AQUASEAL™

■ **1-Komponenten-Versiegelung für glatte Oberflächen bei wasserlöslichen Kernmaterialien**

Aquaseal wurde speziell zur Versiegelung der wasserlöslichen Kernmaterialien Aquacore und Aquapour entwickelt.

Auf der Oberfläche von Formen oder Werkzeugen bildet es eine glatte, porenfreie Schutzschicht, die eine Harzabwanderung in das poröse Werkzeug während des Laminier- oder RTM-Verfahrens (Resin Transfer Moulding) verhindert.

Aquaseal eignet sich für herkömmliche Harze und Prepregs mit einer Kerntemperatur von bis zu 193 ºC und läßt sich mit Leitungswasser in Minutenschnelle auswaschen.

Zum Abformen ist ein Trennmittel erforderlich!

Aquaseal wird mittels Spritzpistole oder Pinsel in mehreren Schichten gleichmäßig auf das gesamte Teil aufgetragen. Durch die blaue Farbe des Materials wird sichtbar, an welchen Stellen die Versiegelung noch nicht ausreichend aufgetragen ist.

AQUASEAL™

■ ***1-Component-Sealing for smooth surfaces on water-soluble mandrel materials***

Aquaseal has been specially formulated to seal the water-soluble mandrel materials Aquacore and Aquapour. It provides a smooth, nonporous finish on the surface of a mold or tool and inhibits the migration of resins into the porous tool during the lay up or RTM process.

Aquaseal is compatible with the core temperatures of commercial resins and pre-preg compounds up to 193 °C and washes away in minutes with tap water.

We recommend separating agents for easy demoulding!

Aquaseal may be applied with a spray gun or brush. Several coat should be applied. It should be applied evenly over the entire part so as to prevent cracking of the mandrel. We have added an environmentally safe blue dye to aid in detecting how well the sealer is applied.

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Aquaseal

Aquaseal 3818 has been specially formulated to seal the water-soluble mandrel materials Aquacore and Aquapour. It provides a smooth, nonporous finish on the surface of a mold or tool and inhibits the migration of resins into the porous tool during the lay up or RTM process.

Aquaseal 3818 is compatible with the core temperatures of commercial resins and pre-preg compounds up to 193°C and washes away in minutes with tap water.

Aquaseal 3818 may be applied with a spray gun or brush. Several coats should be applied.
It should be applied evenly over the entire part so as to prevent cracking of the mandrel.

We have added an environmentally safe blue dye to aid in detecting how well the sealer is applied.

After achieving the desired finish, Aquaseal 3818 is thermally stable up to 193°C. To remove, simply wash away mandrel material and sealer with plain tap water.

Aquaseal 3818 is environmentally friendly; no special disposal procedures are required.

Aquaseal 3818 is available in Quart, ½ Gallon and 5 Gallon containers.

Call or fax Aero Consultants AG for assistance with your specific manufacturing requirements.

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Instructions for using Aquaseal

Aquaseal has been specially formulated to seal the watersoluble mandrel materials Aquacore and Aquapour.

Form the mandrel material into the desired shape and dry it in a convection oven to cure. Once the mandrel is dried and cooled, apply Aquaseal to seal the product prior to usage. It will take 4-6 coats to acquire the desired finish.

Note: Aquaseal is not to be used on mandrel prior to drying in convection oven.
After the sealing is dried, apply a Release Agent or a Release Wax.

Tips for applying Aquaseal 3818

- Shake sealer well before applying it to the mandrel, as setting is common
- Aquaseal can be sprayed or brushed onto the mandrel
  a. Aquaseal can be sprayed on with a spray gun
  b. Aquaseal can be applied with any brush suitable for latex or waterbased paint
  c. It will take several coats to obtain the desired finish on the mandrel material
- We recommend to spray on the first coat onto the mandrel and allow to dry. Once the first coat is dry, you can continue to spray or brush the additional coats. It should be applied evenly over the entire part so as to prevent cracking of the mandrel.
- Drying times for Aquaseal vary according to humidity and room temperature. It may be necessary to apply 4 - 6 coats. We have added an environmentally safe blue dye to aid in detecting how well the sealer is applied.
- Allow approx. 20 min. drying time in an oven at 65°C between coats for sealer to dry properly.
- To remove, simply wash out mandrel material and sealer with tap water. Room temperature water will remove sealer, but heated water will significantly increase the wash out process.
- Aquaseal takes slightly longer to dissolve than the mandrel, but still requires only water. Soaking in water for 15 minutes will loosen sealer. No special procedure is needed for the disposal of the product. Aquaseal is completely environmentally friendly.

Call or fax Aero Consultants AG for assistance with your specific manufacturing requirements.

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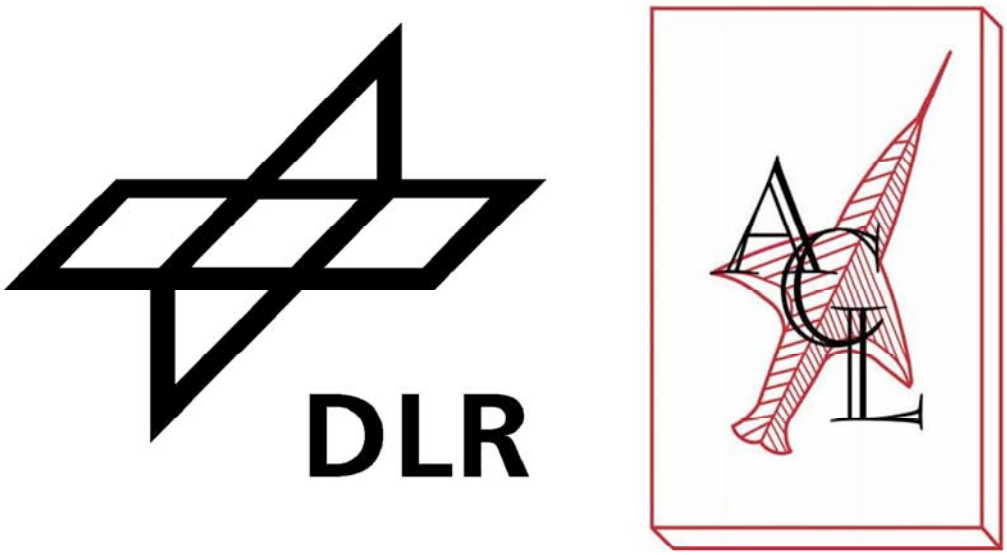
Report

Microwave Drying of Aquacore, Aquapour and Aquaseal



Institute for Composite Structures and Adaptive Systems
DLR Braunschweig

Braunschweig, June 2005

Contents

1 Overview

This report discusses the findings of our analysis of the forming materials Aquapour and Aquacore as well as the releasing agent Aquaseal, produced by Aero Consultants Ltd. AG. The drying behaviour of said materials in a microwave oven was examined, especially with respect to possible acceleration of the drying process in comparison to conventional ovens.

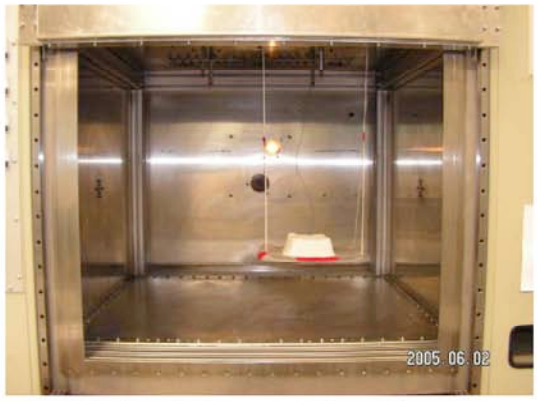


Abbildung 1: Gesamter Mikrowellenraum

2 Experiment Setup

The Institute of Composite Structures and Adaptive Systems uses a custom-built microwave oven equipped with four magnetrons. Each magnetron can be separately controlled to supply up to 2000W of microwave power at a frequency of 2.45GHz to a 1m^3 cavity. In order to examine the drying process it is necessary to continuously weigh the specimen.
Since it was not possible to install a scale within the microwave field a scale was placed above the microwave cavity, and cords of polypropylene (PP) routed through openings in the cavity wall were used to connect it to a polypropylene plate supporting the specimen (Fig. 2). To enable water to evaporate from the underside of the specimen, holes were drilled into the plate. Fig. 1 shows the microwave cavity with the specimen placed on the plate.

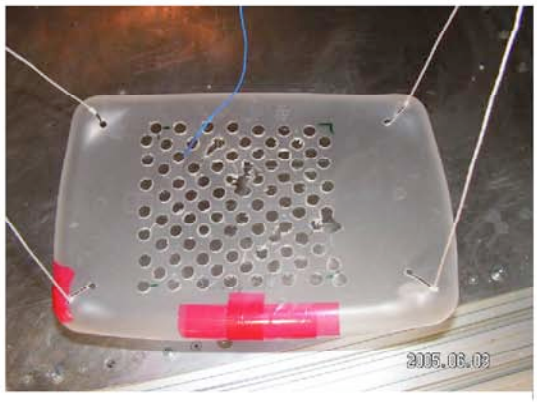


Abbildung 2: Gelochte Platte

3 Experiments

3.1 Aquacore and Aquapour

Aquacore and Aquapur are both delivered in form of a powder which was then shaped into a specimen. The shape was provided by small PP containers which were filled with Aquacore or a mixture of water and Aquapour. The dimensions of the specimens were about 4.5cm x 12.5cm x 12.5cm, resulting in a volume of about 700ml.
Aquacore is inserted into the PP mould without any further preparation. The whole process of forming is completed within 15 minutes.
Aquapour is mixed with 45% by weight of water and left to sit for one hour before it is demoulded.
The specimens are then placed on the plate inside the microwave cavity. The emitted microwave power is kept constant throughout the experiment. During its course temperature and weight of the specimen are recorded at regular intervals. When the weight of the specimen remains constant, the experiment is terminated.
The temperature is measured by means of thermocouples inserted 1cm into the specimen.

Figure 3: material in forms

3.2 Aquaseal

The releasing agent Aquaseal is delivered in liquid form. In order to examine the drying of Aquaseal the specimen, formed from Aquapour or Aquacore, it is weighed, covered in Aquaseal using a compressed-air spray gun and subsequently weighed again and placed inside the microwave oven. During the drying process the weight of the specimen is recorded at regular intervals until no further decrease in weight is noted.

Figure 4: applying Aquaseal

4 Results

4.1 Aquacore

4.1.1 400W/m³

The first experiment was conducted at a power density of 400W/m³, the measurements taken are displayed in Diagram 1. The weight settles after about 90 minutes, no defects were found on visual inspection.

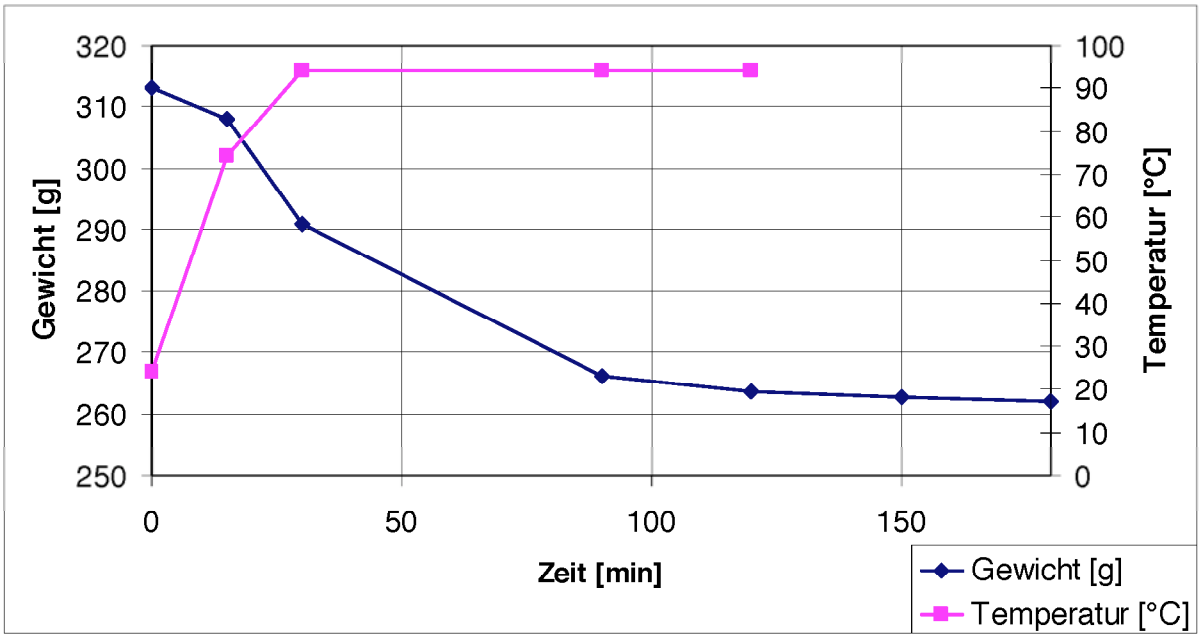


Diagram 1: Aquacore dried at 400W/m³

4.1.2 1000W/m³

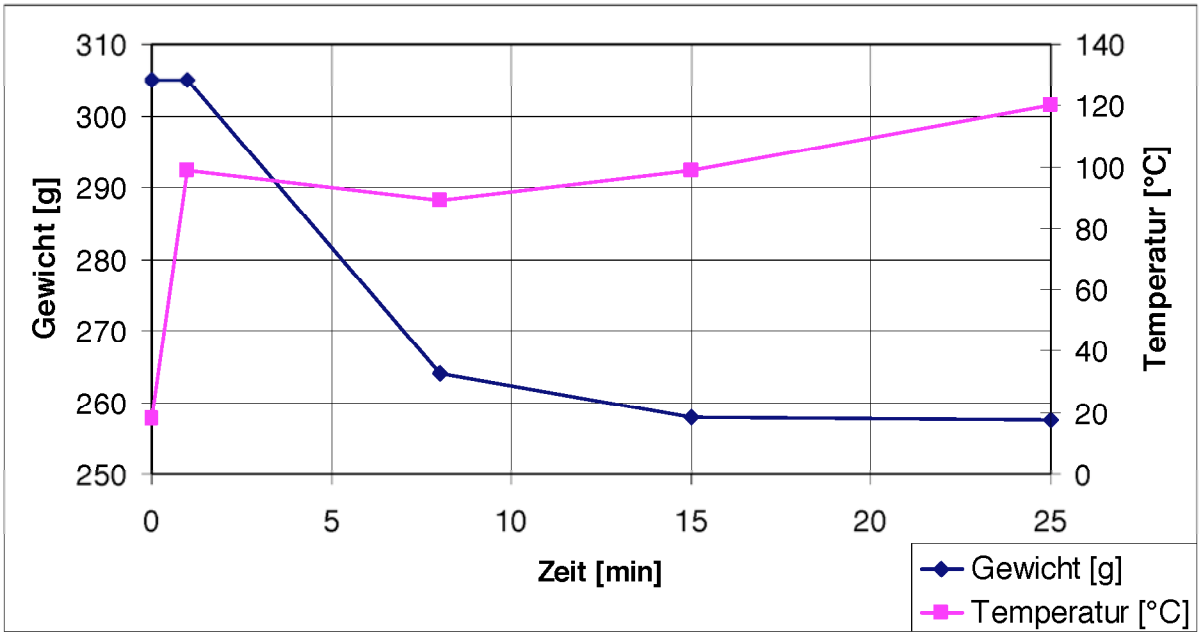


Diagram 2: Aquacore dried at 1000W/m³

At 1000W/m^3 the specimen had completely dried after 15 minutes. Measurements can be found in Diagram 2. No defects could be found on visual inspection.

4.1.3 2000W/m³

The measurements of Aquacore dried at 2000W/m³ can be found in Table 1 as well as Diagram 3. According to these the specimen dried within 7 minutes. The weight decreased exponentially while temperature increases at a rate of 120°C/min up to the boiling point of water and remains at this level for about 4 minutes. As the water content decreases the temperature rises further. Visual inspection reveals no grave defects, only the surface of the supporting plate has left a small imprint in the specimen. The dried specimen can be seen in Fig. 5.

Figure 5: Aquacore specimen at 2000W/m³

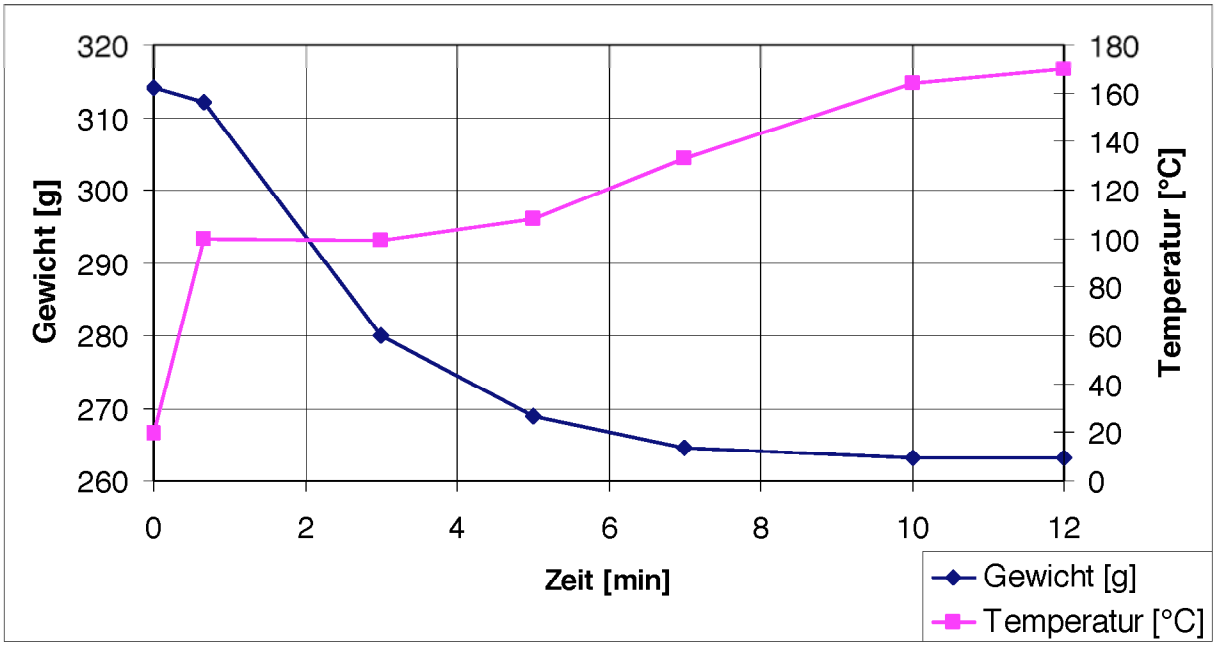


Diagram 3: Aquacore dried at 2000W/m³

Zeit [min]	0	0,66	3	5	7	10	12
Gewicht [g]	314	312	280	269	264	263	263
Temperatur[°C]	20	99	99	108	133	164	172

Tabelle 1: Aquacore dried at 2000 W/m³

4.1.4 Conclusion

Drying of Aquacore can be greatly accelerated by using a microwave oven instead of a conventional following the manufacturer's specifications. Since Aquacore is very porous the generated steam can escape at a sufficient rate.The drying time is presumably limited because of temporary softening in the border regions. This behaviour remains subject to further investigation.

4.2 Aquapour

4.2.1 400W/m³ und 300W/m³

The first experiment with Aquapour is conducted at a power density of 400W/m³. Upon application of microwave energy the temperature rises almost linearly to 79°C within 26 minutes. At that point the specimen is destroyed in an explosion. Its remains can be seen in Fig. 6. Application of 300W/m³ also results in a somewhat less violent destruction of the specimen.

Figure 6: destroyed specimen at 400 W/m³

4.2.2 200W/m³

Safe drying of Aquapour was achieved at 200W/m³. The results of this experiment can be seen in Diagram 4 and Table 2. Measurements indicate that the specimen has completely dried after 180 minutes. Up to that point weight, and consequently water content, decrease linearly. Temperature increases up to the boiling point of water after 45 minutes. 105 minutes into the experiment the temperature starts to decrease again.

Figure 7: destroyed specimen at 300W/m³

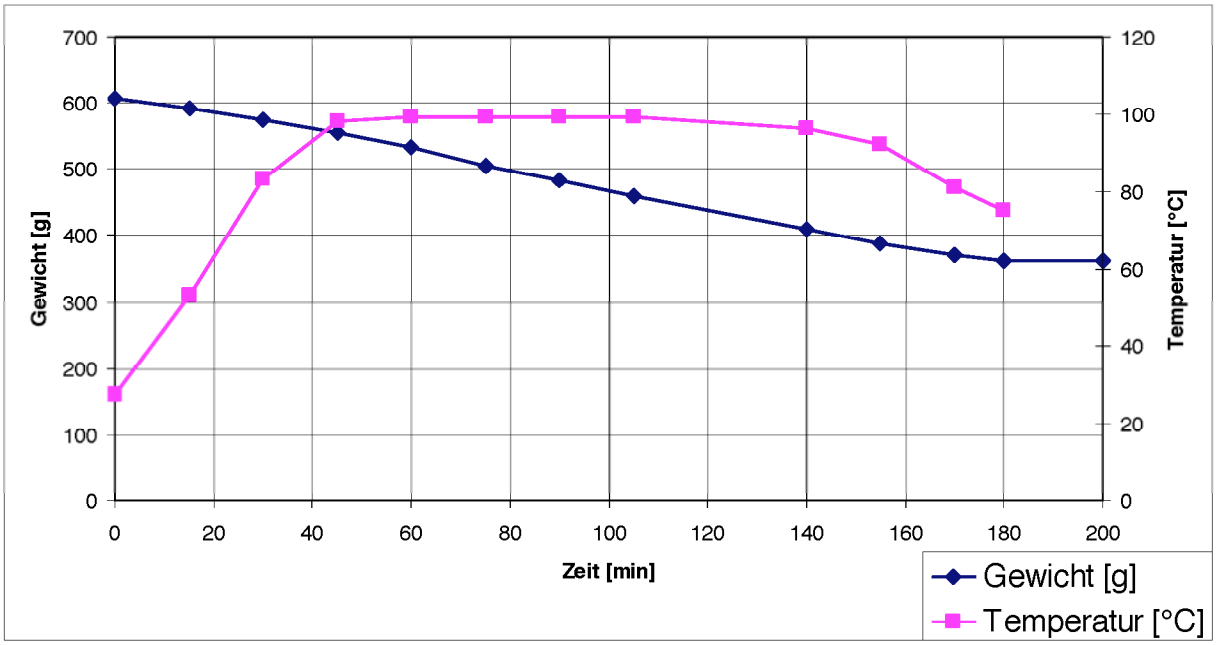


Diagram 4: Aquapour dried at 200W/m³

Zeit [min]	0	15	30	45	60	75	90	105	140	155	170	180	200
Gewicht [g]	607	592	574	555	533	506	483	460	409	388	369	362	362
Temperatur[°C]	27	53	83	98	99	99	99	99	96	92	81	75	

Table 2: Aquapour dried at 200 W/m³

4.2.3 Conclusion

Specifications for Aquapour state a drying time of about 1,5 hours per inch of thickness. These drying speeds can also be achieved using microwave heating.
Drying time is limited by the material's low porosity. Since the developing steam can not escape quickly enough, resulting in an explosion.
It should be noted that the microwave oven used was not designed for drying processes. It is possible that e.g. a different atmosphere inside the cavity could accelerate drying.

4.3 Aquaseal

The drying of Aquaseal using microwave heating was examined at different powers and using different substrates. The results obtained from the experiments can be found in Table 5. The diagram shows that the drying time depends on sealant thickness as well as applied power.
Bad results were obtained only for thick coats and using a power density of 2000W/m³. This experiment resulted in a rough surface interspersed with bubbles as can be seen in Fig. 8.

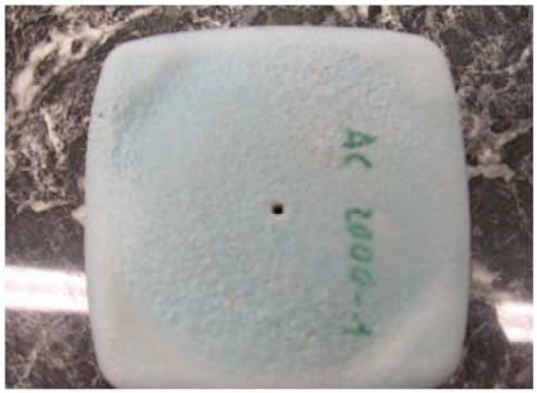


Figure 8: drying at 2000W/m³

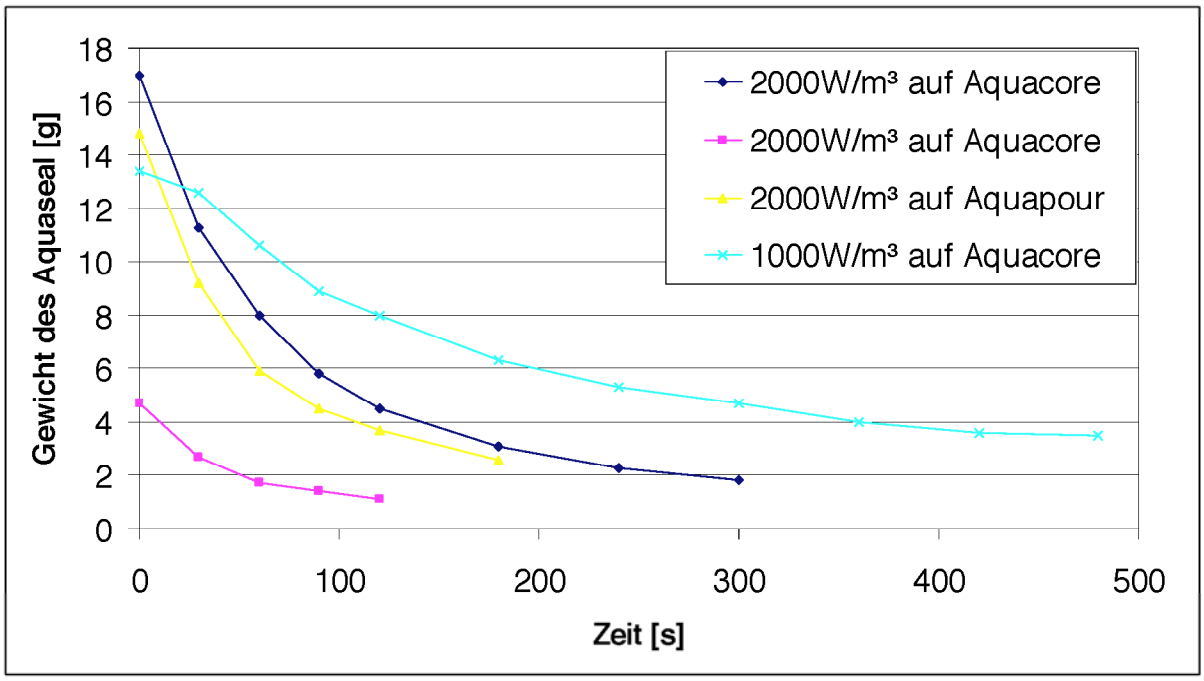


Diagram 5: drying of Aquaseal

4.3.1 Conclusion

The higher the radiated power, the shorter the drying time, as can be seen by comparing the drying process of Aquaseal on Aquacore at 1000W/m³ versus 2000W/m³.
The lower the amount of Aquaseal used, the thinner the layer. Thinner layers result in decreased drying time, although the drying time does not quite decrease at the same rate as the thickness.
Drying time is limited because for thick layers the radiated power has to be reduced, e.g. at 2000W/m³ a 17g coat of Aquacore will blister while 5g of Aquacore will dry at the same power without adverse effect.
A comparison shows that the same amount of releasing agent applied to Aquacore or Aquapour and then dried at the same power level will induce blistering with Aquacore but not with Aquacore. In general Aquaseal will dry slightly quicker on Aquacore.