

Self-desiccation of Self- Levelling Flooring Products and Investigations of Different Measurement Methods

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SAMMANFATTNING

Titel: Självtorkning av Avjämningsmassor och Undersökning av Fuktmätningmetoder.

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Bakgrund: Avjämningsmassor används främst på golv av betong. Deras syfte är att jämna ut golvet och göra det plant. Det faktum att de är självtjämnande betyder att de likt vatten fördelas ut på golvet innan de hårdnar till en plan massa. Vissa av dessa produkter marknadsförs också som självtorkande. Ett citat från en stor leverantör på den svenska marknaden angående deras självtorkande avjämningsmassor lyder: ”I en självtorkande produkt står de kemiska reaktionerna och de fysikaliska processerna för huvuddelen av torkningen. Dessa produkter är avsedda för tidig ytbeläggning. RF i produkten är vid tidig ytbeläggning fortfarande hög, men sjunker sedan med tiden allteftersom de inre processerna fortgår. Fuktmätning av självtorkande produkter före ytbeläggning är därför inte relevant”. Då avjämningsmassor appliceras sent i byggprocessen, så är det av intresse att de stelnar snabbt och därför innehåller mer bindemedel och mindre vatten. Självtorkning betyder att fritt vatten binds kemiskt till materialet i sådan utsträckning att den relativa fuktigheten sjunker. I betong har självtorkningen en stor betydelse för betongens torkning och det kan vara av intresse att undersöka om så också är fallet för avjämningsmassor eller om torkningen måste ske med hjälp av ytavdunstning. När till exempel en parkett eller en PVC matta skall appliceras på ett golv, så är det av betydelse att golvet inte avger för mycket fukt till materialet som senare kan orsaka problem för inneklimatet i rummet.

Syfte: Syftet med detta examensarbete var att undersöka två olika typer av avjämningsmassor och olika metoder att mäta självtorkning med. Det finns ett stort antal metoder som kan användas, där metoder för mätning av relativ fuktighet är vanliga i Sverige och metoder för att mäta fuktkvot är vanliga i andra Europeiska länder.

Metod:

Gjutningar av två typer av avjämningsmassor utfördes och hydrationsprocessen skedde i ett rum med temperatur på runt 20 °C. En stor del av provkropparna förslöts så att ingen uttorkning skulle ske mot omgivande klimat, sänkningar i relativ fuktighet skulle då ses som en validering av självuttorkning. Provkroppar lämnades också för att torka till omgivande klimat för att se inverkan av ytavdunstningen. Genom att också använda olika metoder att lagra och extrahera prover så kunde skillnader i fuktnivåer på grund av detta upptäckas. Följande metoder användes i detta projekt:

- Isoterm Kalorimeter med inbyggda RH-sensorer.
- RH-sensorer i stora glasflaskor.
- RH-sensorer i provrör
- Torkning av prover i ugn 65°C
- Torkning av prover i ugn 105°C
- Mätning av fuktkvot med en karbidmätare
- Mätning av MVER (Moisture Vapour Emission Rate) med Kalciumkloridmetoden.

Slutsatser:

Ingen av produkterna visade någon självuttorkning i den mening att den relativa fuktigheten sänktes genom bindning av fritt vatten kemiskt, då provkropparna var förseglade mot omgivande klimat. Relativ fuktighet och fuktkvot beskriver olika aspekter av fukttillståndet i ett material och därför är vår åsikt att en kombination av de två är att föredra när man utvärderar fukttillståndet i ett material.

Nyckelord:

self-levelling compounds, moisture content, relative humidity, oven drying, carbide method, isothermal calorimeter

ABSTRACT

Title: Self-Desiccation of Self-Levelling Flooring Products and Investigations of Different Moisture Measurement Methods

Authors: Christoffer Smith and Simon Tikkanen Jönn

Supervisors: Lars Wadsö, Building Materials, Lund University
Andre Mayer, Chief Technology Officer, Bostik SA

Background: Self-levelling flooring compounds (SLCs) are mainly used on concrete floors. Their purpose is to smooth the floors and make them horizontal. The fact that they are self-levelling means that they spread out like water over the floor before hardening to a horizontal layer. Some of them are also advertised as being self-desiccating. A quote from a big manufacturer on the Swedish market regarding their self-desiccating SLCs is: “In a self-desiccating product the chemical reactions and the physical processes represents the majority of the dehydration. These products are used when early surface coating is needed. RH in the product is during the time of the early surface coating still high, but decrease as the inner processes continues. Moisture measurement for these products before surface coating is therefore not relevant”. As the products are applied late in the building process it is often of interest that they hydrate quickly and contain less water and more binder. Self-desiccation means that free water is removed by chemical reactions in the hydration process, to such a high degree that the relative humidity (RH) of the system decreases. In concrete products self-desiccation can be of importance as such products can dry without external drying and it is of interest to investigate whether this is of the same importance for SLCs as well, or if the SLCs always mainly dry by surface evaporation. When e.g. a carpet or parquet shall be placed on floor it is important that the floor does not give away too much moisture that can cause problems with regard to the floor covering

Purpose: The purpose of this master thesis was to evaluate two types of SLCs and different methods for measuring self-desiccation. There are a number of methods that can be used, for example, relative humidity based methods mostly used in Sweden and moisture content based methods used in many other European countries.

Method:

Two self-levelling flooring products were cast and their moisture states were followed at 20 °C. Some samples were sealed during the hydration process, so there was no drying to the ambient air. Any decrease in relative humidity in such samples would be a validation of self-desiccation. Other samples were allowed to dry to the ambient to see the impact of surface evaporation. With different extracting and storing methods differences in moisture levels due to such aspects could be evaluated. These following methods were used:

- Isothermal calorimetry with built in RH sensors.
- RH-sensors in large glass jars.
- RH-sensors in test tubes.
- Drying samples at 65°C at different times.
- Drying samples at 105°C at different times.
- Measurement of moisture content by a carbide meter at different times.
- Measurement with the calcium chloride method at different times.

Conclusions:

None of the products tested showed self-desiccation in the meaning of a decrease in RH when the samples were prevented from drying to the ambient air. RH and moisture content describes different aspects of the moisture state of a material and therefore it is our opinion that a combination of the two is to be preferred when evaluating moisture conditions.

Keywords:

self-levelling compounds, moisture content, relative humidity, oven drying, carbide method, isothermal calorimeter.

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1 GLOSSARY

Nomenclature

a_w	Water activity	1
m	Mass	g
u	Moisture content	1
φ	Relative humidity	1
p	Pressure	Pa
p_s	Saturation pressure	Pa
v	Vapour content	g/m^3
v_s	Saturation vapour content	g/m^3
T	Temperature	$^{\circ}\text{C}$

Abbreviations

MC	Moisture Content
MVER	Moisture Vapour Emission Rate
PA	Product A
PB	Product B
RH	Relative Humidity
SLC	Self-levelling Compound
PC	Portland Cement
CAC	Calcium Aluminate Cement

Chemical short-hand notation for cementitious materials

C	CaO
A	Al_2O_3 ,
S	SiO_2
$\bar{\text{S}}$	SO_3
F	Fe_2O_3
H	H_2O

2 INTRODUCTION

2.1 Background

Too high moisture levels in newly cast cement based materials can cause problems. As cement based materials often are in contact with moisture sensitive materials (linoleum carpets, wood), knowledge about the moisture properties in the cement based material is of importance. When e.g. a carpet or parquet shall be placed on the floor the cement based material should not give away too much moisture that can cause floor covering stability issues and other issues in the indoor environment.

Self-levelling flooring compounds (SLCs) are mainly used on concrete floors. Their purpose is to smooth out the floor and make it horizontal. The fact that they are self-levelling means that they spread out like water over the floor before hardening to a horizontal layer. Some of them are also advertised as being self-desiccating and a quote from a big manufacturer on the Swedish market regarding their self-desiccating SLCs is: “In a self-desiccating product the chemical reactions and the physical processes represents the majority of the dehydration. These products are used when early surface coating is needed. Relative humidity (RH) in the product is during the time of the early surface coating still high, but decreases as the inner processes continues. Moisture measurement for these products before surface coating is therefore not relevant”. As the products are applied late in the construction process it is often of interest that they dry quickly. Self-desiccation means that free water is removed by chemical reactions in the hydration process, to such a high degree that the RH of the system decreases [1]. In concrete products with low water/cement ratios the self-desiccation is of importance in the drying process and it is of interest to investigate whether this is also the case for SLCs, or if SLCs mainly dry by surface evaporation.

2.2 Purpose of project

The purpose of this master thesis was to evaluate two types of SLCs and different methods to determine self-desiccation. There are a number of methods that can be used. Among others, relative humidity based methods mostly used in Sweden and moisture content (MC) based methods used in many other European countries. The objectives of this master thesis project were:

- Study and compare common methods to assess self-desiccation of SLCs.
- Study two commercial SLCs self-desiccation, and analyse whether the chemical binding in SLCs have an impact on RH and whether SLCs are self-desiccating.
- Evaluate the impact of surface evaporation in the drying process of SLCs.
- Study the reaction rate of two commercial SLCs in an isothermal calorimeter.
- Compare RH and MC as ways of assessing the moisture state of SLCs.

2.3 Limitations

There are many different SLCs on the market. In this project only two SLC products with unknown contents have been tested. The results and conclusions should not be generalized to SLCs in general or to any specific type of SLCs, but should only be seen valid for two commercial SLCs. As the recipe and composition of both SLCs were unknown to the writers of this report, no information and analysis of the ingredients and the chemical composition have

been done. Long term aspects have not been studied in this report. Tests have only been made during a period of up to 14 days. In this project all samples were cast in small/medium-sized vials, plastic Petri dishes or in formwork, so there would be no drying to a (concrete) substrate. Drying was achieved through self-desiccation or self-desiccation combined with surface evaporation.

3 MOISTURE

Nearly all materials contain moisture and although many materials are dependent on moisture, too high moisture states can cause unfavourable consequences for the materials' structure and properties. Too much moisture in a material often leads to unwanted processes such as mould growth, frost damage or emissions. Water can be found in different phases (solid, gas or liquid) depending on the ambient temperature and pressure. In this Chapter, interactions between water, air and materials will be described.

3.1 Moisture in air

Building materials are surrounded by air. When they are porous, they contain air that is in contact with the ambient air. When studying moisture conditions in building materials' it is therefore of importance to include the surrounding air's ability to gain and emit moisture.

Air is a mixture of different gases, mainly nitrogen, oxygen and water vapour. The level of water vapour in the air has a major influence on the water conditions in building materials'. The amount of water vapour in the air is usually expressed as vapour content v (g/m^3) or vapour pressure p (Pa) [2].

Vapour content is the mass concentration of water in the air. The air can hold a limited amount of water at a certain temperature. This is called the saturation vapour content v_s (g/m^3). The vapour content cannot be higher than the saturation vapour content as the excess will condense [2]. The vapour content can be calculated from the vapour pressure using the ideal gas law, see Eq. 1.

$$p = 461.4 \cdot (T + 273.15) \cdot v \quad (1)$$

Where T ($^{\circ}\text{C}$).

The ratio between vapour content v and saturation vapour content v_s , is of interest when studying moisture conditions in building materials and is called relative humidity (RH), φ (1), see Eq. 2 [2].

$$\varphi = \frac{p}{p_s} = \frac{v}{v_s} \quad (2)$$

3.2 Moisture in materials

3.2.1 Chemically and physically bound water

In porous materials water can be bound as chemically and physically compounds. Chemically bound water is water that has reacted chemically and formed a material such as when the mixing water in cement-based materials is bound to the binding cement. Chemically bound water is strongly bound to the material, because water is a chemical constituent of the material. Physically bound water is defined as moisture. It can be removed from the material by drying without damaging the material. Physically bound water can be bound to a material by adsorption and capillary condensation [3].

Adsorption occurs when water molecules are bound to solid materials by weak forces like van der Waal interactions. When the ambient air has low relative humidity, only one or a few layers of molecules can be bound to a material's inner surfaces. If the relative humidity increases more layers of molecules can be bound [2]. The amount of adsorbed water, is a function of the RH and temperature of the ambient air [3].

Capillary condensation is when a positive interaction between water vapour and the surfaces of small pores causes the pores to be filled with liquid water [4]. When the attractive forces between water molecules and the material are strong enough a concave water surface (menisci) is formed. A water molecule approaching the menisci is more attracted to the menisci than to a flat liquid surface as seen in Figure 1. Due to this, the water molecule can be merged into the menisci at a lower relative humidity than for a flat liquid surface. The water molecule can therefore condense into the menisci at an RH lower than 100%. This phenomenon is called capillary condensation [5].

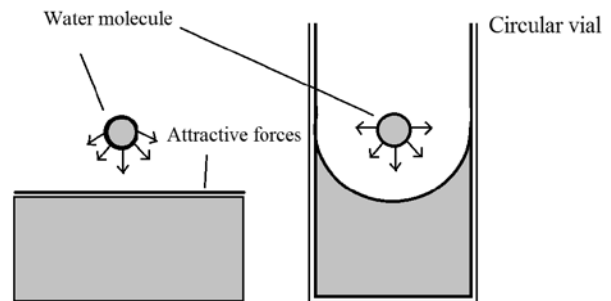


Figure 1- Attraction forces to water surface [5].

Capillary condensation takes place in a pore when the RH increases above a certain critical value, which is a function of the radius of the pore. For example, only nano meter (10^{-9}) sized pores will be filled at 60% RH, while also micro meter (10^{-6}) size pores will be filled at 99.9% RH. Figure 2 shows how capillary condensation can occur in a pore with a varying pore radius [2].

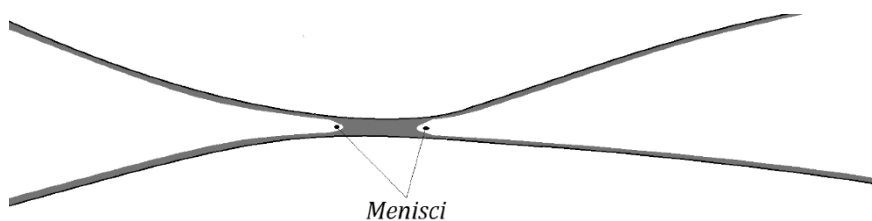


Figure 2 - Water menisci caused by capillary condensation [16].

3.2.2 Water activity

Water activity indicates how strong water is bound, not only chemically but also physically in materials and its tendency to escape from a material [6]. Water activity expresses the availability of moisture in materials and it is believed that the rates of many processes involving water are primarily dependent on the water activity such as for example mould growth. However, chemical and biological processes may also be dependent on transport properties which are not explained by water activity, here MC may be better to use [1].

At normal temperatures and pressures, the numerical value of the water activity a_w (1) is very similar to the ratio between vapour pressure p (Pa) of water in equilibrium with the moisture state of a material and the vapour pressure of pure water p_s (Pa) at the same temperature, i.e., the RH [7] (the definition of water activity is made in terms of fugacity, not vapour pressure, but the differences between these are negligible at normal conditions). Note that water activity

is not the same as RH though they are strongly linked to each other. RH is the ratio of the vapour pressure of air to its saturation vapour pressure. When vapour and temperature equilibrium is obtained between the ambient air and a material (as for an example in a sealed container after some time); the numerical value of the water activity and RH are equal to another, see Eq.3 [6].

$$a_w = \frac{p}{p_0} = \varphi \quad (3)$$

3.2.3 Moisture content

The total amount of physically bound water can be stated in different ways. It is common to use moisture content (MC) u (1) of the dry mass to quantify the amount of water in a material. Within the building materials' field MC is commonly defined as the mass of physically water divided by the dry mass of the material (dry moisture content). The MC can be determined by determine a material's wet mass m_{wet} before and dry mass m_{dry} after it has been dried, see Eq.4 [2].

$$u_{dry} = \frac{\text{mass of evaporable water}}{\text{dry mass of material}} = \frac{m_{wet} - m_{dry}}{m_{dry}} \quad (4)$$

In other fields, for example food science, it is common to define MC as mass of water divided by the wet mass of the material (wet moisture content), see Eq.5.

$$u_{wet} = \frac{\text{mass of evaporable water}}{\text{wet mass of material}} = \frac{m_{wet} - m_{dry}}{m_{wet}} \quad (5)$$

u_{wet} can be recalculated to u_{dry} by taking u_{wet} and solve for m_{dry} , see Eq.6

$$m_{dry} = m_{wet}(1 - u_w) \quad (6)$$

Insert the solved m_{dry} into Eq. 4 for u_{dry} , see Eq.7.

$$u_{dry} = \frac{m_{wet} - (m_{wet}(1 - u_{wet}))}{m_{wet}(1 - u_{wet})} = \frac{u_{wet}}{1 - u_{dry}} \quad (7)$$

MC is a quantitative way of measuring the amount of water that is present in a sample. MC determination is important in specifying recipes and monitoring drying processes. However, MC alone is not a reliable predictor of microbial and chemical processes. This is for example obvious for two porous materials that are identical in all aspects (matrix material, pore size) except that one of them has twice the porosity of the other and will thus have twice the MC, but

the situation in each pore is the same. MC does not describe how available the water in a material is, because the water can be bound differently in different materials [6]. The MC depends on how a sample is dried, as more moisture is usually lost when the sample is dried at higher temperatures (or in, e.g., vacuum). The distinction between physical and chemically bound water is also often hard to determine in practice as both physical and chemically bound water can be bound more or less tightly [6].

3.2.3.1 Sorption isotherms

Materials absorb vapour from the surrounding air and at equilibrium, the amount of water absorbed by a material, is primarily a function of the surrounding RH. This gives a relation between the amount of moisture in a material and the RH in the air which makes it possible to describe how much water a material absorbs at different RH levels. This relation is called sorption isotherm. An example of a sorption isotherm is given in Figure 3 [2].

When vapour-moisture equilibrium is achieved, it is possible to measure the state of the water in the material by knowing the ambient relative humidity of the material. Sorption isotherms differ between different materials due to different morphology and composition [5]. The sorption isotherm can also change with time, for example due to hydration processes when a hydraulic binder material reacts with water and the pore structure becomes finer at higher degrees of hydration [1]. As mentioned above, sorption occurs mainly by two processes: adsorption and capillary condensation which together are called absorption.

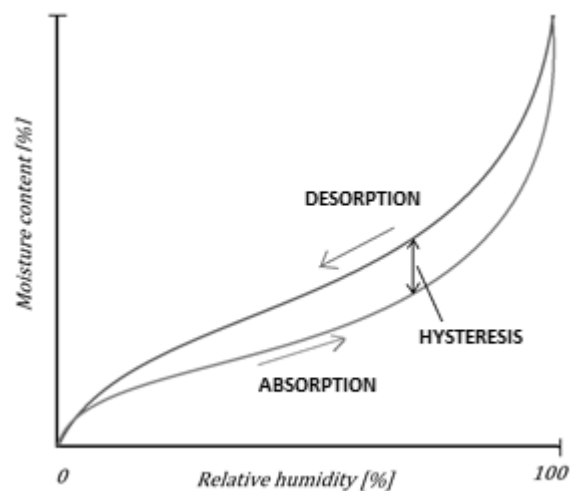


Figure 3 - Sorption isotherm [2].

Hysteresis is the differences between adsorption and desorption, shown in Figure 3. During desorption the porous material contains more moisture than what it can absorb at any given RH [2]. Hysteresis may occur because of several reasons, see Anderberg [1].

3.2.4 Critical moisture state

Many materials found in buildings can be degraded at high levels of moisture. This does for example apply to floor coverings. Damage due to moisture can for example be moisture induced movements (shrinkage, swelling), decomposition of the flooring material, or hydrolysis of the floor adhesives. It can also be biological infestation of moulds. The critical moisture condition is the point at which, if this level is exceeded, damage such as the ones mentioned above can occur (see examples of acceptable RH in floor coverings in Hens [8]). Critical moisture conditions can be expressed both as RH and MC, and there is debate which of these is most relevant.

3.3 Moisture transport

Moisture transport in porous media occurs when there is a presence of driving forces. There are two different forces when it comes to moisture transport, the concentration gradient and the

external pressure gradient. External pressure gradients are for example convection by the wind forcing the moisture through the material [1].

There are two types of moisture transport cause by a concentration gradient, vapour and liquid transport. In pores that not are water filled vapour transport occurs due to vapour diffusion [1]. Diffusion occur when water molecules moves randomly from an area of high concentration to an area with lower concentration of water molecules [2].

4 SELF-LEVELLING FLOORING COMPOUNDS

4.1 Background

The aim with self-levelling flooring compounds (SLC) is to create a smooth surface for the final flooring. Depending on the recipe of an SLC its application is made in layers normally between 1 mm to 20 mm on different types of substrates as for example concrete [9]. The first SLC with pumpable characteristics was developed in the middle of the 1970s [10]. It was made of Portland cement as a binder together with a flowing agent based on casein. This product made it possible to produce horizontal smooth surfaces by a pumpable mortar, instead of being forced to after-treat the concrete surface. The product gained much popularity on the Swedish market and was in the beginning of the 1980s used on nearly 90% of the concrete floors produced [10].

In 2000, Nordic producers of SLC developed new formulas without casein. The casein was replaced by flowing agents that were synthetic, in addition the binders were also changed. They were instead made by mixtures of aluminate cements, different calcium sulphates and Portland cements [10]. This improved the characteristics of the product, making the compound less aggressive to other materials and compounds due to lower pH levels. Today SLC is used in Sweden on a large scale, approximately 70 % of the produced floors in Sweden are levelled with SLC with synthetic flowing agents [10].

SLC used in Sweden are primarily composed of binders, redispersible polymers, filling materials and admixtures [10]. The different binders are usually a mixture of calcium aluminate cement (CAC), Portland cement (PC) and different forms of calcium sulphates ($C\bar{S}H_x$) [9]. Anderberg [10] explains that this formula gives a binder system with rapid drying, rapid hardening and shrinkage compensation with rather high water to binder ratios. To improve the surface resistance to abrasion and improve the flexural and tensile strengths a redispersible polymer powder is also added. The polymer powder can be described as a secondary interspersed binder system as the particles of the polymer coalesce and forms a film. Sand and finely grain ground mineral materials are used as aggregates. Different additives control for example curing time, flowing characteristics, setting time, separation and entrainment of air. Normal SLCs contain about 15 different ingredients, which makes them complex products [10].

4.2 Hydration process of inorganic binders

Inorganic binders purpose is to hold solid particles together in for example concrete. They are normally divided into two groups, hydraulic (reacts with water) and non-hydraulic (reacts with other substances) [10].

4.2.1 Portland cement

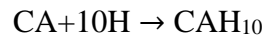
Portland Cement (PC) is a calcium silicate cement, which is produced by burning a mixture of limestone and clay at 1500 °C [11]. The main clinker components are forms of Alite (C_3S), Belite (C_2S), Ferrite (C_4AF) and Aluminate (C_3A). The main hydration products C-S-H and CH are from the reaction of C_3S and C_2S with water [12].

Hydration of PC is an exothermal process and its heat production can be measured with an isothermal calorimeter (explained in next chapter). A lot of such measurements have been made on PC pastes and mortars and these results are usually quite simple compared to the heat production from SLC-systems (see examples in Wadsö et.al [13]). The heat production for

SLCs can differ significant from product to product because of the additives which gives SLCs their self-levelling properties.

4.2.2 Calcium aluminate cement

CAC normally has bauxite and limestone as raw materials. The raw material is melted at 1500-1600 °C and then cooled and grounded [10]. When pure CAC hydrates, different formations of aluminate hydrates are formed depending on the temperature [12]. An example for low temperature, is given below:



These formations are metastable phases and will convert to more stable phases such as hydrogarnet (C_3AH_6) and gibbsite (AH_3) over time [12]. These hydration products are not as voluminous and makes the product weaker, which limits its usage [10].



CAC is the most important type of special cement and its characteristics are resistance to sulphate attack and a rapid strength development [10]. Newman et.al [14] describes some more of the characteristics of CACs:

- As the main binder of concretes with special uses, for example concretes that needs to have
 - High resistance towards chemical attack, for example acids.
 - High abrasion resistance.
 - Resistance to high temperatures and temperature changes.
- As a component in blended systems, e.g. SLCs.

The strength development of CAC is much faster than for PC. This is because when the aluminium cement is mixed with water the clinker components dissolves from the cement grains and the products of the reaction are formed in the solution. This is in contrast to PC, where the reaction products are formed on the grains of the cement and therefore slows down further reaction [10].

4.2.3 Calcium sulphate

Calcium sulphates ($C\bar{S}H_x$) are added to cement mixes for different reasons, such as, enabling self-desiccation at high water to binder ratios, shrinkage compensation and to prevent flash-setting in PC. They exist in numerous forms, with different quantities of structural water and can be found both as natural- and industrial products. Calcium sulphates are usually grouped into three groups, anhydrite ($C\bar{S}$), hemihydrate ($C\bar{S}H_{0,5}$) and dihydrate (gypsum) ($C\bar{S}H_2$). Mixed with water, anhydrite needs an accelerator to form gypsum, while hemihydrate relatively fast forms gypsum without an accelerator [10].

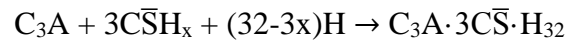
4.2.4 Combinations of inorganic binders

Aluminium cement and calcium sulphate

When CAC and calcium sulphates reacts with water, ettringite and aluminate hydrates are the main reaction products. As long as sulphates are available, a fast formation of ettringite occurs.

Almost 50% of the weight of ettringite is water and therefore combinations of inorganic binders are often used in products where self-desiccation is desired [10].

In SLCs it is common to combine different inorganic binders. The most common of such combinations is the ternary blend of CAC, Calcium sulphate and PC. The hydration of such blend produces ettringite ($C_3A \cdot 3\bar{C}\bar{S} \cdot H_{32}$) and aluminate hydrates. A typical reaction is presented below [12].



Note that this reaction consumes a significant amount of water (H_{32}) which is wanted for self-desiccation.

If dehydrate ($\bar{C}\bar{S}H_2$) or hemihydrate ($\bar{C}\bar{S}H_{0.5}$) is blended with C_3A before mixing with water the initial reaction is controlled, as a layer of protective ettringite is formed on the surface of the C_3A crystals. [11].

4.3 Drying process

According to Anderberg [10] there are three different processes involved when SLCs are drying. These processes are as follows:

- Self-desiccation
- Surface evaporation
- Flow of moisture to the substrate

4.3.1 Self-desiccation

Self-desiccation occurs both from chemical and physical binding of water. As the hydration process proceeds the reactions consumes both water and binder. Both the water and binder are chemically bound in the reaction products. A part of the mixing water will thereby become chemically bound in the material [10]. During the hydration a fine pore system is also created which is capable of binding water physically by capillary condensation and surface adsorption [10].

All materials where water reacts with a binder and turns into a solid exhibits a self-desiccating effect. This effect occurs for example in all cement-based materials. There are only for a few products the drying by only self-desiccation is adequate to meet the requirements regarding approved moisture states. Often drying by surface evaporation is needed in order to meet the requirements in different applications [1].

Chemical binding of water

Hydration is a process when water reacts with binders, e.g. cement and calcium sulphate and becomes chemically bound in the reaction products. The hydration rate is dependent on moisture state, temperature, the degree of hydration and the admixtures [1]. To determine the amount of chemically bound water in PC-based materials the most common way is to first dry the material at 105 °C. This releases the water that is physically bound and when the physically bound water is released, the material can be heated to approximately 1100 °C, to release the chemically bound water. SLCs are usually dried at lower temperatures as it is believed that drying in temperatures exceeding 60 °C may release some of the chemically bound water [1].

Physical binding of water

In the pore system created by the hydration process water is bound both as surface adsorption and capillary condensation [10]. Water is physically bound to surfaces and water menisci in the pore system that is being developed in the hydration process [1]. This makes the sorption isotherm of an SLC change as the chemical binding of water proceeds and the pore structure develops [1]. The sorption capacity is greater at higher degree of hydration. This is because the pores become finer at higher degree of hydration. Materials that are cement-based have large areas of inner surface and pores radii in the nano meter (10^{-9}) range. This means that even at a relatively low RH (for example at 60%) they are capable of holding capillary condensed water [1]. Apart from capillary water, water is also physically bound as surface adsorption. To determine the amount of physically bound water in materials the most common way is to dry the material at 105°C and measure the moisture released. The proper drying temperature for SLCs has been debated. There are thoughts that even drying at a temperature of 40°C may release some of the chemically bound water [1]. A recent study by Baquerizo et.al [15], showed that ettringite (the most common reaction product in SLCs) could release chemically bound water in temperatures of $50\text{-}80^{\circ}\text{C}$ in combination with low RH($<10\%$).

4.3.2 Surface evaporation

Surface evaporation is another phenomenon to take into consideration when an SLC is drying. It starts immediately as the mixing begins. After the compound is cast, transport of water up to the surface (bleeding) occurs, which forms a water film on the surface of the compound [1]. The rate of surface evaporation during this early stage depends primarily on the RH of the ambient, the temperature and air speed over the surface. When 1-2 hours have passed the main hydration reaction starts which turns the liquid compound into a solid. A moisture distribution then develops through the compound as the surface and the material gradually dries. When this has occurred the evaporation from the surface strongly depends on the transport of moisture from the inner part of the material to the surface of the material [1].

4.3.3 Moisture transport to the substrate

Another factor affecting the drying process of SLC is moisture transport to the substrate, depending on which material the SLC is cast on. Normally SLC is cast on concrete, but sometimes on other materials as well [1]. Moisture from the SLC can then be transported down into the material. To reduce this transport a primer is normally applied on the concrete before casting the SLC, which decreases the initial moisture transport to the substrate significantly. Even though a primer is used the moisture will redistribute between the SLC and the substrate in a longer perspective. This makes the moisture state of the substrate and SLC important in the long-term period [1].

5 MEASUREMENT METHODS

In this chapter a short description of the methods used is presented (a more thorough description will be presented in chapter 6).

5.1 Standards

For estimating materials moisture states, adequate testing methods are required so the results are reliable and valid. Such testing methods are presented in different standard documents. Different standards are described below and the standards includes different testing methods for different materials [16].

ISO	International Organization for Standardization
EN	CEN, Comité Européen de Normalisation
ASTM	American Society for Testing and Material
BS	British Standards Institution
DIN	Deutsches Institut für Normung
NF	AFNOR, Association Française de Normalisation

5.2 Oven drying method

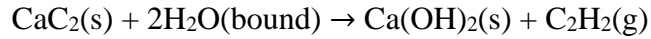
In the oven drying method, the relative humidity in the air is reduced by an increase in temperature. Warm air can contain more water until it is saturated as its saturation vapour pressure is higher. The sample loses moisture to the air until the sample reaches the relative humidity equilibrium condition at the temperature of the oven [17]. The mobility of the water molecules is also higher at higher temperature. These are the reasons why drying at 105°C is much faster than drying at lower temperatures.

The principal of determining water content with the oven drying method is to weight the wet mass m_{wet} of the sample using a balance. Thereafter the sample is dried in the oven at a constant temperature until a constant mass is reached. Constant mass is considered, e.g. when less than 1% of MC has been lost during a 1 h period. Then remove the sample from the oven, let it cool in a dry environment, and record the mass as the dry mass m_{dry} . Determine the MC by using Eq.4 [18].

5.3 Calcium Carbide method

The calcium carbide method is based on a heterogeneous reaction of a solid (carbide) and physically bound water in a material [17]. During the reaction acetylene gas (C_2H_2) is produced which increases the pressure in a steel bottle which can be measured by a manometer on the bottle. By knowing the acetylene pressure, the temperature and the volume of the vessel, the water content of the sample can be calculated [19]. This measurement method is suitable to determine the water content of a sample because when a water molecule is consumed, the same amount of acetylene is always formed [17].

The following chemical formula describes the reaction with water (H_2O) and calcium carbide (CaC_2):



Calcium carbide + Water Calcium hydroxide + Acetylene

To determine the MC with this method a special carbide meter (CM) is required. This meter consists of two parts, a steel pressure bottle and a manometer for pressure readings. The procedure starts with placing 4 steel balls, a carbide ampoule and the weighed crushed test sample in the bottle and closing it [17]. The CM device is then shaken vigorously and the reaction starts with the shattering of the calcium carbide ampoule, so that the carbide starts reacting with the water in the test sample. By rotating the CM device in a circular movement it is ensured that all of the water in the test sample reacts with the calcium carbide. The result from the experiment can later be read from the manometer as the pressure increases in the bottle. This pressure is thereafter converted to MC of the test sample by using a conversion table, Appendix 11.1 [17]. The measured MC is commonly stated as the wet MC (not explicitly stated in the manual of the instrument used).

5.4 Calcium Chloride method

This test method as described by Brickman [20], aims to measure the concrete moisture vapour emission rate (MVER). Dry calcium chloride acts as a drying agent, so when the water molecules have reacted with the calcium chloride they are not released again. Calcium chloride used for the testing should not contain any water. The totally dry calcium chloride crystals are kept in a sealed plastic dish stored until they are used for the test [20].

The dish containing the dry calcium chloride is weighed. On the test site, the dish with calcium chloride is placed under a dome-shaped hood of transparent plastic with sealed flanges, see Figure 4. The dish is then left in this position for 60-72 hours and afterwards the dish is immediately weighed [20]. The increase in weight is equal to the amount of water that the calcium chloride attracted. The difference in weight is afterwards used together with the area of the hood and the dish, and the time of exposure to calculate the MVER, Eq.8 [20]. The quantity of vapour being emitted is measured in pounds of moisture released over a 1000 ft² area during a period of 24-hours. This unit can be transformed to SI-unit by multiplying the result with 56.51. The unit obtained then is µg/(s m²) [21].



Figure 4 – Dry calcium chloride placed under a dome-shaped hood.

$$\text{MVER} = \frac{52.91 \cdot \Delta M}{A \cdot t} \quad (8)$$

Where:

- MVER moisture vapour emission rate, lb/1000 ft²/24 h
- ΔM change in mass, in grams.
- A Contact area of the flanged cover on concrete in ft² deducting the area of the CaCl₂ dish
- t exposure time in hours.

5.5 Isothermal Calorimetry

Calorimetry is the measurement of heat and heat production. Isothermal (heat conduction) calorimeters determine the thermal power from samples under isothermal conditions which may be used as a measure of reaction rate [22].

ASTM C1689 [23] describes that an isothermal calorimeter consists of a heat sink in a thermostat. It also includes two heat flow sensors placed on the heat sink, each with a specimen vial holder connected to each heat sensor. The fresh mixture of a cementitious material is placed in one vial holder and in the other a thermally inert material is placed as a reference, see Figure 5. The inert specimen is made of non-reactive material with similar thermal properties as the testing sample. The heat flow from the reacting specimen passes the heat flow sensor and is measured. The output of the calorimeter is the differences in heat flow between both specimens. The fact that the heat is allowed to drift away from the specimen, makes it possible to maintain essentially constant temperature (isothermal conditions) [23].

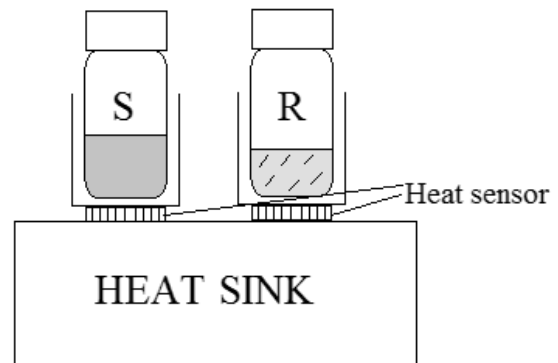


Figure 5 - Isothermal calorimetry consisting of a vial holder with a sample (S) and a vial holder with the reference specimen (R), [31]

5.6 RH-sensor

An RH-sensor is used to determine the RH of in an extracted sample or inside a material. Most such sensors are based on the capacitive measurement principle as the capacitance of materials increase with increasing MC. The sensor is produced from a hygroscopic material, that absorbs/desorbs moisture from/to the air until it is in equilibrium with the surrounding air [24]. The type of RH-sensor that is shown in Figure 6 is used for determine RH of an extracted sample, where RH, temperature and dew point is determined and presented on the screen.



Figure 6- Capacitive RH-sensor (Testo 605-H1) attached on a test tube with a sample

6 EXPERIMENTS

Tests were performed on two anonymous SLC products that we call PA and PB. In this chapter the mixing procedure, the sample extraction methods, and measurement procedures will be presented in detail. Table 1 describes the measurement methods used and with which storing and extraction method.

Table 1 - Moisture measurement methods used in this project

Moisture measurement methods	<i>20 ml vials</i>	<i>500 ml vials</i>	<i>Mould with three prisms (40 mm x 40 mm x 160 mm)</i> <i>both sealed and open</i>	<i>Petri dishes</i> <i>both sealed and open</i>	<i>From floor; samples taken out by core drilling</i>	<i>Measurement made directly on floor.</i>
<i>RH-sensor (continuous measurement)</i>		X				
<i>Calorimeter with RH-sensor (continuous measurement)</i>	X					
<i>RH-sensor extracted sample</i>				X		
<i>Oven drying 65 °C</i>	X		X	X	X	
<i>Oven drying 105 °C</i>	X				X	
<i>Carbide method</i>	X				X	
<i>Calcium chloride method</i>						X

6.1 Mixing procedure

The mixing procedure was performed according to the manufacturer's instructions. A few days before casting a container was filled with water and left in the laboratory to obtain room temperature water. Both products were mixed with a ratio 6/25 (Water/SLC-powder) at the lowest mixing speed. The following mixing procedure was used for all mixtures:

1. Weigh up room temperate water in a bowl.
2. Weigh up the SLC powder.
3. Pour the SLC powder into the water and start mixing with the kitchen mixer.
4. Mix for 30 seconds (1 minute for prism samples)
5. Let the screed rest for 1 minute (5 minutes for prism samples)
6. A second mix during 15 seconds
7. Pore the SLC into a container within 10 minutes

6.2 Casting samples

6.2.1 Casting in small containers

Due to the small amount of SLC that was required for each casting, the mixing was executed with an ordinary household mixer, see Figure 7. This was done for the castings in moulds, 500 ml vials, 20 ml vials and Petri dishes, see Figure 8. The weighing was performed with a balance with an accuracy of 0.1 grams. After mixing, the SLC was poured into the vials or forms. This process is described below.



Figure 7 - Mixing with household mixer.

Closed 20 ml vials

After mixing, the SLC was poured into 20 ml vials, with the aid of a funnel. They were filled with approximately 12 ml of SLC. Then a lid was attached to seal the samples from the ambient.

Plastic Petri dish

SLC was poured into plastic Petri dishes with radii of 3 cm and height of 1 cm. Half of the samples were not sealed from the ambient and half of the samples were sealed from the ambient. All sealed samples had a lid attached after casting and were put into moisture tight plastic bags that were sealed with moisture tight tape.

Closed 500 ml bottles

Approximately 400 ml of SLC was cast directly in each glass bottle, which was sealed by an airtight lid to which an RH-measurer later would be connected.

Mould with prisms'

Three prisms could be cast in each mould. Tests were made for both sealed and non-sealed samples. After mixing the SLC was poured into the mould. The samples that were going to be sealed were put into two plastic bags which were sealed with moisture resistant tape.



Figure 8 - From left to right: 20 ml PE vials, plastic Petri dish, 500 ml vial and a mould for prisms.

6.2.2 Floor casting

The formwork for the floor casting had the dimensions of 700 mm × 700 mm × 15 mm. As only self-desiccation was to be studied the forms needed to be covered with plastic. Figure 9 shows a corner of the form and how the pieces were attached to the ground plate. Preparations were made for the plastic cover that would later seal the floor from ambient air after casting and the cover was attached to the form with a vapour-tight sealing tape.



Figure 9 - From left to right: plastic sealed corner of the form and the completed form with a plastic cover attached to it.

A larger amount of SLC needed to be prepared for the floor casting. A balance with a higher range and an accuracy of 1 gram was used for the weighing of water and SLC powder. One batch was prepared for each form. A mixer attached to a drilling machine suitable for mixing larger quantities of SLCs was used. After mixing, the SLC was poured into the form. With the aid of a spatula the SLC was levelled horizontally. The floor was then sealed from the ambient air with a plastic film and the flanges were taped with the vapour-tight sealing tape, see Figure 10.

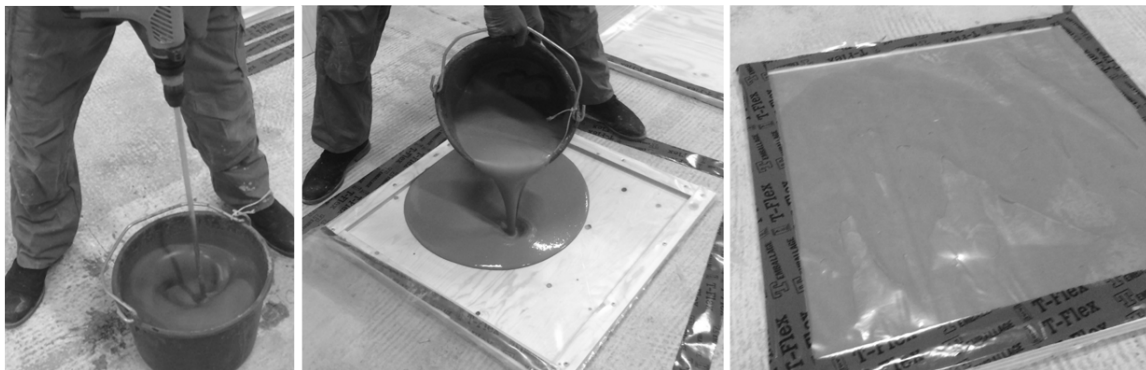


Figure 10 - From left to right: SLC mixed, poured into form and sealed after casting.

6.3 Storing of cast samples

All cast samples were stored in a laboratory. The temperature and the RH in the ambient were measured by a RH-logger, the average temperature in the room was about 20°C and the average RH was about 40% as can be seen in Appendix 11.4 and Appendix 11.5.

6.4 Sample extracting

6.4.1 Closed 20 ml vials

Before measurement each sample was extracted from the 20 ml PE vials by the following steps:

1. The material was crushed to small fragments (smaller than 10 mm) with a lump hammer when the sample was still in the vial, see Figure 11.
2. The sample was poured into a Petri-dish and the Petri-dish was then sealed.
3. These samples were tested with the oven method and carbide method.



Figure 11 - Crushing samples with lump hammer.

This process shortened the time in ambient air to prevent moisture evaporation. The pieces were to be smaller than 10 mm for the measurements to be more accurate.

6.4.2 Plastic Petri dishes

SLCs that had hydrated in both sealed and open dishes were extracted from the Petri dishes. For the closed dishes the extraction started by opening the plastic bag and the lid was quickly removed from the dish. Thereafter the procedure was the same for both types of samples, see Figure 12. The procedure was performed by the following steps:

1. The dish was gently cracked using a lump hammer to be able to obtain the SLC from it, without any plastic pieces or fractions being included.
2. Thereafter the pieces were put into a steel container where it was crushed by a lump hammer into smaller fragments (<10 mm).
3. These samples were thereafter tested with the conventional oven drying method and the RH-method.



Figure 12 – From left to right: the procedure for extracting SLCs from plastic Petri dishes

6.4.3 Mould with prisms'

The samples that were sealed were first removed from the plastic bag and then both methods were following the same procedure:

1. A chisel and lump hammer was used to extract each prism from the mould, see Figure 13.
2. Each prism was then tested by the oven method for prisms as described in 6.5.2.



Figure 13 – Extraction of prisms from the mould.

6.4.4 Floor forms

Measurements were also performed on the SLCs that were cast in floor forms. The samples were extracted by core drilling, see Figure 14. First the temperature on the surface of the SLC, where the drilling was going to occur, was measured by an IR-thermometer. Before the drilling procedure started, a drilling plate was placed on the SLC to stabilize the drill. During the drilling procedure a vacuum cleaner was used to remove dust and particles in the borehole that would otherwise create friction and heat.

The drilling was only continued for 20 seconds and after that there was a short pause, to remove debris from the borehole and the hole-saw. The procedure was repeated until the core was extracted. When the core was extracted the temperature of the core was determined and then the sample was quickly put into a plastic bag to prevent moisture to evaporate to the ambient air. The samples were then crushed inside the plastic bag with a hammer for testing with the carbide method and oven method.



Figure 14 – From left to right: measuring of temperature with IR-thermometer, core drilling with vacuum cleaner and the SLC core after extraction.

6.5 Oven drying method

During the testing two methods of determining the MC of PA and PB were used. The conventional oven method at a temperature of 65°C and 105°C and a method used for mould prisms at a temperature of 65 °C.

6.5.1 Conventional oven drying method

The following procedure was used to determine the water content of a material by drying the sample to constant mass. The samples were dried in one oven with a temperature of 105°C and one oven with a temperature of 65°C. Three different samples were prepared for each hydration time. Tests were done with PA and PB after 24 hours, 48 hours, 72 hours, 7 days and 14 days. The SLC samples were taken from closed 20 ml PE vials, Petri dishes and samples extracted by core drilling. This procedure is similar to a method described by the US Department of Transportation [18]. The following steps were used during the tests.

1. The empty container was weighed with the lid on and the mass was noted in the protocol.
2. Approximately 10 g of the SLC was placed in a glass Petri dish, see Figure 15. The Petri dish was concealed by a lid to protect the compound from drying to the ambient air. The weight measured was recorded as the wet mass.



Figure 15 - Weighing of SLC before oven drying.

3. After removing the lid, the samples were placed in the oven. The drying time was set to 24 hours for all specimens to achieve results that were comparable between the samples and the drying temperatures.
4. After 24 hours the samples were taken out from the oven and once again covered by the same lids to prevent the sample from absorbing moisture from the air, see Figure 16. They were left to cool down for at least one hour and then weighed again and the mass recorded as the dry mass.
5. The mass of the empty Petri dish was then subtracted from the mass of the Petri dish with the dry SLC to calculate the mass of the compounds dry weight. The MC in the SLC was then calculated according to Eq.8.



Figure 16 - Samples cooling after 24 hours in drying oven

6.5.2 Oven drying method for prisms

In the oven drying method for prisms, the prisms were dried at a temperature of 65°C during 6 days. The following procedure was used:

1. The SLC was cast in prism moulds according to standard EN-196-1, and weighed directly after.
2. The samples that should be sealed from the ambient were put into two plastic bags.
3. After 24 hours of hydration each mould was weighed again. This was done to see how much moisture that had evaporated.
4. After the moulds with SLC were weighed, the samples were demoulded and each sample prism was weighed. This mass was recorded as the wet mass.
 - a. First the samples that were sealed were removed from the plastic bags, and time in ambient recorded until put into oven as described in step 5.
5. Each prism was then put into an oven to dry at 65°C for 6 days.
6. After 6 days the samples were removed from the oven, placed in plastic bags, and allowed to cool so that the mass of each sample prism could be determined as the dry mass.
7. The MC was then calculated according to Eq.8.

6.6 Carbide method

In this method the MC of a sample is measured as a pressure as the water in the sample reacts with the calcium carbide forming the gas acetylene C_2H_2 . Tests were done with both PA and PB after 24 hours, 48 hours, 72 hours, 7 days and 14 days. The samples were extracted from closed 20 ml PE vials and from samples extracted from floor by core drilling. The following procedure was used while testing the SLCs in the carbide meter (CCM device Alu Classic dig, Ratdke Messtechnik) and is similar to the procedure described by DIN 18560-4:2011-03 [17].

6.6.1 Calibration

Before starting the tests, a calibration of the carbide meter was done. This was to check the accuracy and the suitability of the whole carbide meter as a system. Calibration was done in a shaded and well ventilated place.

1. The steel balls were put into the pressure bottle followed by the carbide ampule and the calibration ampule containing water. Then the bottle was sealed by attaching the manometer cover to the bottle.
2. The carbide meter was shaken vigorously for 2-3 minutes to shatter the ampules to make the reagents react with one another. The final pressure had to be within the limit of $1.00 \text{ bar} \pm 0.05 \text{ bar}$ to be accepted (0.98 bar was obtained).

6.6.2 Measurement procedure

1. About 5 grams of SLC was put on a dish and weighed. Thereafter the dish was sealed with a lid to protect it from the ambient. Time in ambient (sample exposed to ambient air moisture) was noted.
2. The sample was then quickly put in the carbide meter followed by 4 steel balls and finally the carbide ampule. The manometer was then attached to the carbide meter to seal it, see Figure 17.
3. The test was started by shaking the carbide meter vigorously.
 - a. The shaking shattered the carbide ampule, which gave an increase to the pressure reading on the manometer. The duration of the shaking was 2 min.
 - b. After 2 min shaking, the carbide meter was put on the table to rest for 3 min.
 - c. When 5 min had passed the carbide meter was shaken again for 1 minute.
 - d. Finally, the carbide meter had to rest for 4 min and after 10 min since the test started, the carbide meter was shaken for another 10 s.
4. The temperature, (see Figure 18) and pressure were noted in the protocol. A conversion table was used to convert, (Appendix 11.1), the pressure of the acetylene gas into mass of water.
5. MC was then calculated.



Figure 17 - Equipment for the carbide meter method.



Figure 18 - End temperature after measurement

6.7 Calcium Chloride method

This method measured the moisture vapour emission rate (MVER). Calcium chloride (CaCl_2) is a chemical compound that attracts water, this process works as the water molecules attaches to the CaCl_2 molecules. The following steps were used during this test and are according to the standard test method ASTM F1869-11 [21].

6.7.1 Measurement procedure

1. 16 grams of dried CaCl_2 were weighed and put in a Petri dish, which afterwards immediately was sealed with a lid to prevent the CaCl_2 to attract water from the ambient air.
2. At the test site the lid was removed from the Petri dish and placed on the SLC where the measurement was going to be conducted. Immediately afterwards a dome-shaped hood was put over the Petri dish and sealed with a sealant and a moisture-proof tape as seen in Figure 19.
3. The CaCl_2 was then left there for 72 hours.
4. After 72 hours the dome-shaped hood was cut open with a knife and the Petri dish containing CaCl_2 was directly sealed with the lid as seen in Figure 20. The exact time of this was noted in the protocol.
5. The dish with the lid on was then weighed and the mass was noted in the protocol.
6. The MVER was then calculated with Eq.9. The test results were then converted to SI units by multiplying the results with 56.51 to obtain the results in $\mu\text{g}/(\text{s m}^2)$.



Figure 19- Dome-shaped hood



Figure 20 – Cutting the dome-shaped hood open.

6.8 Isothermal calorimeter with RH-sensor

Isothermal calorimetry was used to determine the hydration kinetics in cementitious mixtures by using an isothermal calorimeter. In the present project some of the sample vials were equipped with RH-sensors that could assess the RH inside the vials. For our measurements a calorimeter called TAM Air (Thermometric, Now TA Instrument) was used, see Figure 21. It consisted of 16 channels of which 8 were used as reference channels and 8 channels were used for test samples. Each channel could hold a vial



Figure 21 - TAM Air isothermal calorimetry

of 20 ml. The RH-sensors were from the manufacturer Sensirion and were logged with a Sensirion data logger.

6.8.1 Calibration

The calorimeter was calibrated electrically. According to ASTM C1679-13 [23] calibrations should be done at regular intervals of one year or less. Each measured value is presented as mV and with the calibration coefficient for each channel the value was translated to mW.

All RH-sensors that were used in the experiment were also calibrated. This was done by exposing each sensor to saturated salt solution of KCL and KNO₃ with known RH (85% and 94%), see Figure 22.



Figure 22 - Calibrating of RH-sensors with salt brines.

6.8.2 Measurement procedure

The following steps were performed during this test:

1. As reference object, sample vials with 3 g of water were used. They were placed in the TAM Air instrument, one for each sample of SLC that was tested.
2. To obtain similar heat capacity for the SLC samples, the compound should contain 3 grams of water for each sample. Calculations were made to determine the amount of SLC which was similar to the heat capacity of 3 grams of water.
3. Before casting, the computer connected to the TAM Air equipment was activated to start measurement series. The exact time when the measurement was started was noted.
4. The SLC was cast. The exact time of when the SLC powder was added to the water was noted. About 6 ml of the SLC was poured down into each vial.

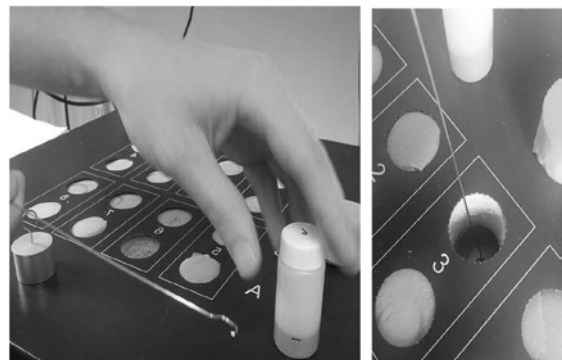


Figure 23 - Sample of SLC put down into the TAM Air machine

5. Next stage was to put the vials into the vial holder in the TAM Air as seen in Figure 23. As the TAM Air was connected to the computer, the measurement of heat generation during the hydration of the compound was conducted during a continuous period of two weeks. Four samples of PA and four samples of PB were tested.
6. After the main hydration peak had passed an RH-sensor was attached to some of the samples. The sample was lifted up from the machine using a stick with doubled sided tape.
7. The lid on the vial was thereafter exchanged to the lid with a RH sensor attached to the lid and lowered down again into the calorimeter. Insulation was used to seal the space between the cable and the hole, see Figure 24.



Figure 24 – Insulation sealing the space between hole and cable.

6.9 RH method

Sensors (Testo 605-H1) for measuring RH were used for samples cast directly into 500 ml vials and samples extracted from Petri dishes, which were crushed and poured into test tubes, see Figure 25.



Figure 25 – 500 ml vials and test tubes with attached RH-sensors

6.9.1 Calibration

Calibrations were done before measurement. The sensors were exposed to different known RHs and the values on the displays were noted in a protocol. After doing this procedure for different RH-levels, a diagram was made which presented the ratio between the displayed RH and actual RH. These calibration diagrams were used to translate the RH-values displayed to actual values.

6.9.2 Measurement procedure

The RH-measurements of 500 ml vials were continuous and all sensors stayed attached during the hydration period. Measurement was performed over a long term period and RH values were noted sporadically. The displayed value was noted and later converted into the actual RH-value.

The RH-sensors were attached to the test tube after the material had been crushed and poured into the test tubes. The test tubes were put into an insulated box until the RH value was stable. The value where thereafter noted at least 12 hours after attaching the sensor. The procedure was the same for each predetermined measurement time interval.

7 RESULTS AND DISCUSSION

In this chapter the results from the tests, as seen in Appendix 11.2, are presented and discussed. Thereafter follows a general discussion of this master thesis project. Note that in this report all results for MC is presented on a dry basis. The CM results are therefore recalculated from wet MC to dry MC (Eq. 6-7).

In most of the tests at least three measurements have been made for each time interval. The standard deviation is shown as black vertical lines at each mean value. In all the tests of PA and PB the Water/SLC-powder ratio was 0.24. This gives a MC of 24 % (dry basis) before the hydration process has started.

7.1 Oven drying 65°C

7.1.1 Closed 20 ml PE vials

Figure 26 shows measurements with oven drying (65°C) where both PA and PB have been cast in 20 ml PE vials that were sealed from the ambient air during hydration. It shows that PB has significantly lower MC than PA, already after one day of hydration. It can be seen that from 7 to 14 days of hydration the products are coming closer to each other in MC. This indicates that PA binds more water chemically relative to PB from 7 to 14 days of hydration.

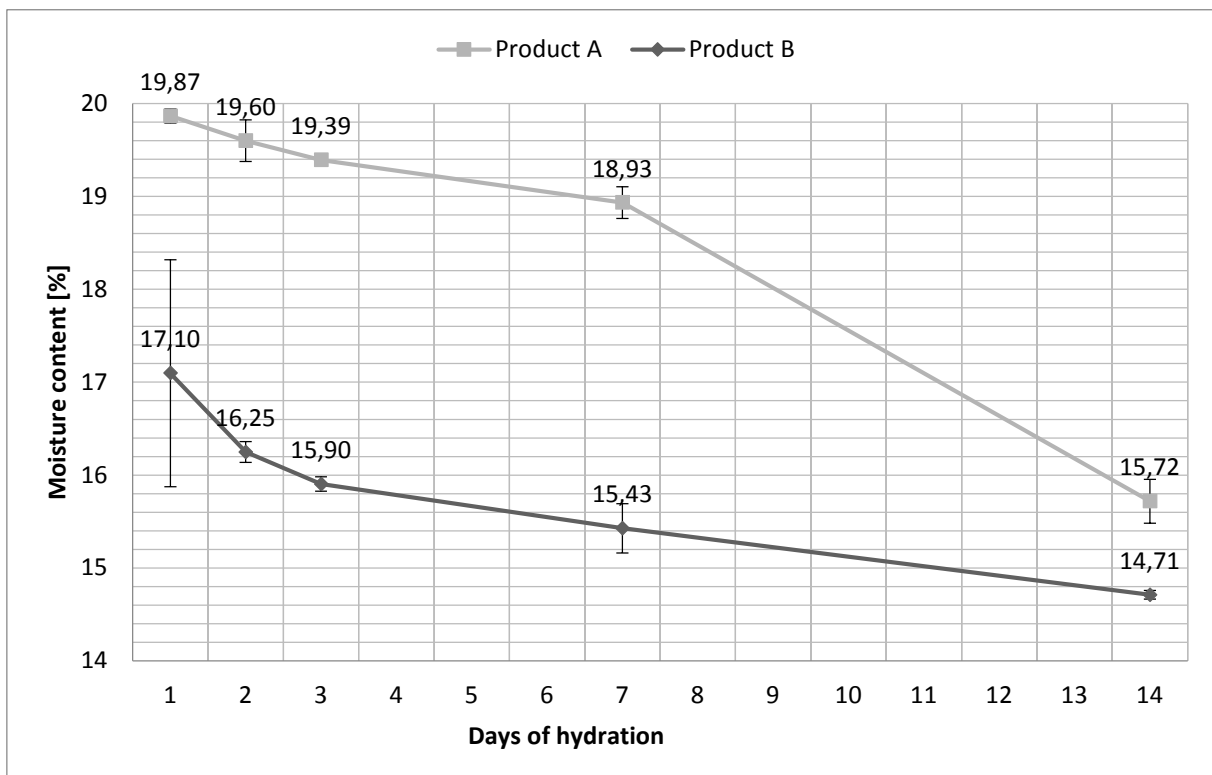


Figure 26 - Oven drying at 65°C with samples cast in 20 ml PE vials.

7.1.2 Core drilling

Samples were also extracted from the floor by core drilling and dried in an oven and the results are shown in Figure 27. As the results were similar to the results with in the 20 ml PE vials, the 7 and 14 days' measurements were not made.

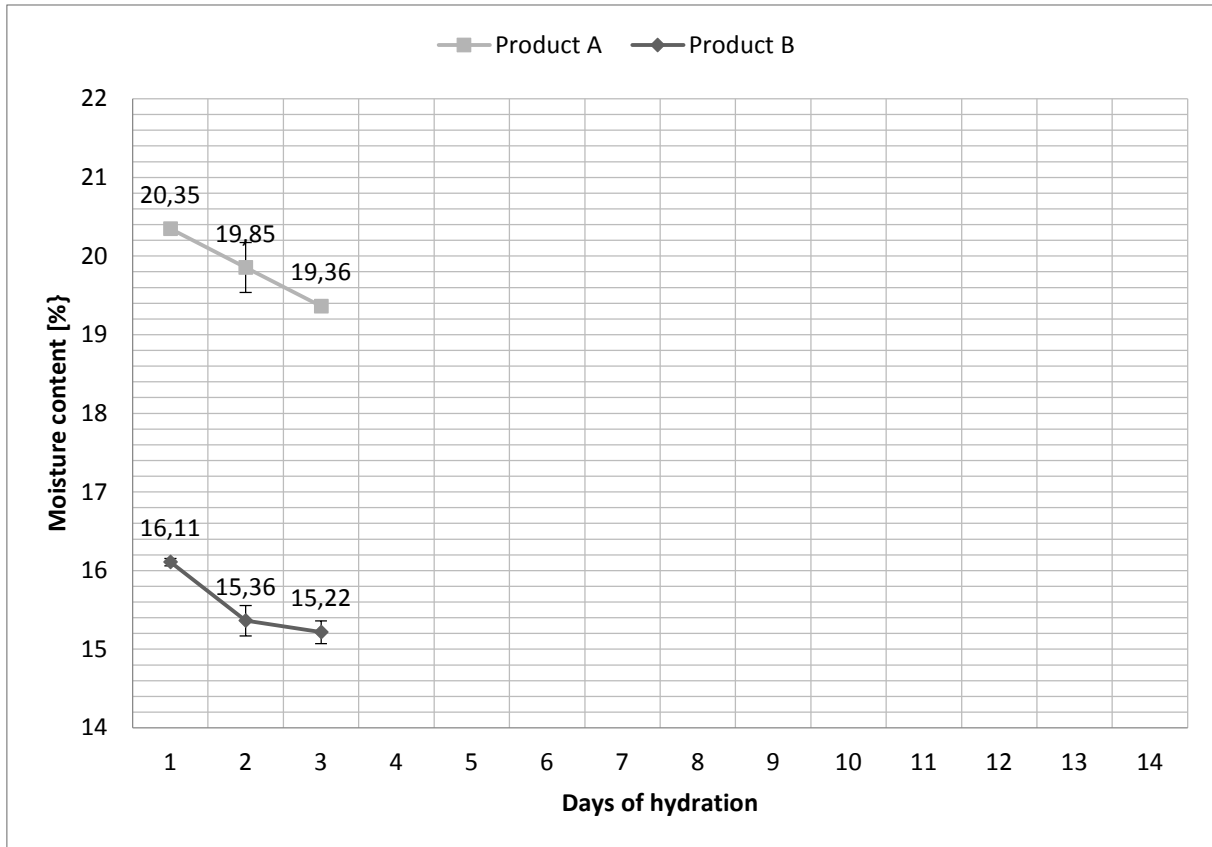


Figure 27 – Oven drying 65 °C with samples taken out by core drilling from floor.

7.1.3 Closed Petri dishes

Closed Petri dishes showed similar results as the closed 20 ml PE vials, see Figure 28.

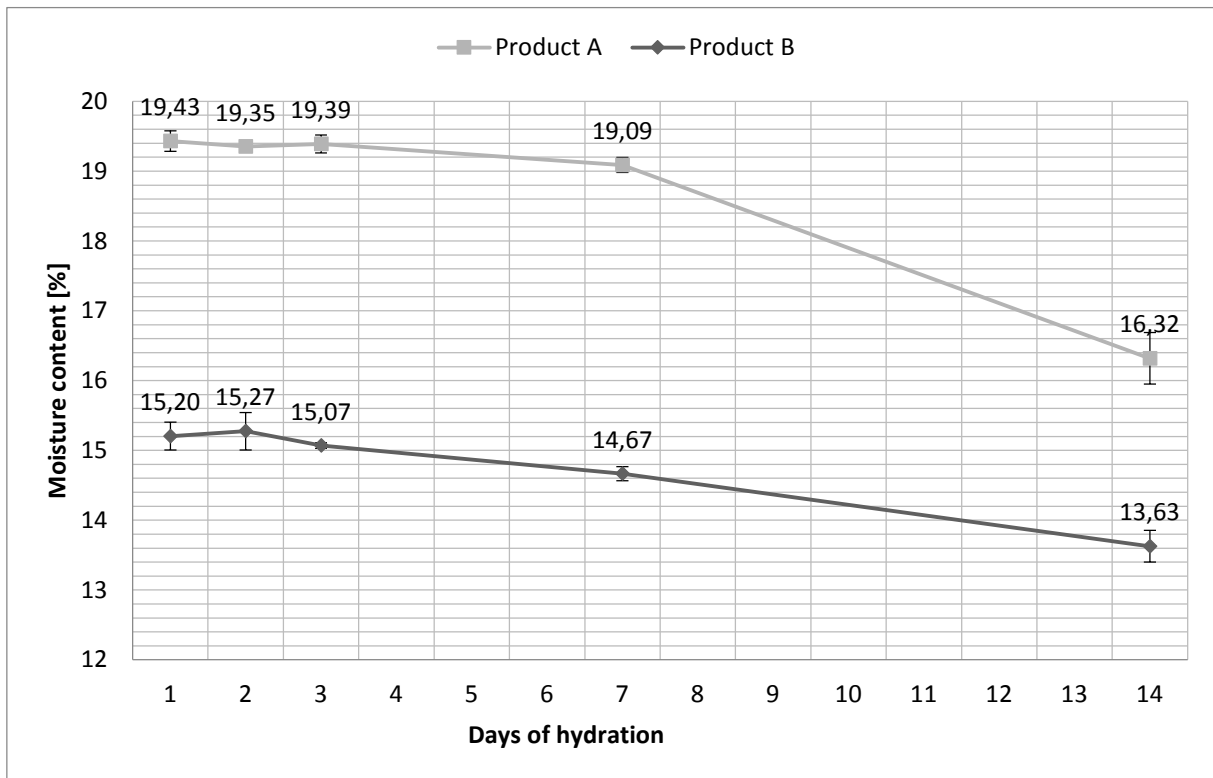


Figure 28 – Oven drying 65°C with samples from closed Petri dishes.

7.1.4 Comparison oven drying 65 °C (closed samples)

Figure 29 shows a comparison between the results from the oven drying method (65°C) with samples extracted from core drilling, 20 ml PE vials and Petri dishes. The results for PA are very similar to each other, which indicates that the measured MCs are repeatable. For PB on the other hand, there are some small differences in MC between 20 ml vials compared to core drilling and Petri dishes. Worth to notice is that PB was more difficult to drill and more heat was released due to friction, (see drilling time and temperature in Appendix 11.3). More moisture may therefore evaporate due to the increased temperature. That could explain why the MC for core drilling is lower. Condensation was noted on the sealed Petri dishes containing PB which also could be a cause to the lower MC readings as the condensed moisture could not be measured.

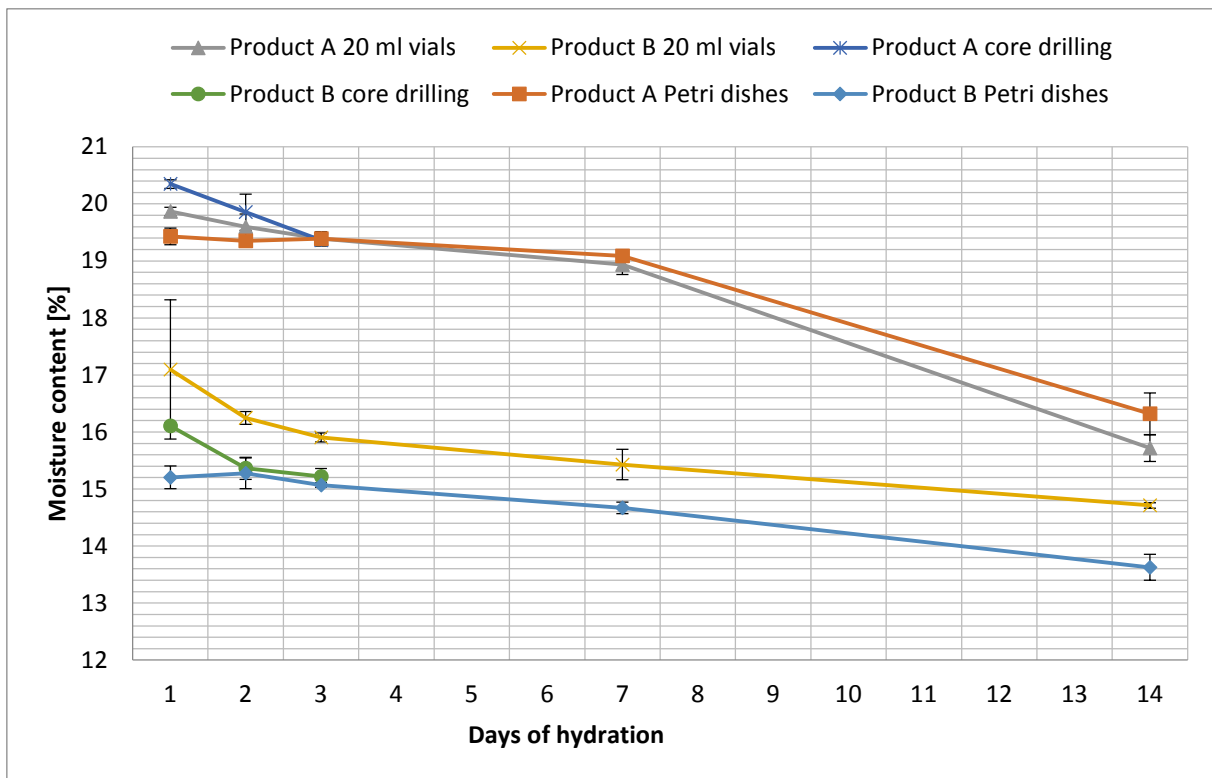


Figure 29 – Comparison oven drying at 65 °C for closed samples.

7.1.5 Open Petri dishes

Samples cast in open Petri dishes shows a different drying curve than closed samples when looking at MC. After 1 day of hydration PA and PB shows the same levels of MCs, but after 2 days of hydration PA has dried substantially compared with PB, see Figure 30. After 3 days of hydration the MC level for both products are stable.

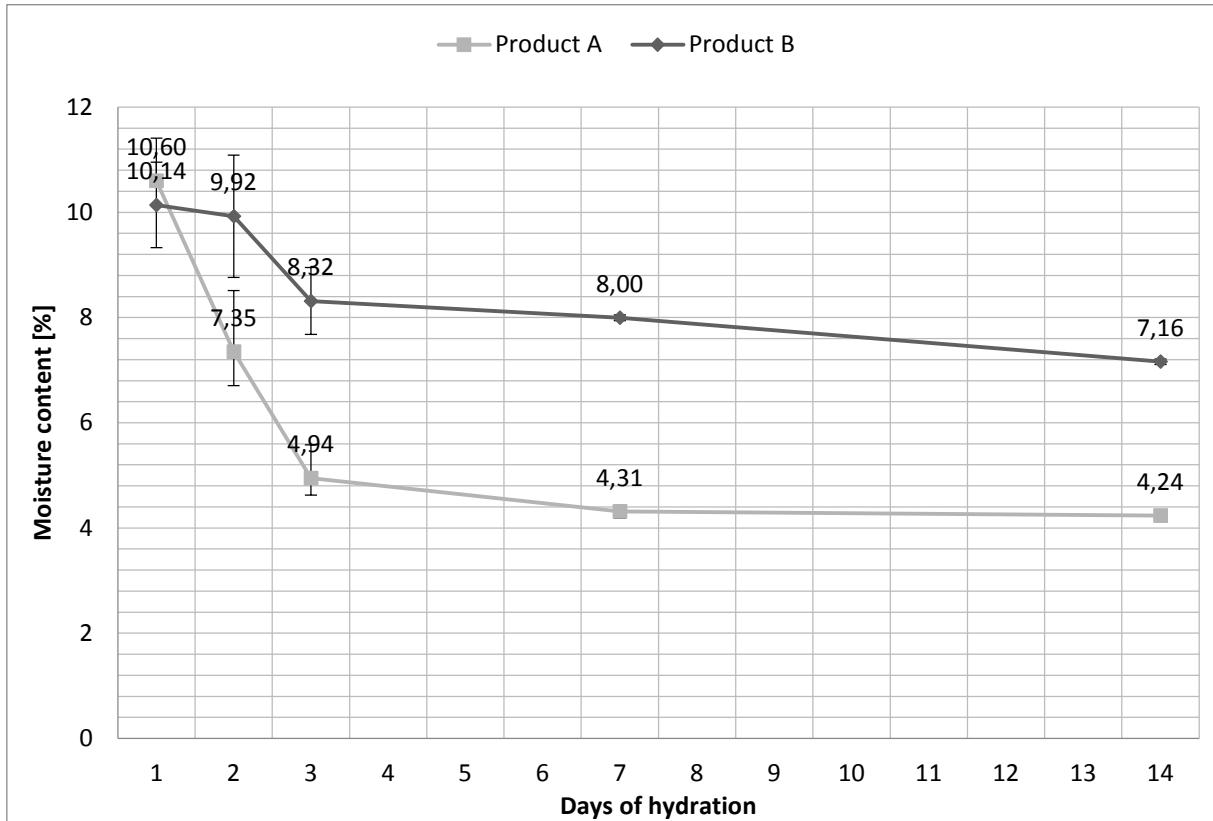


Figure 30 – Oven drying 65 °C with samples from open Petri dishes

7.1.6 Prism in moulds

In Table 2, MC is presented for prisms that have hydrated for 1 day and then dried in the oven for 6 days. For PA, the MC is similar to the closed samples in Figure 29, but the open moulds for PA has a higher MC than for Petri dishes that have hydrated with surface evaporation, see Figure 30. PB shows quite low and similar MC for both open and closed prisms.

Table 2- MC for prisms dried in oven (65 °C).

Product	MC (%)	
	Open	Closed
A	16.71	19.33
B	10.64	11.68

7.2 Oven drying 105°C

7.2.1 Closed 20 ml PE vials

Figure 31 presents result from the 105°C oven drying and the graphs for both PA and PB have a similar look as the graphs for 65°C, see Figure 26. Both products shows higher MCs for 105°C than for 65°C oven drying, as the higher temperature can dry out more moisture within the drying time (24 h) or that some structural water from the products also is lost at 105°C.

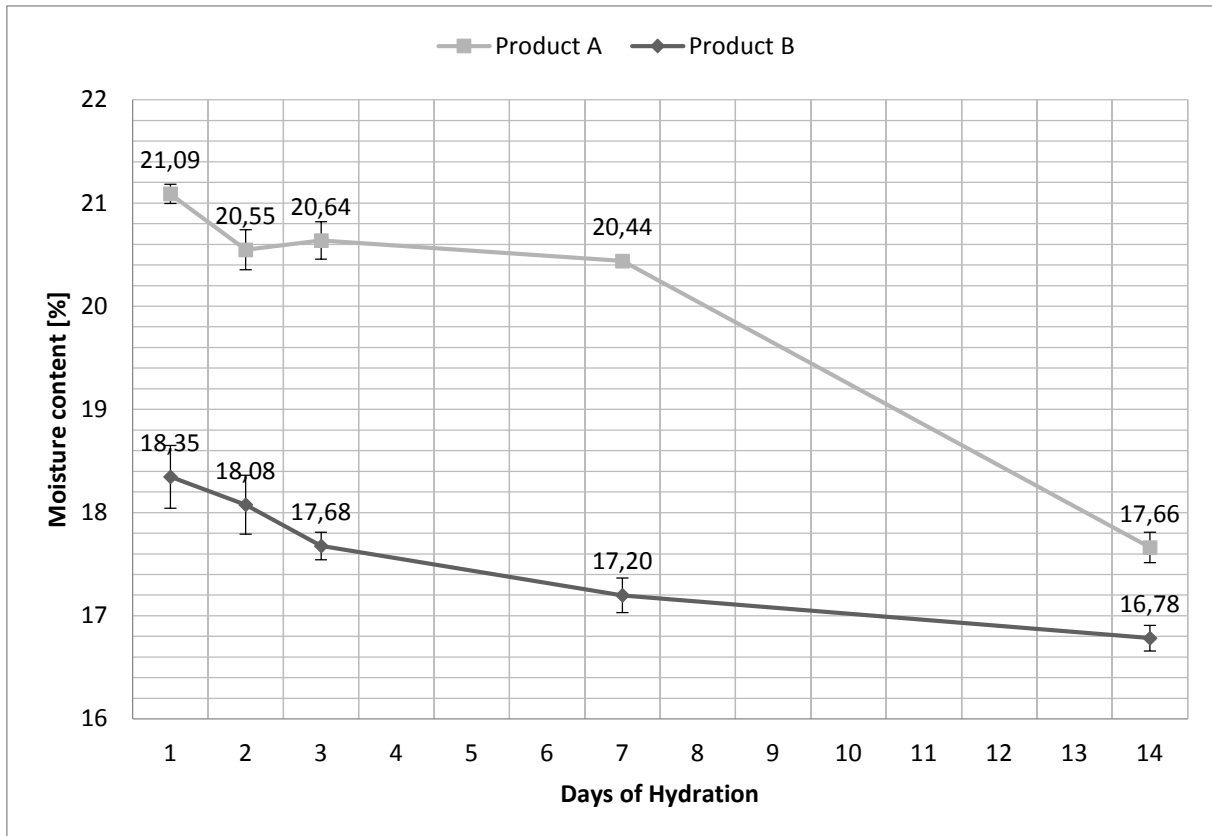


Figure 31 - Oven drying 105°C with samples cast in closed 20 ml PE vials.

7.2.2 Core drilling

As described earlier only three measurements were made for samples extracted with core drilling. In Figure 32 both products shows a minimal decrease in MC over a 3 days interval.

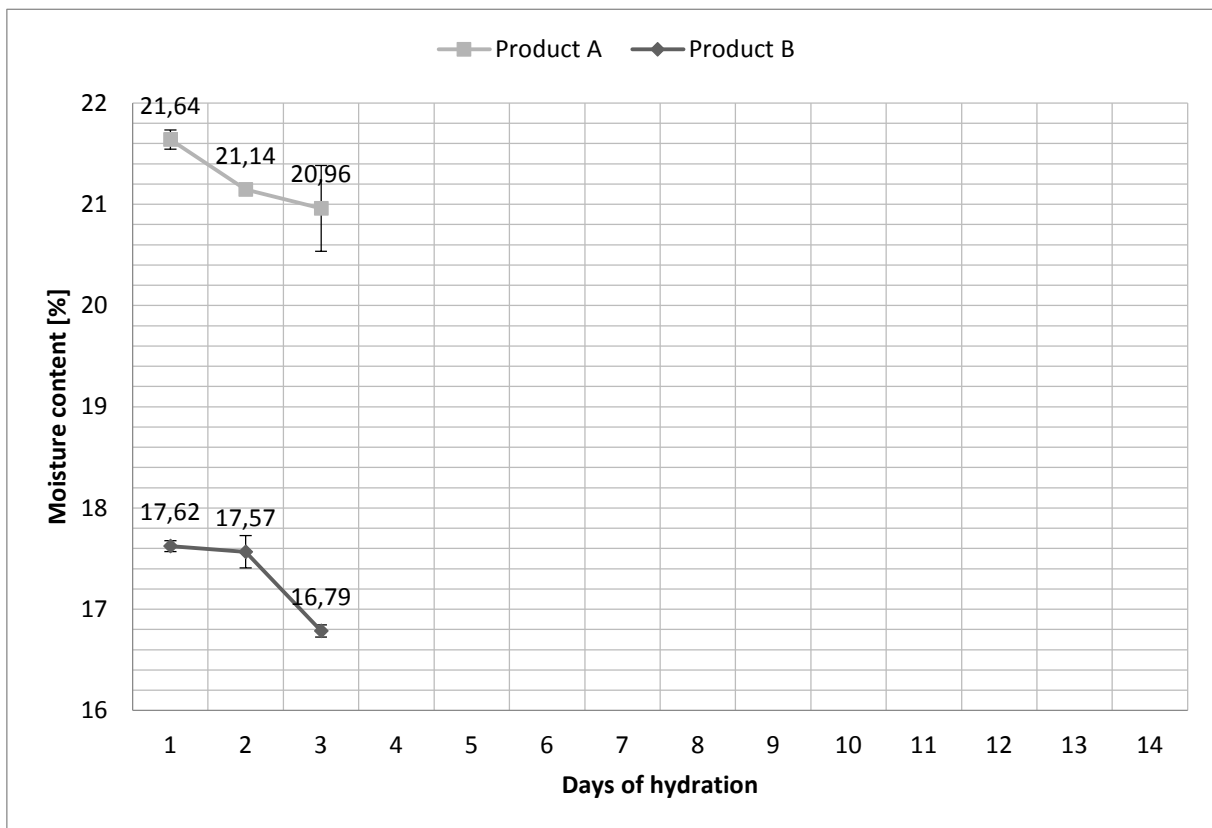


Figure 32 - Oven drying 105°C with samples taken out by core drilling from floor.

7.2.3 Comparison oven drying 105°C (closed samples)

Figure 33 compares the results from oven drying at 105°C with samples extracted from 20 ml PE vials and through core drilling from floor. As in the case with 65°C, Figure 29, the results with core drilling as extracting method shows higher moisture levels for PA, while PB shows lower moisture levels.

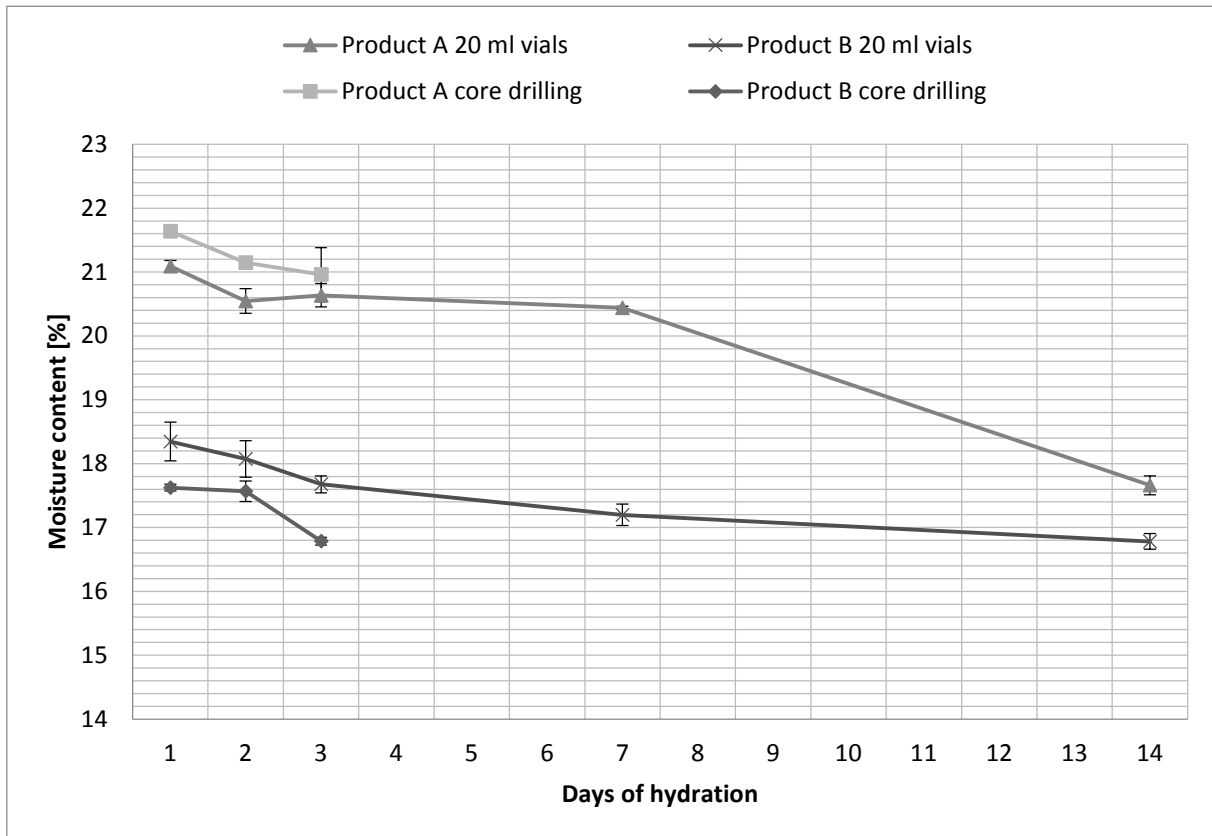


Figure 33 - Comparison of oven drying at 105°C for closed samples.

7.3 Carbide method

7.3.1 Closed 20 ml PE vials

The data shown in Figure 34 for PA, shows an increase in MC during the first 3 days of hydration, but the results have high standard deviations and it is probable that the actual MC decreases also for PA. By comparing the oven drying method and the carbide method, the carbide method shows moisture levels that are similar as the oven method, when recalculated to the dry basis.

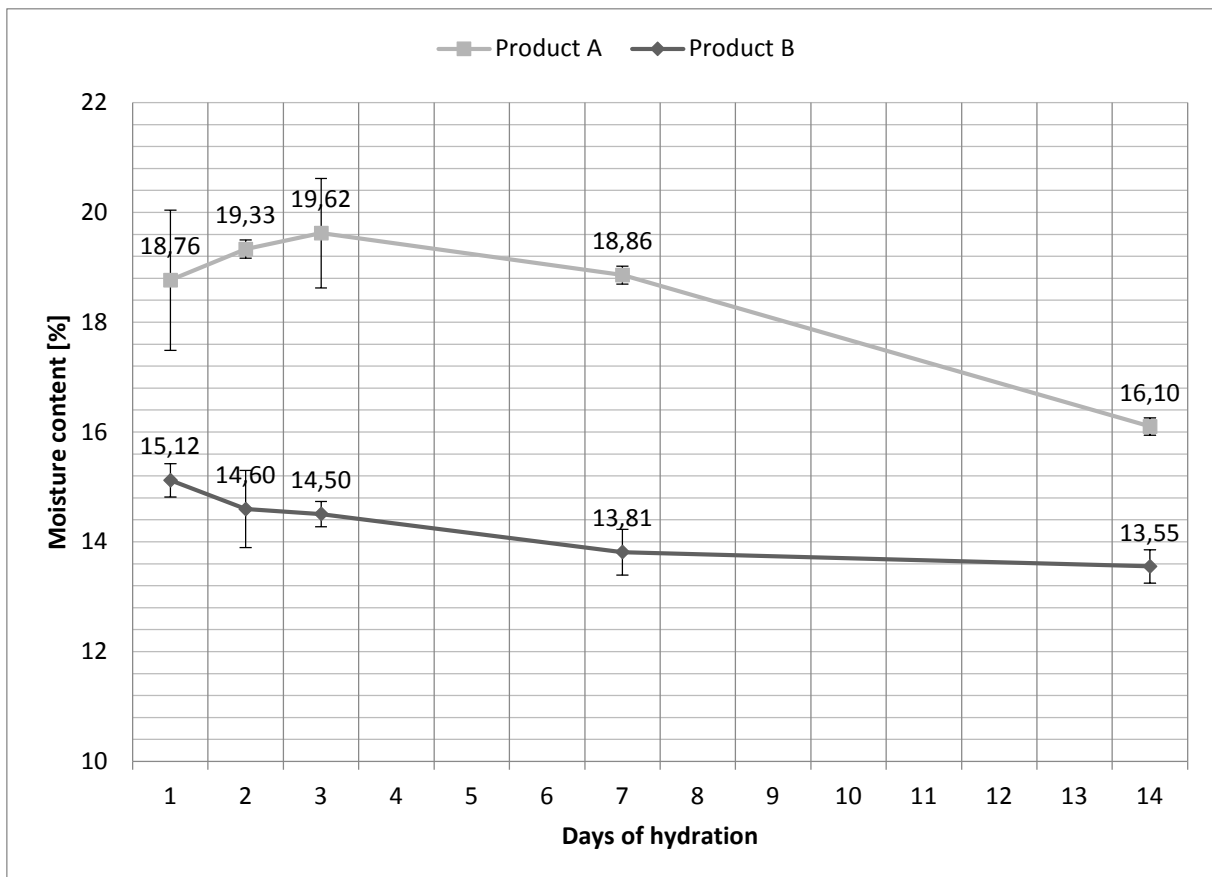


Figure 34 – Carbide method with samples cast in closed 20 ml PE vials.

7.3.2 Core drilling

For samples taken by core drilling from the floors, Figure 35 shows some unstable results for PA though PB's moisture levels decrease linearly.

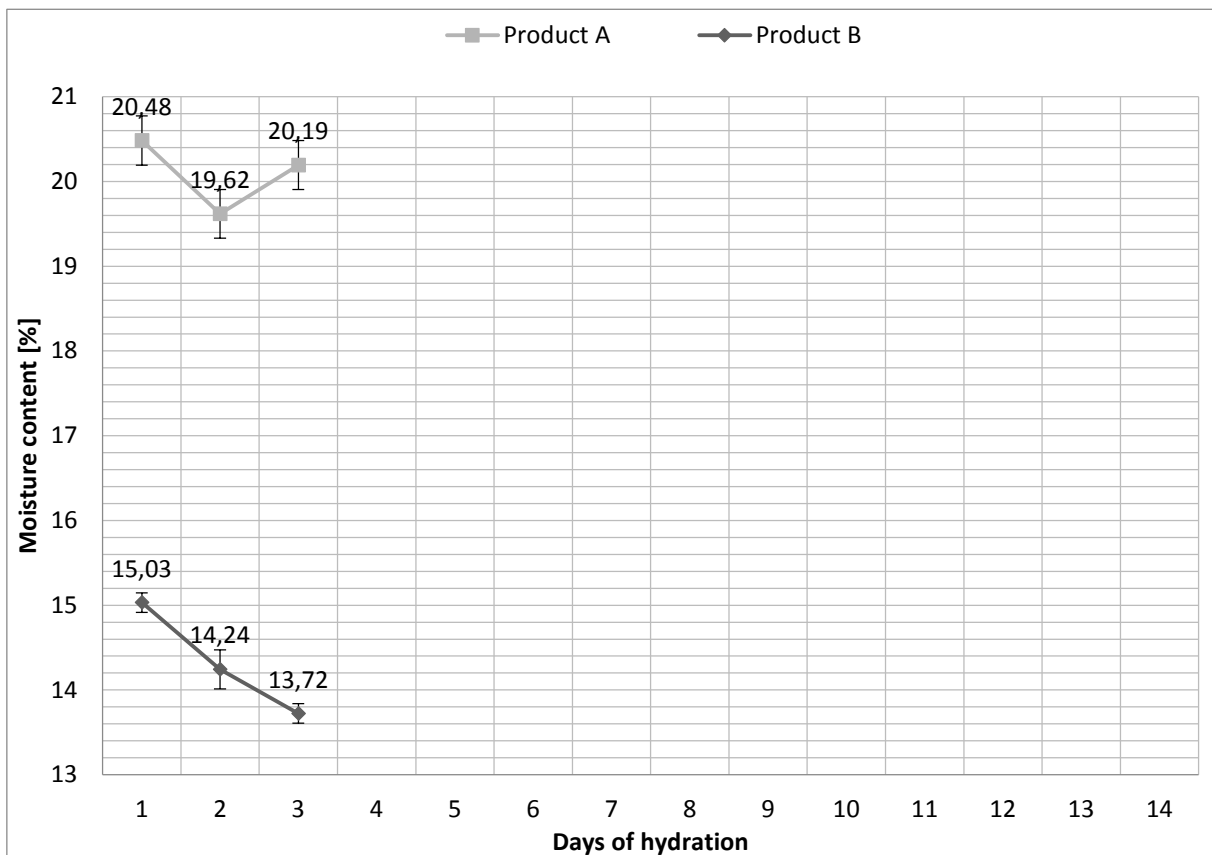


Figure 35 – Carbide method with samples taken out by core drilling from floor.

7.3.3 Comparison carbide method (closed samples)

Figure 36 shows a comparison between samples cast in 20 ml vials and extracted by core drilling measured with the carbide method. Though the results are a little scattered the data shows the same relationship as for the oven method, with a lower moisture level for PB and a higher for PA regarding core drilling compared to 20 ml vials.

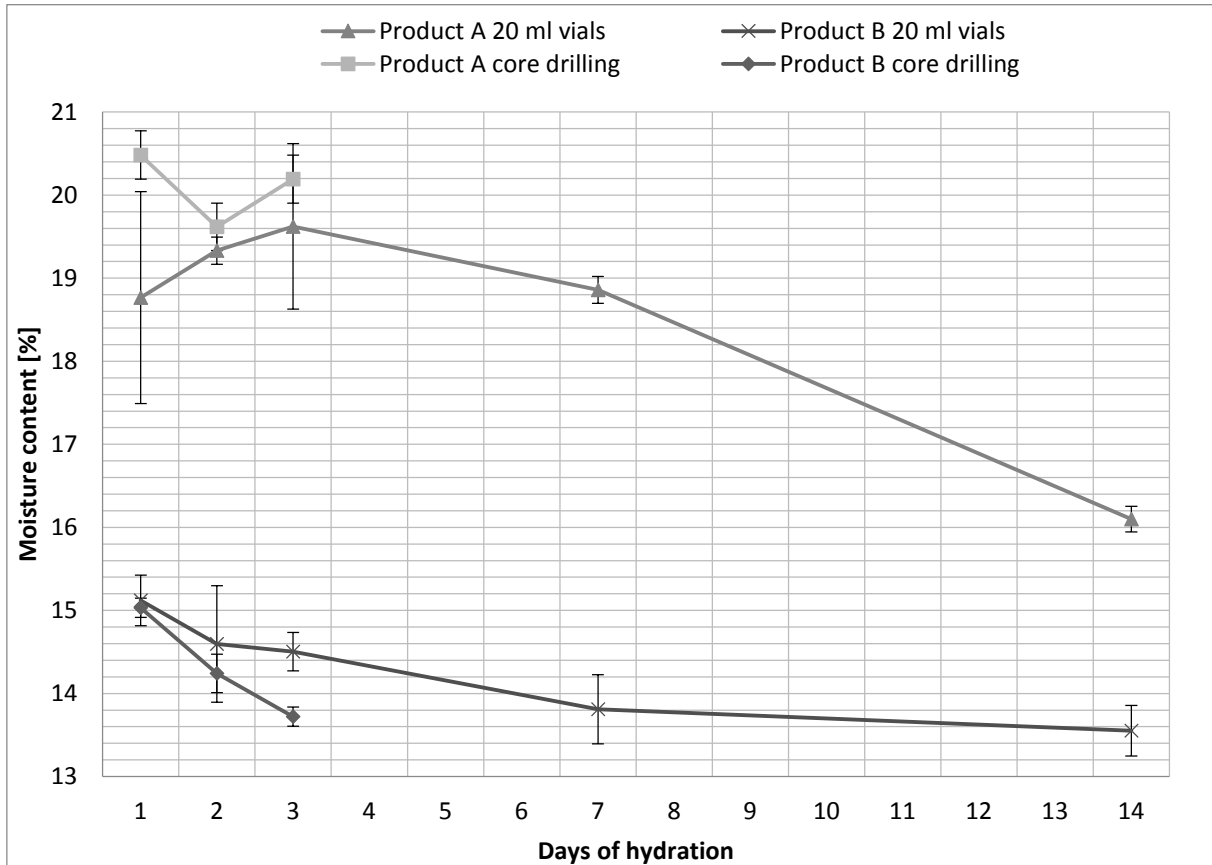


Figure 36 – Comparison of carbide method for closed samples.

7.4 Calcium Chloride method

The calcium chloride tests shows only small variations in moisture vapour emission rate (MVER) for PA and PB, see Figure 37 (note the compressed y-axis scale). The reliability of the results is unknown because only one measurement was done for each time interval and product.

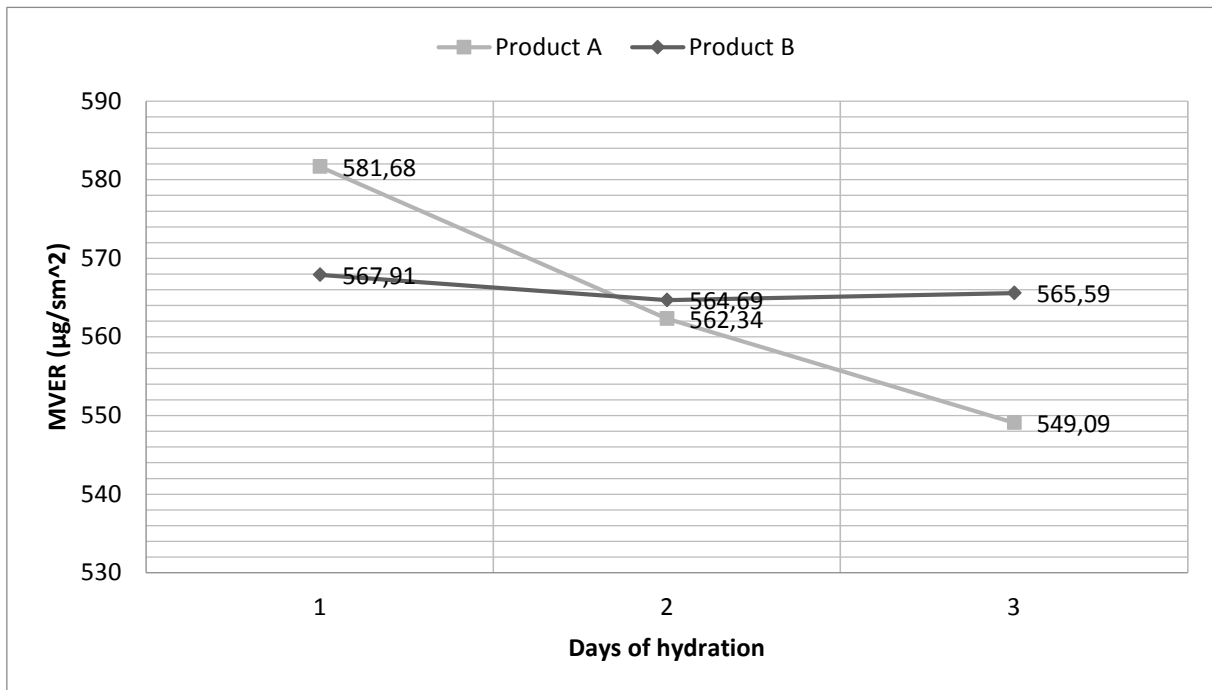


Figure 37 - MVER for PA and PB with the calcium chloride method

7.5 RH methods

7.5.1 Closed 500 ml containers

The results shown in Figure 38 do only show small variations in RH for the two products (note the compressed RH-scale). The values showed are not calibrated values, because the calibrated values could only be obtained when the displayed value on the RH-sensors showed an RH that was lower than approximately 98-98.5 % which would give an actual RH of 97 %. None of the results were therefore under 97 % of RH.

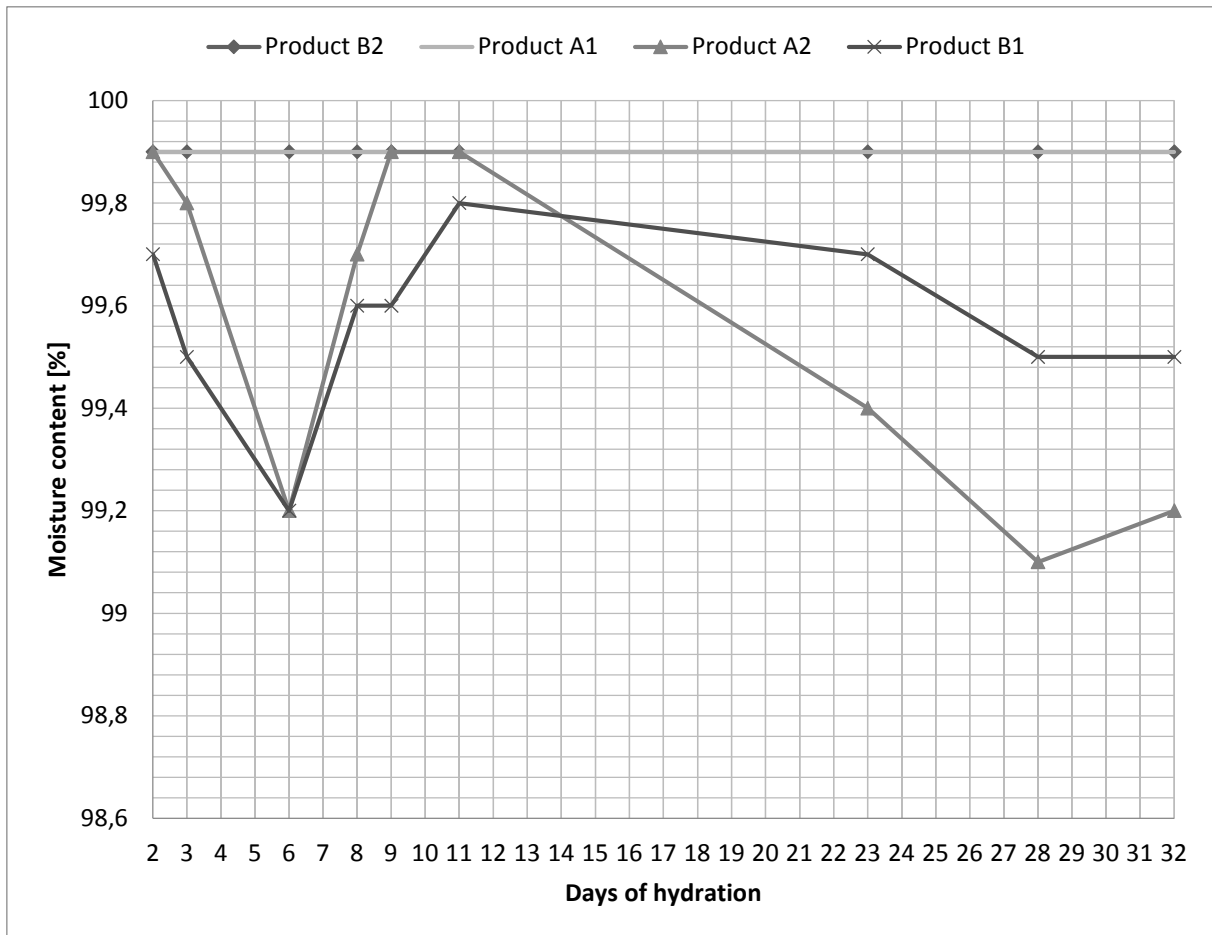


Figure 38 – RH measurements from closed 500 ml vials

7.5.2 RH Petri dishes

The values in Figure 39 are all calibrated values and the sealed Petri dishes do not show any decreases in RH. The Petri dishes that had hydrated with surface evaporation shows decreases in RH. It seems that PA after 7 days have dried to equilibrium RH in the room (35-40 %, see Appendix 11.5).

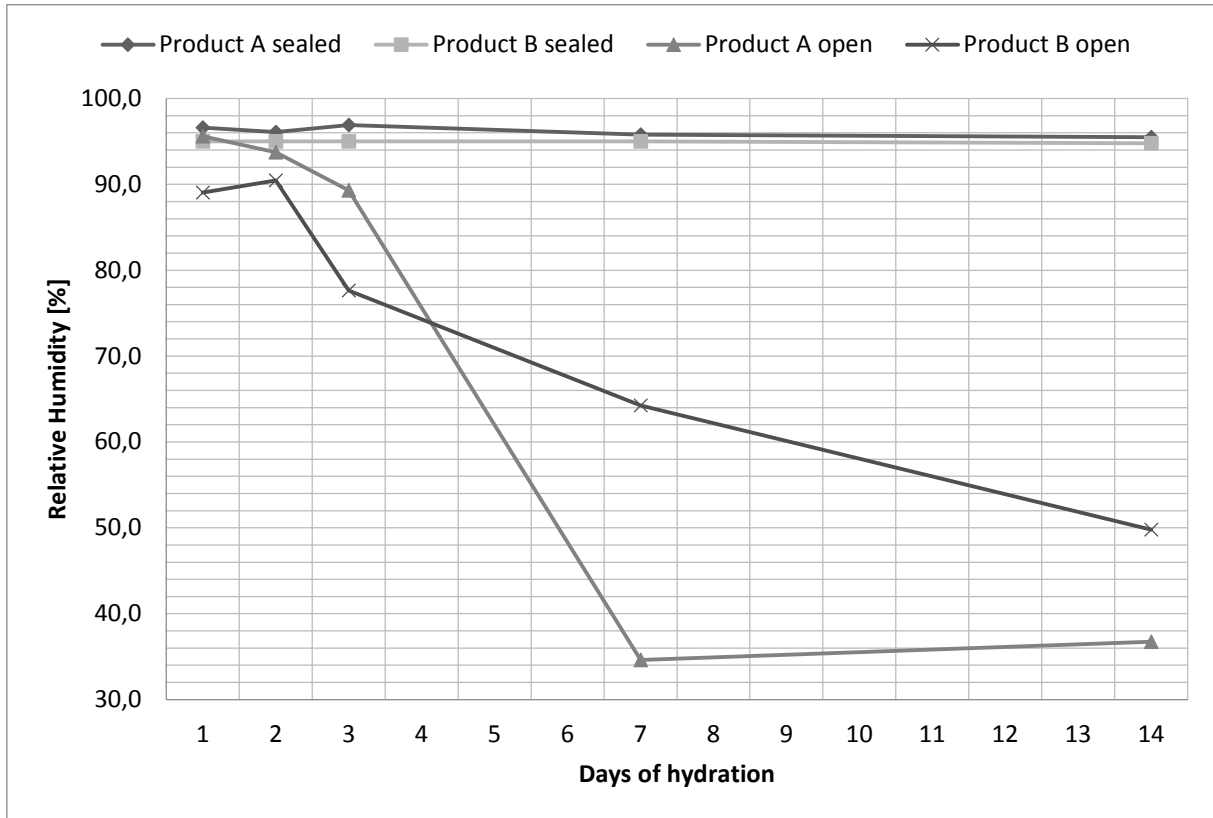


Figure 39 – RH for samples extracted from Petri dishes.

7.6 Isothermal calorimetry with RH-sensor

Figure 40 shows the heat generation of PA and PB during the period of 16 days. Figure 40A shows the heat release from the sample during the first 20 hours (thermal power/mW/g). Figure 40B shows the hydration during the first 500 hours (thermal power/mW/g) and Figure 40C shows the total heat generation (J/g) during the period of 500 hours. As can be seen in Figure 40A, PB has the highest hydration during the first 5 hours and PA has a much lower hydration, but is peaking during a slightly longer period of 12 hours. Notable is that PA has a second peak from approximately 200 until 400 hours. This peak is much lower than the first one, but continues for a long time. The consequences of this can be seen in Figure 40C as PA and PB after 500 hours has generated almost the same amount of heat.

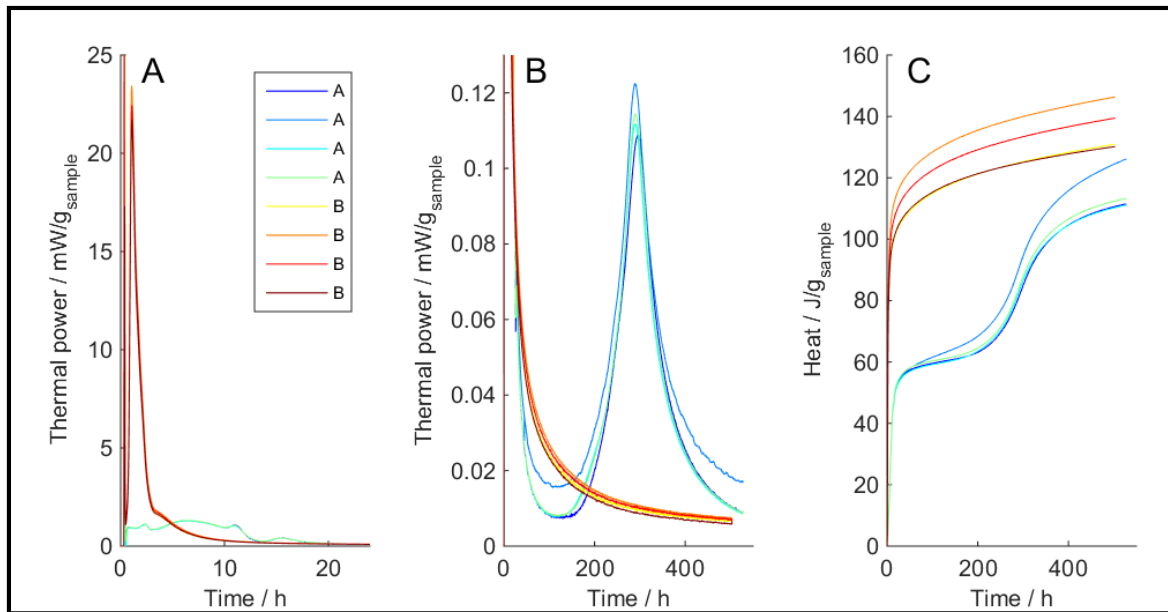


Figure 40 - Heat generation by PA and PB

7.7 Discussion

7.7.1 Practical concerns executing the measurements

Oven method

The oven method is easy to implement. It is easy to understand the measurements as the dry mass is subtracted from the wet mass and the subtracted value then is divided with the dry mass to obtain the MC. On the other hand, it is impractical that an oven is needed to do the measurement. This is not practical when measurements shall be done in situ at the building site. One negative aspect is also that the drying needs to occur during a period of at least (24 h) or more. The standard deviation was in most cases small.

Carbide method

The carbide method can be performed in situ at the building site and the measurement only last around 10 minutes in total which is practical. The measurements were a bit more difficult to understand as the readings were of the pressure inside the bottle. The pressure was then converted to MC by a conversion table in the manual. It was unclear if the conversion table gave the MC in dry or wet mass basis. Small reading errors from the manometer could also give notable variations in the result. The standard deviation was higher than for the oven method.

RH method

The RH method was easy to carry out as the samples were put in a glass bottle and the RH-sensor attached to the bottle. The displayed RH could be read directly from the RH-sensor after the equilibrium was reached (after minimum 12 h). A negative aspect of this method is that RH is depending on the temperature of the ambient and should therefore be carried out in a laboratory environment which is impractical when measurements shall be done at building sites. The conditions at the test site must be verified for example by logging the temperature.

Calcium Chloride method

The calcium chloride method measures the MVER. This method is impractical as the measurements have to be done during a period of at least 60 h and needs a big area at the test site to be performed. It is also depending on the temperature.

7.7.2 Self-desiccation of the SLCs

When determining whether a material is self-desiccating or not it is of importance to clarify what the definition of self-desiccation is. Usually self-desiccation is defined as the removal of free water by a chemical reaction (hydration), which makes the RH in the system decrease even in the absence of drying to the ambient.

Products that are self-desiccating are often advertised as they can be surface covered 1-3 days after casting, e.g. by a carpet, because the self-desiccation is continuing binding the water, which makes the RH in the SLC decrease under the critical moisture state of the flooring materials. However different flooring materials have different critical moisture states. Therefore, it is of importance to analyse each specific self-desiccating SLC to know when the RH has decreased to an RH-level which is under the critical moisture state of the flooring material.

It is also of importance to evaluate how much water that still is in the material, and that can be dried out, something that is described by the MC. The methods being used were RH-measurement with RH-sensor, MVER by the calcium chloride method and MC by the carbide- and the oven-method at two temperatures. Also different casting and extraction methods were used to determine whether there were variations in results depending on these variables.

Results when PA and PB were sealed from the ambient air and only allowed to dry by self-desiccation shows that the MC for PA was higher than for PB during the whole test period of two weeks, this can be seen in Figure 29, Figure 33 and Figure 36. The most distinct difference was after the first day of hydration. Thereafter came a period of 6 -7 days where the curves for both PA and PB had a similar gradient appearance.

After about 8 days of hydration, PA starts to decrease more in MC relative to PB, and after 14 days, PA has almost the same MC level as PB. This is believed to be due to the hydration being more intense in PB the first couple of hours, but after about six hours the hydration PB decreases rapidly and drops below PAs hydration, as shown in the results for the isothermal calorimetry in Figure 40. The hydration of PA also increases after approximately 8 days (second peak in Figure 40B), the heat production is low but continues for a longer time.

Results for closed prisms in Table 2, shows that MC for PA are in the same regions as for the other methods, PB on the other hand shows lower MC. It is assumed that PB develops a finer pore structure during the first day of hydration. The prisms are not crushed during the testing and possibly a period of 6 days of drying is not enough to dry out the physically bound water completely.

When we compared the carbide method and the oven drying method, the MC obtained from both methods were similar to each other. This was when the MC for the carbide method was recalculated from wet base to dry base with Eq.7.

The results from the calcium chloride method is given as measures of moisture vapour emission rate (MVER) which refers to the vapour emission from the slab. But in thick slabs, MVER only refers to the top layer of the SLC and the moisture conditions in lower layers of the SLC is hard to evaluate. Water emitted is dependent on temperature and the results are more about permeability than water content in the SLC. As seen in Figure 37 the result shows high levels of MVER for both PA and PB. A concrete can be considered to be dry when MVER does not exceed 3 lbs/1000ft²/24h which could be converted to 170 µg/(s m²) [25].

Measurement of RH was also done during a period of two weeks. It was clearly seen that all samples for both PA and PB had no decrease in RH, when they were only allowed to dry by self-desiccation (seen in Figure 38 and Figure 39). By examining the results, it is clear that neither PA nor PB have measureable self-desiccation after 14 days.

Similar results have also been obtained in other studies testing self-desiccation in SLCs. In a report [26] by FuktCom, they studied self-desiccation in thick layers of SLCs (40-50 mm). Some samples were covered already after 3 days of hydration and RH was measured at the same time. After 6 months of being covered RH was measured once again. The results showed very small decreases in RH and the values were over the Swedish critical RH level for flooring adhesives of 85 % [26]. In other words, this report also indicates that there is no notable self-desiccation in SLCs.

7.7.3 Drying by self-desiccation and surface evaporation

To study the impact of surface evaporation further testing was performed, where PA and PB were drying both by self-desiccation and by surface evaporation, to see the differences in MC and RH, when this factor was included. Results show that PA and PB shows the same MC after 1 day of hydration in the open, but later PA decreases more than PB as seen in Figure 30. This indicates that PA loses more moisture through surface evaporation and the reason for this could be that the chemical reaction for PB creates finer pores (bonds more water chemically). Moisture transport is slower in fine pore systems and therefore PB has slower moisture transport than PA. PB also felt stiffer when crushing it with the lump hammer than PA, which also indicates that it has a more developed structure and possibly finer pores.

Results for open prisms, as seen in Table 2 shows that PA has a higher MC for the prisms than the Petri dishes. We believe this is because the moisture has to be transported a longer way to the surface during the first 24 hours of drying which makes the Petri dish dry faster before put into the oven. PB on the other hand shows similar MC values for the prisms and the Petri dish. This is believed to be because PB has fine pores and the moisture transport is therefore slow.

Measurements of the RH were also made for PA and PB when they could dry to the ambient air. As can be seen in Figure 39, PA has decreased to approximately 95% RH after one day of hydration and PB has decreased to about 90 %. After the seventh day, the RH of PA has decreased to around 35% (ambient RH in laboratory), while PB has decreased to about 64% RH, see Figure 39. This is believed to be because PB binds more water chemically and creates finer pores. PA on the other hand has larger pores and the moisture transport is thereby faster, making PA losing more moisture through surface evaporation. After 14 days PA is still on the same RH as the ambient air and PB has decreased down to 50% RH. It is notable that when drying in combination with self-desiccation and surface evaporation PB has decreased under the critical moisture state (85%) after 3 days and PA somewhere between 3 to 7 days.

7.7.4 Differences between MC and RH

When comparing the results, it is notable that even though the MC decreased by several percent, this gave no decrease in the RH-level (sealed samples). When determining the critical moisture state of a material, in contact with the SLCs, the RH must be known. MC is therefore not a good way to determine what the current critical moisture state is. To be able to determine the RH by MC the sorption isotherm for the material must be known. The sorption isotherm of a concrete or SLC is constantly changing during the early phases of hydration which makes this difficult, especially as the composition can vary and even be poorly understood. This problem is also addressed by Nilsson [27].

MC describes how much water that is still available as physically bound water that can be dried out of the material and how much water that needs to be dried out to achieve a certain lower MC. RH on the other hand describes the state of the water and whether the RH are under the critical moisture state or not during the time of measurement. There might still be water left in the SLC which can cause problems at later stages, as moisture can be redistributed in the material. A combination of measurements of RH and MC can therefore be of interest to fully understand the drying process of the SLCs and if there is a risk that damages because of moisture can occur now or in the future. If only one method is to be used the problem with MC is that a material containing for example much filling material gives lower MC than a material containing less filling material. This is because the sample with filling material has less volume

to obtain water, but it does not describe which state the water is in. The RH on the other hand describes the state of the water and whether materials that are in contact with the SLC will be affected by the water (decreased under the critical moisture state or not).

A problem regarding the measurement of MC, is that it is uncertain if the water released is from only physically bound water or from physically and chemically bound water. If chemically bound water also is released, this will result in higher MC readings, than what is the actual MC of the material. In practice it can be hard to distinguish between physically and chemically bound water. This problem is avoided when measuring RH as the material does not have to be dried at high temperatures or react with carbide. It is also uncertain whether all of the physically bound water is available for example mould growth, as the physically bound water may be bound differently and with varying forces. RH only measures the water that is available to the surrounding materials.

7.8 Measurement uncertainties

The uncertainties of a measurement indicate the quality of the measurement. The uncertainty is the doubts that exist of the result of the measurement. It is wise to make measurement at least in triplicate. If only one measurement is done, a mistake can go unnoticed and with two measurements is it hard to tell which measurement that is wrong if they don't agree. However, with three measurements you can be suspicious about one, when two agrees and one is different [28].

When looking at the different methods used in this master thesis project, oven drying was the most used method. The result from this method is however slightly dependent on vapour content of the air in the oven, as the air in the oven cannot have a vapour pressure that is lower than the atmospheric air pressure. This means that all physically bound water cannot be dried out of the material with oven drying. This is usually neglected because at higher temperatures RH is very low. During the tests made in the laboratory, RH in the oven could be calculated by knowing the temperature and the RH in the laboratory. An RH-logger showed that RH in the laboratory was about 32% and the temperature was about 21°C, which gives a vapour content of 5.9 g/m³. By using an equation to determine RH in high temperatures from Sonntag [29] the RH of the oven at 65°C was calculated to be 3.7% which is low, but not zero.

It is also unclear if the SLC dried at 105°C, and even dried at 65°C, loses chemically bound water. It is important to know when no more physical water is released. In this master thesis project, drying was made during both 24 hours and 6 days. No tests were made to obtain a more specific time interval to when the drying was complete. It is therefore a risk that some physically bound moisture did not have time to dry out or that chemically bound water was released when drying at high temperatures.

The results with the carbide method are dependent on the shaking procedure of the carbide meter. If the SLC sample was not completely crushed, there could still be water in the sample not reacting with the carbide. An uncertainty is also the ocular reading of the manometer, whose display had an accuracy of 0.05 bar. A difference of 0.1 bar gives a difference of 2% in MC. The difference between start and stop temperature during the shaking procedure has also an effect for the result, but for high MCs, as in the present case, the temperature has a non-significant impact. A report by Podebradska et.al [19] also states that when using the calcium carbide method on hydrating cement paste, the readings of the acetylene manometer increases

significantly during a period of up to six hours. This could among other be due to slow release of water from the cement gel, because of strong bonding of water in small gel pores.

As said before regarding the calcium chloride method, MVER only refers to the top layer of the SLC and the moisture conditions in lower layers of the SLC is hard to evaluate. One more uncertainty for this method could also be that only one test was made for each time interval and it is recommended to do 3 tests up to a floor area of 100 m².

An uncertainty of the RH method could be if the plug to the test tube with the RH sensor attached is not totally sealed. Dust and dirt on the sensor also gives inaccurate results for the RH measurement. Another uncertainty could be that the RH in the air is not in equilibrium with the RH in the sample.

The extraction of the sample also has importance for the results. Before measurement, all samples that were sealed during hydration, comes in contact with the ambient air during extraction. The crushing to smaller fragments also enables more surface area to be in contact with ambient air so that moisture can evaporate during a longer period. Time in ambient air has been measured during all extraction processes.

8 CONCLUSION

- The reaction of products PA and PB resulted in a lowered moisture content, but the reduction in RH under sealed conditions was too low to be measured.
- RH shows the state of the water in the material. It is a good indicator to whether the water in the SLC is a risk for moisture induced problems to the surrounding materials.
- It is difficult to know whether the MC only describes the physical water or if there is chemical water released as well because of decomposition. It is also difficult to know whether all physical water measured is to be considered a risk for the surrounding materials.
- Together RH and MC gives more information about a materials moisture state than either RH or MC alone.
- When PA and PB dried through self-desiccation and surface evaporation, PB was under 85 % of RH already after 3 days. PA decreased to the RH of the ambient air already after 7 days.

9 SUGGESTION FOR FURTHER STUDIES

A more realistic way of testing the products might be to let the SLC dry in the ambient for the first days and measure the RH at this point. Afterwards the samples could be sealed from the ambient air for a period of time and RH are once again measured after a period of days/weeks. Normally when a carpet is attached it is not directly after casting, but after a couple of days (1-3).

It would also be of interest to study if less mixing water could give an influence on the self-desiccation for the SLC. A study could be made where mixing could be done with different water/SLC powder ratios. Measurements with RH and MC methods could then give interesting results.

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11 APPENDIX

11.1 Conversion table carbide meter

CONVERSION TABLE: PRESSURE MATERIAL MOISTURE CONTENT

Pressure	Sample weight					
Bar (black)	3g	5g	10g	20g (red)	50g (green)	100g (blue)
Watercontent in % by weight in relation to the dry wright						
0	0	0	0	0	0	0
0.2	6.3	3.8	1.9	0.9	0.38	0.19
0.3	9.7	5.8	2.9	1.5	0.58	0.28
0.4	13.0	7.8	3.9	2	0.78	0.38
0.5	16.3	9.8	4.9	2.5	0.98	0.47
0.6	19.7	11.8	5.9	3	1.18	0.57
0.7	23.0	13.8	6.9	3.5	1.37	0.66
0.8	26.3	15.8	7.9	4	1.57	0.76
0.9	29.7	17.8	8.9	4.5	1.76	0.85
1	33.3	20	10	5	1.96	0.95
1.1	36.7	22	11	5.5	2.16	1.05
1.2	40.0	24	12	6	2.35	1.14
1.3	43.3	26	13	6.5	2.55	1.23
1.4	46.7	28	14	7	2.74	1.33
1.5	50.0	30	15	7.5	2.94	1.42
Acetylene can decompose and damage the manometer above this pressure!						
1.6	53.3	32	16	8	3.13	1.51

11.2 Measurement data

Oven drying 65°C 20 ml vials													
Product A		2016-02-22 09:07											
Number	ID	Predeter. time	Time in ambient(m:ss)	V Container(g)	V sample+container(g)	V wet(g)	Time into Oven	V after 24 H (g)	V dry (24 H)(g)	Time out of oven	Total time in oven	MC	Std dev
1	AO1DA	2016-02-23 09:07	01:21	61.144	71.652	10.008	2016-02-23 09:18	69.495	8.351	2016-02-24 09:22	24:04:00	19.80	0.0758
2	AO1DB	2016-02-23 09:07	01:10	62.185	72.195	10.030	2016-02-23 09:18	70.557	8.372	2016-02-24 09:22	24:04:00	19.80	
3	AO1DC	2016-02-23 09:07	01:07	62.786	72.893	10.107	2016-02-23 09:18	71.212	8.426	2016-02-24 09:22	24:04:00	19.95	
4	AO1DA	2016-02-24 09:07	01:07	60.436	70.468	10.032	2016-02-24 09:24	68.81	8.374	2016-02-25 09:34	24:10:00	19.80	0.2228
5	AO1DB	2016-02-24 09:07	02:39	61.298	71.317	10.019	2016-02-24 09:24	69.692	8.394	2016-02-25 09:34	24:10:00	19.36	
6	AO1DC	2016-02-24 09:07	01:17	62.481	72.618	10.137	2016-02-24 09:24	70.954	8.473	2016-02-25 09:34	24:10:00	19.54	
7	AO1DA	2016-02-25 09:07	01:45	62.387	72.323	9.936	2016-02-25 09:38	70.699	8.312	2016-02-26 09:38	24:00:00	19.54	0.0388
8	AO1DB	2016-02-25 09:07	01:20	61.493	71.728	10.235	2016-02-25 09:38	70.053	8.560	2016-02-26 09:38	24:00:00	19.57	
9	AO1DC	2016-02-25 09:07	01:18	62.160	72.271	10.111	2016-02-25 09:38	70.613	8.453	2016-02-26 09:38	24:00:00	19.61	
10	AO1DA	2016-02-29 09:07	01:13	64.105	74.061	9.956	2016-02-29 09:45	72.472	8.367	2016-03-01 09:45	24:00:00	18.99	0.1714
11	AO1DB	2016-02-29 09:07	01:15	58.944	68.936	9.992	2016-02-29 09:45	67.359	8.415	2016-03-01 09:45	24:00:00	18.74	
12	AO1DC	2016-02-29 09:07	01:02	62.162	72.153	9.991	2016-02-29 09:45	70.553	8.391	2016-03-01 09:45	24:00:00	19.07	
13	AO1DA	2016-03-07 09:07	01:42	58.944	68.933	9.989	2016-03-07 09:32	67.572	8.628	2016-03-08 09:32	24:00:00	15.77	0.2360
14	AO1DB	2016-03-07 09:07	01:02	59.284	69.618	10.134	2016-03-07 09:32	68.126	8.742	2016-03-08 09:32	24:00:00	15.92	
15	AO1DC	2016-03-07 09:07	01:08	61.426	71.561	10.134	2016-03-07 09:32	70.203	8.777	2016-03-08 09:32	24:00:00	15.46	
Product B													
Number	ID	Predeter. time	Time in ambient(m:ss)	V Container(g)	V sample+container(g)	V wet(g)	Time into Oven	V after 24 H (g)	V dry (24 H)(g)	Time out of oven	Total time in oven	MC	Std dev
1	BO1DA	2016-03-01 09:49	01:09	62.795	72.798	10.003	2016-03-01 10:15	71.408	8.613	2016-03-02 10:12	23:57:00	16.14	1.2223
2	BO1DB	2016-03-01 09:49	01:18	62.708	72.898	9.990	2016-03-01 10:15	71.270	8.562	2016-03-02 10:12	23:57:00	16.58	
3	BO1DC	2016-03-01 09:49	01:11	58.751	68.807	10.056	2016-03-01 10:15	67.239	8.488	2016-03-02 10:12	23:57:00	16.47	
4	BO1DA	2016-03-02 09:49	01:23	63.161	73.174	10.013	2016-03-02 10:12	71.777	8.616	2016-03-03 10:12	24:00:00	16.21	0.1123
5	BO1DB	2016-03-02 09:49	01:18	60.464	70.522	10.058	2016-03-02 10:12	69.123	8.659	2016-03-03 10:12	24:00:00	16.16	
6	BO1DC	2016-03-02 09:49	01:16	61.546	71.596	10.050	2016-03-02 10:12	70.182	8.636	2016-03-03 10:12	24:00:00	16.37	
7	BO1DA	2016-03-03 09:49	01:11	58.434	68.415	9.981	2016-03-03 10:12	67.050	8.616	2016-03-04 10:12	24:00:00	15.84	0.0786
8	BO1DB	2016-03-03 09:49	01:03	61.384	71.367	9.983	2016-03-03 10:12	69.999	8.615	2016-03-04 10:12	24:00:00	15.88	
9	BO1DC	2016-03-03 09:49	01:14	64.659	74.684	10.025	2016-03-03 10:12	73.302	8.643	2016-03-04 10:12	24:00:00	15.99	
10	BO1DA	2016-03-07 09:49	00:50	62.724	72.676	9.982	2016-03-07 09:50	71.327	8.603	2016-03-08 09:50	24:00:00	15.68	0.2854
11	BO1DB	2016-03-07 09:49	01:03	60.092	70.096	10.004	2016-03-07 09:50	68.757	8.665	2016-03-08 09:50	24:00:00	15.45	
12	BO1DC	2016-03-07 09:49	01:04	61.119	71.151	10.032	2016-03-07 09:50	69.831	8.712	2016-03-08 09:50	24:00:00	15.15	
13	BO1DA	2016-03-14 09:49	01:28	59.595	69.337	9.842	2016-03-14 09:56	68.471	8.576	2016-03-15 09:54	23:56:00	14.76	0.0470
14	BO1DB	2016-03-14 09:49	01:26	61.665	71.893	10.037	2016-03-14 09:56	70.609	8.753	2016-03-15 09:54	23:56:00	14.67	
15	BO1DC	2016-03-14 09:49	01:14	64.802	74.772	9.970	2016-03-14 09:56	73.494	8.692	2016-03-15 09:54	23:56:00	14.70	

Oven drying 65°C core drilling

Product A

Number	ID	Predeter. time for mea.	Type floor	Type of core	Time in ambient	V Container(g)	V sample+container(g)	V wet(g)	Time into Oven	V after(24 H)(g)	V dry (24 H)(g)	Time out of oven	Total time	MC	Std dev	Comments
1	AOHDA	2006-03-16 09:25	A1	1	0110	62,201	72,167	9,966	2006-03-17 03:31	70,484	8,283	2006-03-18 03:32	24,0100	20,32	0,0767	
2	AOHDB	2006-03-16 09:25	A1	1	0220	63,397	73,363	9,966	2006-03-17 03:31	71,682	8,285	2006-03-18 03:32	24,0100	20,29		
3	AOHDE	2006-03-16 09:25	A1	3	0101	59,997	69,740	10,143	2006-03-17 03:31	68,019	8,422	2006-03-18 03:32	24,0100	20,43		
4	AOZDA	2006-03-17 08:33	A2	2	0217	61,940	71,698	10,158	2006-03-17 09:41	69,783	8,243	2006-03-18 09:46	24,0000	23,23		sample dismissed
5	AOZDB	2006-03-17 08:33	A2	1	0104	62,394	72,413	10,029	2006-03-17 09:41	70,738	8,382	2006-03-18 09:46	24,0000	20,08	0,3174	
6	AOZDE	2006-03-17 08:33	A2	1	0153	60,217	70,437	10,222	2006-03-17 09:41	68,760	8,543	2006-03-18 09:46	24,0000	19,63		
7	AO3DA	2006-03-18 09:05	A3	2	0118	62,643	72,688	10,045	2006-03-18 09:45	71,056	8,413	2006-03-19 09:46	24,0100	19,40	0,0879	
8	AO3DB	2006-03-18 09:05	A3	2	0203	63,505	73,492	9,987	2006-03-18 09:45	71,869	8,384	2006-03-19 09:46	24,0100	19,40		
9	AO3DE	2006-03-18 09:05	A3	3	0104	63,701	73,864	10,163	2006-03-18 09:45	72,221	8,52	2006-03-19 09:46	24,0100	19,28		
10	AOZDA															
11	AOZDB															
12	AOZDE															
13	AOHDA															
14	AOHDB															
15	AOHDE															

Product B

Number	ID	Predeter. time for mea.	Type floor	Type of core	Time in ambient	V Container(g)	V sample+container(g)	V wet(g)	Time into Oven	V after(24 H)(g)	V dry (24 H)(g)	Time out of oven	Total time	MC	Std dev	Comments
1	BOHDA	2006-03-16 14:19	B1	1	0130	63,034	73,008	10,074	2006-03-16 14:10	71,713	8,679	2006-03-17 14:07	23,5700	16,07	0,0483	
2	BOHDB	2006-03-16 14:19	B1	1	0216	61,663	71,785	10,102	2006-03-16 14:10	70,381	8,698	2006-03-17 14:07	23,5700	16,14		
3	BOHDE	2006-03-16 14:19	B1	2	0122	62,473	71,28	8,807	2006-03-16 14:10	71,028	8,653	2006-03-17 14:07	23,5700	17,8		sample dismissed
4	BOZDA	2006-03-17 10:07	B2	2	0137	60,034	70,106	10,072	2006-03-17 10:40	68,75	8,716	2006-03-18 10:54	24,1400	15,56	0,1938	
5	BOZDB	2006-03-17 10:07	B2	3	0059	59,770	69,676	9,906	2006-03-17 10:40	68,357	8,687	2006-03-18 10:54	24,1400	15,36		
6	BOZDE	2006-03-17 10:07	B2	3	0133	62,066	72,057	9,991	2006-03-17 10:40	70,741	8,675	2006-03-18 10:54	24,1400	15,17		
7	BO3DA	2006-03-18 14:01	B3	2	0138	59,046	68,995	9,949	2006-03-18 14:19	67,672	8,626	2006-03-18 14:16	23,5700	15,34	0,1451	
8	BO3DB	2006-03-18 14:01	B3	1	0101	58,011	67,33	9,319	2006-03-18 14:19	66,617	8,606	2006-03-18 14:16	23,5700	15,26		
9	BO3DE	2006-03-18 14:01	B3	1	0158	63,684	73,611	9,927	2006-03-18 14:19	72,312	8,628	2006-03-18 14:16	23,5700	15,06		
10	BOZDA															
11	BOZDB															
12	BOZDE															
13	BOHDA															
14	BOHDB															
15	BOHDE															

Oven drying 65°C Petri Closed

Product A														
Time for casting														
2016-04-04 10:08														
Number	ID	Predicted time for mea.	Time in ambient(min:s)	V Container(g)	V sample-container(g)	V wet(g)	Time into Oven	V after(24 H)(g)	V dry (24 H)(g)	Time out of oven	Total time in oven	MC	Std dev	Comments
1	AO1DA	2016-04-05 10:08	01:53	61.911	72.051	10.140	2016-04-05 10:30	70.413	8.502	2016-04-06 10:30	24:00:00	18.27	0.1471	
2	AO1DB	2016-04-05 10:08	01:42	62.512	72.485	9.973	2016-04-05 10:30	70.854	8.342	2016-04-06 10:30	24:00:00	19.55		
3	AO1DC	2016-04-05 10:08	01:28	61.502	71.510	10.008	2016-04-05 10:30	69.879	8.377	2016-04-06 10:30	24:00:00	19.47		
4	AO1DA	2016-04-06 10:08	01:38	60.062	69.972	9.911	2016-04-06 10:30	68.37	8.308	2016-04-07 10:33	24:03:00	18.28	0.0722	
5	AO1DB	2016-04-06 10:08	01:35	69.743	69.760	10.017	2016-04-06 10:30	68.136	8.393	2016-04-07 10:33	24:03:00	18.36		
6	AO1DC	2016-04-06 10:08	01:34	69.346	69.384	10.038	2016-04-06 10:30	67.751	8.405	2016-04-07 10:33	24:03:00	18.43		
7	AO1DA	2016-04-07 10:08	01:41	68.645	68.665	10.02	2016-04-07 10:33	67.046	8.401	2016-04-08 10:32	23:58:00	18.27	0.1272	
8	AO1DB	2016-04-07 10:08	01:34	61.475	71.473	9.998	2016-04-07 10:33	69.64	8.365	2016-04-08 10:32	23:58:00	18.52		
9	AO1DC	2016-04-07 10:08	01:37	67.223	67.215	9.992	2016-04-07 10:33	65.569	8.366	2016-04-08 10:32	23:59:00	19.44		
10	AO1DA	2016-04-11 10:08	01:42	61.615	71.631	10.016	2016-04-11 10:24	70.017	8.402	2016-04-12 10:21	23:57:00	18.21	0.1071	
11	AO1DB	2016-04-11 10:08	01:39	60.148	70.135	9.987	2016-04-11 10:24	68.537	8.389	2016-04-12 10:21	23:57:00	18.05		
12	AO1DC	2016-04-11 10:08	01:50	63.523	73.541	10.018	2016-04-11 10:24	71.941	8.418	2016-04-12 10:21	23:57:00	18.01		
13	AO1DA	2016-04-18 10:08	01:26	65.029	75.012	9.983	2016-04-18 10:15	73.641	8.612	2016-04-19 10:15	24:00:00	15.32	0.3675	
14	AO1DB	2016-04-18 10:08	01:39	60.104	70.105	10.001	2016-04-18 10:15	68.678	8.574	2016-04-19 10:15	24:00:00	16.64		
15	AO1DC	2016-04-18 10:08	01:48	63.337	73.334	9.997	2016-04-18 10:15	72.526	8.589	2016-04-19 10:15	24:00:00	16.39		

Product B														
Time for casting														
2016-04-04 10:48														
Number	ID	Predicted time for mea.	Time in ambient(min)	V Container(g)	V sample-container(g)	V wet(g)	Time into Oven	V after(24 H)(g)	V dry (24 H)(g)	Time out of oven	Total time	Moisture at	Std dev	Comments
1	BO1DA	2016-04-05 10:48	01:51	59.509	69.511	10.002	2016-04-05 11:08	68.2	8.691	2016-04-06 11:08	24:00:00	15.08	0.1998	Condensation on lid
2	BO1DB	2016-04-05 10:48	01:35	59.380	69.342	9.962	2016-04-05 11:08	68.010	8.630	2016-04-06 11:08	24:00:00	15.43		Condensation on lid
3	BO1DC	2016-04-05 10:48	02:00	62.561	72.650	10.089	2016-04-05 11:08	71.327	8.766	2016-04-06 11:08	24:00:00	15.09		Condensation on lid
4	BO1DA	2016-04-06 10:48	01:28	60.152	70.154	10.002	2016-04-06 11:08	68.852	8.700	2016-04-07 11:08	24:00:00	14.97	0.2687	
5	BO1DB	2016-04-06 10:48	01:58	62.167	72.207	10.14	2016-04-06 11:08	70.953	8.786	2016-04-07 11:08	24:00:00	15.41		
6	BO1DC	2016-04-06 10:48	01:36	69.443	69.442	9.999	2016-04-06 11:08	68.104	8.661	2016-04-07 11:08	24:00:00	15.45		
7	BO1DA	2016-04-07 10:48	02:30	62.642	72.732	10.09	2016-04-07 11:08	71.389	8.747	2016-04-08 11:08	24:00:00	15.35	0.0405	
8	BO1DB	2016-04-07 10:48	01:52	62.655	72.655	10	2016-04-07 11:08	71.33	8.675	2016-04-08 11:08	24:00:00	15.27		
9	BO1DC	2016-04-07 10:48	01:55	60.222	70.231	10.009	2016-04-07 11:08	68.901	8.679	2016-04-08 11:08	24:00:00	15.32		
10	BO1DA	2016-04-11 10:48	02:15	59.883	69.891	10.008	2016-04-11 11:05	68.415	8.732	2016-04-12 11:08	24:03:00	14.61	0.1010	
11	BO1DB	2016-04-11 10:48	02:31	62.707	72.731	10.024	2016-04-11 11:05	71.44	8.733	2016-04-12 11:08	24:03:00	14.78		
12	BO1DC	2016-04-11 10:48	01:53	60.7	70.69	9.99	2016-04-11 11:05	69.417	8.717	2016-04-12 11:08	24:03:00	14.60		
13	BO1DA	2016-04-18 10:48	02:11	60.893	70.975	10.082	2016-04-18 10:45	69.748	8.895	2016-04-19 10:45	24:00:00	13.86	0.2289	
14	BO1DB	2016-04-18 10:48	02:06	61.503	71.96	9.992	2016-04-18 10:45	70.297	8.794	2016-04-19 10:45	24:00:00	13.62		
15	BO1DC	2016-04-18 10:48	01:45	68.898	68.869	10.001	2016-04-18 10:45	67.677	8.819	2016-04-19 10:45	24:00:00	13.40		

Prisms in molds open and closed

Product A															
Number	ID	Time casting	V mold(g)	V mold after casting(g)	Weight 24 H	Time unforming	V wet(g)	Time in ambient(min:ss)	Time into Oven	V after(6 days)(g)	Time out of oven	Total time(hh:mm)	MC	Mean MC	Std dev
	1 Aa1	2016-04-11:2:56	9939	11425	11392	2016-04-12:12:46	481.7		2016-04-12:12:51	413.1	2016-04-18:13:00	144:09:00	16.61	16.71	0.1089
	2 Aa2						484.0			414.3			16.82		
	3 Aa3						483.5			414.3			16.70		
Product B															
Number	ID	Time casting	V mold(g)	V mold after casting(g)	Weight 24 H	Time unforming	V wet(g)	Time in ambient(min:ss)	Time into Oven	V after(6 days)(g)	Time out of oven	Total time(hh:mm)	MC	Mean MC	Std dev
	1 Bb1	2016-04-11:3:42	9938	11449	11430	2016-04-12:13:37	499.3		2016-04-11:3:42	451.4	2016-04-18:13:34	167:52:00	10.61	10.84	0.0332
	2 Bb2						496.5			448.8			10.88		
	3 Bb3						494.9			447.3			10.84		
Number	ID	Time casting	V mold(g)	V mold after casting(g)	Weight 24 H	Time unforming	V wet(g)	Time in ambient(min:ss)	Time into Oven	V after(6 days)(g)	Time out of oven	Total time(hh:mm)	MC	Mean MC	Std dev
	1 Bb1	2016-04-11:4:04	9934	11443	11441	2016-04-12:13:55	507.8	03:28:00	2016-04-11:3:58	454.8	2016-04-18:13:54	167:56:00	11.70	11.88	0.1487
	2 Bb2						496.3			445.0			11.53		
	3 Bb3						500.3			447.4			11.82		

Oven drying 65°C Petri Open

Product A Time for casting												
2016-04-04 10:08												
Number	ID	Predeter, time for mea.	V Container(g)	V sample-container(g)	V wet(g)	Time into Oven	V after(24 H)(g)	V dry (24 H)(g)	Time out of oven	Total time in oven	MC	Std dev
1	A01Da	2016-04-05 10:08	61,382	71,415	10,033	2016-04-05 10:13	70,531	9,149	2016-04-06 10:13	24:00:00	9.66	0.8195
2	A01Db	2016-04-05 10:08	58,573	68,565	9,992	2016-04-05 10:13	67,57	8,397	2016-04-06 10:13	24:00:00	11.06	
3	A01Dc	2016-04-05 10:08	59,667	69,688	10,021	2016-04-05 10:13	68,889	9,022	2016-04-06 10:13	24:00:00	11.07	
4	A02Da	2016-04-06 10:08	59,431	69,537	10,106	2016-04-06 10:13	68,299	9,368	2016-04-07 10:19	24:06:00	7.88	1.8628
5	A02Db	2016-04-06 10:08	62,752	72,758	10,006	2016-04-06 10:13	72,003	9,251	2016-04-07 10:19	24:06:00	8.16	
6	A02Dc	2016-04-06 10:08	62,346	72,966	10,022	2016-04-06 10:13	72,297	9,451	2016-04-07 10:19	24:06:00	6.02	
7	A03Da	2016-04-07 10:08	62,556	72,679	10,021	2016-04-07 10:19	72,136	9,478	2016-04-08 10:19	24:00:00	5.73	0.6382
8	A03Db	2016-04-07 10:08	57,348	67,349	10,001	2016-04-07 10:19	67,394	9,446	2016-04-08 10:19	24:00:00	5.88	
9	A03Dc	2016-04-07 10:08	59,658	69,667	10,009	2016-04-07 10:19	69,217	9,559	2016-04-08 10:19	24:00:00	4.71	
10	A07Da	2016-04-11 10:08	64,11	74,115	10,005	2016-04-11 10:10	73,207	9,597	2016-04-12 10:12	24:02:00	4.25	0.0663
11	A07Db	2016-04-11 10:08	59,262	69,259	9,997	2016-04-11 10:10	68,844	9,582	2016-04-12 10:12	24:02:00	4.33	
12	A07Dc	2016-04-11 10:08	62,393	72,398	10,005	2016-04-11 10:10	72,680	9,587	2016-04-12 10:12	24:02:00	4.36	
13	A01HDa	2016-04-18 10:08	59,507	69,511	10,004	2016-04-18 10:02	69,108	9,601	2016-04-19 10:00	23:58:00	4.20	0.0524
14	A01HDb	2016-04-18 10:08	60,112	70,113	10,001	2016-04-18 10:02	69,701	9,589	2016-04-19 10:00	23:58:00	4.30	
15	A01HDc	2016-04-18 10:08	61,859	71,867	10,008	2016-04-18 10:02	71,462	9,603	2016-04-19 10:00	23:58:00	4.22	

Product B Time for casting												
2016-02-29 10:48												
Number	ID	Predeter, time for mea.	V Container(g)	V sample-container(g)	V wet(g)	Time into Oven	V after(24 H)(g)	V dry (24 H)(g)	Time out of oven	Total time in oven	Moisture content	
1	B01Da	2016-03-01 10:48	59,457	69,559	10,102	2016-04-05 10:59	68,625	9,168	2016-04-06 10:59	24:00:00	10.19	0.0696
2	B01Db	2016-03-01 10:48	62,566	72,684	10,028	2016-04-05 10:59	71,758	9,102	2016-04-06 10:59	24:00:00	10.17	
3	B01Dc	2016-03-01 10:48	61,704	71,692	9,988	2016-04-05 10:59	70,779	9,075	2016-04-06 10:59	24:00:00	10.06	
4	B02Da	2016-03-02 10:48	58,845	68,862	10,007	2016-04-06 10:59	67,916	9,071	2016-04-07 11:02	24:03:00	10.32	0.6494
5	B02Db	2016-03-02 10:48	59,249	69,229	9,98	2016-04-06 10:59	68,299	9,050	2016-04-07 11:02	24:03:00	10.28	
6	B02Dc	2016-03-02 10:48	64,685	74,694	10,009	2016-04-06 10:59	73,853	9,168	2016-04-07 11:02	24:03:00	9.17	
7	B03Da	2016-03-03 10:48	60,111	70,145	10,034	2016-04-07 11:02	69,351	9,24	2016-04-08 11:03	24:01:00	8.59	0.3179
8	B03Db	2016-03-03 10:48	65,291	75,278	9,987	2016-04-07 11:02	74,52	9,229	2016-04-08 11:03	24:01:00	8.21	
9	B03Dc	2016-03-03 10:48	62,619	72,55	9,931	2016-04-07 11:02	71,743	9,124	2016-04-08 11:03	24:01:00	8.84	
10	B07Da	2016-03-07 10:48	57,334	67,347	10,013	2016-04-11 10:50	66,615	9,281	2016-04-12 10:50	24:00:00	7.89	0.1274
11	B07Db	2016-03-07 10:48	59,288	69,293	10,005	2016-04-11 10:50	68,555	9,267	2016-04-12 10:50	24:00:00	7.96	
12	B07Dc	2016-03-07 10:48	59,344	69,338	9,995	2016-04-11 10:50	68,587	9,243	2016-04-12 10:50	24:00:00	8.14	
13	B01HDa	2016-03-14 10:48	60,355	70,340	9,985	2016-04-18 10:31	69,667	9,312	2016-04-19 10:32	24:01:00	7.23	0.0821
14	B01HDb	2016-03-14 10:48	60,153	70,163	10,01	2016-04-18 10:31	69,492	9,339	2016-04-19 10:32	24:01:00	7.18	
15	B01HDc	2016-03-14 10:48	60,371	70,368	9,997	2016-04-18 10:31	69,708	9,337	2016-04-19 10:32	24:01:00	7.07	

Oven drying 105°C 20 ml vials

Product A														
Time for casting														
2016-02-22 09:07														
Number	ID	Predeter. time	Time in ambient(mins)	V Container(g)	V sample-container(g)	V wet(g)	Time into Oven	V after 24 H (g)	V dry (24 H)	Time out of oven	Total time in oven	MFC	Std dev	Comments
1	AO1Da	2016-02-23 09:07	0141	60.414	70.264	9.950	2016-02-23 09:07	68.624	8.210	2016-02-24 09:18	24.1100	2.119	0.0924	
2	AO1Db	2016-02-23 09:07	0150	61.253	71.219	9.965	2016-02-23 09:07	69.488	8.225	2016-02-24 09:18	24.1100	2.102		
3	AO1De	2016-02-23 09:07	0117	61.280	71.452	10.172	2016-02-23 09:07	69.683	8.403	2016-02-24 09:18	24.1100	2.105		
4	AO2Da	2016-02-24 09:07	0120	60.255	70.227	9.972	2016-02-24 09:25	68.517	8.262	2016-02-25 09:33	24.0800	2.070	0.1941	
5	AO2Db	2016-02-24 09:07	0138	61.506	71.486	9.980	2016-02-24 09:25	69.800	8.294	2016-02-25 09:33	24.0800	2.033		
6	AO2De	2016-02-24 09:07	0138	61.719	71.616	9.899	2016-02-24 09:25	69.325	8.207	2016-02-25 09:33	24.0800	2.052		
7	AO3Da	2016-02-25 09:07	0111	59.406	69.295	9.889	2016-02-25 09:40	67.702	8.286	2016-02-26 09:40	24.0000	2.041	0.1823	
8	AO3Db	2016-02-25 09:07	0119	61.547	71.588	10.039	2016-02-25 09:40	69.863	8.316	2016-02-26 09:40	24.0000	2.072		
9	AO3De	2016-02-25 09:07	0147	61.327	71.258	9.931	2016-02-25 09:40	69.553	8.226	2016-02-26 09:40	24.0000	2.073		
10	AO7Da	2016-02-29 09:07	0107	60.216	69.622	9.406	2016-02-29 09:17	68.024	7.808	2016-03-01 09:20	24.0300	2.047	0.0294	
11	AO7Db	2016-02-29 09:07	0115	60.442	70.392	9.950	2016-02-29 09:17	68.705	8.263	2016-03-01 09:20	24.0300	2.042		
12	AO7De	2016-02-29 09:07	0124	61.068	71.082	10.014	2016-02-29 09:17	69.383	8.315	2016-03-01 09:20	24.0300	2.043		
13	AO1Da	2016-03-07 09:07	0116	64.404	74.285	9.881	2016-03-07 09:15	72.891	8.487	2016-03-08 09:20	24.0500	1.780	0.1483	
14	AO1Db	2016-03-07 09:07	0104	61.987	72.045	10.058	2016-03-07 09:15	70.523	8.535	2016-03-08 09:20	24.0500	1.733		
15	AO1De	2016-03-07 09:07	0059	61.378	71.297	9.919	2016-03-07 09:15	69.816	8.438	2016-03-08 09:20	24.0500	1.755		
Product B														
Time for casting														
2016-02-29 09:49														
Number	ID	Predeter. time	Time in ambient(mins)	V Container(g)	V sample-container(g)	V wet(g)	Time into Oven	V after 24 H (g)	V dry (24 H)	Time out of oven	Total time in oven	MFC	Std dev	Comments
1	BO1Da	2016-03-01 09:49	0115	60.707	70.841	9.934	2016-03-01 10:15	69.098	8.391	2016-03-02 10:12	23.9700	18.39	0.3044	
2	BO1Db	2016-03-01 09:49	0116	62.014	72.092	10.078	2016-03-01 10:15	70.553	8.539	2016-03-02 10:12	23.9700	18.02		
3	BO1De	2016-03-01 09:49	0150	61.465	71.578	10.113	2016-03-01 10:15	69.990	8.525	2016-03-02 10:12	23.9700	18.63		
4	BO2Da	2016-03-02 09:49	0120	60.175	70.315	10.140	2016-03-02 10:12	68.786	8.611	2016-03-03 10:15	24.0300	17.76	0.2853	Condensation on lid
5	BO2Db	2016-03-02 09:49	0101	62.091	72.102	10.011	2016-03-02 10:12	70.563	8.472	2016-03-03 10:15	24.0300	18.17		Condensation on lid
6	BO2De	2016-03-02 09:49	0056	61.581	71.605	10.024	2016-03-02 10:12	70.054	8.473	2016-03-03 10:15	24.0300	18.31		Condensation on lid
7	BO3Da	2016-03-03 09:49	0133	59.644	69.651	10.007	2016-03-03 10:15	68.158	8.514	2016-03-04 10:16	24.0100	17.54	0.1236	
8	BO3Db	2016-03-03 09:49	0127	62.831	73.055	10.224	2016-03-03 10:15	71.51	8.679	2016-03-04 10:16	24.0100	17.80		
9	BO3De	2016-03-03 09:49	0129	62.204	72.222	10.018	2016-03-03 10:15	70.716	8.512	2016-03-04 10:16	24.0100	17.69		
10	BO7Da	2016-03-07 09:49	0114	62.95	72.99	10.04	2016-03-07 09:42	71.516	8.566	2016-03-08 09:44	24.0200	17.21	0.1691	
11	BO7Db	2016-03-07 09:49	0115	59.743	69.835	10.092	2016-03-07 09:42	68.342	8.599	2016-03-08 09:44	24.0200	17.36		
12	BO7De	2016-03-07 09:49	0109	60.182	70.214	10.022	2016-03-07 09:42	68.756	8.564	2016-03-08 09:44	24.0200	17.02		
13	BO1Da	2016-03-14 09:49	0119	62.791	72.750	9.959	2016-03-14 09:58	71.229	8.538	2016-03-15 09:54	23.9600	16.64	0.1245	
14	BO1Db	2016-03-14 09:49	0129	61.067	71.085	10.018	2016-03-14 09:58	69.638	8.571	2016-03-15 09:54	23.9600	16.88		
15	BO1De	2016-03-14 09:49	0120	60.013	70.02	10.007	2016-03-14 09:58	68.579	8.566	2016-03-15 09:54	23.9600	16.82		

Oven drying 105°C core drilling

Product A

Number	ID	Predeter. time for mea.	Type floor	Type of core	Time in ambient(m:ss)	V Container(g)	V sample-cont (V wet)(g)	Time into Oven	V after(24 H)(g)	V dry (24 H)(g)	Time out of oven	Total time	MC	Std dev	Comments	
1	A01Da	2016-03-16 09:25	A1	3	02:00	59.532	69.665	10:33	2016-03-16 10:40	67.965	8.323	2016-03-17 10:41	2430:00	21.75	0.0839	
2	A01Db	2016-03-16 09:25	A1	5	00:53	62.598	72.631	10:03	2016-03-16 10:40	70.949	8.251	2016-03-17 10:41	2430:00	21.60		
3	A01Dc	2016-03-16 09:25	A1	5	01:57	60.827	70.931	10:04	2016-03-16 10:40	69.138	8.311	2016-03-17 10:41	2430:00	21.57		
4	A02Da	2016-03-17 08:33	A3	3	01:19	60.147	70.168	10:21	2016-03-17 09:11	66.417	8.270	2016-03-18 09:12	2430:00	21.17	0.0208	
5	A02Db	2016-03-17 08:33	A3	3	02:04	56.615	66.514	9:59	2016-03-17 09:11	64.871	8.266	2016-03-18 09:12	2430:00	21.11		
6	A02Dc	2016-03-17 08:33	A3	2	01:12	57.328	67.295	9:57	2016-03-17 09:11	65.555	8.227	2016-03-18 09:12	2430:00	21.15		
7	A03Da	2016-03-18 09:05	A2	3	01:50	60.803	70.621	10:16	2016-03-18 09:50	66.316	8.315	2016-03-18 09:50	2430:00	20.48	0.4231	
8	A03Db	2016-03-18 09:05	A2	4	01:00	59.7	69.781	10:01	2016-03-18 09:50	66.012	8.312	2016-03-18 09:50	2430:00	21.28		
9	A03Dc	2016-03-18 09:05	A2	4	01:44	61.474	71.362	9:58	2016-03-18 09:50	69.638	8.164	2016-03-18 09:50	2430:00	21.12		
10	A07Da															
11	A07Db															
12	A07Dc															
13	A01HDa															
14	A01HDb															
15	A01HDc															

Product B

Number	ID	Predeter. time for mea.	Type floor	Type of core	Time in ambient(m:ss)	V Container(g)	V sample-cont (V wet)(g)	Time into Oven	V after(24 H)(g)	V dry (24 H)(g)	Time out of oven	Total time	MC	Std dev	Comments	
1	B01Da	2016-03-16 14:19	E1	2	02:05	56.698	66.678	9:50	2016-03-16 14:21	67.187	8.489	2016-03-17 14:13	2352:00	17.56	0.0527	
2	B01Db	2016-03-16 14:19	E1	3	01:13	63.505	73.577	10:02	2016-03-16 14:21	72.065	8.560	2016-03-17 14:13	2352:00	17.66		
3	B01Dc	2016-03-16 14:19	E1	3	02:04	62.64	72.715	10:05	2016-03-16 14:21	71.204	8.564	2016-03-17 14:13	2352:00	17.64		
4	B02Da	2016-03-17 10:07	E3	1	01:07	62.034	72.119	10:05	2016-03-17 10:41	70.603	8.569	2016-03-18 10:54	2413:00	17.69	0.1591	
5	B02Db	2016-03-17 10:07	E3	1	02:10	59.701	69.873	10:12	2016-03-17 10:41	68.349	8.648	2016-03-18 10:54	2413:00	17.62		
6	B02Dc	2016-03-17 10:07	E3	2	00:59	60.587	70.484	9:57	2016-03-17 10:41	69.018	8.431	2016-03-18 10:54	2413:00	17.39		
7	B03Da	2016-03-16 14:01	E2	1	01:10	64.14	74.084	9:54	2016-03-16 14:20	72.65	8.51	2016-03-19 14:16	2356:00	16.85	0.0695	
8	B03Db	2016-03-16 14:01	E2	1	02:14	59.259	69.292	10:03	2016-03-16 14:20	67.954	8.595	2016-03-19 14:16	2356:00	16.73		
9	B03Dc	2016-03-16 14:01	E2	2	00:58	58.967	68.976	10:09	2016-03-16 14:20	67.538	8.571	2016-03-19 14:16	2356:00	16.78		
10	B07Da															
11	B07Db															
12	B07Dc															
13	B01HDa															
14	B01HDb															
15	B01HDc															

Carbide method 20 ml vials

Product A		Time for casting	2016-02-23 12:30	12:30:00																
Number	ID	Predeter. time	Time in ambient(m:ss)	Actual time for mea.	Weight (g)	Start temp(°C)	End temp(°C)	Pressure (bar)	End time	MC	Std dev									
1	AK1Da	2016-02-24 12:30	01:32	12:29	5	22	25	0.80	12:39	15.8	0.3018									
2	AK1Db	2016-02-24 12:30	00:55	13:00	5	24.5	27	0.76	13:10	15.0										
3	AK1De	2016-02-24 12:30	00:45	13:16	5	26	27	0.85	13:26	16.8										
4	AK2Da	2016-02-25 12:30	00:43	12:29	5	20	24.5	0.82	12:39	16.2	0.1155									
5	AK2Db	2016-02-25 12:30	00:39	12:48	5	24.5	27	0.81	12:56	16.0										
6	AK2De	2016-02-25 12:30	01:01	13:03	5	26	27	0.82	13:13	16.2										
7	AK3Da	2016-02-26 12:30	00:46	12:18	5	21.5	25	0.81	12:28	16.0	0.6928									
8	AK3Db	2016-02-26 12:30	00:55	12:33	5	26	27	0.87	12:43	17.2										
9	AK3De	2016-02-26 12:30	00:34	12:51	5	27	27	0.81	13:01	16.0										
10	AK7Da	2016-03-01 12:30	00:50	12:00	5	20	24.5	0.8	12:10	15.8	0.1155									
11	AK7Db	2016-03-01 12:30	00:40	12:16	5	24	26	0.8	12:26	15.8										
12	AK7De	2016-03-01 12:30	00:42	12:33	5	25	27	0.81	12:43	16										
13	AK14Da	2016-03-08 12:30	00:26	12:11	5	21.5	24.5	0.7	12:21	13.8	0.1155									
14	AK14Db	2016-03-08 12:30	00:47	12:30	5	24.5	24.5	0.7	12:40	13.8										
15	AK14De	2016-03-08 12:30	00:32	12:55	5	24.5	27	0.71	13:05	14										

Product B		Time for casting	2016-03-01 10:29	10:29:00																
Number	ID	Predeter. time	Time in ambient(m:ss)	Actual time for mea.	Weight (g)	Start temp(°C)	End temp(°C)	Pressure (bar)	End time	MC	Std dev									
1	BK1Da	2016-03-02 10:29	00:43	10:22	5	20	24.5	0.67	10:32	13.2	0.3055									
2	BK1Db	2016-03-02 10:29	00:51	10:37	5	24	26	0.65	10:47	12.8										
3	BK1De	2016-03-02 10:29	00:51	10:52	5	24.5	26	0.68	11:02	13.4										
4	BK2Da	2016-03-03 10:29	01:09	10:01	5	20	24.5	0.61	10:11	12	0.7024									
5	BK2Db	2016-03-03 10:29	00:38	10:20	5	24.5	24.5	0.65	10:30	12.8										
6	BK2De	2016-03-03 10:29	00:39	10:38	5	24.5	27	0.68	10:48	13.4										
7	BK3Da	2016-03-04 10:29	00:27	10:08	5	18.5	21.5	0.63	10:18	12.4	0.2309									
8	BK3Db	2016-03-04 10:29	00:47	10:28	5	22	24.5	0.65	10:38	12.8										
9	BK3De	2016-03-04 10:29	00:36	10:47	5	24.5	26	0.65	10:57	12.8										
10	BK7Da	2016-03-08 10:29	00:58	09:56	5	21	24.5	0.6	10:06	11.8	0.4163									
11	BK7Db	2016-03-08 10:29	00:31	10:12	5	24.5	24.5	0.61	10:22	12										
12	BK7De	2016-03-08 10:29	01:01	10:29	5	24.5	25	0.64	10:39	12.6										
13	BK14Da	2016-03-15 10:29	00:55	10:24	5	21	24.5	0.69	10:34	11.6	0.3055									
14	BK14Db	2016-03-15 10:29	00:33	10:40	5	24.5	26	0.61	10:50	12										
15	BK14De	2016-03-15 10:29	00:36	10:55	5	24.5	27	0.62	11:05	12.2										

Carbide method core drilling

Product A

Number	ID	Predictor. time for mea.	Type of Floor	Type of core	Time in ambient(m:ss)	Actual time for mea.	Weight (g)	Start temp(C)	End temp(C)	Pressure	End tim	MC	MC dry	Std dev	Comments
5	AK1Dc	2016-03-16 09:25	A1	2	00:42	10:09	5	20	24.5	0.86	10:19	17	20.5	0.2903	
6	AK1Db	2016-03-16 09:25	A1	2	01:24	10:25	5	26	27	0.87	10:35	17.2	20.6		
7	AK1Dc	2016-03-16 09:25	A1	2	02:03	10:38	5	26	27.5	0.85	10:48	16.8	20.2		
8	AK2Dc	2016-03-17 08:33	A2	4	01:45	08:50	5	21.5	25	0.84	09:00	16.6	19.9	0.2862	
9	AK2Db	2016-03-17 08:33	A2	4	01:58	09:08	5	24	27	0.83	09:18	16.4	19.6		
10	AK2Dc	2016-03-17 08:33	A2	4	02:25	09:23	5	27	28	0.82	09:33	16.2	19.3		
11	AK3Dc	2016-03-18 09:05	A3	1	01:05	09:23	5	20	26	0.84	09:33	16.6	19.9	0.2883	
12	AK3Db	2016-03-18 09:05	A3	1	01:51	09:40	5	24.5	26	0.85	09:50	16.6	20.2		
13	AK3Dc	2016-03-18 09:05	A3	1	02:24	09:53	5	26	27.5	0.86	10:03	17	20.5		
14	AK1Dc														
15	AK1Db														
16	AK1Dc														
17	AK1Dc														
18	AK1Db														
19	AK1Dc														

Product B

Number	ID	Predictor. time for mea.	Type of Floor	Type of core	Time in ambient	Actual time for mea.	Weight (g)	Start temp(C)	End temp(C)	Pressure	End tim	MC	MC dry	Std dev	Comments
1	BK1Dc	2016-03-16 14:19	B1	4	01:22	13:55	5	21.5	24.5	0.66		13	14.9	0.1155	
2	BK1Db	2016-03-16 14:19	B1	4	02:01	14:11	5	24.5	27	0.67		13.2	15.2		
3	BK1Dc	2016-03-16 14:19	B1	4	02:39	14:28	5	26	27	0.66		13	14.9		
4	BK2Dc	2016-03-17 10:07	B2	4	01:00	10:08	5	24	26.5	0.64		12.6	14.4	0.2909	
5	BK2Db	2016-03-17 10:07	B2	4	01:30	10:24	5	25	28	0.64		12.6	14.4		
6	BK2Dc	2016-03-17 10:07	B2	4	02:05	10:41	5	25	28	0.62		12.2	13.9		
7	BK3Dc	2016-03-18 14:01	B3	4	00:38	13:42	5	22	26	0.61		12	13.6	0.1155	
8	BK3Db	2016-03-18 14:01	B3	4	01:27	14:00	5	25.5	27	0.61		12	13.6		
9	BK3Dc	2016-03-18 14:01	B3	4	01:58	14:15	5	25.5	28	0.62		12.2	13.9		
10	BK1Dc														
11	BK1Db														
12	BK1Dc														
13	BK1Dc														
14	BK1Db														
15	BK1Dc														

Area box	cm²																		
Length=	39.500	1.296																	
Breadth=	29.500	0.989																	
Area=	1165.250	1.254																	
Area petri dish	cm²																		
Radius=	4.000	0.131																	
Area=	50.265	0.054																	

Calcium chloride

Product A

Type of floor	Casting time	Days after casting	Time removing plat	Weight sample+container dry (g)	Time for mea	Weight sample+container wet (g)	µM	Time for ending mea	Total time(hours)	A box (ft ²)	Alpetri dish (ft ²)	A=(Ab-Ad) ft ²	MWER(µhr000ft ² per 24 hours	MWER (SI)
A1	2016-03-15 09:25	1	2016-03-16 09:18	74.436	2016-03-16 09:49	91.247	16.811	2016-03-19 09:49	72:00:00	1.2543	0.0541	1.2002	10.29	59.889
A3	2016-03-15 08:33	2	2016-03-17 08:15	74.838	2016-03-17 08:34	91.090	16.252	2016-03-20 08:32	7:18:00	1.2543	0.0541	1.2002	9.95	562.34
A2	2016-03-15 09:02	3	2016-03-18 08:51	76.100	2016-03-18 09:11	91.989	15.889	2016-03-21 09:11	72:00:00	1.2543	0.0541	1.2002	9.72	544.09
A7														
A4														

Product B

Type of floor	Casting time	Days after casting	Time removing plat	Weight sample+container dry (g)	Time for mea	Weight sample+container wet (g)	µM	Time for ending mea	Total time(hours)	A box (ft ²)	Alpetri dish (ft ²)	A=(Ab-Ad) ft ²	MWER (SI)	
B1	2016-03-15 14:19	1	2016-03-16 13:08	77.085	2016-03-16 13:26	93.478	16.413	2016-03-19 13:32	7:57:00	1.2543	0.0541	1.2002	10.99	567.910
B2	2016-03-15 10:17	2	2016-03-17 09:45	75.220	2016-03-17 10:04	91.640	16.32	2016-03-20 10:04	72:00:00	1.2543	0.0541	1.2002	9.993	584.692
B3	2016-03-15 14:01	3	2016-03-18 13:17	76.886	2016-03-18 13:26	93.242	16.346	2016-03-21 13:32	7:57:00	1.2543	0.0541	1.2002	10.09	565.592
B7														
B4														

RH Closed Petri dishes									
Product A									
Time for casting		2016-04-04 10:08							
Number	ID	Time for attaching	Time after casting	RF sensor ID	Time for reading value	RH (%)	Temp (°C)	Dew point (°C)	RH corrected (%)
1	AO1D	2016-04-05 10:30	24:00:00	(11-7)	2016-04-06 09:47	99,4	19,9	19,7	96,6
2	AO2D	2016-04-06 10:18	48:00:00	(11-7)	2016-04-07 09:55	99,0	19,8	19,6	96,1
3	AO3D	2016-04-07 10:27	72:00:00	(11-7)	2016-04-08 10:43	99,6	19,8	19,7	96,9
4	AO7D	2016-04-11 10:17	168:00:00	(11-7)	2016-04-12 10:15	98,4	19,9	19,6	95,8
5	AO14D	2016-04-18 10:07	336:00:00	(11-7)	2016-04-19 09:56	98,0	19,9	19,5	95,5
6									
7									
8									
9									
10									
11									
Product B									
Time for casting		2016-04-04 10:48							
Number	ID	Time for attaching	Time after casting	RF sensor ID	Time for reading value	RH (%)	Temp (°C)	Dew point (°C)	RH corrected (%)
1	BO1Da	2016-04-05 11:08	24:00:00	(11-2)	2016-04-06 09:54	99,9	19,8	19,7	95,0
2	BO2Da	2016-04-06 10:52	48:00:00	(11-2)	2016-04-07 10:52	99,9	19,8	19,7	95,0
3	BO3Da	2016-04-07 10:57	72:00:00	(11-2)	2016-04-08 10:45	99,9	19,9	19,8	95,0
4	BO7Da	2016-04-11 11:02	168:00:00	(11-2)	2016-04-12 10:17	99,7	19,9	19,8	95,0
5	BO14Da	2016-04-18 10:36	336:00:00	(11-2)	2016-04-19 10:36	99,4	19,9	19,8	94,8
6									
7									
8									
9									
10									
11									

RH Open Petri dishes										
Product A										
Time for casting		2016-04-04 10:08								
Number	ID	Time for attaching	Time after casting	RF sensor ID	Time for reading value	RH (%)	Temp (°C)	Dew point (°C)	RH corrected (%)	RH mean
1	AO1Da	2016-04-05 10:13	24:00:00	(10-5)	2016-04-06 09:46	97,7	20,1	19,7	94,2	
2	AO2Da	2016-04-05 10:13	24:00:00	(10-14)	2016-04-06 09:49	99,7	20,0	20,0	97,0	95,6
3	AO2Da	2016-04-06 10:05	48:00:00	(10-5)	2016-04-07 09:52	95,1	20,0	19,2	92,0	
4	AO2Da	2016-04-06 10:07	48:00:00	(10-14)	2016-04-07 09:53	98,1	19,8	19,5	95,5	93,8
5	AO3Da	2016-04-07 10:12	72:00:00	(10-5)	2016-04-08 10:42	90,6	20,1	18,5	87,8	
6	AO3Da	2016-04-07 10:15	72:00:00	(10-14)	2016-04-08 10:42	93,6	19,8	19,8	90,8	89,3
7	AO7Da	2016-04-11 10:11	168:00:00	(10-5)	2016-04-12 10:13	37,8	20,1	5,2	34,8	
8	AO7Da	2016-04-11 10:11	168:00:00	(10-14)	2016-04-12 10:13	37,0	19,8	4,8	34,4	34,6
9	AO14D	2016-04-18 09:51	336:00:00	(10-5)	2016-04-19 09:55	40,3	20,1	6,2	37,8	
10	AO14D	2016-04-18 09:57	336:00:00	(10-14)	2016-04-19 09:55	38,2	19,8	5,2	35,7	36,8
11										
Product B										
Time for casting		2016-02-29 10:48								
Number	ID	Time for attaching	Time after casting	RF sensor ID	Time for reading value	RH (%)	Temp (°C)	Dew point (°C)	RH corrected (%)	RH mean
1	BO1Da	2016-04-05 10:59	24:00:00	(11-4)	2016-04-06 09:52	93,1	19,9	18,7	90,1	
2	BO1Db	2016-04-05 10:59	24:00:00	(11-6)	2016-04-06 09:53	90,9	19,9	18,3	88,0	89,1
3	BO2Da	2016-04-06 10:39	48:00:00	(11-4)	2016-04-07 09:57	94,3	19,9	18,9	91,5	
4	BO2Db	2016-04-06 10:43	48:00:00	(11-6)	2016-04-07 09:57	92,0	19,9	18,5	89,4	90,5
5	BO3Da	2016-04-07 10:45	72:00:00	(11-4)	2016-04-08 10:44	80,0	19,9	16,3	77,4	
6	BO3Db	2016-04-07 10:51	72:00:00	(11-6)	2016-04-08 10:44	80,1	19,9	16,3	77,9	77,7
7	BO7Da	2016-04-11 10:39	168:00:00	(11-4)	2016-04-12 10:16	66,8	19,9	13,5	64,2	
8	BO7Db	2016-04-11 10:44	168:00:00	(11-6)	2016-04-12 10:16	66,4	19,9	13,4	64,3	64,3
9	BO14D	2016-04-18 10:21	336:00:00	(11-4)	2016-04-19 09:57	51,1	20,0	9,6	48,6	
10	BO14D	2016-04-18 10:26	336:00:00	(11-6)	2016-04-19 09:57	53,3	19,9	10,2	51,0	49,8
11										

RH sensor 500 ml

Product A							
ID	ID RH se	Casting time	Date for attaching RH sensor	Date-time	Dew point	Temp	RH(%)
A1	(10-11)	2016-03-07 13:08	2016-03-09 15:19				
				2016-03-10 10:23	20	20	99,9
				2016-03-11 11:50	20,1	20,1	99,9
				2016-03-14 12:05	20,3	20,4	99,9
				2016-03-15 14:45	20	20,1	99,9
				2016-03-16 14:32	19,9	19,9	99,9
				2016-03-18 14:34	19,7	19,7	99,9
				2016-03-30 13:35	19,1	19,1	99,9
				2016-04-05 11:20	19,2	19,2	99,9
				2016-04-08 13:15	19,2	19,3	99,9
A2	(10-9)	2016-03-07 13:08	2016-03-09 15:19				
				2016-03-10 10:23	19,9	19,9	99,9
				2016-03-11 11:50	20	20	99,8
				2016-03-14 12:05	20,1	20,3	99,2
				2016-03-15 14:45	19,9	20	99,7
				2016-03-16 14:32	19,8	19,8	99,9
				2016-03-18 14:34	19,6	19,6	99,9
				2016-03-30 13:35	18,8	18,9	99,4
				2016-04-05 11:20	19	19,1	99,1
				2016-04-08 13:15	19	19,1	99,2

Product B							
ID	ID RH se	Casting time	Date for attaching RH sensor	Date-time	Dew point	Temp	RH(%)
B1	(11-3)	2016-03-07 13:33	2016-03-09 15:19				
				2016-03-10 10:23	19,7	19,8	99,7
				2016-03-11 11:50	19,8	19,9	99,5
				2016-03-14 12:05	19,9	20,1	99,2
				2016-03-15 14:45	19,7	19,8	99,6
				2016-03-16 14:32	19,6	19,7	99,6
				2016-03-18 14:34	19,3	19,4	99,8
				2016-03-30 13:35	18,8	18,9	99,7
				2016-04-05 11:20	18,9	19	99,5
				2016-04-08 13:15	19	19,1	99,5
B2	(11-9)	2016-03-07 13:33	2016-03-09 15:19				
				2016-03-10 10:23	19,8	19,8	99,9
				2016-03-11 11:50	19,7	19,8	99,9
				2016-03-14 12:05	20	20,1	99,9
				2016-03-15 14:45	19,7	19,8	99,9
				2016-03-16 14:32	19,6	19,5	99,9
				2016-03-18 14:34	19,3	19,4	99,9
				2016-03-30 13:35	18,7	18,8	99,9
				2016-04-05 11:20	18,9	19	99,9
				2016-04-08 13:15	18,9	19	99,9

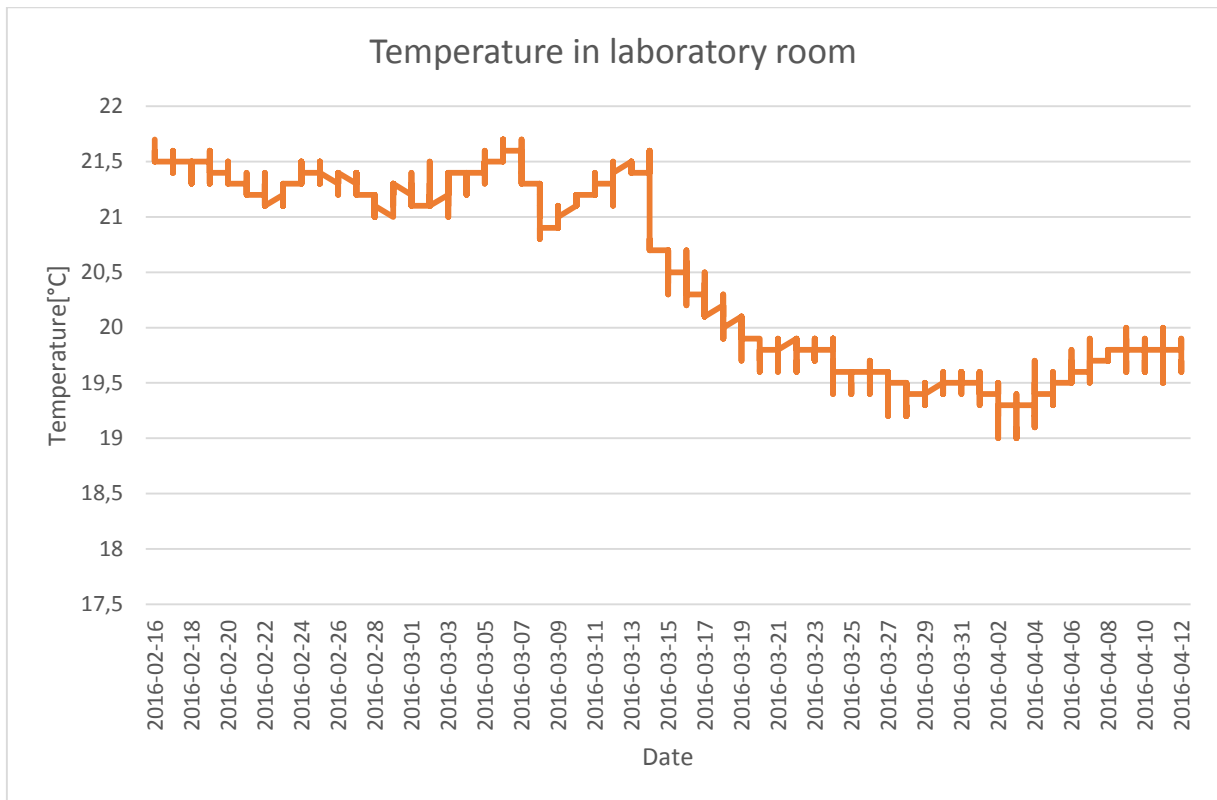
Isothermal calorimetry Tam Air 5

Product A						
Number	Start of measurement (computer)	Weight (g)	Time of casting	Time finished casting	Time for attaching RH sensor	
1	2016-03-08 12:37	13,335	2016-03-08 12:50	2016-03-08 12:56		
2	2016-03-08 12:37	11,149	2016-03-08 12:50	2016-03-08 12:56	2016-03-09 08:47	
3	2016-03-08 12:37	10,042	2016-03-08 12:50	2016-03-08 12:56		
4	2016-03-08 12:37	11,213	2016-03-08 12:50	2016-03-08 12:56		
RH(%)	100	100	100	100	100	100
Date	2016-03-10	2016-03-11	2016-03-14	2016-03-15	2016-03-18	2016-03-30
Product B						
Number	Start of measurement (computer)	Weight (g)	Time of casting	Time finished casting	Time for attaching RH sensor	
5	2016-03-08 12:37	10,568	2016-03-09 13:16	2016-03-09 13:19		
6	2016-03-08 12:37	10,429	2016-03-09 13:16	2016-03-09 13:19		
7	2016-03-08 12:37	10,228	2016-03-09 13:16	2016-03-09 13:19		
8	2016-03-08 12:37	11,661	2016-03-09 13:16	2016-03-09 13:19		

11.3 Core drilling

Product A						
Floor sample	Time for removing plastic	Type of core	Start time	Temp floor('C)	Temp core('C)	Time coredrilling-plastic bag(mm:ss)
A1	2016-03-16 09:18	1	2015-03-16 09:21	19,5	38	01:04
		2	2015-03-16 09:26	19,5	38,5	00:47
		3	2015-03-16 09:29	19,5	35,3	00:35
		4	2015-03-16 09:32	19,5	38,6	01:25
		5	2015-03-16 09:35	19,5	39,5	00:49
A2	2016-03-17 08:13	1	2016-03-17 09:19	18,4	44,7	00:36
		2	2016-03-17 09:21	18,4	43,2	00:41
		3	2016-03-17 09:23	18,5	38,5	00:45
		4	2016-03-17 09:26	18,3	49,5	00:42
A3	2016-03-18 08:51	1	2016-03-18 08:53	18,6	43	00:40
		2	2016-03-18 08:57	18,6	41,4	00:44
		3	2016-03-18 08:59	18,8	44,7	00:41
		4	2016-03-18 09:03	18,4	45,3	00:33
Product B						
Floor sample	Time for removing plastic	Type of core	Start time	Temp floor('C)	Temp core('C)	Time coredrilling-plastic bag(mm:ss)
B1	2016-03-16 13:08	1	2016-03-16 13:11	18,7	40,1	01:09
		2	2016-03-16 13:16	18,6	44,5	01:28
		3	2016-03-16 13:21	18,3	41,7	01:16
		4	2016-03-16 13:29	18,1	41,4	02:16
B2	2016-03-17 09:45	1	2016-03-17 09:47	18,6	56,7	01:05
		2	2016-03-17 09:51	18,4	56	01:20
		3	2016-03-17 09:54	18,6	48,6	00:52
		4	2016-03-17 09:57	18	36,3	01:14
B3	2016-03-18 13:17	1	2016-03-18 13:19	18,4	53	00:50
		2	2016-03-18 13:23	18,5	58,3	01:11
		3	2016-03-18 13:25	18,5	60,3	00:55
		4	2016-03-18 13:27	17,7	53	00:50

11.4 Temperature in laboratory room



11.5 RH in laboratory room

