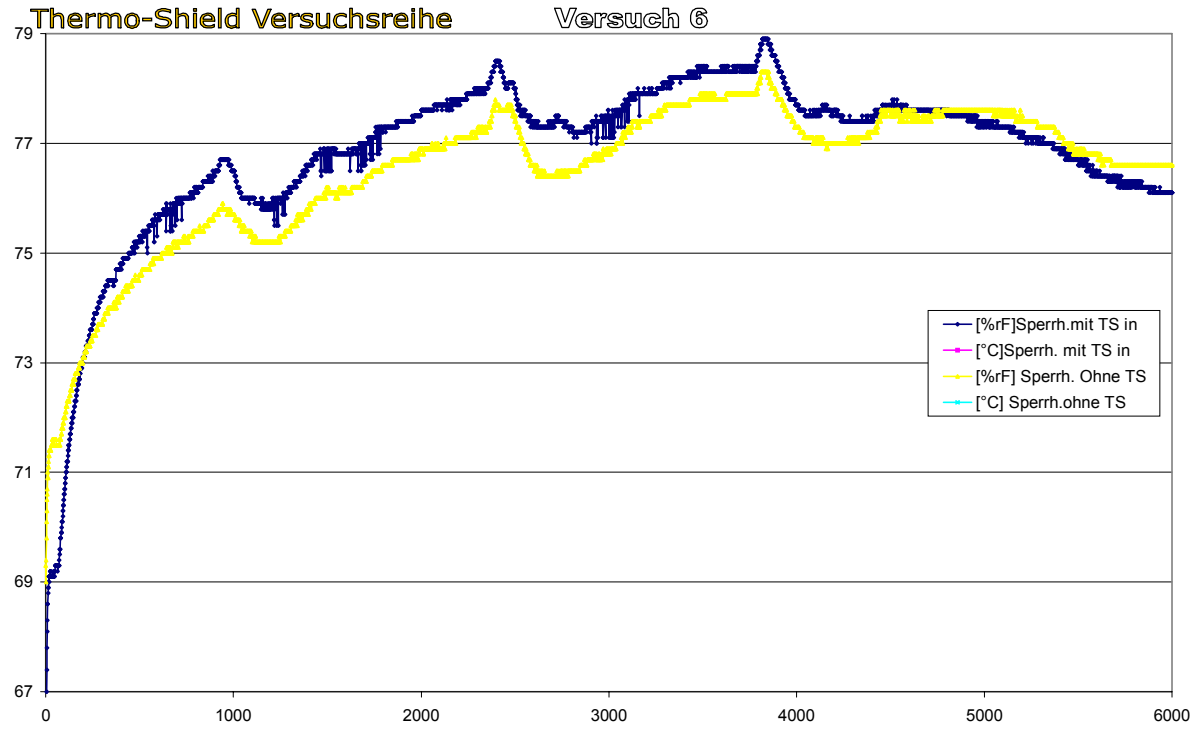
1st: Test run 5

2 chambers with plastic plates
a) with Thermo-Shield coating
b) with untreated surface



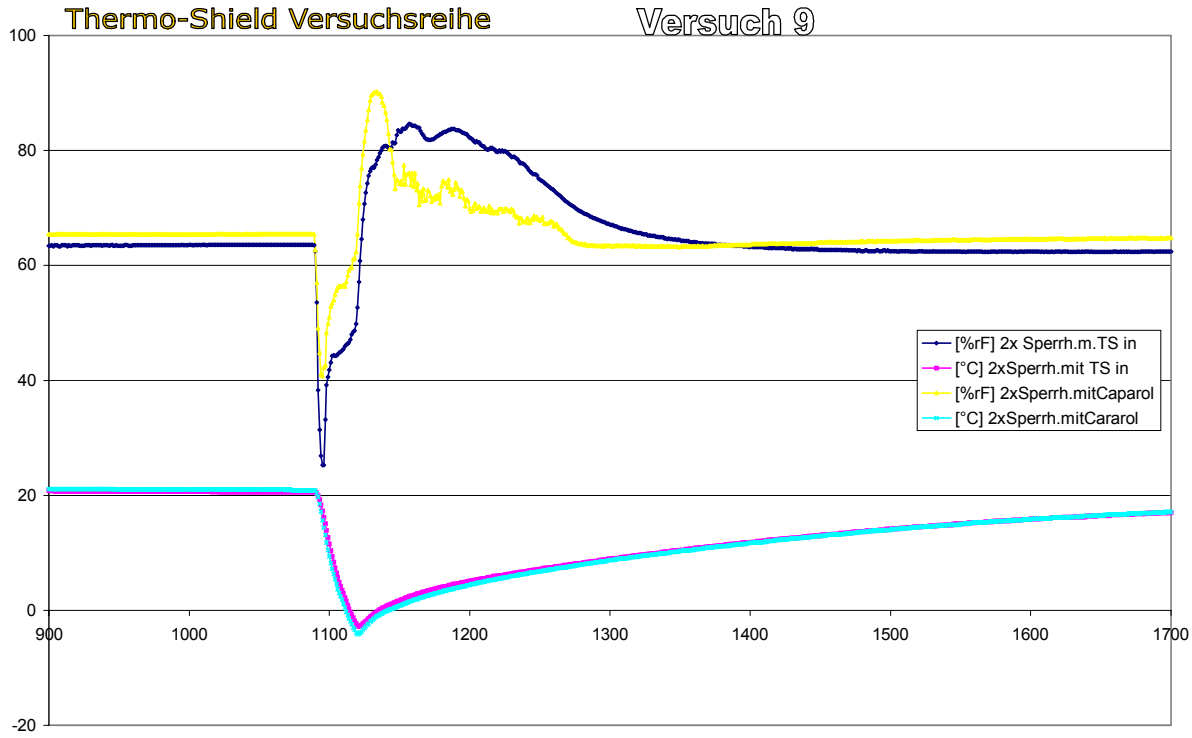
The upper blue and yellow curves show relative moisture in the chambers. They start with approximately the same values. But at heating after cooling, relative moisture behaves different. The blue curve, representing Thermo-Shield coating, evolves at a flat level. This corresponds accordingly to the surface influence of Thermo-Shield Coating.

2nd: Test run 6
2 chambers with plywood plates
a) with Thermo-Shield coating
b) with untreated surface



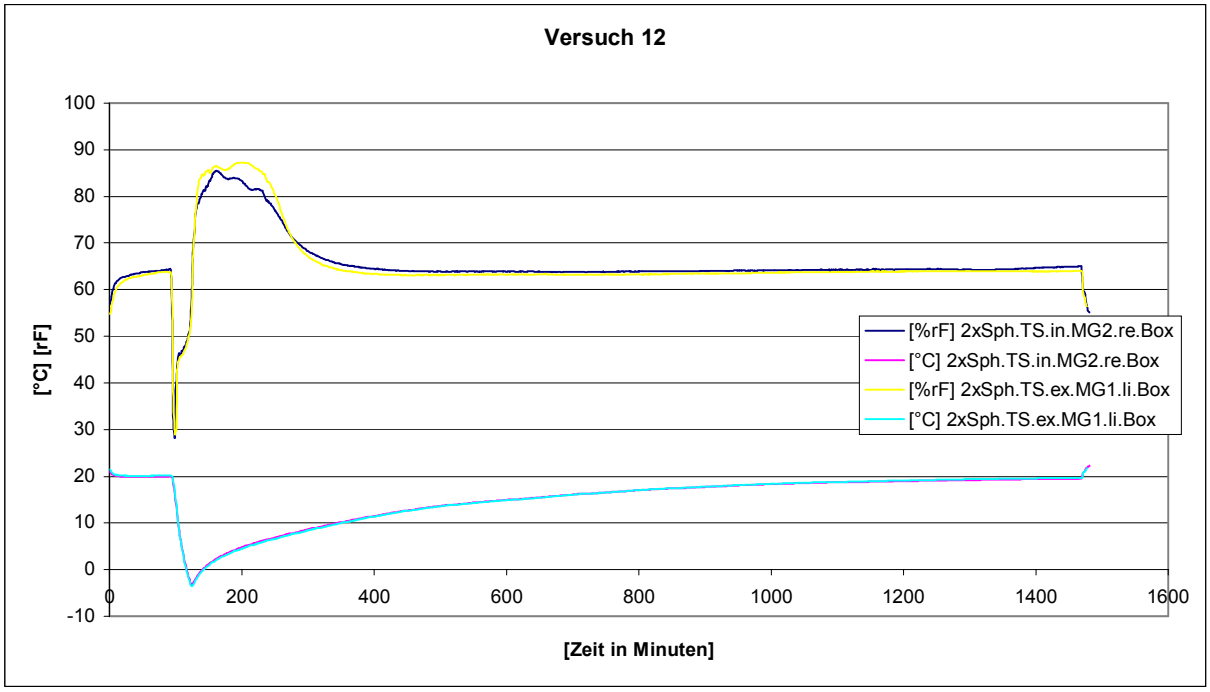
This test run shows fast moisture increase in untreated plywood from starting phase. Untreated wood transports moisture better into itself. The surface does not reach saturation as does Thermo-Shield. But the total moisture absorption is after a certain time greater as with Thermo-Shield. That demonstrates: Fast surface dynamics and slow moisture conveying into the material with Thermo-Shield. As comparison, these results can be observed also on test run 16.

3rd: Test run 9
2 chambers with plywood plates
a) with Thermo-Shield coating
b) with CAPA (Caparol) normal paint



This test run with a coating of regular inside paint (CAPA), shows the following effects:
Thermo-Shield reacts faster with its surface, the maximum value (yellow curve) remains lower at the beginning, even so CAPA conveys moisture very fast into the underlying material. For this reason, relative moisture does not fall as low as with Thermo-Shield Coating. That means less variation in air moisture, but a large moisture variation in wood material.

4th: Test run 12
2 chambers with plywood plates
a) with Thermo-Shield Exterieur coating
b) with Thermo-Shield Interieur coating



The direct comparison of Thermo-Shield Interieur and Exterieur shows only small differences. Interieur conveys moisture better than Exterieur, this makes sense. With a permeable inner wall coating and an impermeable outer wall coating, problems have to be expected. These findings coincide with practical experience.

Lörrach, march 3rd, 2004

Siegfried Delzer