Hydrophobe III -
3rd International Conference on Surface Technology with Water Repellent Agents,
Aedificatio Publishers, 247–256 (2001)

Treatment of Rising Damp in Wet Conditions with New Hydrophobic Pore Filling Resins

G. J. Pleyers
pleyers. building institute, Würselen, Germany

Abstract

The study had a two-fold aim. In the first place, to evaluate effectiveness of new products for the treatment of rising damp, in particular for the special case of water saturated masonry. Secondly, to develop new pore filling resins for the treatment of rising damp in any kind of conditions. The results show that the new pore filling resins with hydrophobic additives work properly on water satured building materials.

1 Introduction

Masonry with non effective or without damp-proof courses are often damaged by rising damp or salts in the basement. These damages become visible as defective plaster, coatings and deteriorating joint mortar as well as crystallized salts on the masonry surface.

Commercially available methods for the treatment of rising damp are based on mechanical, electrophysical and chemical procedures. From a financial aspect, the chemical drill hole injection system is one of the most interesting application systems although it can present problems when applied to water-saturated brick masonry. Therefore new approaches had to be developed to solve these problems.

The aim of this research was to study the effectiveness of new hydrophobic pore filling resins when applied in wet conditions as compared to currently available commercial products for the treatment of rising damp. An important consideration was the minimization of the water vapour transfer across this material to improve conditions in the interior spaces limited by these damp walls.

2 Experimental

2.1 Background Information

Many references are found in the German literature regarding the high degree of saturation that lower courses of building may have. In many cases, these can reach 100% saturation, however, the surface of such saturated brick masonry may appear nearly dry if water vapour evaporation is fast. In these cases, the interior spaces limited by such moisture laden walls are inevitably damp. No values are available defining the minimum water vapour permeability to maintain a comfortable interior space.

2.2 Testing Program and Sample Preparation

The present study was carried out at the Institute for Building Research Aachen (ibac) during the past 10 years. For this purpose one type of brick and 3 different injection products were selected. The products are based on a solvent free modified epoxy resin, a silicate ester based product and a water based acrylic gel. The following table summarizes this information as well as indicating their operation mode. The specific information for the products was provided by the manufacturers literature according to current codes of practice.

Based on topic specific literature and our own practical experience the water content of the brick for the application of the products was selected. Hence the test specimens (bricks: 24 x 7.2 x 11.5 cm) were water saturated before the product was applied at a pressure of about 3 bar (0.3 MPa). The application takes between 1 to 5 min for each brick.

Table 1: Selected injection materials (IS)

Name	Description	Mode of Operation
IS06	AY Gel	pore filling
IS07	KSE-based	narrowing
IS08	solvent free epoxy resin (modified)	pore filling hydrophobic

Past current practice used the maximum water uptake for each type of brick to calculate the required application volume. For the specific bricks used in these tests a minimum of 250-g injection material is needed - since the pore volume =25%; saturation =100%, and drill hole distance 12 cm; the treated brick volume treated is 12 x 7.2 x 11.5 cm. Because of previous poor results with this small amount of material, tests with 500-g and 1000-g were also carried out.

To obtain the information of the effective injection material content in the pore system, 4 holes (3-mm diameter) were drilled, cleaned and closed with a plastic plug before the application was started. After the injection procedure was finished, the plastic plug was removed and about 5-g of the non reacted injection material was taken out of the drill hole through the residual injection pressure in the pore system. This operation was performed at the injection drill hole (distance of 0.0 cm) and at 2.5 cm, 6.0 cm and 9.0 cm distance from the injection point. After this procedure the drill holes were closed (s. Fig. 2).

The samples were then stored under water for 28-days (temperature of 23°C). Then the specimens were prepared for the effectiveness test (see Fig. 1 and 2).

Evaporation rates were determined from slices (2 x 7.2x 11.5 cm) cut from the test bricks, fitted into an appropriate ???contained with one side in contact with water. The specimens were taken at mean drill hole distances of about 2.5 cm, 6.0 cm and 9.0 cm. The evaporation rates were determined by weighing the whole test system at different times and the results expressed in $g/(m^2 h)$. Stationary conditions were observed after a period of about 10 days.

Table 2 shows the different investigation parameters:

3 Results and Discussion

In the relevant topic-specific literature no limiting value for the maximum allowable evaporation rate could be found. A permissible value for a maximum evaporation rate could be found by using a simple model and some calculations. This was based on the question: How much moisture could be substituted by an ordinary number of air changes? Taking into consideration average indoor comfortable cli-

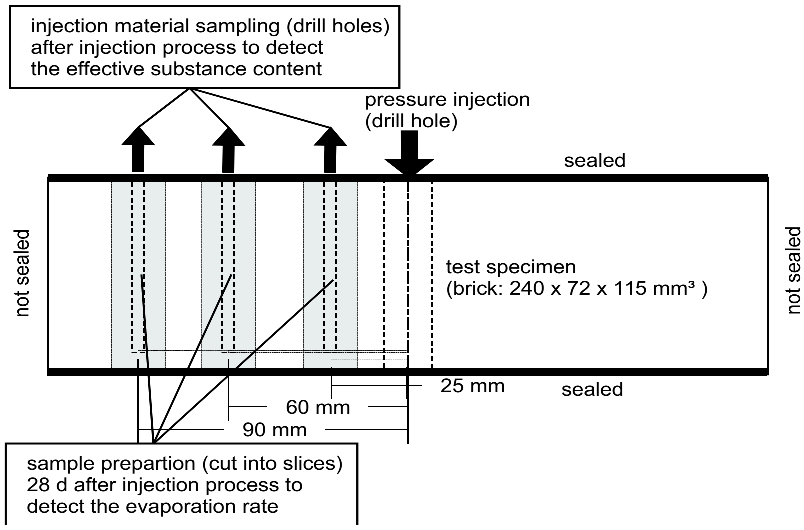

Figure 1: Prepared test specimen

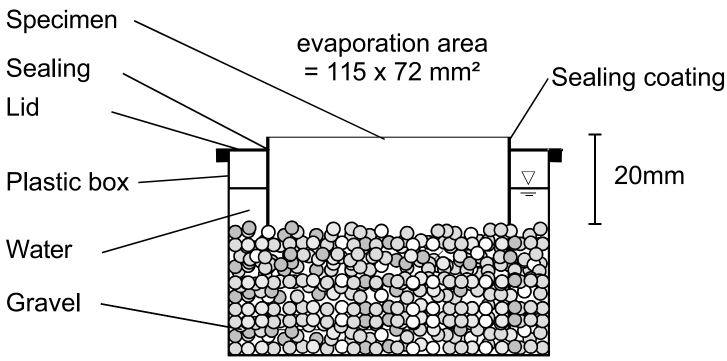

Figure 2: Evaporation rate determination

mate conditions the maximum evaporation rate was calculated and was found to be around 100 g/(m²·d). This maximum evaporation rate was used as a standard against which the laboratory test results could be evaluated.

The following diagrams show the results of the effective substance content and the corresponding evaporation rates of the three injection materials.

Table 2: Different investigation parameters

Substrate	Solid brick		
test conditions (before injection)	water saturated		
injection materials	IS06 (AY)	IS07 (KSE OH)	IS08 (Eph)
injection material quantities	250 g 500 g 1000 g		
injection pressure	3 bar (0.3 MPa)		
test conditions (after injection)	storage under water		

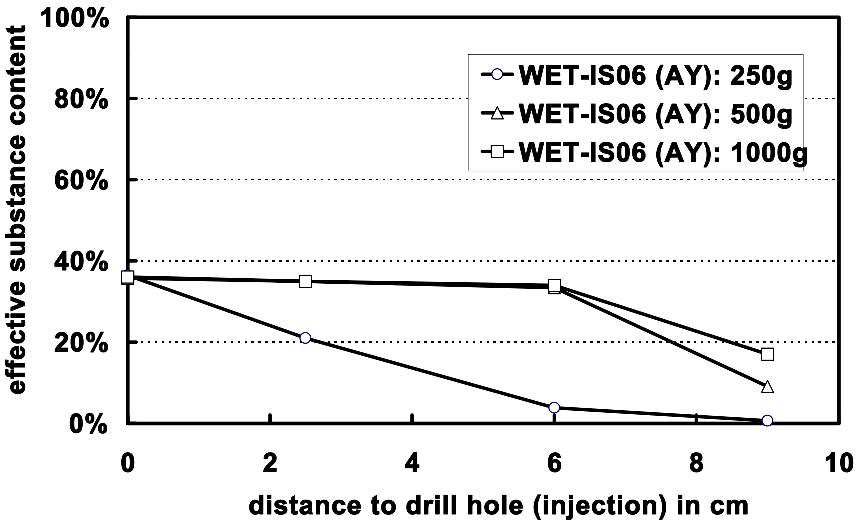

Figure 3: Effective substance content - injection material IS06 (AY)

The injection material IS06 is a water based acrylic gel. It is normally used for grouting work in the ground. But it is now being used more frequently for the treatment of rising damp. The effective substance content is not more than 36 % even in the injection drill hole. This material can be used as a swelling agent.

The following figure 4 shows the results of the evaporation rate. This is between 500 and 600 g/(m²d) - 6 times more than the maximum allowable rate..Even if

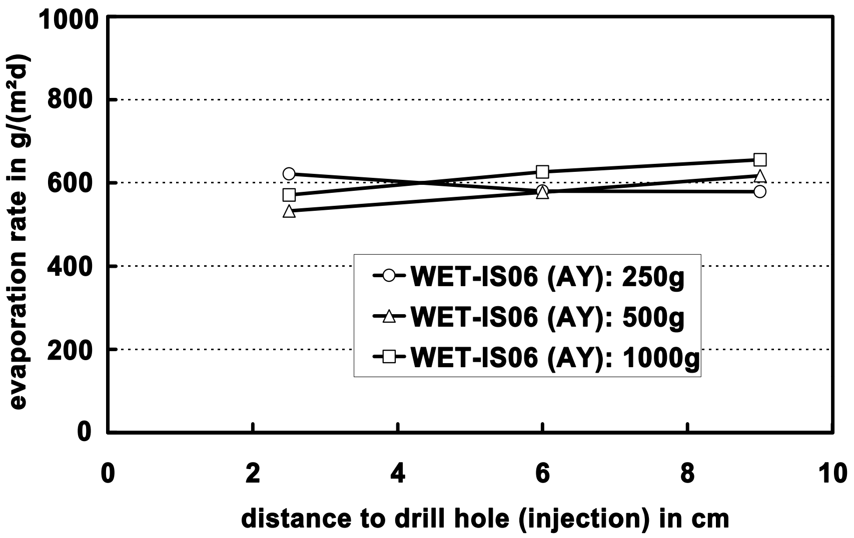

Figure 4: Evaporation rates - injection material IS06 (AY)

about 1000 g were injected into one brick - about 4 times of the pore volume - a “blocking” effect would not be achieved.

The injection material IS07 is often used as a supplement in products for the treatment of rising damp. This special material, without any hydrophobic properties, was selected to get information about its pore blocking effect. The effective substance content is about 60 %, it is the maximum possible amount that can be obtained with this substance.

The evaporation rate obtained with this product is shown in Figure 6. The effective substance content, between 50% and 60%, is not enough to reduce the evaporation rate down to less than 100g/m^{2}d. There is no chance to prevent the rising damp problem in a proper way with this material. An explanation is given in Figure 7.

Figure 7 describes the situation in both untreated and treated pore system. The water saturated pore system did not allow direct contact of the injection material with the pore surface, as supported by SEM examination. The water film could not be removed from the pore surface by the pressure injection. The resulting evaporation rate demonstrate the model of the transport process in an injection material modified pore system. The result is an evaporation rate of over 600 g/(m^{2}d).

The results can be summarized as follows. The injection reduced pore volume but this fact did not result in significantly lower capillary transport capability.

The results of the effective substance content obtained with injection material IS08 are shown in figure 8. This product is a modified solvent free epoxy resin resulting

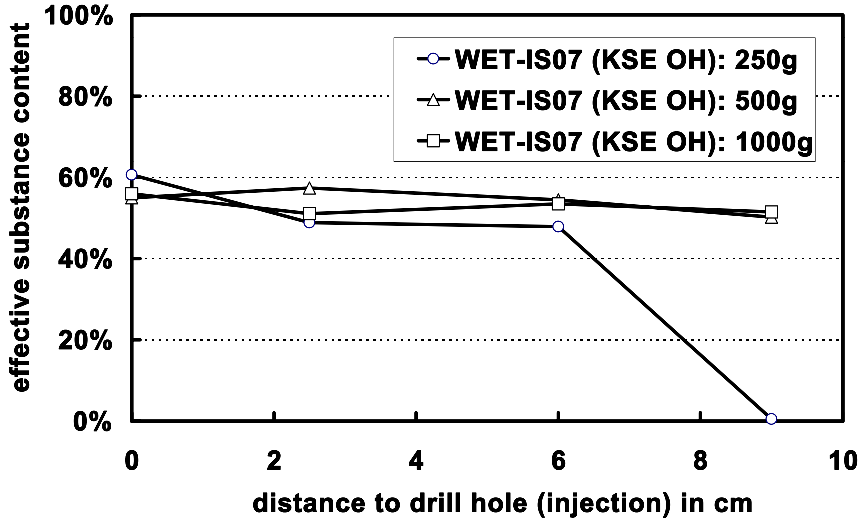

Figure 5: Effective substance content - injection material IS07 (KSE OH)

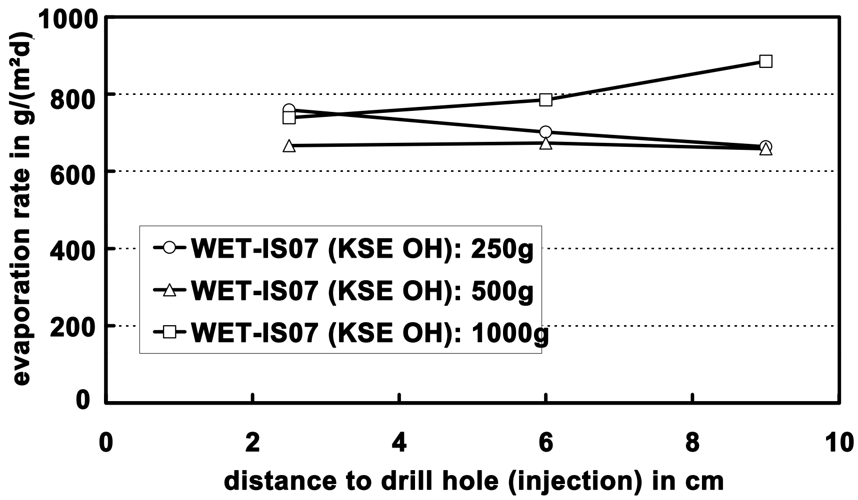

Figure 6: Evaporation rates - injection material IS07 (KSE OH)

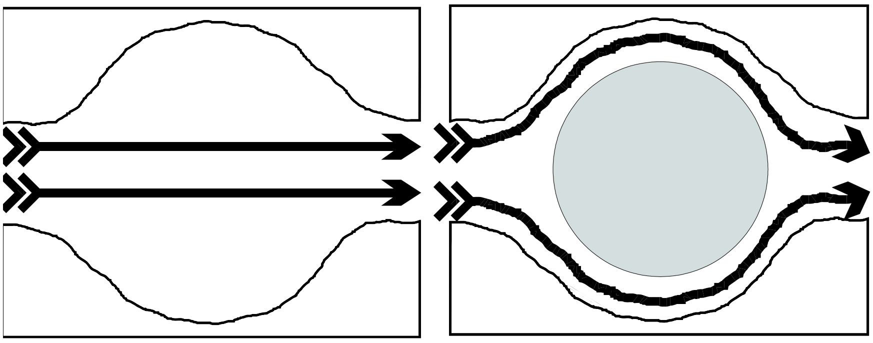

Figure 7: Capillary transport processes in untreated and treated pore systems - pore entrance / -exit

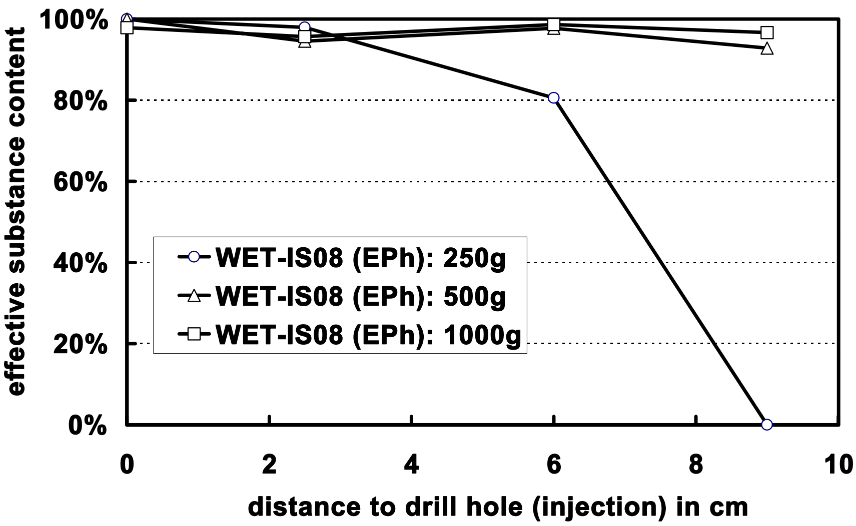

Figure 8: Effective substance content – injection material IS08 (EPh)

in a nearly 100 % effective substance content with injection quantities of 500 and 1000 g.

For the above mentioned amounts of injected material, 500-g and 1000-g, the corresponding evaporation rates at a 6-cm distance from the injection hole are 20 g/m^2d and 90 g/m^2d, respectively. This means that a distance of about 12-cm between drill holes is sufficient to produce a well performing damp-proof course. This drill

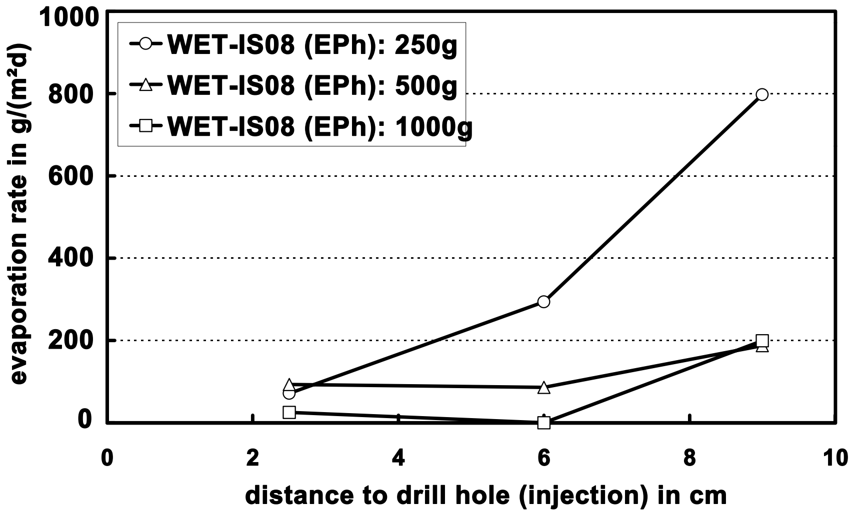

Figure 9: Evaporation rates - injection material IS08 (EPh)

hole distance is suggested in most guidelines for treatment of rising damp by injection.

4 Conclusions

The results show that the tested products IS06 and IS07 are not likely to reduce rising damp for brick masonries in water saturated conditions.

Previous investigation have shown that pressure injected materials into water saturated substrates replace only a part of the pore water. A thin water layer adheres on the pore surfaces and could not be replaced by this kind of injection material. Hence, it is necessary that the injection material be able to displace as much water as possible out of the pore system. The investigated injection products IS06 and IS07 are not capable of reaching a sufficiently high effective substance content for this purpose. Therefore, the water layer which adheres on the pore surfaces is still enough to allow more water to pass throug the pore system - shown in the results of the evaporation tests.

The injection material IS08 allows to introduce an effective substance content of about 100 %. Furthermore its viscosity of about 16 mPa s (like milk) at 20°C is ideal for filling the pore system in such a way that the water transport is practically interrupted. Finally, this product reduces water vapour permeability to below the calculated 100 g/m^{2}d value that allows to maintain a comfortable interior space even if the brick below the injected material is saturated with water.

5 References

1. Sasse, H.R./Pleyers, G. (1997): *Reduzierung von Mauerwerksfeuchte - Untersuchung und Entwicklung chemischer Bohrlochinjektionsverfahren als wirksame Horizontalsperre für den nachträglichen Einbau in Ziegelmauerwerk*, Aachen, Institut für Bauforschung (Forschungsbericht F 496).
2. Pleyers, G. (1998): *Treatment of Rising Damp With Hydrophobic Agents in Wet Conditions*, Wittmann, F.H., ed., Water Repellent Treatment of Building Materials, Proceedings of Hydrophobe II, Zürich, pp. 189-196.
3. Pleyers, G. (1998): *Ist eine Porenverengung zur Reduzierung kapillar aufsteigender Mauerfeuchte geeignet?*, Stuttgart. In: Jahresberichte Steinzerfall - Steinkonservierung, **6** (1994-1996), pp. 157-163.
4. T 558 pm-95: *Surface Wettability and Absorbency of Sheeted Materials Using an Automated Contact Angle Tester*, Provisional method, TAPPI, 1995.
5. ASTM G 26-96: *Standard Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials*, ASTM, 1996.
6. Norberg, P. (1998): *Microclimate Measurements in the Built Environment*, BMG-MT TR21: Doctoral Thesis, Gävle, Sweden.
7. DIN 18550:1985: *Plaster-Part 1: Terminology and requirements*, DIN, 1985.