Jørgen Haldorsen Tomren

Maling som tørker

Himlingsmalings innvirkning på uttørkingsevnen til kompakte tretak med smart dampsperre

Masteroppgave i Bygg- og miljøteknikk
Veileder: Tore Kvande
Medveileder: Erlend Andenæs
November 2023

Masteroppgave

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Norges teknisk-naturvitenskapelige universitet
Fakultet for ingeniørvitenskap
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Forord

Jeg vil gjerne takke alle som har hjulpet meg gjennom både lette og tunge tider, og har mye av æren for at jeg til slutt kom i mål. Jeg vil takke familien min som alltid støttet meg og sønnen min, Edias, som alltid trodde på meg og motiverte med til å jobbe videre.

Jeg vil også spesifikt takke Erlend Andenæs, Tore Kvande, Stig Geving og Ole Aunrønning.

Ole hjalp meg å komme gjennom den praktiske delen av laboratorieforsøket ved opplæring og veiledning.

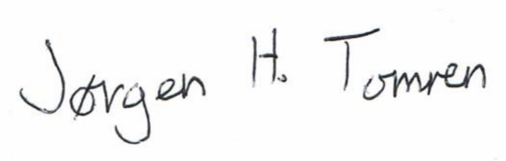
Tore Kvande, professor i bygningsmaterialer ved Institutt for bygg- og miljøteknikk, har vært hovedveileder for denne masteroppgaven. I vanskelige tider har han hatt oppmuntrende ord og inspirasjon. Tore kom med mange idéer og innspill som gjorde mange aspekter av oppgaven enklere. Tore var alltid tilgjengelig for å svare på om noe var godt nok, burde endres eller rett og slett ikke være med i oppgaven.

Erlend Andenæs var en uvurderlig hjelp når det kom til å skrive forskningsartikkelen. Vi diskuterte mange idéer og snakket om forskjellige løsninger og fremgangsmåter. Erlend gjorde også en viktig jobb med den språklige delen av forskningsartikkelen. Hans hjelp ble satt stor pris på.

Stig Geving, seniorforsker ved SINTEF Community, kom med viktig støtte og opplæring når det kom til fuktrelaterte utfordringer. Spesielt støtte relatert til beregninger i WUFI i starten av arbeidet som ga en trygghet for resultatene som ville komme. Ved å dra nytte av Stig sin kunnskap følte vi oss trygge på at simuleringene ville være både gode og realistiske.

Til slutt vil jeg takke alle forelesere jeg har hatt gjennom mine år på NTNU, samt mine medstudenter som gjorde at disse årene aldri vil glemmes.

Trondheim, 6. november 2023



Jørgen Haldorsen Tomren

Sammendrag

Smarte dampsperrer gjør klimaskall i stand til å tørke mot innsiden av et bygg. Denne egenskapen kan benyttes i flate kompakte tretak til å lage slankere konstruksjoner ved å plassere bærekonstruksjonen av tre inn i isolasjonssjiktet. Det er derimot knyttet usikkerheter til om denne type konstruksjon kan påvirke eller bremse tørking mot inneluft ved at fukt blir fanget mellom den smarte dampsperren og himlingsplatene.

Denne masteroppgaven har bestemt vanndampmotstanden til gipsplater malt med to, fire og seks lag vanlig takmaling fra forskjellige produsenter og undersøkt innvirkningen på den innoverrettede uttørkningsevnen til det kompakte taket. Koppmetoden, etter NS-EN ISO 12572:2016 *Byggematerialers og -produkters hygrotermiske egenskaper. Bestemmelse av egenskaper med hensyn til vanndampgjennomgang. Koppmetode*, ble brukt til å bestemme s_d-verdien til produktene. WUFI®2D simulasjoner ble gjennomført for å vurdere faren for muggvekst i flate kompakte tretak med malte takplater. Forsøkene viste at en malt takplate av gips kan få en ekvivalent luftlagstykkelse (s_d-verdi) så lav som 74 mm for to lag med den mest dampåpne malingen og så høy som 530 mm for seks lag med den mest damptette malingen. For en umalt gipsplate ble s_d-verdien målt til å være 71 mm.

Forskjellene i dampmotstanden til himlingsplatene forårsaket av malingene viste seg å ikke ha en stor innvirkning på denne typen konstruksjon sine egenskaper for tørking. Applikering av maling kan gjøre at takkonstruksjonen tørker saktere, men resultatene viste ingen markant økning i fare for muggvekst, selv ved veldig dårlige fuktforhold.

Abstract

Smart vapour barriers enable building envelopes to dry toward the interior side. This property can be used in compact wooden roofs to create more slender structures by placing the wooden load-bearing elements inside the insulation layer. There is, however, some concern that the ceiling assembly on the interior side may inhibit inward drying by trapping moisture between the vapour barrier and the ceiling boards.

This article examined the water vapour resistance of gypsum boards painted with two, four, and six layers of typical ceiling paints, and examined the effect this had on the inward drying capabilities of the compact wooden roof. The cup method, according to NS-EN ISO 12572:2016 *Hygrothermal Performance of Building Materials and Products. Determination of Water Vapour Transmission Properties. Cup method*, was used to determine the s_d-values of the products used. WUFI® 2D simulations were conducted to assess the risk of mould growth in compact wooden roofs with painted board ceilings.
It was found that a painted ceiling board may exhibit an equivalent stagnant air layer thickness (s_d-value) between 74 mm for two layers of the most vapour-open paint and 530 mm for six layers of the least vapour-open. For an unpainted board, the s_d-value was measured to be 71 mm.

The differences in the water vapour resistances of the painted gypsum boards was not found to make a substantial impact on the drying of a typical compact wooden roof. The application of paint may cause the assembly to dry at a slightly slower rate but was not found to present a notably higher risk of mould growth, even under unfavourable conditions.

Innholdsfortegnelse

Introduksjon

Denne masteroppgaven består i hovedsak av en forskningsartikkel utgitt basert på litteratursøk, laboratorieforsøk og fuktsimuleringer gjort i forbindelse med oppgaven. En mer tradisjonell faglig introduksjon inkludert presentasjon av formål med arbeidet finner sted i selve forskningsartikkelen. Denne introduksjonen ønsker først og fremst å kort beskrive hvordan masteroppgaven er bygget opp samt å forklare noen avgrensninger.

På grunn av tilgjengelig datakraft ble fuktsimuleringsperioden begrenset til fem år. Av samme grunn ble bare én type smart dampsperre studert. Det hadde vært ønskelig å simulere for flere smarte dampsperrer, malinger og over en lenger tidsperiode, men arbeidsomfanget måtte begrenses på grunn av tilgjengelig tid.

Først kommer hoveddelen av oppgaven som er en forskningsartikkel publisert i *Buildings* den 28. august 2023. Artikkelen presenterer hele det faglige innholdet i masteroppgaven med introduksjon, metode, resultater, diskusjon og sammendrag. Forfatterbidragene er beskrevet sist i artikkelen.

Etter forskningsartikkelen er et innlegg i fagtidsskriftet *Byggeindustrien* tatt med, hvor hovedfunn fra masteroppgaven er presentert på norsk. Innlegget er skrevet med veiledning fra Erlend Andenæs.

Da forskningsartikkelen ble sendt inn til *Buildings* fikk vi tilbakemelding om at det måtte «minior revisions» til før artikkelen kunne bli utgitt. Tilbakemeldingene fra reviewers og svarene de fikk er gjengitt i sin helhet. Kort tid etter oppretting av artikkelen ble den utgitt. Da jeg er student ble hovedveileder Tore Kvande av praktiske årsaker oppført som «corresponding author», men jeg vil presisere at jeg hadde ansvaret for å rette opp feil, gjøre endringer og fullføre ting som gjenstod før artikkelen ble utgitt.

Til slutt kommer resultatene fra laboratorieforsøkene, samt målingene forsøkene er basert på. Dette for å vise hele datagrunnlaget til oppgaven. Dataene er etterspurt av journalen og er oppgitt å finnes i masteroppgaven lagt ut på NTNU Open (ntnuopen.ntnu.no).

Forskningsartikkel

Forskningsartikkel

Tomren JH, Andenæs E, Geving S & Kvande T: **Water Vapour Resistance of Ceiling Paints—Implications for the Use of Smart Vapour Barriers in Compact Wooden Roofs**. *Buildings* 2023, Vol 13(9), 2185; doi.org/10.3390/buildings13092185, ISSN 2075-5309

buildings

Article

Water Vapour Resistance of Ceiling Paints—Implications for the Use of Smart Vapour Barriers in Compact Wooden Roofs

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Abstract: Smart vapour barriers enable building envelopes to dry toward the interior side. This property can be used in compact wooden roofs to create more slender structures by placing the wooden load-bearing elements inside the insulation layer. There is, however, some concern that the ceiling assembly on the interior side may inhibit inward drying by trapping moisture between the vapour barrier and the ceiling boards. This article examined the water vapour resistance of gypsum boards painted with two, four, and six layers of typical ceiling paints. WUFI® 2D simulations were conducted to assess the risk of mould growth in compact wooden roofs with painted board ceilings. It was found that a painted ceiling board may exhibit an equivalent stagnant air layer thickness (s_d value) between 0.074 m for two layers of the most vapour-open paint and 0.53 m for six layers of the least vapour-open. For an unpainted board, the s_d value was measured to be 0.071 m. The difference was not found to make a substantial impact on the drying of a typical compact wooden roof. The application of paint may cause the assembly to dry at a slightly slower rate but was not found to present a notably higher risk of mould growth, even under unfavourable conditions.

Keywords: ceiling paint; compact wooden roof; smart vapour barrier; drying; mould growth risk

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1. Introduction

New types of roof assembly are being developed to minimise material use and carbon impact in the building sector. Conventionally, in compact roofs featuring wooden structural materials (compact wooden roofs), the structural elements must be separated from the insulation layer due to the risk of moisture damage. In a conventional compact roof, vapour-tight layers are used on both the exterior (roofing) and interior side (vapour barrier) of the insulation layer [1]. In principle, this prevents moisture from entering the assembly. However, any built-in moisture or leakage moisture (from exterior leaks of precipitation, condensation of moisture from indoor air, or leakage from pipes) may be trapped inside the assembly, increasing the risk of mould growth in organic materials. Mould growth may lead to rot and the deterioration of the structure [2–4] and is associated with respiratory health problems including asthma [5,6]. However, mould grows less intensely if no organic materials are present [7]. To avoid mould problems, compact wooden roofs have conventionally separated the insulation layer and the load-bearing elements [8]. This solution yields low moisture risk but makes the roof assembly very thick, which may be a concern for developments where the permitted building height is limited.

Recommendations for managing moisture in buildings stress that drying is necessary if sources of moisture cannot be avoided [9,10]. Smart vapour barriers (SVBs), also called "adaptive vapour barriers", can be used to facilitate drying toward the interior side of the assembly. Hence, SVBs may allow wooden structural elements to be placed within the insulation layer and thus drastically reduce the overall thickness of the building envelope assembly [8,11]. SVBs form a crucial component of compact wooden roofs. Pilot projects [12,13] are built to document the moisture performance of compact wooden roofs that use SVBs to achieve the necessary drying capability [14–17]. The intention is for the roof to dry towards the interior side, as the roofing on the exterior side must remain watertight to prevent the intrusion of moisture from the exterior.

The primary function of an SVB is to be water-vapour-permeable when the relative humidity (RH) is high—typically during summertime in cold climates—and vapour-tight when RH is low [15,18], as illustrated in Figure 1. This behaviour inhibits moisture transport into the building envelope from the interior side but permits the drying of built-in moisture.

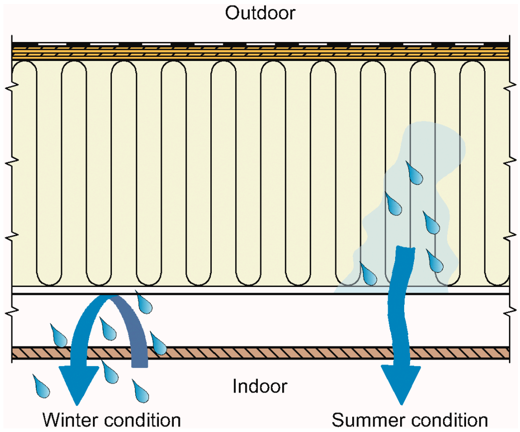


Figure 1. The working principle of an SVB in a compact wooden roof.

However, materials used for the assembly of the building envelope may exhibit a lower vapour permeability than desired, with implications for the effective drying of moisture [9]. If the surface on the drying side is wholly or partially covered by a layer that is less vapour-permeable than recommended, drying may be inhibited and mould growth may result [9]. For exterior drying, this has been demonstrated to be a concern in the case of wind barrier tape, which may be two orders of magnitude more vapour-tight than the wind barrier itself, due to the adhesive [19]. For wind barriers, which cover the exterior wall surface towards a ventilated air cavity, the Norwegian recommendations suggest that the s_d value (equivalent stagnant air layer thickness) should be 0.5 m or less to ensure effective drying [20].

The drying of materials toward the interior side of the vapour barrier (s_d value > 10 m [21]) has received little attention. In cold climates, the vapour barrier is placed toward the interior side of the building envelope. Only very limited vapour transport occurs across conventional vapour barriers, and the thermal and moisture gradients to the interior air are very low. Hence, drying towards the interior has usually not been a point of concern. However, when using vapour retarders or SVBs, drying towards the interior becomes important to the drying performance of the structure [22]. The drying performance of SVBs and smart vapour retarders has been a subject of study in recent years by, e.g., Tariku et al. [23], Yoshinaga [24], and Fechner and Meißner [25].

For roofs, the interior surface is the ceiling assembly. It typically consists of painted plaster or gypsum boards that are separated from the vapour barrier by a small air cavity caused by the battens used to fix the vapour barrier to the roof beams. The air cavity is also commonly used to hide electric cables. However, there is a concern that a too vapour-tight ceiling may trap moisture and prevent the roof assembly from drying adequately.

A limited number of earlier studies on the water vapour permeability of paint were identified. In 1953, Eckhaus et al. [26] found that pigmented paints were more porous and vapour-permeable than non-pigmented paints, and that the porosity (and hence, vapour permeability) increased sharply at a critical point of pigment saturation. Similar conclusions were found by Thun and Øvregaard [27] in 1961. Pigmented, butyl-based paints exhibited a much higher vapour permeability than other investigated paints. Huldén and Hansen [28] reported similar findings, and also that the effect of aging on the water vapour permeability of paints was primarily caused by cracking rather than any deterioration of the paint. Topçuoğlu et al. reached similar conclusions to the previous studies in 2006, summing up their findings as follows: "...the barrier property of the waterborne acrylic based paint films against humidity decreases with decreased binder content due to uneven distribution of the pigments, consequently, porous structure formation in the films." [29].

Šadauskienė et al. [30] measured the permeability of exterior paints to determine their impacts on the exterior drying of rendered façades. The s_d value of the paint when applied to render was found to be less than 0.6 m. Brito et al. [31] found that "the way the paint systems affect the drying of the substrate ... may vary significantly depending on the moisture content of the substrate". In the context of the quote, a substrate refers to the material to which the coat of paint is being applied.

Two of the identified studies investigated paint for corrosion protection, which is not normally relevant for painted ceilings, but their results are included here for the sake of completeness. Nicodemo et al. [32] examined the water permeability properties of corrosion protection paint. They noted that the concentration of the curing agent in the paint affected the water vapour permeability as well as the oxygen permeability. For corrosion protection, oxygen permeability should be kept at a minimum. Hoseinpoor et al. [33] noted that in the context of corrosion protection, the tendency for paint to blister was lower for a paint system with a less permeable topcoat.

The present study seeks to investigate whether a painted ceiling assembly may exhibit a sufficiently high vapour resistance to interfere with the intended inward drying of the roof assembly through an SVB. To address this general inquiry, the following research questions were formulated:

- What is the range of water vapour resistance for common ceiling paints?
- What are the implications of the water vapour resistance of ceiling paints on the drying properties of compact wooden roofs?

The following limitations to the study are acknowledged: The study investigated six ceiling paints that were available from commercial suppliers in Norway, applied to a standard gypsum board. The physical or chemical basis of the properties of paint were not explored. A section of a compact wooden roof was simulated in WUFI® 2D to assess the theoretical drying capability of a roof using these paints. The simulation of the SVB used moisture properties of the Isola AirGuard® Smart2 SVB [34]. The simulation investigated drying conditions in a compact wooden roof assembly designed to satisfy Norwegian technical requirements. The simulation did not consider the situation at the roof corners, edges, or any other interruptions to the standard roof geometry.

2. Methodology

2.1. Laboratory Measurements

2.1.1. Selection of Products

This study sought to investigate the implications and consequences of painting over a gypsum board ceiling of a compact wooden roof assembly. Ceilings may be painted by a contractor as part of the construction process or by inhabitants seeking to refurbish, adding multiple layers of paint to the gypsum boards. Commercially available ceiling paint products were thus purchased at two local consumer-oriented hardware stores and one professional paint supply store. The selected paints were all specifically marketed as ceiling paints. The six paints belonged to different cost tiers, from "professional quality" to the most inexpensive paint on offer. A standard white colour was chosen for all six paints. They were made by five different manufacturers. One of the paints was advertised for its low rate of degassing and was marketed towards allergy sufferers and pregnant women. All paints were delivered in three-litre buckets.

One type of commercially available gypsum board was also purchased, to serve as substrate for the paints.

2.1.2. Preparation of Samples

One gypsum board was acquired for each type of paint and stored in a laboratory climate for about a week before sample preparation began. The gypsum boards were delineated into four equal segments, and each segment was painted with two layers of paint. The paint was evenly applied while the boards were lying flat with the painted surface up, indoors in a laboratory climate. The amount of paint applied per coat was in accordance with the manufacturers' recommendations. The paint was allowed to dry for the time specified by the manufacturer, and for four hours at a minimum between each layer of paint. Two of the segments were then painted with two additional layers of paint. Finally, one of these segments was painted with two more layers. The samples were all painted by the same experienced laboratory technician using the same type of equipment, to ensure that the paint layers maintained thickness and cover as uniformly as possible.

After a minimum of one week, the plates were cut into four sections along the segment delineation lines: two sections with two layers of paint, one with four layers and one with six layers. One of the two-layer sections was set aside for spares in case additional samples were required. The three remaining sections were cut into six pieces each. A circular specimen with a diameter of 0.174 m was prepared from each piece using a circular vice and a band saw. Five such specimens were required to run a test, leaving one as a spare for each series. The unpainted gypsum board used for measurements was stored together with the painted samples.

2.1.3. Test Procedure

The test procedure used to determine the water vapour resistance of the specimens was carried out as described in NS-EN ISO 12572:2016 [35]. The specimens were conditioned in a controlled climate chamber (23 ± 1 °C, RH 50 ± 5%) for 3–4 days before mounting in cups to create the test samples. Each sample consisted of a circular cup filled with a solution of potassium nitrite (KNO_3), using the painted gypsum specimen as its sealed lid. The samples were stored and weighed in the controlled climate chamber until the end of the tests. A series of samples is portrayed in Figure 2.

Figure 2. Samples of painted gypsum board, stored on shelves in a controlled climate chamber.

The KNO_3 solution ensured a constant RH of 94% [35] within the test sample cup. The evaporated salt solution diffused through the specimen, at a rate determined by the specimen's water vapour permeability. The mass of the samples was weighed after initial preparation, and then at regular intervals. A reference weight of 1000 g was weighed before and after the samples to correct the output of the scale. The scale was a METTLER TOLEDO in the Excellence line, which measured at a resolution of 0.001 g and was accurate to within 0% at the time of weighing. The scale was kept within a plastic housing to protect from interference. Its accuracy is controlled annually by the Norwegian Metrology Service. The scale is pictured in Figure 3.

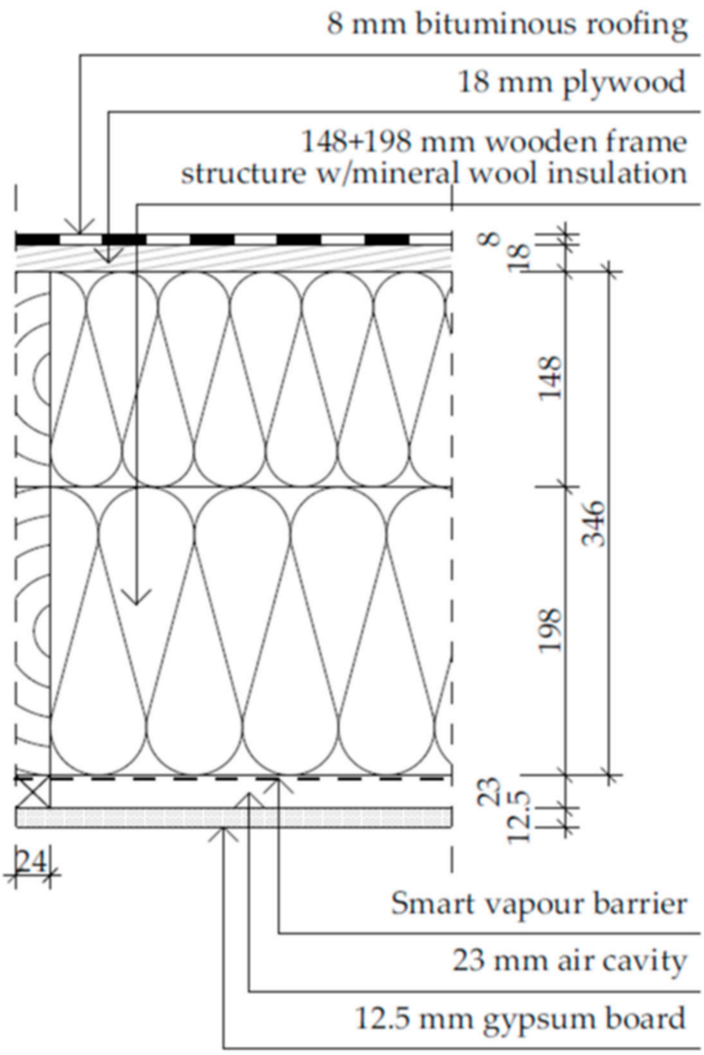
Figure 3. The scale used for measurements.

The interval of weighing depends on the expected water vapour permeability value and may be adjusted as the results begin to become apparent. For the present study, a weighing interval of once per day was selected and followed throughout the measurement period. The water vapour permeability is determined by the rate of change in weight over time. A stable rate of change is deemed to have been found if the change in weight over five consecutive weight measurements remains constant to within ±5% of their average rate of change [35].

2.2. WUFI Simulations

2.2.1. Geometry and Materials

The geometry of the modelled roof assembly, with monitor points for moisture assessment, is shown in Figure 4. This assembly is typical for the middle of a roof span, with mineral wool insulation placed within a frame structure made of 0.048 m wide wooden beams placed at a centre-to-centre distance of 0.6 m. A plywood board served as the roof underlay, covered with a bituminous roofing sheet. The SVB was mounted on the underside of the insulation layer. The ceiling was a gypsum board separated from the vapour barrier by a 0.023 m air cavity. The modelled geometry consisted of a cut-out of one 0.6 m wide section of the roof, centred around a wooden beam. Since this cut-out was symmetrical around the wooden beam, only one half of the section was modelled to save computing resources. Hence, the width of the simulated area is 0.3 m.



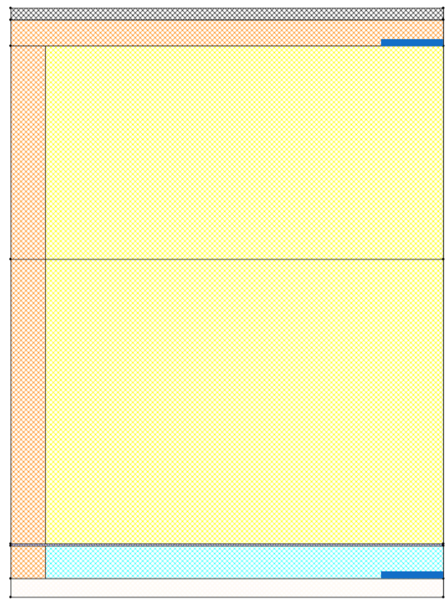


Figure 4. Roof geometry simulated using WUFI 2D, schematic (**left**) and WUFI geometry (**right**). Monitor point for moisture assessment shown in blue (upper and lower right corners).

2.2.2. Simulation Input Data

The roof assembly was modelled using the hygrothermal simulation program WUFI® 2D by Fraunhofer IBP [36]. WUFI is an acronym of Wärme Und Feuchte Instationär—which, translated, means heat and moisture transiency. The material parameters used for the simulation are shown in Table 1. Material data were retrieved from the built-in WUFI material library, except the smart vapour barrier, whose data were found in the technical approval document [34], as conducted in a previous study by Storaas [17]. Table 2 shows the simulation input parameters. The simulation location of Kristiansund was chosen because its climate was previously found to be the most challenging for moisture safety in compact wooden roofs in Norway—if a solution is found not to present a mould risk there, it may be considered safe everywhere else too [17,37]. Oslo, as a comparison case, exhibits a warmer and drier climate. Rather high initial moisture values for the materials were chosen, to create a situation where the moisture safety of the assembly was dependent on the rate of drying. SINTEF generally recommends not to encapsulate a wooden structure whose moisture content is above 15 weight-% [38]. However, 20 weight-% is not an uncommonly high wood moisture level during the construction period. Using 20 weight-% illustrates the effects of drying to a greater degree. Likewise, a simulation start date in September is considered to elevate the mould growth risk, as the assembly is then considered to be encapsulated right at the beginning of the wetting season, and the longest possible amount of time elapses before drying begins. It may be considered a worst-case scenario for these moisture simulations.

Table 1. Material properties for the WUFI 2D simulations. The s_d value is given for the direction of drying, vertically.

Materials	Density [kg/m³]	Thermal Conductivity [W/(mK)]	s_d Value [m]
Roofing	715	2.3	300
Plywood	410	0.13	3.78
Wood (Scandinavian spruce transverse direction II)	390	0.13	38
Mineral wool	60	0.040	0.45
Smart vapour barrier	85	2.4	0.25–12.8 (See Table 3 in [34])
Air cavity	1.3	0.16	0.012
Gypsum board	850	0.2	0.071

Table 2. Input parameters for the simulations in WUFI 2D.

WUFI 2D Settings		Standard Parameters	Variations
Numerical grid	Mode X	Coarse	
	Mode Y	Medium	
Exterior climate		Kristiansund	Oslo
Initial moisture	Wood	20 weight-%	15 weight-%
	Mineral wool	80% RH	
	Gypsum board	80% RH	
	Bitumen roofing	80% RH	
	Air cavity	80% RH	
	Smart vapour barrier	80% RH	
Gypsum board s_d value		0.071 m *	0.533 m **
Distance between beams		0.6 m	
Roof slope		0°	
Short-wave radiation absorptivity		0.88	
Interior temperature		23 °C	
Interior moisture supply		Humidity Class 2	
Simulation begins		2022-09-01	
Duration of simulation		43,800 h (five years)	

* Equivalent to that of an unpainted gypsum board, see Section 3.1. ** Equivalent to the highest measured s_d value in the laboratory tests.

2.3. WUFI Mould Index VTT

The WUFI plug-in WUFI Mould Index VTT [39] was used to assess the mould growth risk in the simulated assembly. This plug-in uses a mould growth model based on the work of Viitanen et al. [40–43]. The model describes mould growth based on the factors surface material, temperature, relative humidity (RH), and time. The predicted probability of mould growth activity is indicated on a scale from 0 to 6. The index is annotated as a "traffic light", where a green label indicates an acceptably low risk of mould growth, a yellow label indicates that further investigation may be necessary, and a red label indicates unacceptable risks. For materials inside an assembly, not exposed to air, a Mould Index value of 2 is the threshold between the green and yellow label, while a value greater than 3 yields a red label. A Mould Index value greater than 3 may be physically interpreted to indicate visible mould growth [42].

The simulation parameter settings for the WUFI Mould Index VTT plug-in are listed in Table 3. The monitoring point for moisture in the upper part of the roof assembly, seen in Figure 4, was chosen because it is the most humid part of the assembly and thus represents the highest moisture risk [16,17]. Additional simulations were also conducted with a monitoring point on the back (unpainted) side of the gypsum board, to assess mould risk toward the interior side of the assembly.

Table 3. WUFI Mould Index parameter settings.

Parameter	Setting
Sensitivity class	Sensitive
Material class	Relevant decline
Type of surface	Planed
Type of wood	Softwood
Occupant exposition class	Surfaces inside constructions without direct contact with indoor air

3. Results

3.1. Laboratory Measurements

The measured s_d values for the gypsum board with the six types of paint applied are shown in Table 4. The gypsum board itself had a declared s_d value of 0.078 m in its product datasheet but was measured to be 0.071 m (the standard deviation of the mean was calculated to be 0.001 m). The latter figure was used in the simulations to simulate an unpainted ceiling.

Table 4. Measured s_d values [m] for the different samples (including gypsum board), by number of layers. The standard deviation of the mean for each measurement series is shown in brackets.

Product	Two Layers	Four Layers	Six Layers
A	0.29 (0.003)	0.44 (0.006)	0.53 (0.007)
B	0.093 (0.001)	0.12 (0.001)	0.14 (0.001)
C	0.32 (0.009)	0.43 (0.008)	0.52 (0.005)
D	0.074 (0.001)	0.087 (0.000)	0.091 (0.001)
E	0.16 (0.002)	0.27 (0.007)	0.36 (0.007)
F	0.18 (0.002)	0.28 (0.004)	0.36 (0.003)

Note that the water vapour resistance, as expressed through s_d values, increased at a far-below-linear rate with multiple layers of paint for every product.

3.2. WUFI Simulations

Table 5 describes the variable configurations of each simulation case as well as the VTT Mould Index of each simulation scenario. The application of paint has little impact on the Mould Index. Rather, the initial moisture content of the structure is a much more significant risk factor for mould growth. For every simulation case, the Mould Index on the back side of the gypsum board was found to be 0.01 or lower.

Figure 5 shows the moisture performance of each simulation case as evaluated by using the WUFI Mould Index VTT. In the worst simulation case, the Mould Index rises in the first two years of simulation, because the structure is wetted during the first autumn and the built-in moisture does not dry sufficiently before the next wetting season. However, eventually, the structure dries out in every case, and conditions cease being favourable for mould growth. The effect of the ceiling paint makes very little difference to the overall Mould Index score of each simulation.

Table 5. Description of the six simulation cases and the VTT Mould Index results for each case. The simulation variables are otherwise as listed in Table 2.

Variable		Simulation Case					
		1	**2**	**3**	**4**	**5**	**6**
Location	Kristiansund	X	X	X	X		
	Oslo					X	X
Ceiling	Unpainted	X		X		X	
	Painted		X		X		X
Initial wood moisture content	20%	X	X			X	X
	15%			X	X		
	Mould Index	4.76	4.80	1.19	1.24	2.89	2.93

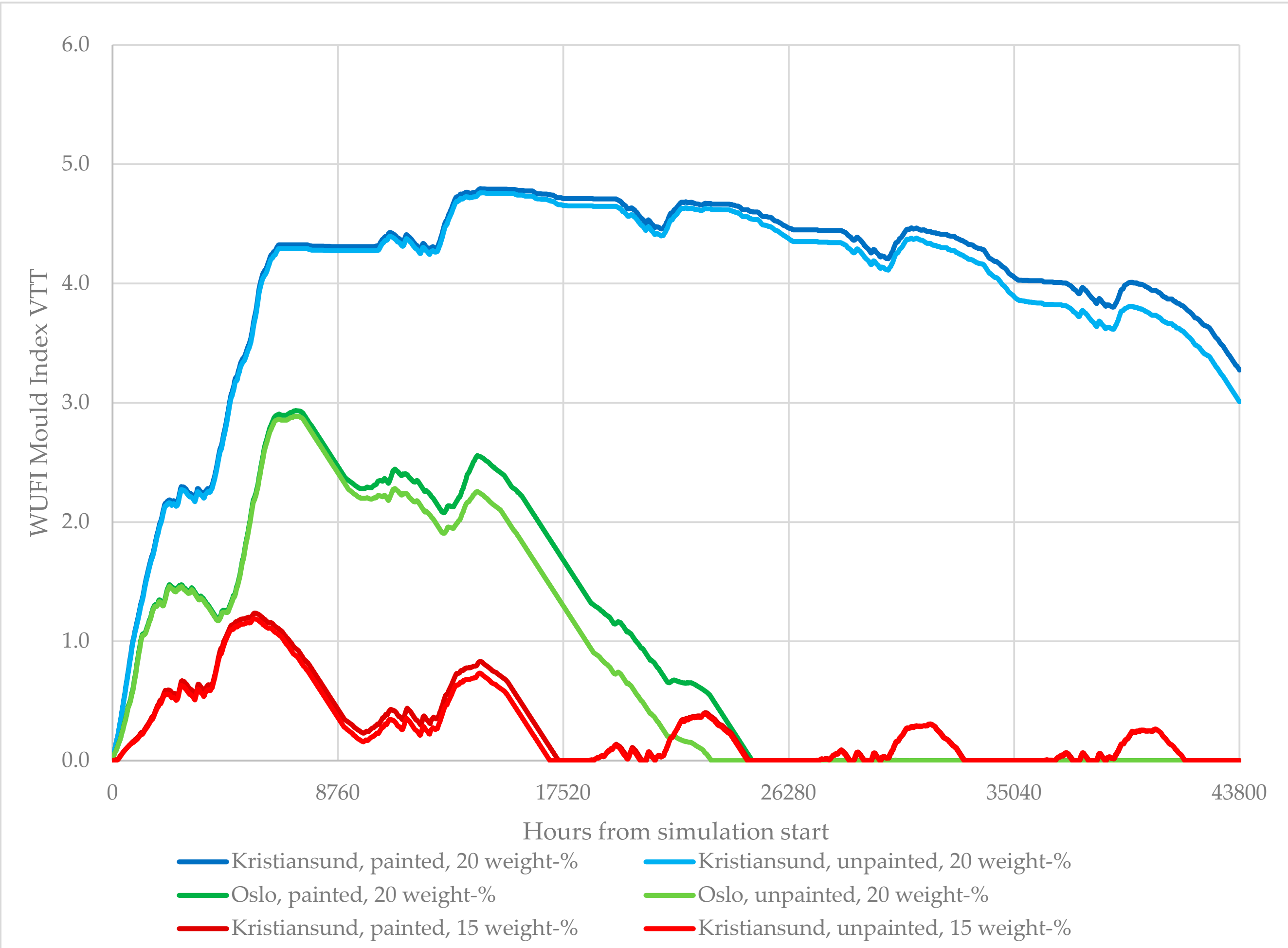


Figure 5. Development of the VTT Mould Growth Index (see Section 2.3) for the six simulation cases. The vertical grid lines are spaced one year apart.

Figure 6 shows the moisture development of each simulation case as indicated by the total water content in the assembly over time. The importance of the local climate is evident, as the simulation case in Oslo dries out faster than the ones in Kristiansund and converges to a lower value.

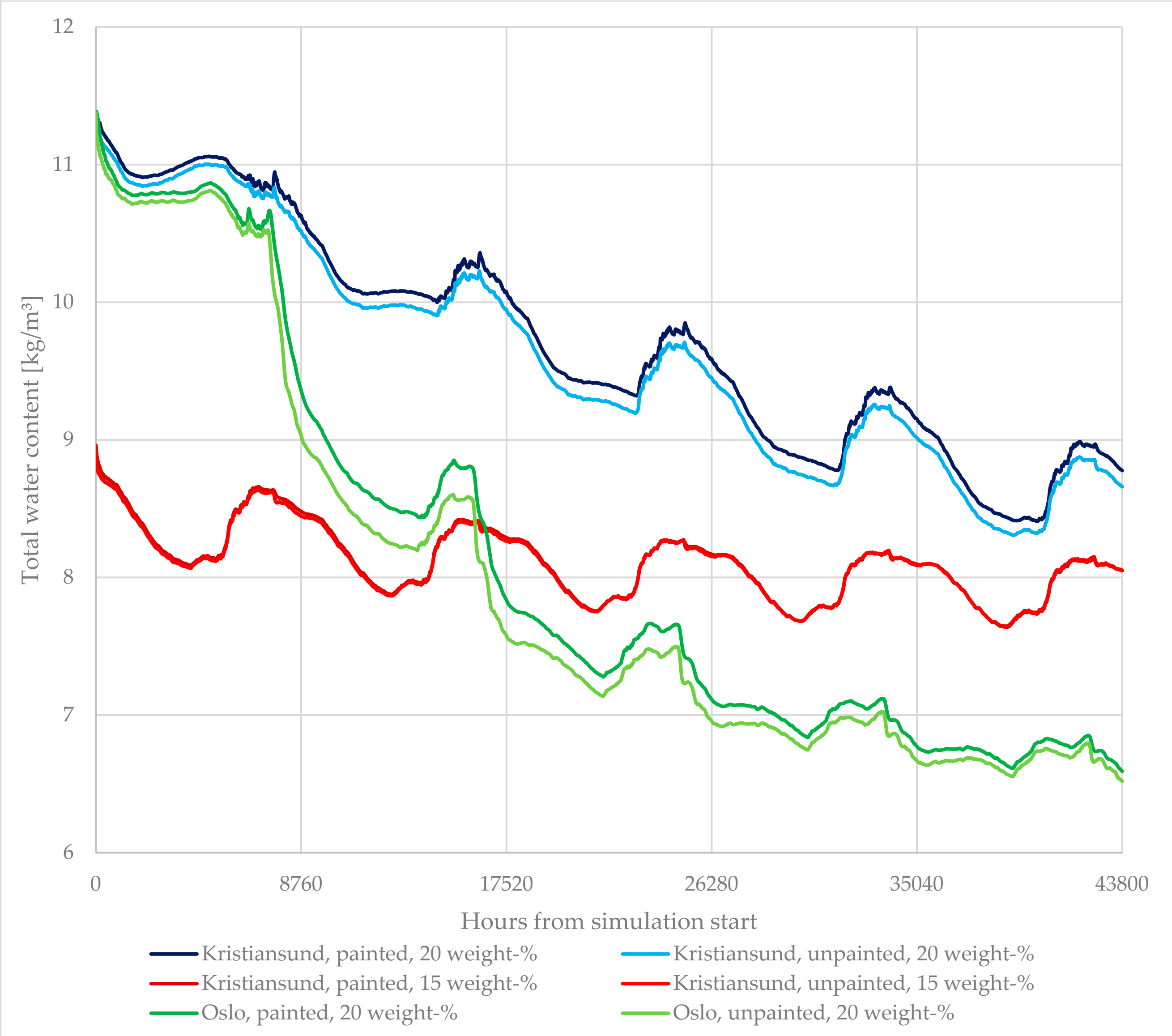


Figure 6. Total water content in the assembly for each of the six simulation cases.

4. Discussion

4.1. What Is the Range of Water Vapour Resistance for Common Ceiling Paints?

Laboratory measurements indicate that all the examined ceiling paints exhibited relatively low values of water vapour resistance. The s_d values of the painted gypsum boards ranged from 0.1 to 0.5 m, depending on the number of layers of paint. This is comparable to the recommended s_d value for wind barriers and breather membranes to facilitate drying to the exterior in ventilated cladding assemblies [20]. As indicated by the results in Section 3, the s_d value of six layers with the least permeable paint was almost double that of the SVB when the roof was in a state of drying. The water vapour resistance did not increase linearly according to the number of layers. The added vapour resistance of each additional layer appeared to decrease with the number of layers. There was, however, some uncertainty related to the thickness of the paint coat, as this was not measured during testing. The samples were prepared from the middle of the gypsum boards, where the thickness of the board and paint was assumed to be more uniform than along the edges.

Note also that six layers of paint are not realistic for the ceiling of a newly built building. However, using these values helps to illustrate the impact of the ceiling paint to a greater degree, since repainting during the lifetime of the building will eventually add more layers of paint.

4.2. What Are the Implications of the Water Vapour Resistance of Ceiling Paints on the Drying Properties of Compact Wooden Roofs?

The impact of the water vapour resistance of ceiling paints on drying was shown to be comparably small. In practice, there was little difference between an unpainted gypsum board and one painted with six coats of the most vapour-tight paint in this study. Gypsum boards painted with common ceiling paints may be considered sufficiently vapour-open to effectively facilitate drying. Even the least vapour-open configuration did not substantially impact the water content of the simulated compact wooden roof assembly relative to the unpainted board, although the drying rate was lowered slightly. The initial water content of the assembly, and the local climate, were shown to impact the drying rate and mould growth to a vastly higher degree.

It may be interesting for future studies to evaluate the drying rate using even more vapour-tight ceiling assemblies. An earlier study of compact wooden roofs with SVBs simulated an internal water vapour resistance up to 1 m, indicating a difference large enough to warrant further study [16].

The present study investigated a generic case of a flat, black roof that received no shading. A shaded roof, one oriented away from the sun or a roof covered by a rooftop terrace deck, will receive less solar radiation and, hence, less heat. This will reduce inward moisture transport compared to the simulated case in the present study. In these cases, the impact of the ceiling paint may be greater. This also means that the design will be even more effective in climates outside of Norway, with greater solar radiation and, thus, increased moisture transportation.

The amount of built-in moisture was shown to impact the moisture performance of the roof to a substantial degree. The consequences of allowing an initial moisture content of 20 weight-% were substantial compared to 15%. Conversely, using a vapour-open ceiling assembly to facilitate drying did not compensate for failing to allow the materials to dry before encapsulating the assembly.

The impact of the building's location is also substantial. A roof assembly in Oslo will experience vastly less mould growth and dry out almost three years earlier than an identical roof assembly in Kristiansund. These findings agree with earlier studies of drying and mould growth in roof assemblies in Norway [16,17,37].

5. Conclusions

The study indicates that gypsum boards painted with commonly available ceiling paints will exhibit sufficiently low water vapour resistance to facilitate effective drying to the interior side of a compact wooden roof with an SVB. The water vapour resistance of the ceiling assembly was found to be very low, regardless of which paint was used and up to six layers of paint. Other factors like built-in moisture or the exterior climate were found to influence the drying rate and mould growth risk to much greater degrees. These results may be used to create reference design guidelines for the use of SVBs in compact wooden roofs.

For future work, it may be interesting to study cases where the impact of ceiling paint may conceivably be greater, for instance in roofs that receive little heating from solar radiation and thus exhibit less inward drying. Future studies may also investigate the impact of ceiling assemblies with even higher water vapour resistance. Interesting materials for study may include pre-painted MDF boards, foil-coated particle boards, or paint intended for use in bathrooms. Other roof details and geometries should also be studied to evaluate the moisture performance of SVBs in compact wooden roofs under a wider range of conditions. Sufficient documentation of the performance is necessary to ensure that the solution can be adopted on an industry-wide scale.

Author Contributions: Conceptualization, T.K.; methodology, J.H.T., E.A. and T.K.; validation, J.H.T.; formal analysis, J.H.T.; investigation, J.H.T.; resources, T.K.; writing—original draft preparation, J.H.T. and E.A.; writing—review and editing, J.H.T., E.A. and T.K.; visualization, J.H.T.; supervision, E.A., S.G. and T.K.; project administration, T.K.; funding acquisition, T.K. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: Supporting reported results will be made available at ntnuopen.ntnu.no three months after censorship of the M.Sc thesis of Jørgen Haldorsen Tomren.

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Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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Fagtidsskrift

Tomren JH & Andenæs E: **Maling som tørker taket**.
Byggeindustrien 13/2023 s 26

Maling som tørker taket

Kompakte tretak med smarte dampsperrer benytter tørking innover for å bli kvitt byggfukt. En masteroppgave på NTNU har undersøkt hvorvidt takmalingens dampmotstand kan påvirke uttørkingen.

Jørgen Haldorsen Tomren og Erlend Andenæs
Institutt for bygg- og miljøteknikk

Kompakte tretak

Kompakte tak består av flere lag som ligger tett inntil hverandre uten luftespalter. Ytterste lag er en taktekning som er vann- og damptett. På innvendig side brukes en dampsperre for å hindre fuktig inneluft fra å lekke inn i taket. Siden disse to lagene er damptette, er det vanligvis ingen mulighet for at konstruksjonen kan tørke ut byggfukt eller lekkasjevann. Det gjør det risikabelt å bygge bærekonstruksjoner av treverk inn i isolasjonslaget. Kompakte tretak utføres derfor vanligvis med taksperrene på innsiden av dampsperren, men dette gjør at konstruksjonen blir tykkere.

Smarte dampsperrer

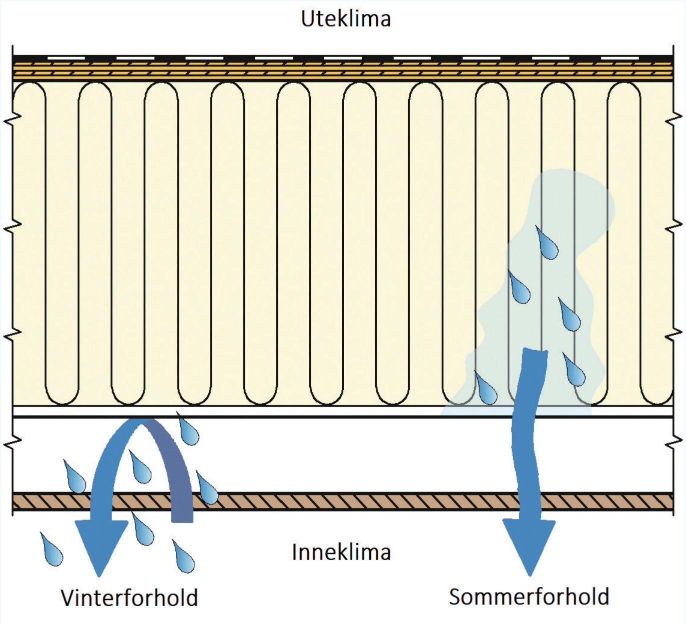
Smarte dampsperrer endrer dampmotstand ut fra fuktnivå i luften. Ved høy relativ luftfuktighet (RF) er dampmotstanden lav, men den blir som en vanlig dampsperre ved lav RF. Dermed kan smarte dampsperrer åpne for uttørking i sommerhalvåret, og stenge for oppfukting om vinteren. Konstruksjonen kan således tørke mot inneluften om sommeren. Det er imidlertid en forutsetning at den delen av konstruksjonen som ligger på innvendig side av dampsperren, må være dampåpen, slik at himlingen ikke stopper uttørkingen.

Farlig maling?

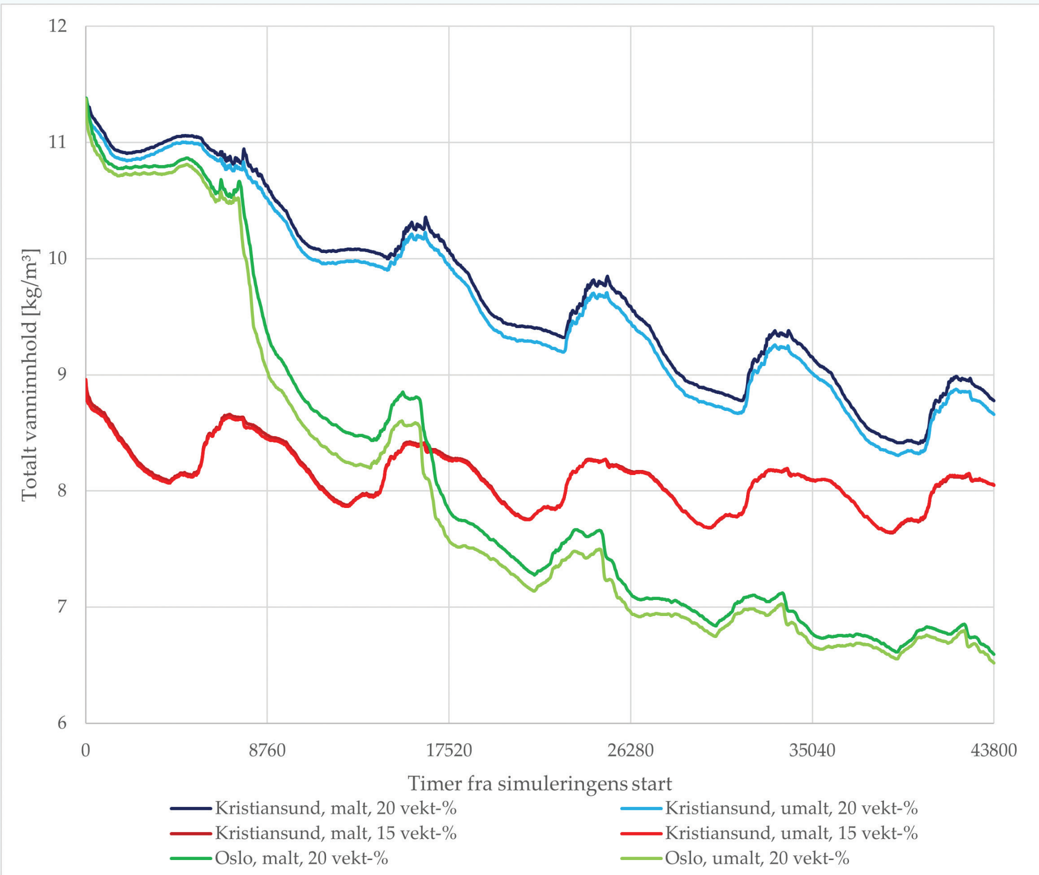
I Norge er det vanlig at himlingen består av malte gipsplater. Jørgen Haldorsen Tomren har i sin masteroppgave for SFI Klima 2050 undersøkt seks typer himlingsmaling i forskjellige prisklasser. Formålet med oppgaven har vært å finne ut om malingen påvirker takets evne til å tørke ut. Dampmotstanden til gipsplater med 0, 2, 4 og 6 lag maling har blitt målt i fuktlaboratoriet til SINTEF og NTNU. En gipsplate uten maling har dampmotstand tilsvarende 71 mm stillestående luft (ekvivalent luftlagstykkelse, eller sd-verdi). Med to lag maling varierer sd-verdien til den malte gipsplaten mellom 74 og 320 mm, avhengig av malingstype. Med seks lag varierer sd-verdien mellom 91 og 530 mm. Selv den mest damptette varianten regnes vanligvis som ganske dampåpen.

Simulering av uttørking

En flat kompakt takkonstruksjon med smart dampsperre (Isola AirGuard® Smart2) og malt gips i himlingen har blitt simulert i et fuktberegningsprogram (WUFI 2D). Simuleringene har foregått over en periode på 5 år, med Oslo og Kristiansund som uteklima. Dato for montering av dampsperren var satt til 1. september. En høy startfukt i trebjelkene på 20 vekt-% har blitt valgt for å simulere verst tenkelige situasjon, mens 15 vekt-% har blitt brukt som et mer realistisk scenario. Simuleringene er fremstilt parvis med gipsplater uten maling og med seks lag av den mest damptette malingen. Resultatet av simuleringene er vist i grafen. Simuleringene viser at malingen har liten påvirkning på uttørkingsevnen til taket. Forhold som startfukt og uteklima er mye mer avgjørende faktorer.



Smarte dampsperrer i kompakte tretak er damptette om vinteren og åpne om sommeren for å tillate tørking, men uttørkingen fungerer optimalt kun viss også himlingen er dampåpen. Illustrasjon: SFI Klima 2050/SINTEF



Uttørking av takkonstruksjonen (totalt vanninnhold) ved seks forskjellige tilfeller: Kristiansund med startfukt for trekonstruksjonen på 20 vekt%, Kristiansund med 15% trefukt og Oslo med 20% trefukt, alle med og uten maling.

Reviewer 1

Svarene som ble gitt på tilbakemeldingene fra «Reviewer 1» på forskningsartikkelen.

Response to reviewer 1

Water vapour resistance of ceiling paints – Implications for the use of smart vapour barriers in compact wooden roofs

Thank you so much for reviewing our article. Your comments are posted below in **bold text**. Our responses are written in normal text style.

1. Please indicate the purpose of the work.

The purpose of the study is formulated through the research questions at the end of Section 1.

2. Line 18, "WUFI simulations…". If an abbreviation occurs in the text for the first time, then it should be explained, and in the future it is advisable to use it.

This is a good comment. We have added «WUFI®2D» to the abstract. In Section 2.2.2 we have explained that WUFI is an acronym **W**ärme **U**nd **F**euchte **I**nstationär—which, translated, means heat and moisture transiency.

3. All physical quantities should be presented in system SI, for instance in lines 184 and 190 - 600 mm and 300 mm, etc should be duplicated in m.

This has now been corrected.

4. In table 1 thermal conductivity unit [W/mK] should be in brackets [W/(mK)].

This has now been corrected.

5. Laboratory measurements, line 235 - please describe the measuring equipment, its accuracy class and experimental error estimate.

The scale used in the laboratory has been better described in the text and pictured in the new Figure 3.

6. In scientific research, tables and graphs data can be not enough, it is advisable and desirable to provide a factorial experiment planning matrix and carry out regression analysis, to approximate graphic dependencies (one-factor and multi-factor) using empirical formulas.

We generally agree with your position here. However, for the present study we have tried several approaches as to how to present the results and found the chosen solution to be the most suitable.

7. Line 255 – the inscription (title) of Fig. 3 is omitted. Accordingly, the numbering of the following figures should be adjusted. In addition, please explain what the abscissa axis means in these figures, and mark the OX axis.

The figure caption describes the purpose of the Figure and explain the axis and, hence, in our opinion replace a Figure title. We have now added a reference to the explanation of the y-axis.

8. Please explain how adequacy of the theory of the experiment is confirmed?

The principle of compact wooden roof with SVB is under development and there has been some doubt about the drying effect of the assembly caused by the ceiling paint. However, the present research confirms the suitability of the roof principle. The vapour resistance of the ceiling paints turned out to be less vapour-tight than feared.

9. The conclusions need revision for being more effective. Please formulate the conclusions more succinctly, dividing them into numbered groups of short sentences.

We feel as if dividing the conclusions into numbered group of short sentences would be less natural and also make the conclusions less effective.

10. Please, indicate how the proposed method can be implemented outside of Norway, in the other countries with different climates?

A sentence has been added indicating the effectiveness of the proposed method in countries with different climates.

11. Please, replace the literature dated by XX century.

We believe that the earliest studies present important context to the literature study, and that their age illustrate the dearth of relevant studies of this property of paint.

Reviewer 2

Svarene som ble gitt på tilbakemeldingene fra «Reviewer 2» på forskningsartikkelen.

Response to reviewer 2

Water vapour resistance of ceiling paints – Implications for the use of smart vapour barriers in compact wooden roofs

Thank you so much for reviewing our article. Your comments are posted below in **bold text**. Our responses are written in normal text style.

This is a well-written paper and of interest to many readers. Only the roof sheathing was evaluated for mold. It would be advised to show the mold index on the ceiling gypsum board in the air cavity. That would confirm that the paint doesn't slow down drying through gypsum too much to create mold issues there.

Thank you. We agree with your great suggestion. We have added a sentence showing the mold index on the gypsum board, see line 274-275.

In the test procedure, mention the RH provided by KNO3 (93% or so?).

This has been added to the text. See line 177.

I think you lumped the paint and the gypsum board as one layer. Is that correct? Do you think there would be any difference in potential mold growth or moisture content of the gypsum board if the paint layer was modeled as a resistance?

The paint and gypsum board were initially modelled as one layer in the simulation. As many simulations had to be conducted, it was found easier to add the paint layers as a resistance instead of changing the properties of the gypsum board for each simulation case. There were run several simulations showing that the results were identical before this approach was chosen. This made it easier with subsequent simulations as none of the material properties, in this case for the gypsum board, had to be changed.

It would be good to show the relative importance of the paint layers by comparing the permeance of the SVB and the paints.

A short sentence has been added to Section 4.1

Comments on the Quality of English Language. I have found and listed only a few minor typo corrections here:

- **Line 50: of compact wooden roofs**
- **Line 108: for paint to blister**
- **Line 145: each segment was painted**
- **Line 165: show RH of KNO3 solution and the other side (50%?)**

The first three typos have been corrected. As for the last one, this was already stated in the text at line 163.

Reviewer 3

Svarene som ble gitt på tilbakemeldingene fra «Reviewer 3» på forskningsartikkelen.

Response to reviewer 3

Water vapour resistance of ceiling paints – Implications for the use of smart vapour barriers in compact wooden roofs

Thank you so much for reviewing our article. Your comments are posted below in **bold text**. Our responses are written in normal text style.

Mold growth is an increasing interesting topic in research, but lack of such studies affects integral management of building maintenance. Thus, this work provides an update to the existing literature and the authors are encouraged to continue this study further, especially experimentally. However, the authors are asked to address the following recommendations and comments to improve quality of the presented achievements and methodology employed:

Thank you for your favourable impression of the work.

Abstract:
1. In line 20, the name for sd should be first presented, then the symbol in parentheses, i.e., XXXX (sd).

"Equivalent stagnant air layer thickness" has been added to the abstract.

Introduction:
1. In lines 61-65, these statements may be in need of a reference for support.

Reference to [9] has been added.

2. Lines 100 and 101, the word "substrate" may be confusing with terms in the building physics field, e.g., the substrate in the green roof layers." Thus, consider using another word or specify what do you mean in this particular case.

The use of "substrate" is as a part of a quote and cannot be changed. We do, however, agree with your comment and have added an explanation to the end of the paragraph.

Methodology:
1. From what I can understand, the amount of paint applied is also being tested, right? For which research question is this important?

It is important for both research questions, though the research questions themselves do not explicitly state a need for differing amounts of paint. The reasoning as to why the amount of paint is important is explained in Section 2.1.1.

2. Line 144, "... about a week." Is this time taken from a standardized procedure as well?

This is not a standardized procedure, but based on commercial testing and experience.

3. Line 148, please specify the drying time specified by the manufacturer.

A short sentence has been added specifying the amount of time between each layer of paint. Every paint was given at least four hours to dry between each layer. This is the recommended time for several of the paints used, and exceeds the recommended minimum of the rest of the paints.

4. Do the stored conditions are the same as in line 163?

The conditions for storing were identical for all samples after the gypsum boards had been cut. This was in the controlled climate lab. The only time the samples exited the lab was for a very short period of time whilst being mounted.

5. The application of the paint seems critical for the experimental study… How can you assure uniformity? Who applied the paint? Is this person skilled? The Ishikawa diagram indicates this is a relevant source of error.

The same skilled and experienced person applied every layer of paint for all the samples. The same experienced person also cut and mounted the samples to ensure the results were as uniform as possible.

6. Photos of all samples are mandatory in section 2.1.2.

A photo has been added.

7. In line 164, "3-4 days before mounting…" Is this time after the one week mentioned in line 144?

This time is in addition to the week mentioned in line 144. The 3-4 days before mounting was in the controlled climate lab where both the RH and temperature were at a near constant. This was also a minimum depending on when the samples were mounted.

8. In section 2.1.3. Visual aid is required.

A photo has been added.

9. Line 177, Is the +/- 5% also recommended from the ISO standard? Please specify.

Yes, this is given by the ISO Standard in section 7.3. A reference has been added.

10. In table 2, why is the simulation duration only five years? Recommended time is up to 10 years. The ISO13788 recommends 2 years. ASHRAE 160-2016 recommends more than 3 years. But more recent research recommends between 10 – 15 years (in 2018, hygrothermal analysis of timber-based external walls across different Australian climate zones, as stated in https://doi.org/10.3390/atmos13111755).

This is mostly due to the computational power available at the time of the simulations. We did not want to decrease the accuracy of the simulations to be able to increase the timespan.

11. Line 231, no need for those references.

We feel as if it is better to include the references as they are the basis for the chosen monitoring points.

Results:

1. **In table 5, The simulation cases (1 to 5) are the same cases as the ones presented in table 4 (A to F)? If so, please unify nomenclature. Either use numbers or letters.**

The simulation cases (1 to 6) in Table 5 are not the same as the products (A-F) shown in Table 4. Table 4 shows the resulting s_d values for the different paint products only. Table 5 shows the simulation cases and which properties are changed for each simulation. For the simulation cases with paint this also includes the paint products. As explained in the text we have chosen six layers of paint A as a worst-case scenario. If simulations had been run with all products this means that we would in a way have simulation case 2A to 2F etc.

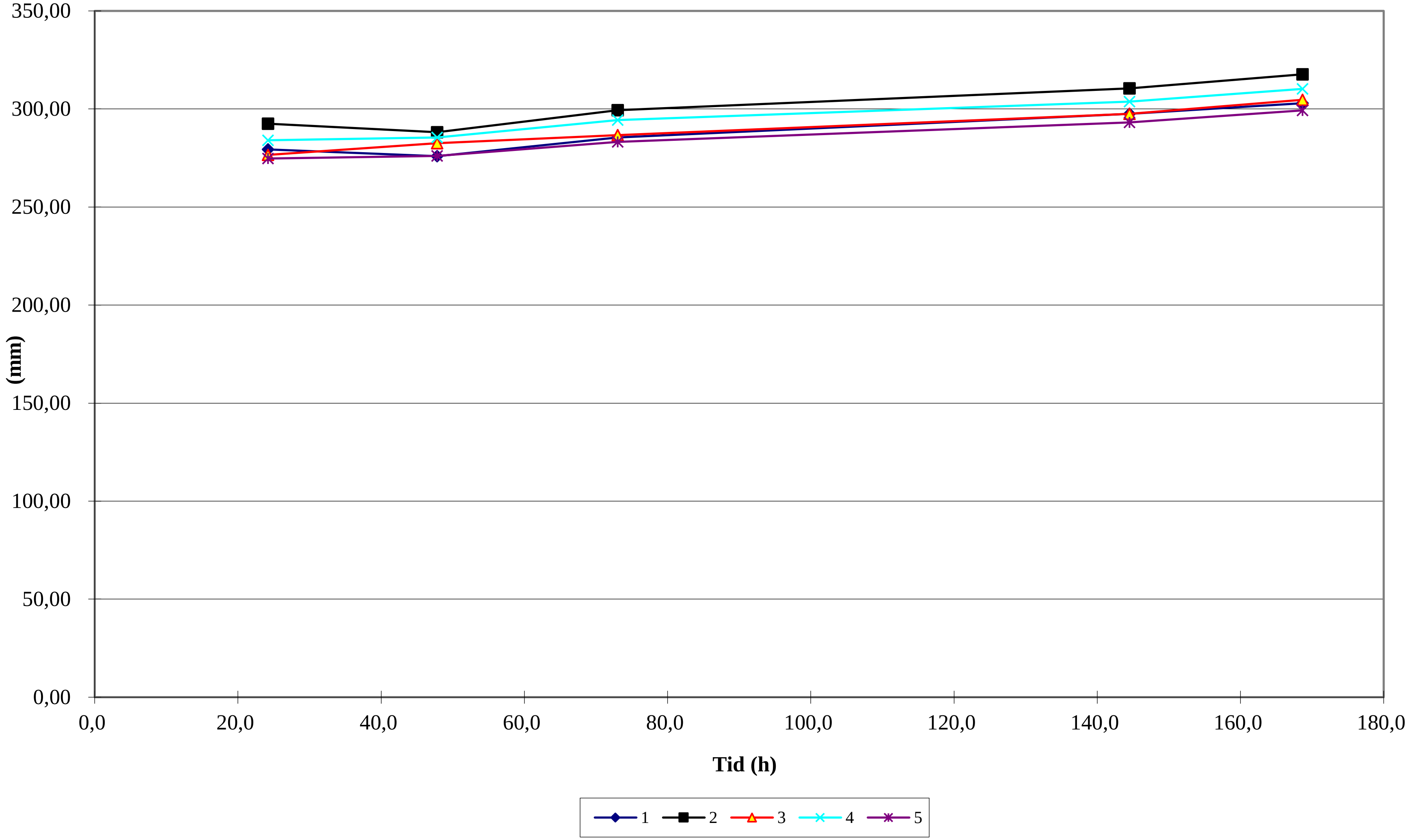
Produkt A

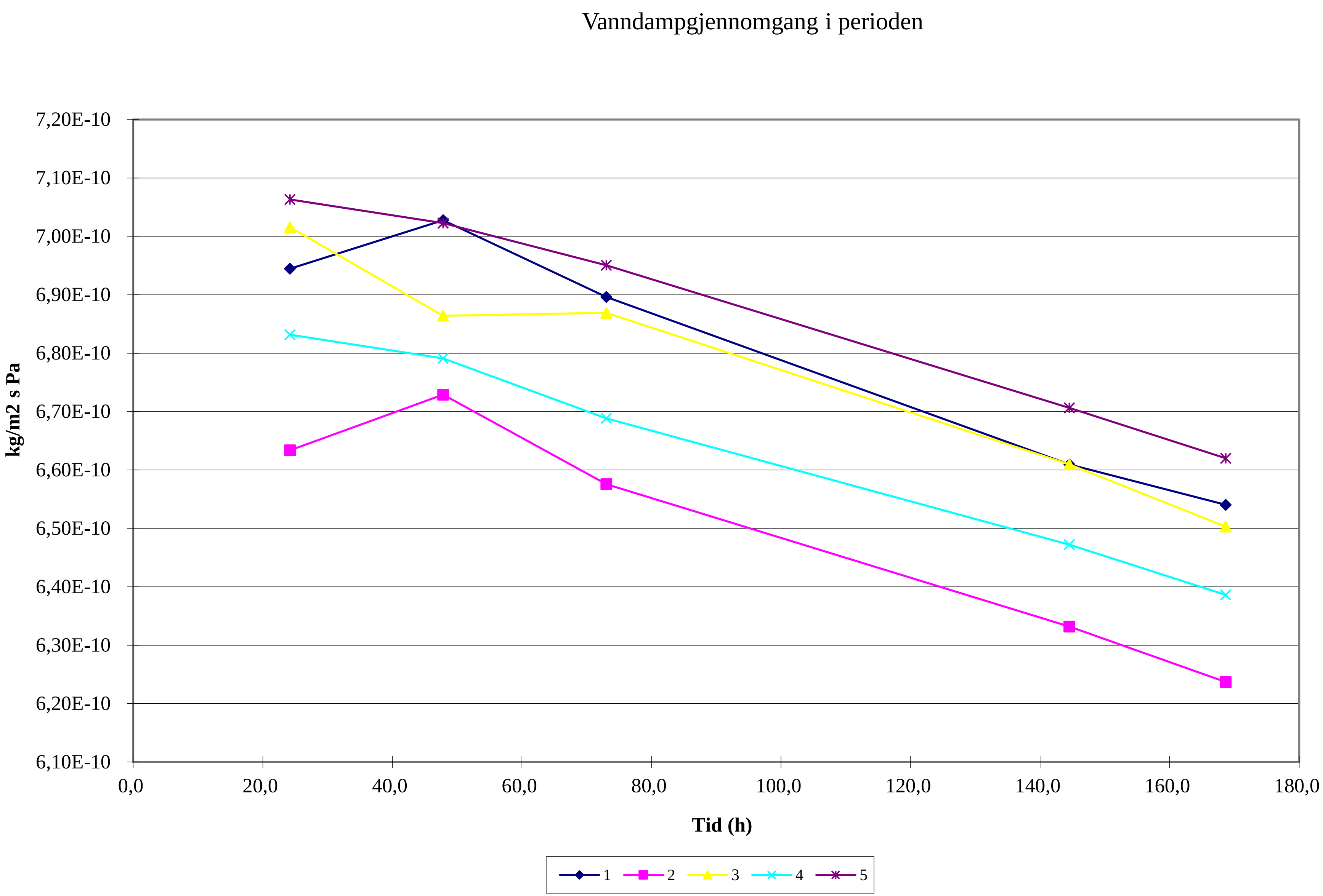
Produkt A

Inndata og resultater fra laboratorieforsøkene til «Produkt A».

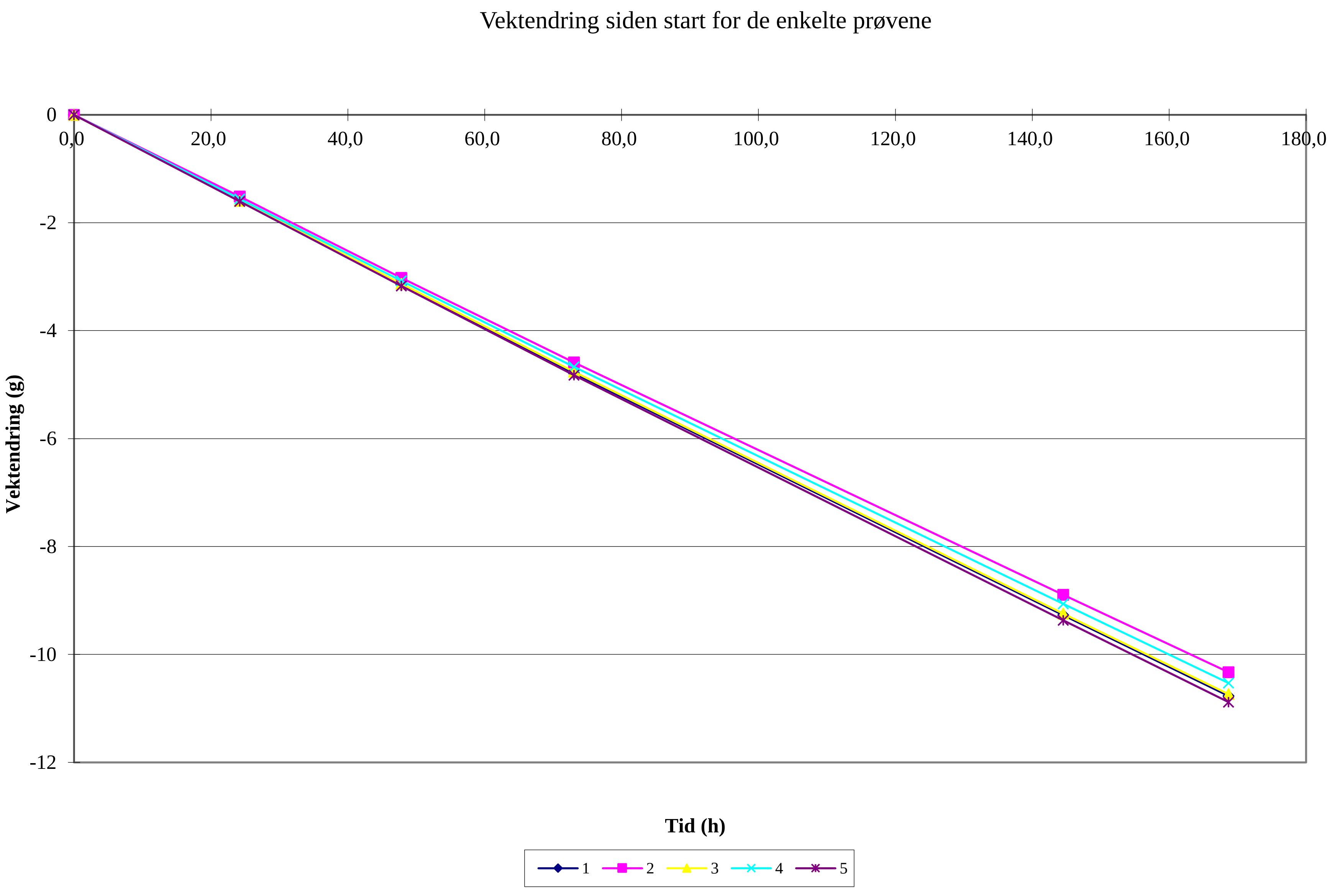
Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	A2				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferkst/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		28.09.2022	
(6)Målenummer:	A2				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		18.10.2022	19.10.2022	20.10.2022	21.10.2022	24.10.2022	25.10.2022				
(13)Tid (CTRL+SHIFT+ :)		08:38	08:51	08:28	09:41	09:09	09:18				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		1012,21	1022,27	1017,65	1010,72	1003,81	995,76				
(16)Barometertrykk i perioden, hPa:		1012,21	1019,46	1020,4	1004,36	1006,31	998,54				
(17)Temperatur luft over boks,°C:		23	23,04	23,09	22,84	23,08	23,07				
(18)Temperatur i saltløsning, °C:		23	23,04	23,09	22,84	23,08	23,07				
(19)RF i rommet, %		50	49,51	49,35	48,92	49,33	49,35				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		999,997	999,995	1000,004	1000,006	1000,005	1000,004				
(22)Vekt,g prøve nr:	1	722,924	721,335	719,784	718,146	713,665	712,167				
(23)Vekt,g prøve nr:	2	720,642	719,119	717,63	716,063	711,758	710,325				
(24)Vekt,g prøve nr:	3	728	726,396	724,879	723,247	718,766	717,276				
(25)Vekt,g prøve nr:	4	712,089	710,524	709,022	707,43	703,036	701,571				
(26)Vekt,g prøve nr:	5	722,665	721,051	719,501	717,851	713,309	711,794				
(27)Vekt,g kontrolllodd etter veiing:		999,997	999,996	1000,005	1000,001	1000,006	1000,006				
Tekst i diagrammet Vektendring											

Ekvivalent luftlagstykkelse i perioden





Vanndampgjennomgang i perioden
7,20E-10
7,10E-10
7,00E-10
6,90E-10
6,80E-10
6,70E-10
6,60E-10
6,50E-10
6,40E-10
6,30E-10
6,20E-10
6,10E-10
kg/m2 s Pa
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5


Vektendring siden start for de enkelte prøvene
0
-2
-4
-6
-8
-10
-12
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Vektendring (g)
Tid (h)
1
2
3
4
5

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	A2	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	A2
Prosjektnummer:	A2	Prøvediameter: (mm)	164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:	KNO3
		Prøveperiode: fra:	19.10.2022
		til:	25.10.2022

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,3
Temperatur i boksen (°C)	23,0
Temperatur i rommet (°C)	23,0
Barometertrykk (hPa)	1009,8

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52
2	12,52
3	12,52
4	12,52
5	12,52
6	12,52

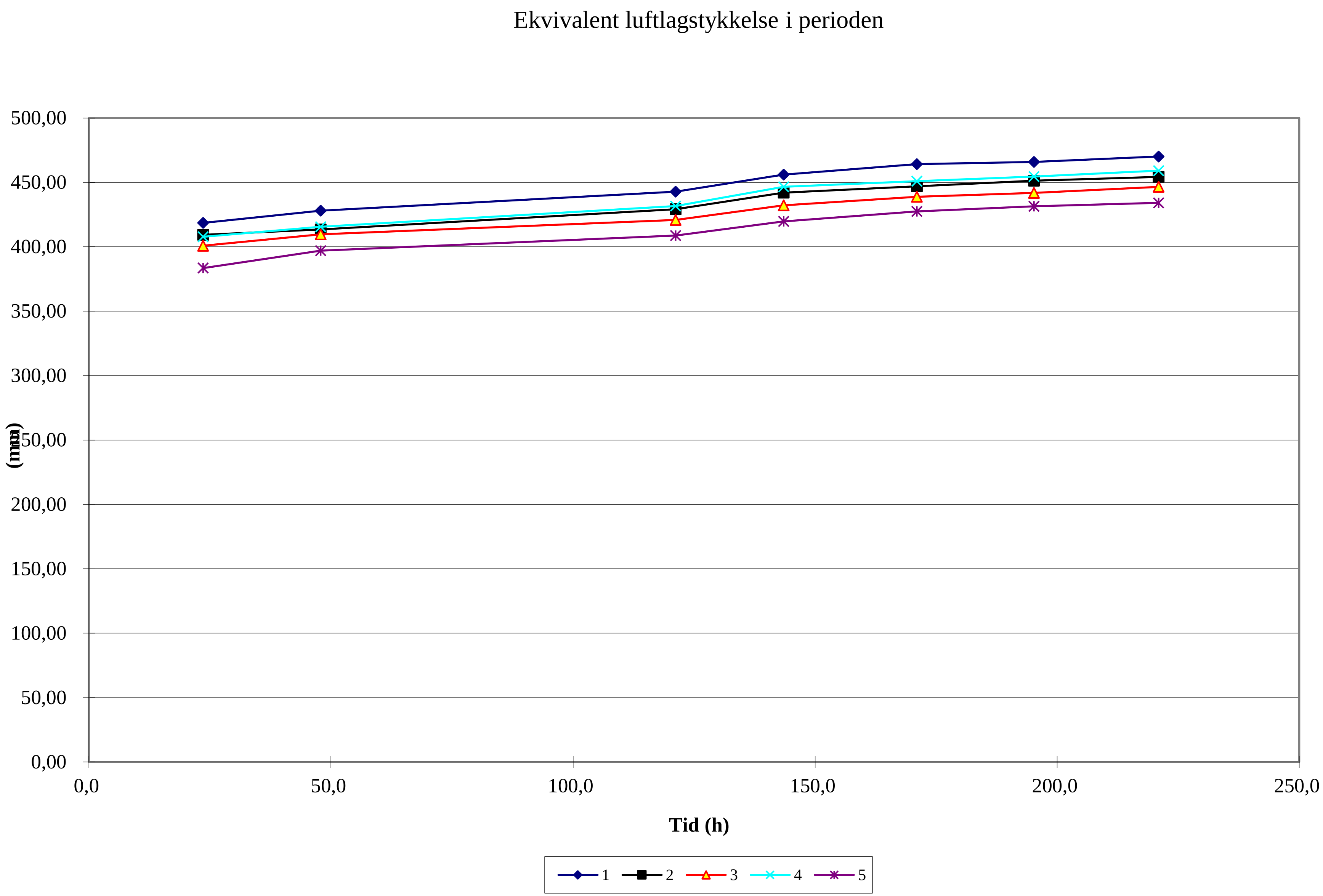
Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

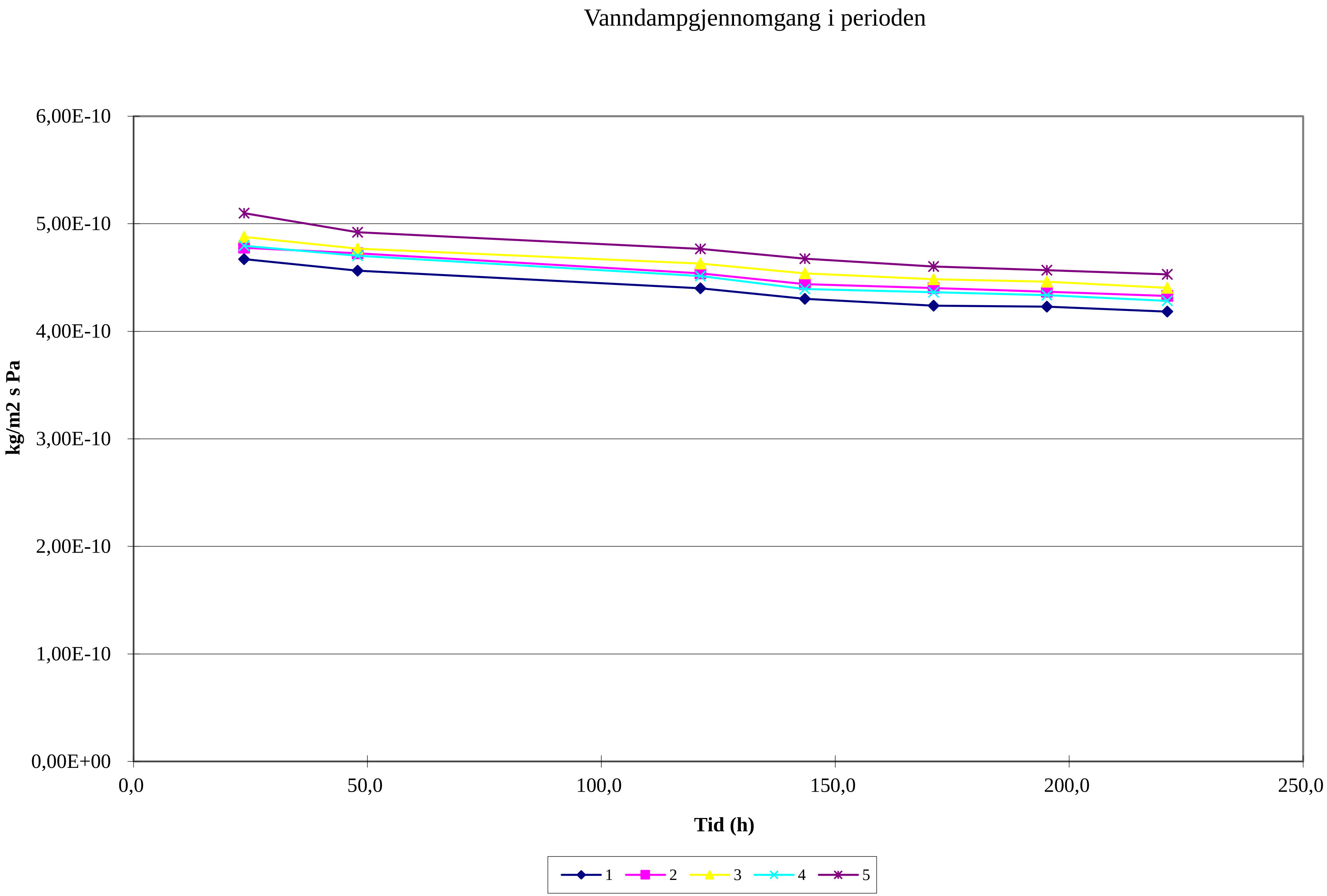
Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	6,75E-10	0,290	1,48E+09
2	6,45E-10	0,304	1,55E+09
3	6,73E-10	0,291	1,49E+09
4	6,59E-10	0,297	1,52E+09
5	6,83E-10	0,287	1,46E+09
Middel	6,67E-10	0,294	1,50E+09
Std. dev. mean. value	6,60606E-12	0,003	1,50E+07

Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

SIGN:

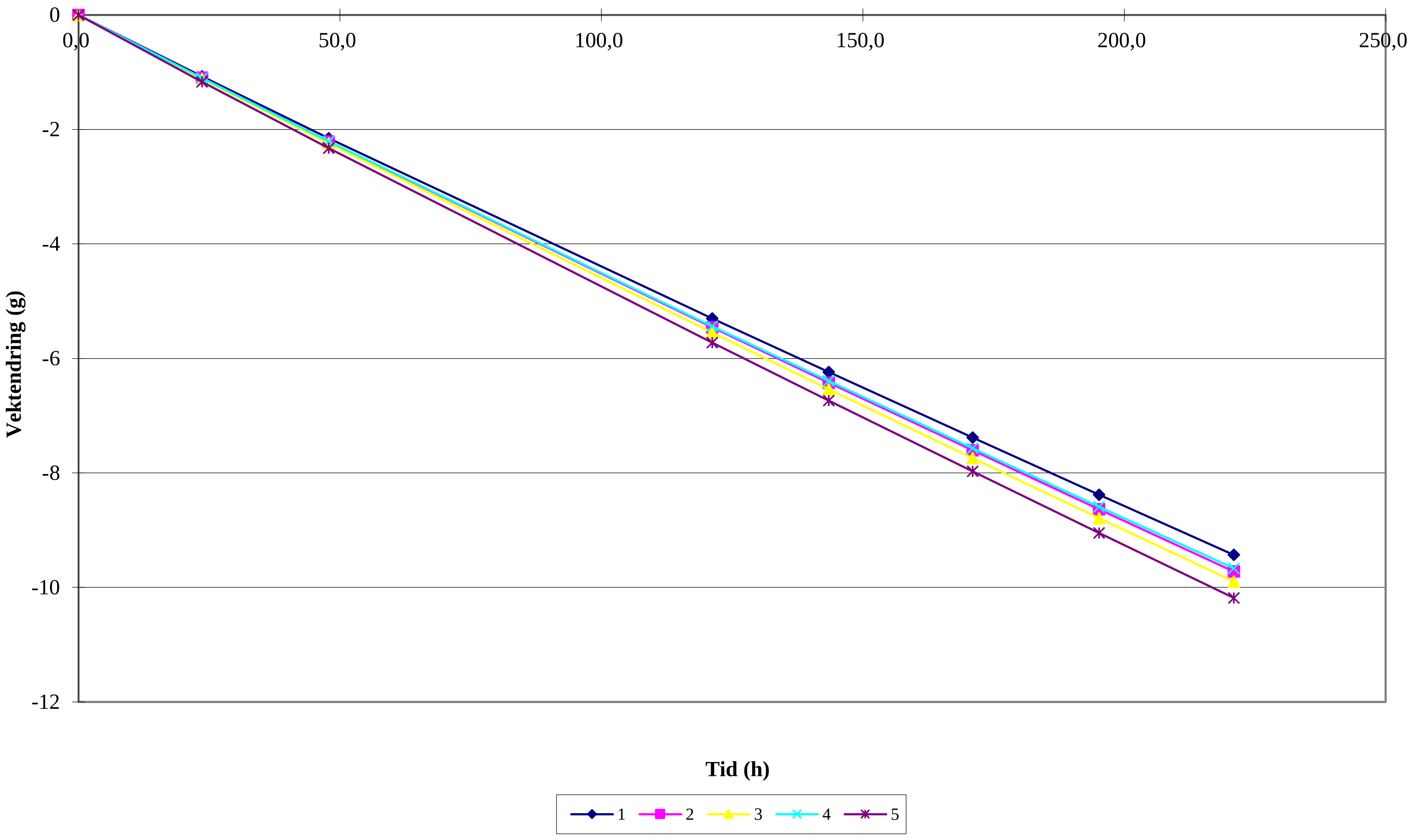
Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	A4				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferkst/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		28.09.2022	
(6)Målenummer:	A4				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		16.11.2022	17.11.2022	18.11.2022	21.11.2022	22.11.2022	23.11.2022	24.11.2022	25.11.2022		
(13)Tid (CTRL+SHIFT+ :)		09:40	09:16	09:32	10:51	09:10	12:41	12:52	14:38		
(14)Beregning fra veiing:	4										
(15)Barometertrykk ved veiing, hPa:		1012,81	1011,33	1015,45	1009,87	1006,33	1004,19	1003,96	1008,31		
(16)Barometertrykk i perioden, hPa:		1012,81	1011,79	1012,61	1015,46	1008,31	1005,45	1003,76	1005,99		
(17)Temperatur luft over boks,°C:		23	23,05	23,07	23,06	23,05	23,05	23,05	23,04		
(18)Temperatur i saltløsning, °C:		23	23,05	23,07	23,06	23,05	23,05	23,05	23,04		
(19)RF i rommet, %		50	49,01	49,12	49,02	49,02	49	49,04	49,06		
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		999,999	1000,003	999,999	999,997	1000,002	1000,000	1000	1000		
(22)Vekt,g prøve nr:	1	695,324	694,254	693,169	690,025	689,088	687,946	686,945	685,889		
(23)Vekt,g prøve nr:	2	716,698	715,605	714,484	711,245	710,28	709,096	708,064	706,973		
(24)Vekt,g prøve nr:	3	712,627	711,512	710,381	707,081	706,095	704,89	703,837	702,728		
(25)Vekt,g prøve nr:	4	696,36	695,263	694,147	690,926	689,97	688,796	687,771	686,691		
(26)Vekt,g prøve nr:	5	717,698	716,535	715,37	711,977	710,963	709,728	708,651	707,512		
(27)Vekt,g kontrolllodd etter veiing:		1000,001	1000,004	1000	999,998	1000	1000,001	1000,001	1000		
Tekst i diagrammet Vektendring											


Ekvivalent luftlagstykkelse i perioden
500,00
450,00
400,00
350,00
300,00
250,00
200,00
150,00
100,00
50,00
0,00
(mm)
0,0
50,0
100,0
150,0
200,0
250,0
Tid (h)
1
2
3
4
5



Vanndampgjennomgang i perioden
kg/m2 s Pa
6,00E-10
5,00E-10
4,00E-10
3,00E-10
2,00E-10
1,00E-10
0,00E+00
0,0
50,0
100,0
150,0
200,0
250,0
Tid (h)
1
2
3
4
5

Vektendring siden start for de enkelte prøvene



SINTEF

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	A4	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	A4
Prosjektnummer:	A4	Prøvediameter: (mm)	164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:	KNO3
		Prøveperiode: fra:	21.11.2022
		til:	25.11.2022

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,0
Temperatur i boksen (°C)	23,1
Temperatur i rommet (°C)	23,1
Barometertrykk (hPa)	1007,8

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52	
2	12,52	
3	12,52	
4	12,52	
5	12,52	
6		0

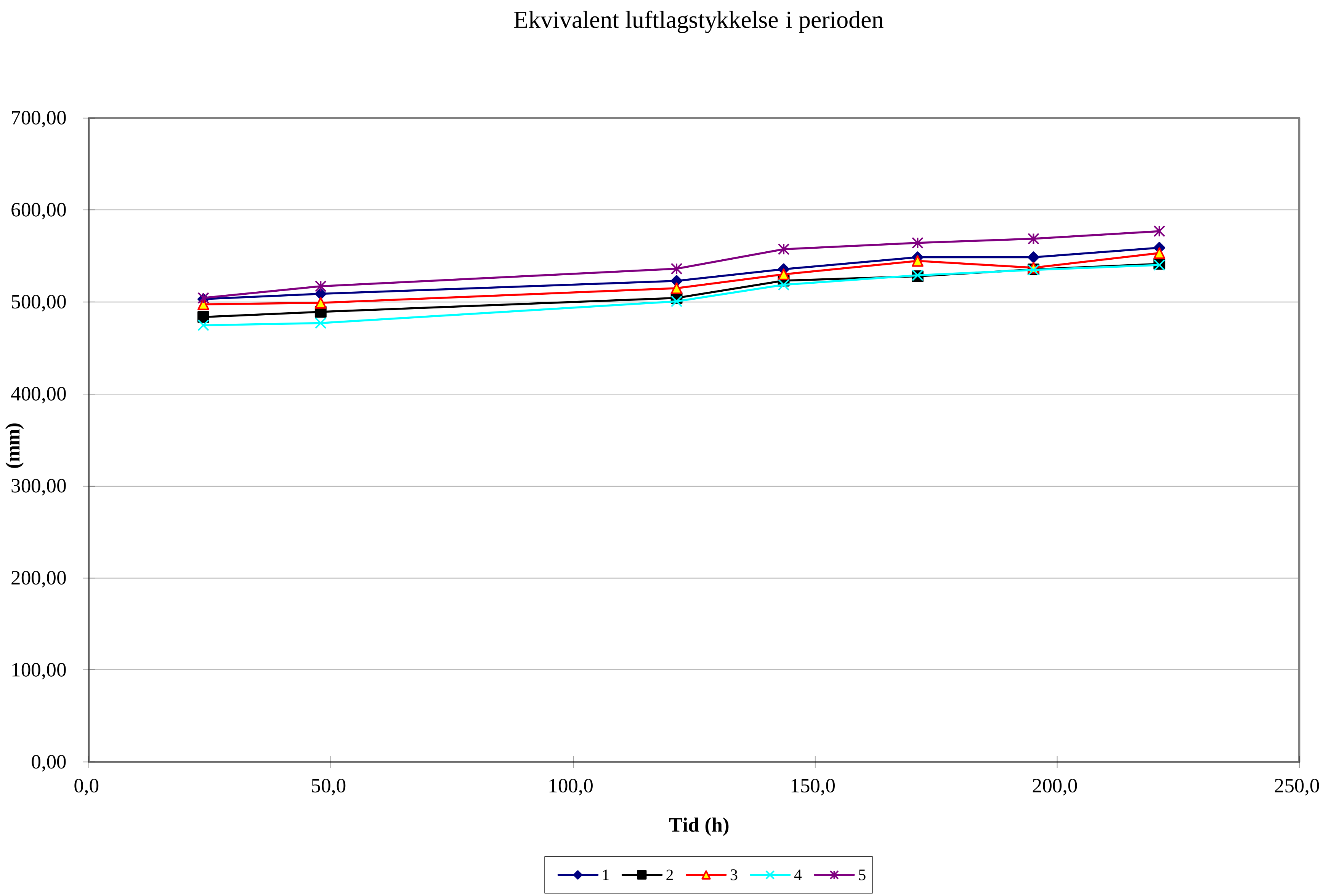
Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	4,31E-10	0,456	2,32E+09
2	4,45E-10	0,441	2,25E+09
3	4,54E-10	0,433	2,20E+09
4	4,41E-10	0,445	2,27E+09
5	4,67E-10	0,421	2,14E+09
Middel	4,47E-10	0,439	2,23E+09
Std. dev. mean. value	6,04297E-12	0,006	3,00E+07

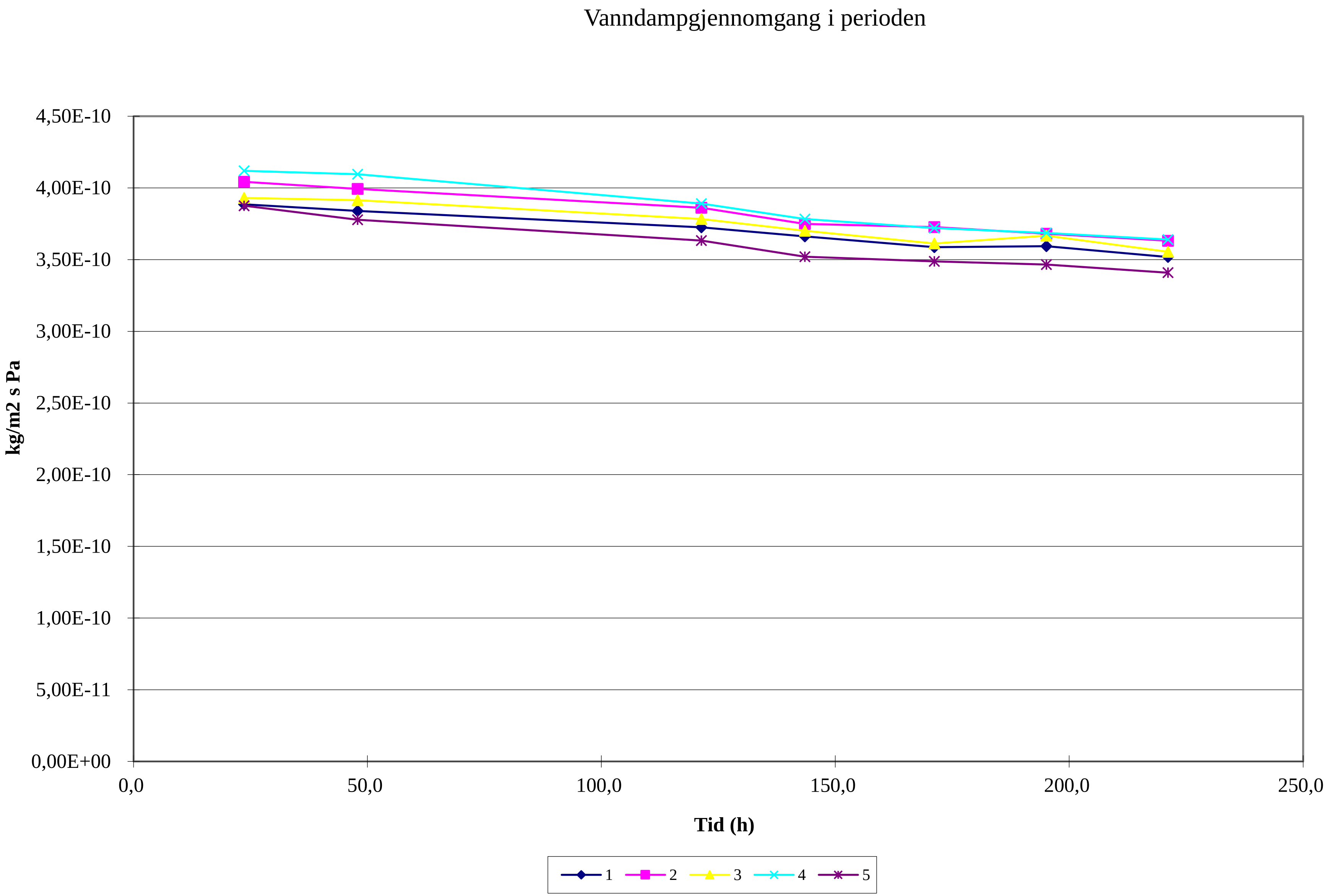
Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven, damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

SIGN:

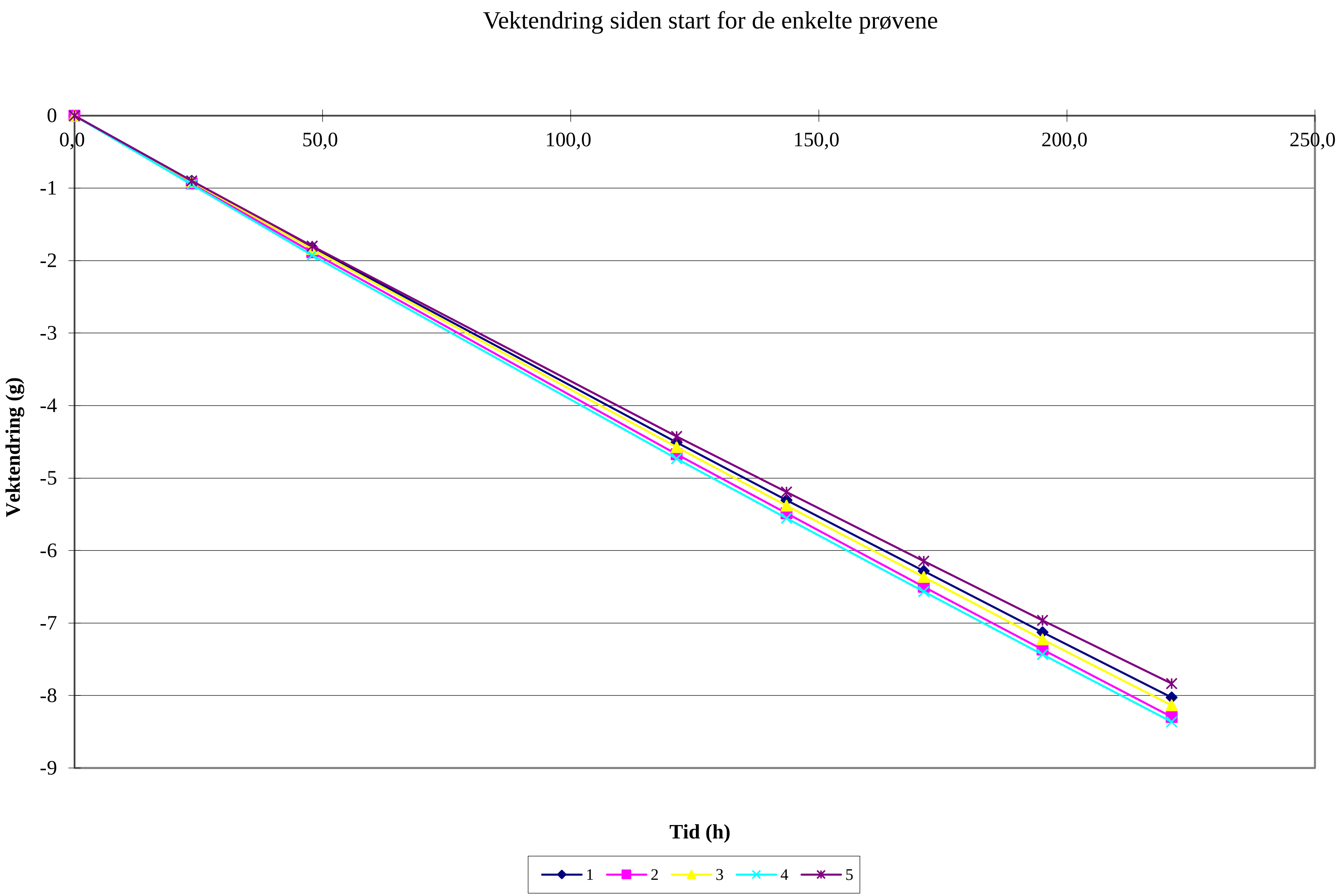
Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	A6				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferskt/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		28.09.2022	
(6)Målenummer:	A6				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		16.11.2022	17.11.2022	18.11.2022	21.11.2022	22.11.2022	23.11.2022	24.11.2022	25.11.2022		
(13)Tid (CTRL+SHIFT+ :)		09:36	09:13	09:29	10:58	09:06	12:47	12:43	14:44		
(14)Beregning fra veiing:	4										
(15)Barometertrykk ved veiing, hPa:		1012,81	1011,33	1015,45	1009,87	1006,33	1004,19	1003,96	1008,31		
(16)Barometertrykk i perioden, hPa:		1012,81	1011,79	1012,61	1015,46	1008,31	1005,45	1003,76	1005,99		
(17)Temperatur luft over boks,°C:		23	23,05	23,07	23,06	23,05	23,05	23,05	23,04		
(18)Temperatur i saltløsning, °C:		23	23,05	23,07	23,06	23,05	23,05	23,05	23,04		
(19)RF i rommet, %		50	49,01	49,12	49,02	49,02	49	49,04	49,06		
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		1000,003	999,998	1000,004	999,998	1000	1000,001	1000	1000		
(22)Vekt,g prøve nr:	1	704,411	703,507	702,593	699,904	699,107	698,128	697,28	696,377		
(23)Vekt,g prøve nr:	2	726,94	726,001	725,052	722,268	721,453	720,437	719,569	718,638		
(24)Vekt,g prøve nr:	3	712,964	712,05	711,119	708,39	707,585	706,599	705,734	704,822		
(25)Vekt,g prøve nr:	4	728,937	727,981	727,009	724,205	723,383	722,369	721,5	720,567		
(26)Vekt,g prøve nr:	5	718,615	717,713	716,813	714,188	713,421	712,468	711,649	710,773		
(27)Vekt,g kontrolllodd etter veiing:		1000,007	1000	1000,005	999,999	1000,002	1000	999,999	1000		
Tekst i diagrammet Vektendring											



Ekvivalent luftlagstykkelse i perioden
700,00
600,00
500,00
400,00
300,00
200,00
100,00
0,00
(mm)
0,0
50,0
100,0
150,0
200,0
250,0
Tid (h)
1
2
3
4
5



Vanndampgjennomgang i perioden
4,50E-10
4,00E-10
3,50E-10
3,00E-10
2,50E-10
2,00E-10
1,50E-10
1,00E-10
5,00E-11
0,00E+00
kg/m2 s Pa
0,0
50,0
100,0
150,0
200,0
250,0
Tid (h)
1
2
3
4
5



Vektendring siden start for de enkelte prøvene
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
0,0
50,0
100,0
150,0
200,0
250,0
Vektendring (g)
Tid (h)
1
2
3
4
5

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	A6	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	A6
Prosjektnummer:	A6	Prøvediameter: (mm)	164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:	KNO3
		Prøveperiode: fra:	21.11.2022
		til:	25.11.2022

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,0
Temperatur i boksen (°C)	23,1
Temperatur i rommet (°C)	23,1
Barometertrykk (hPa)	1007,8

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52	
2	12,52	
3	12,52	
4	12,52	
5	12,52	
6		0

Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	3,65E-10	0,538	2,74E+09
2	3,77E-10	0,521	2,65E+09
3	3,70E-10	0,531	2,71E+09
4	3,78E-10	0,519	2,64E+09
5	3,54E-10	0,555	2,83E+09
Middel	3,69E-10	0,533	2,71E+09
Std. dev. mean. value	4,4486E-12	0,007	3,32E+07

Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

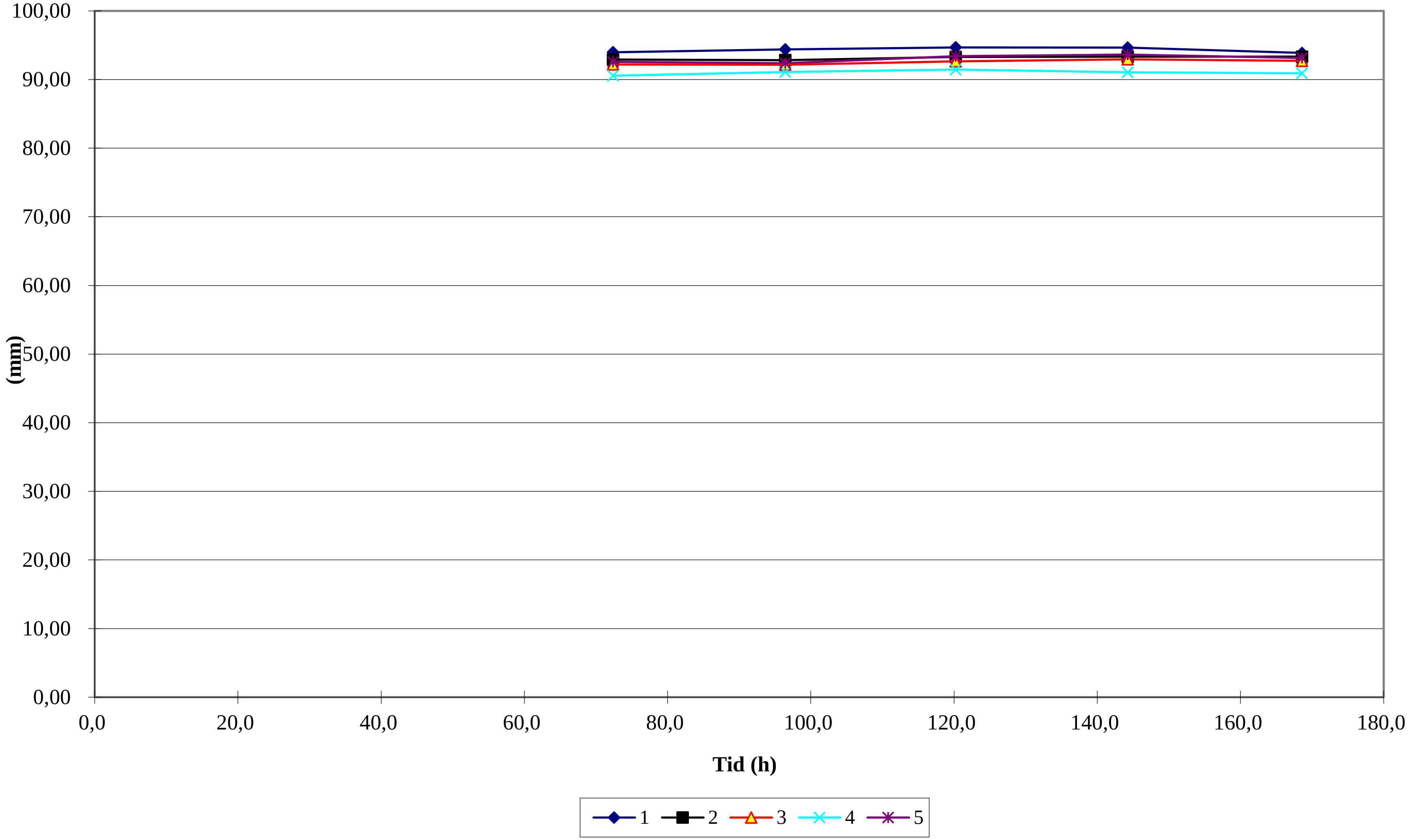
SIGN:

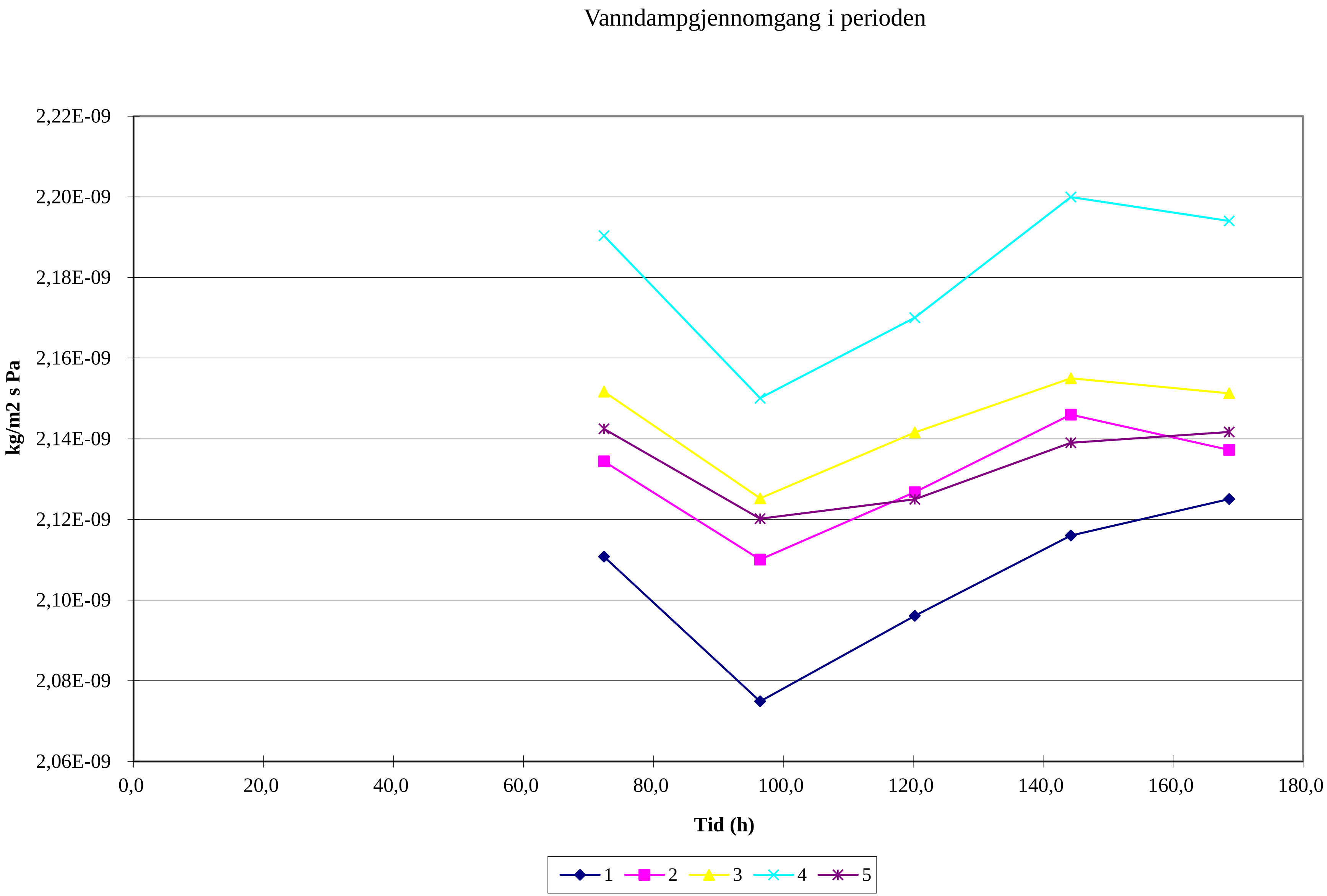
Produkt B

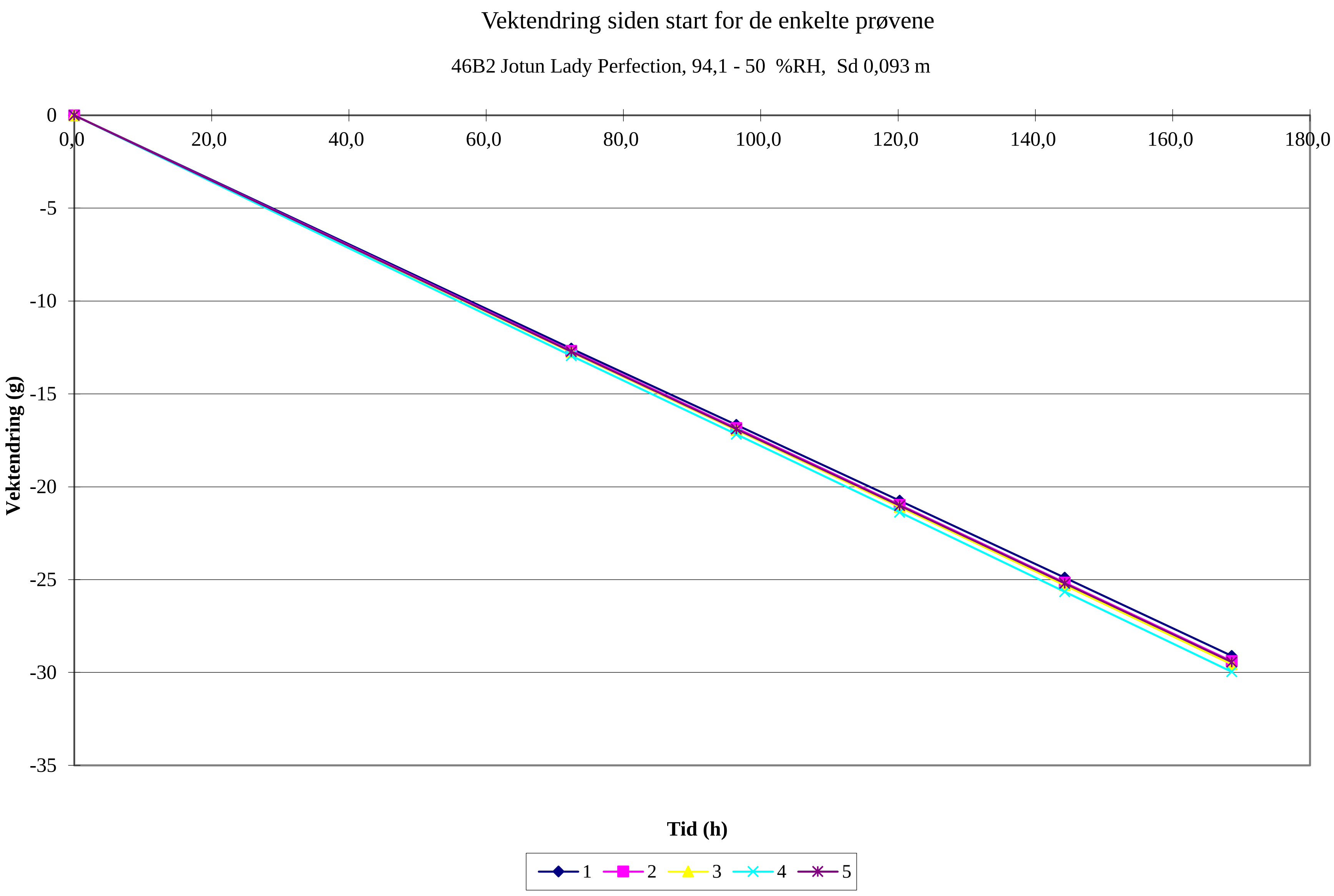
Inndata og resultater fra laboratorieforsøkene til «Produkt B».

Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	B2				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side inn	
(4)Produktype:	Gipsplate 12,5				Prøvest. diameter(mm):		0,174	Ferkst/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		27-09-2022	
(6)Målenummer:	B2				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		30.09.2022	03.10.2022	04.10.2022	05.10.2022	06.10.2022	07.10.2022				
(13)Tid (CTRL+SHIFT+ :)		08:23	08:46	08:49	08:37	08:39	08:59				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		1001,43	1009,73	1003,78	996,4	986,52	989,89				
(16)Barometertrykk i perioden, hPa:		1001,43	997,26	1009,98	996,84	987,64	991,56				
(17)Temperatur luft over boks,°C:		23	23,03	23,04	23,05	23,03	23,03				
(18)Temperatur i saltløsning, °C:		23	23,03	23,04	23,05	23,03	23,03				
(19)RF i rommet, %		50	49,53	49,48	49,6	49,61	49,6				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		1000,003	999,999	1000	1000	1000	999,999				
(22)Vekt,g prøve nr:	1	684,445	671,871	667,782	663,699	659,549	655,332				
(23)Vekt,g prøve nr:	2	676,712	664,024	659,879	655,748	651,551	647,315				
(24)Vekt,g prøve nr:	3	692,759	679,988	675,819	671,665	667,454	663,196				
(25)Vekt,g prøve nr:	4	704,463	691,507	687,299	683,101	678,82	674,495				
(26)Vekt,g prøve nr:	5	755,983	743,256	739,095	734,967	730,781	726,538				
(27)Vekt,g kontrolllodd etter veiing:		1000,005	1000	1000	1000,002	999,999	999,998				
Tekst i diagrammet Vektendring	46B2 Jotun Lady Perfection, 94,1 - 50 %RH, Sd 0,093 m										

Ekvivalent luftlagstykkelse i perioden




Vanndampgjennomgang i perioden
kg/m2 s Pa
2,22E-09
2,20E-09
2,18E-09
2,16E-09
2,14E-09
2,12E-09
2,10E-09
2,08E-09
2,06E-09
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5


Vektendring siden start for de enkelte prøvene
46B2 Jotun Lady Perfection, 94,1 - 50 %RH, Sd 0,093 m
0
-5
-10
-15
-20
-25
-30
-35
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Vektendring (g)
Tid (h)
1
2
3
4
5

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	B2	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	B2
Prosjektnummer:	B2	Prøvediameter: (mm)	164
Produktype:	Gipsplate 12,5	Salttype i boksen:	KNO3
		Prøveperiode: fra:	03.10.2022
		til:	07.10.2022

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,6
Temperatur i boksen (°C)	23,0
Temperatur i rommet (°C)	23,0
Barometertrykk (hPa)	996,7

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52
2	12,52
3	12,52
4	12,52
5	12,52
6	12,52

Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

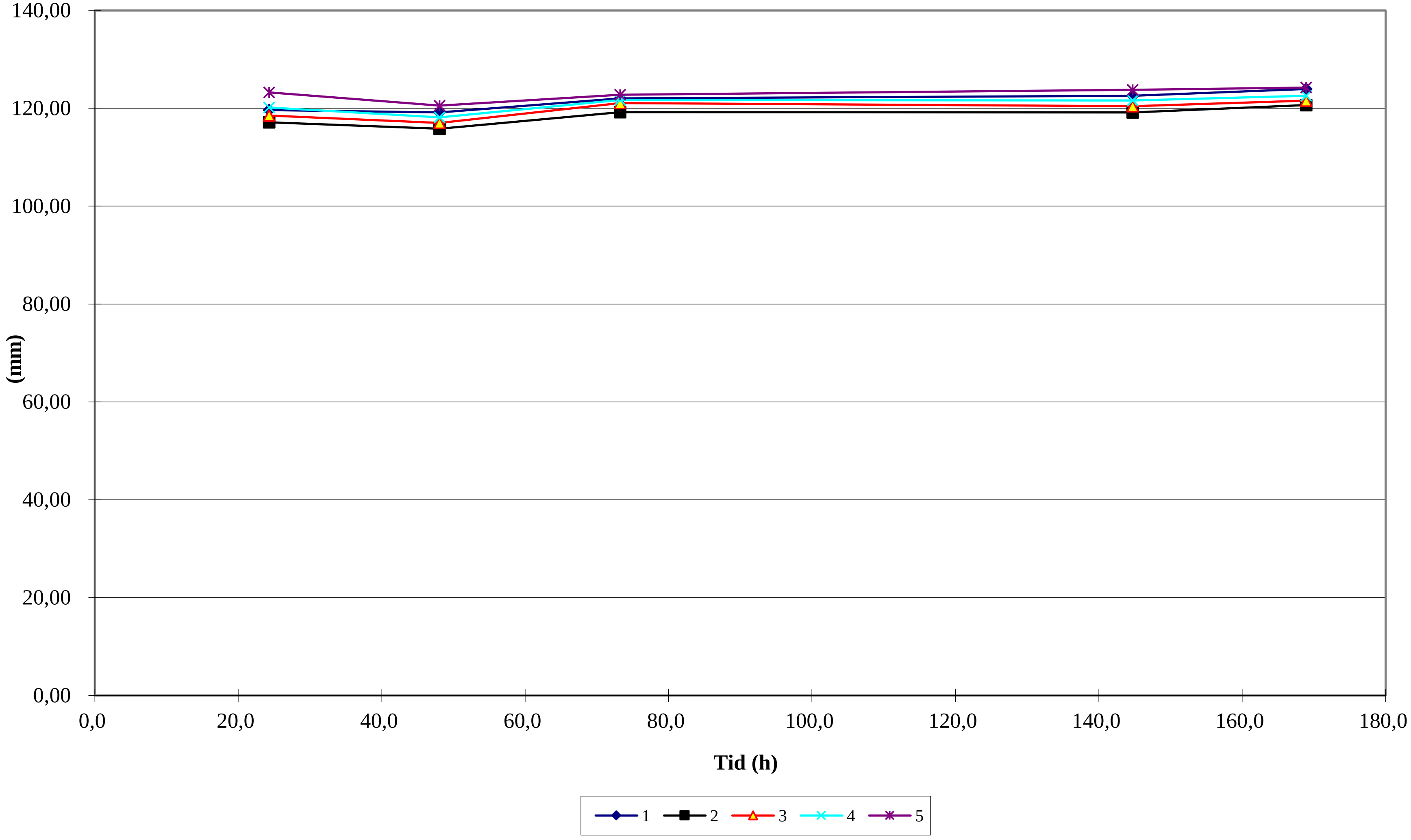
Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	2,11E-09	0,094	4,75E+08
2	2,13E-09	0,093	4,69E+08
3	2,15E-09	0,092	4,66E+08
4	2,18E-09	0,091	4,58E+08
5	2,14E-09	0,093	4,68E+08
Middel	2,14E-09	0,093	4,67E+08
Std. dev. mean. value	1,2562E-11	0,001	2,73E+06

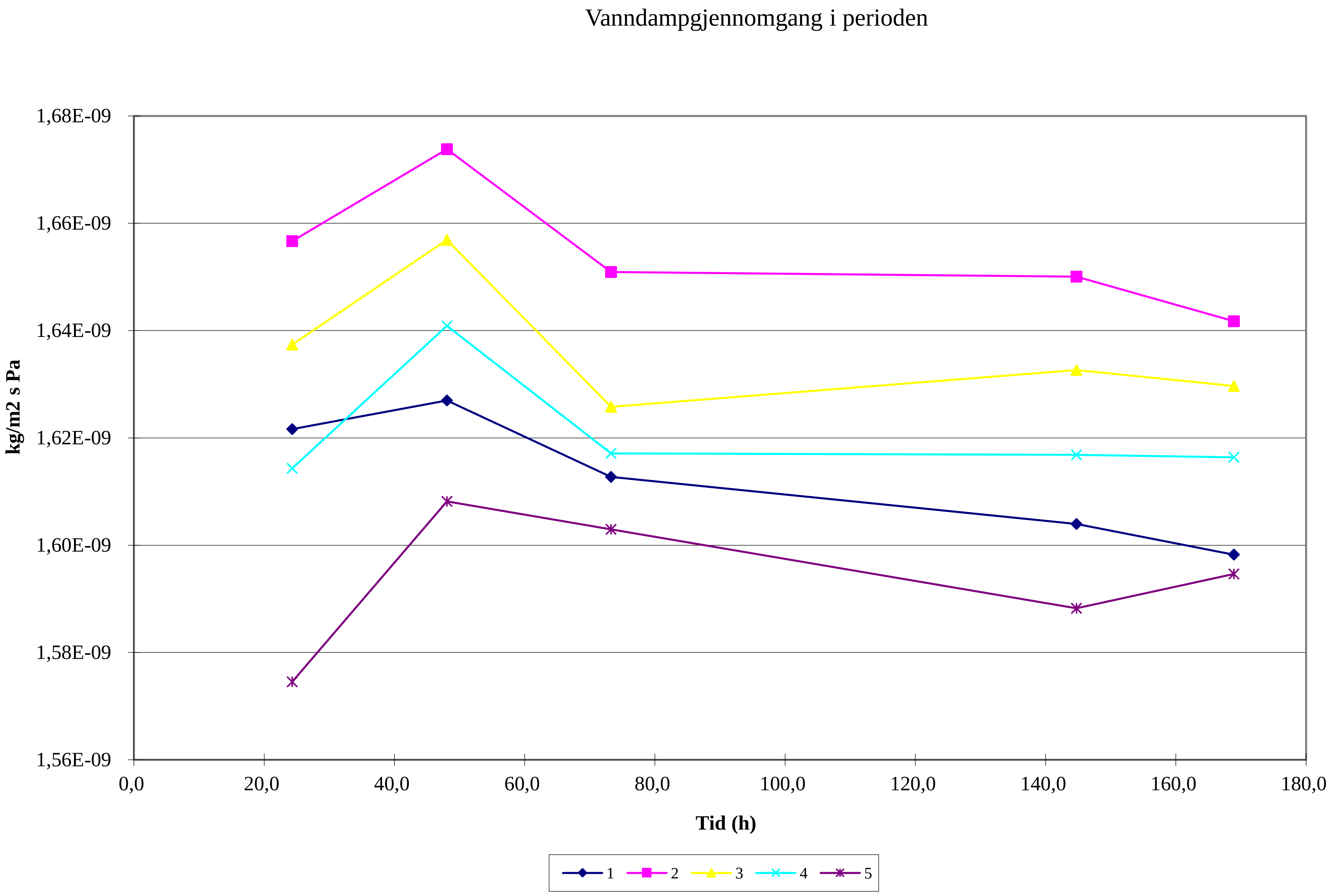
Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

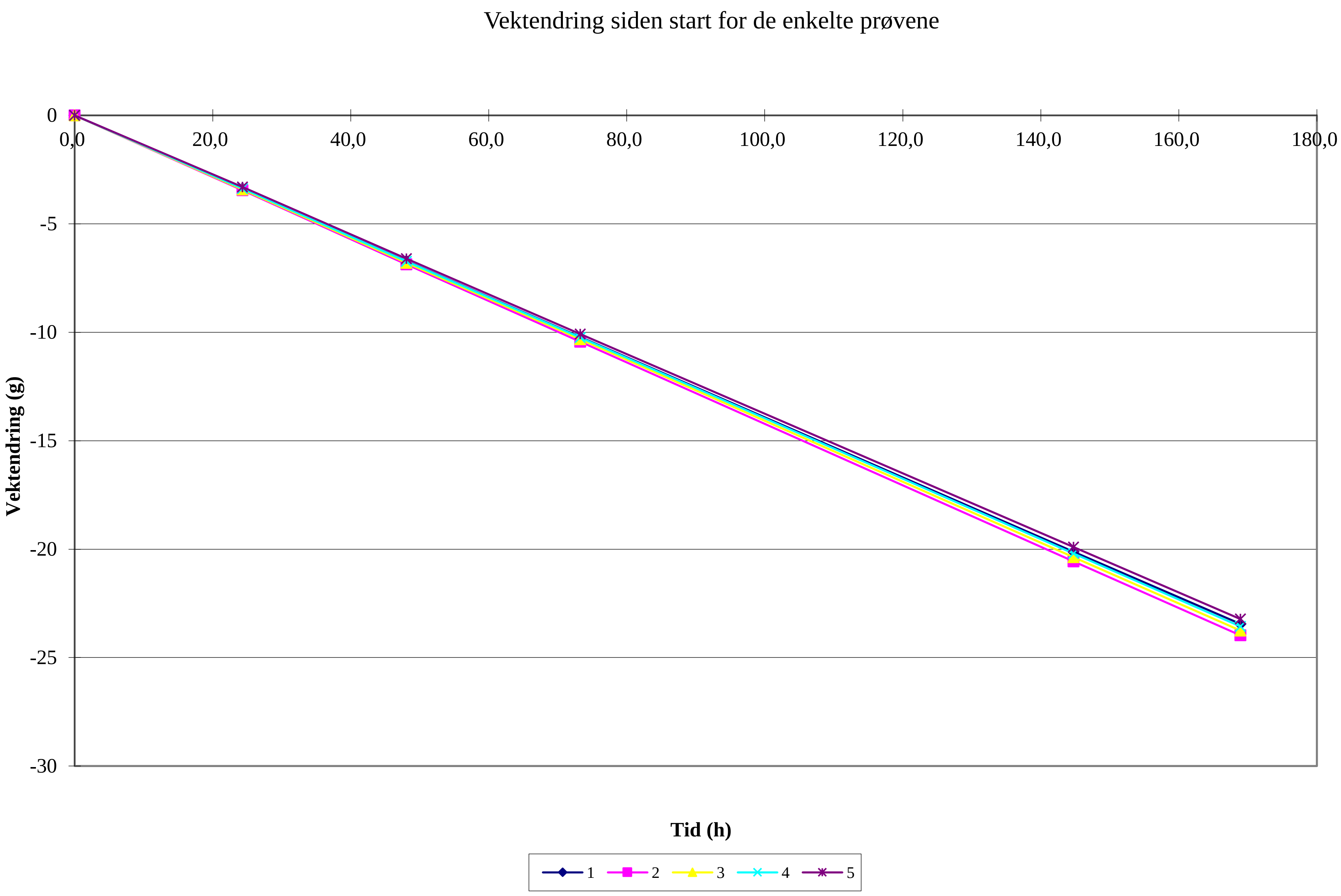
SIGN:

Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	B4				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferkst/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		28.09.2022	
(6)Målenummer:	B4				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		18.10.2022	19.10.2022	20.10.2022	21.10.2022	24.10.2022	25.10.2022				
(13)Tid (CTRL+SHIFT+ :)		08:50	09:09	08:54	10:06	09:34	09:45				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		1012,21	1022,27	1017,65	1010,72	1003,81	995,76				
(16)Barometertrykk i perioden, hPa:		1012,21	1019,46	1020,4	1004,36	1006,31	998,54				
(17)Temperatur luft over boks,°C:		23	23,04	23,09	22,84	23,08	23,07				
(18)Temperatur i saltløsning, °C:		23	23,04	23,09	22,84	23,08	23,07				
(19)RF i rommet, %		50	49,51	49,35	48,92	49,33	49,35				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		999,995	999,998	1000,004	1000,005	1000,005	1000,003				
(22)Vekt,g prøve nr:	1	713,138	709,746	706,427	702,931	693,035	689,703				
(23)Vekt,g prøve nr:	2	698,792	695,338	691,938	688,372	678,237	674,829				
(24)Vekt,g prøve nr:	3	682,926	679,506	676,135	672,615	662,57	659,183				
(25)Vekt,g prøve nr:	4	738,697	735,318	731,975	728,471	718,508	715,144				
(26)Vekt,g prøve nr:	5	777,221	773,913	770,627	767,149	757,335	754,009				
(27)Vekt,g kontrolllodd etter veiing:		999,996	999,998	1000,004	1000,006	1000,006	1000,004				
Tekst i diagrammet Vektendring											

Ekvivalent luftlagstykkelse i perioden




Vanndampgjennomgang i perioden
kg/m2 s Pa
1,68E-09
1,66E-09
1,64E-09
1,62E-09
1,60E-09
1,58E-09
1,56E-09
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5



Vektendring siden start for de enkelte prøvene
0
-5
-10
-15
-20
-25
-30
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Vektendring (g)
Tid (h)
1
2
3
4
5

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	B4	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	B4
Prosjektnummer:	B4	Prøvediameter: (mm)	164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:	KNO3
		Prøveperiode: fra:	19.10.2022
		til:	25.10.2022

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,3
Temperatur i boksen (°C)	23,0
Temperatur i rommet (°C)	23,0
Barometertrykk (hPa)	1009,8

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52
2	12,52
3	12,52
4	12,52
5	12,52
6	12,52

Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

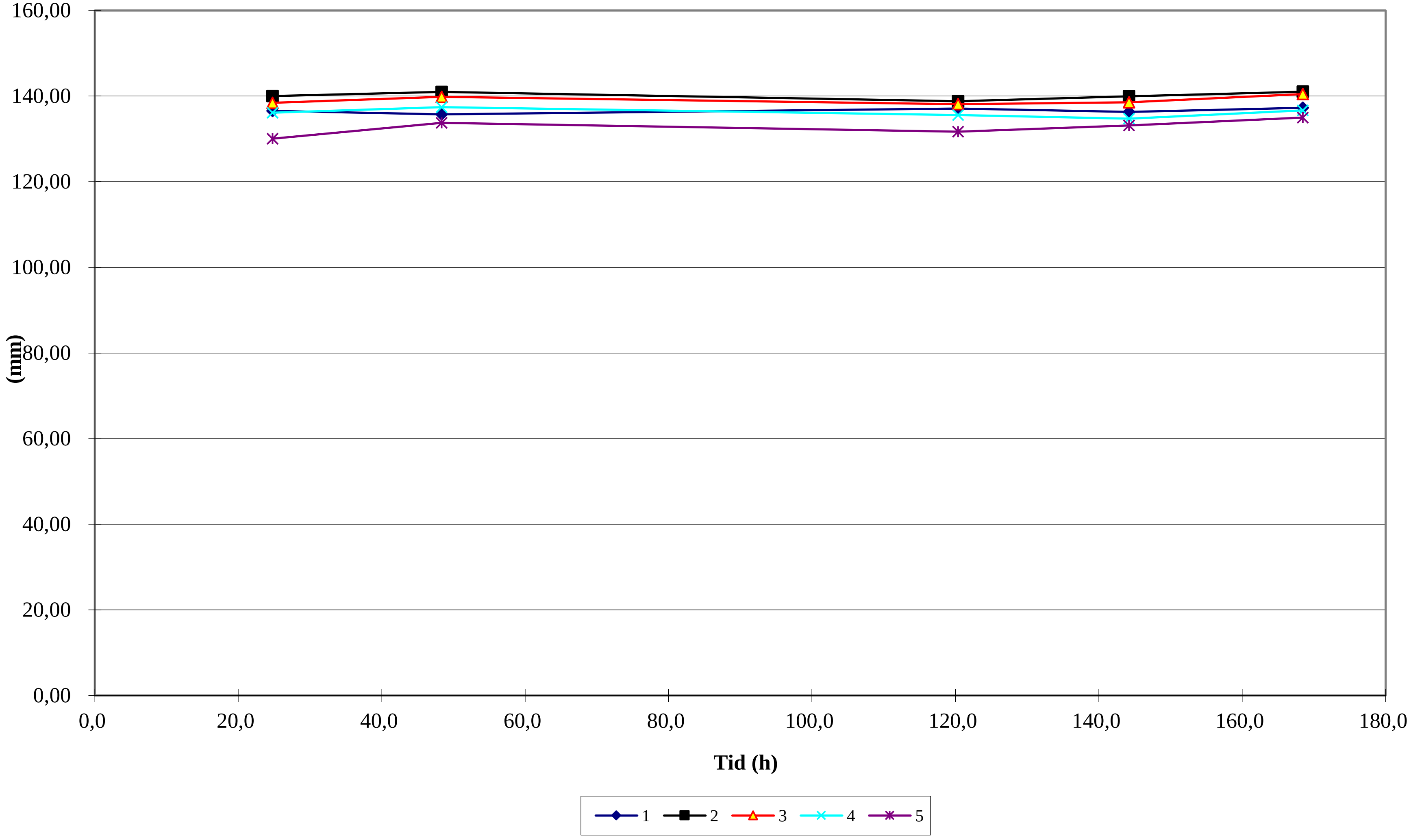
Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	1,61E-09	0,122	6,21E+08
2	1,65E-09	0,118	6,05E+08
3	1,64E-09	0,120	6,12E+08
4	1,62E-09	0,121	6,17E+08
5	1,59E-09	0,123	6,28E+08
Middel	1,62E-09	0,121	6,16E+08
Std. dev. mean. value	1,04619E-11	0,001	3,97E+06

Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

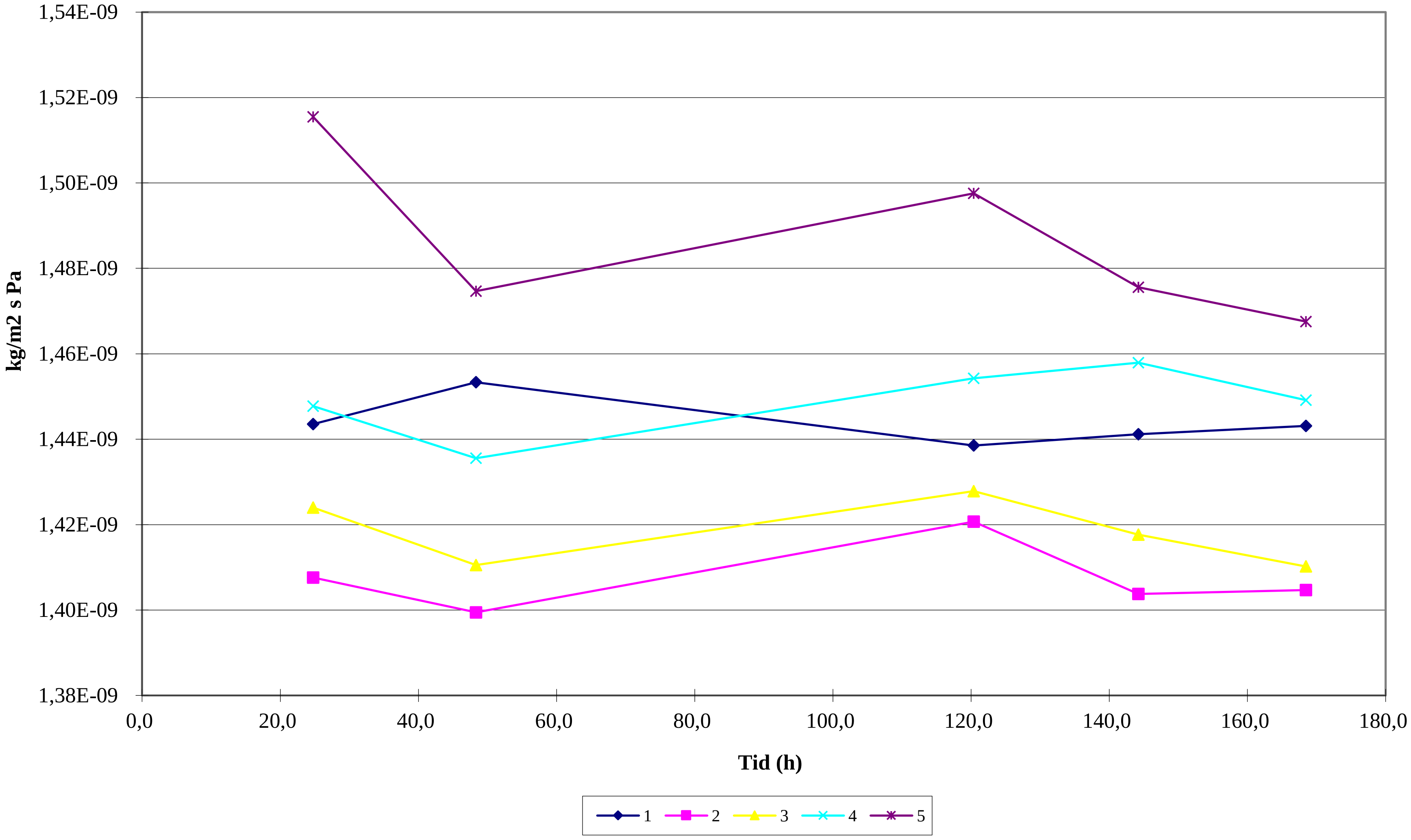
SIGN:

Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	B6				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferskt/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		28.09.2022	
(6)Målenummer:	B6				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		26.10.2022	27.10.2022	28.10.2022	31.10.2022	01.11.2022	02.11.2022				
(13)Tid (CTRL+SHIFT+ :)		08:44	09:30	09:05	09:06	08:56	09:12				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		1003,49	1002,31	1002,44	1005,15	1006,39	996,48				
(16)Barometertrykk i perioden, hPa:		1003,49	1003,73	1002,81	1003,18	1007,07	998,57				
(17)Temperatur luft over boks,°C:		23	23,08	23,07	23,06	23,05	23,04				
(18)Temperatur i saltløsning, °C:		23	23,08	23,07	23,06	23,05	23,04				
(19)RF i rommet, %		50	49,28	49,32	49,27	49,37	49,36				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		1000,002	1000,002	1000,001	1000	1000,001	1000,002				
(22)Vekt,g prøve nr:	1	806,002	802,852	799,837	790,732	787,732	784,681				
(23)Vekt,g prøve nr:	2	740,922	737,84	734,922	725,914	722,981	720				
(24)Vekt,g prøve nr:	3	775,925	772,812	769,874	760,827	757,869	754,878				
(25)Vekt,g prøve nr:	4	758,435	755,277	752,294	743,103	740,073	737,011				
(26)Vekt,g prøve nr:	5	793,728	790,443	787,39	777,965	774,904	771,809				
(27)Vekt,g kontrolllodd etter veiing:		1000	1000,003	999,999	1000,002	1000,003	1000,004				
Tekst i diagrammet Vektendring											

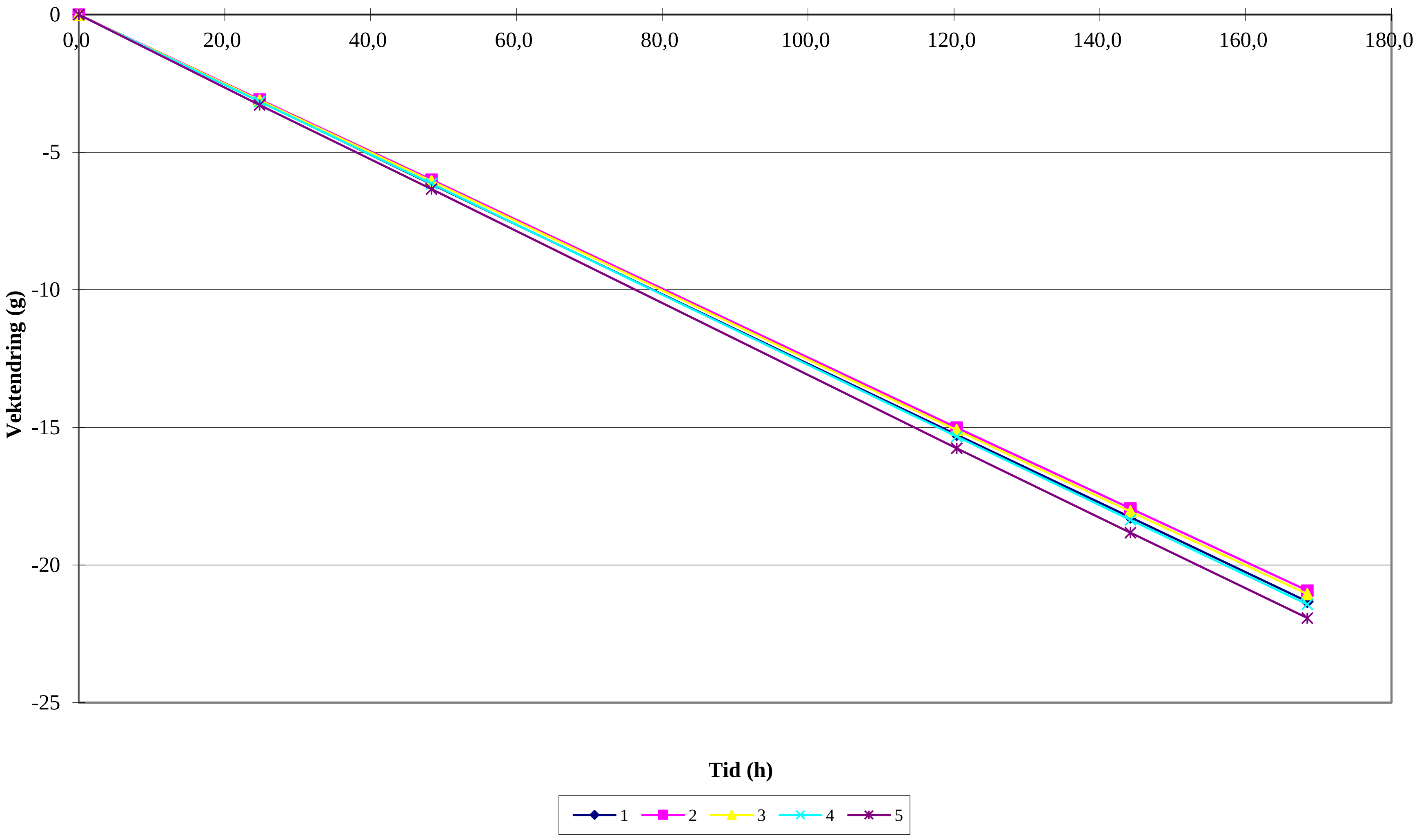
Ekvivalent luftlagstykkelse i perioden



Vanndampgjennomgang i perioden



Vektendring siden start for de enkelte prøvene



PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	B6	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	B6
Prosjektnummer:	B6	Prøvediameter: (mm)	164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:	KNO3
		Prøveperiode: fra:	27.10.2022
		til:	02.11.2022

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,3
Temperatur i boksen (°C)	23,1
Temperatur i rommet (°C)	23,1
Barometertrykk (hPa)	1003,1

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52	
2	12,52	
3	12,52	
4	12,52	
5	12,52	
6		0

Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	1,44E-09	0,137	6,93E+08
2	1,41E-09	0,140	7,09E+08
3	1,42E-09	0,139	7,04E+08
4	1,45E-09	0,136	6,89E+08
5	1,49E-09	0,132	6,71E+08
Middel	1,44E-09	0,137	6,93E+08
Std. dev. mean. value	1,36622E-11	0,001	6,50E+06

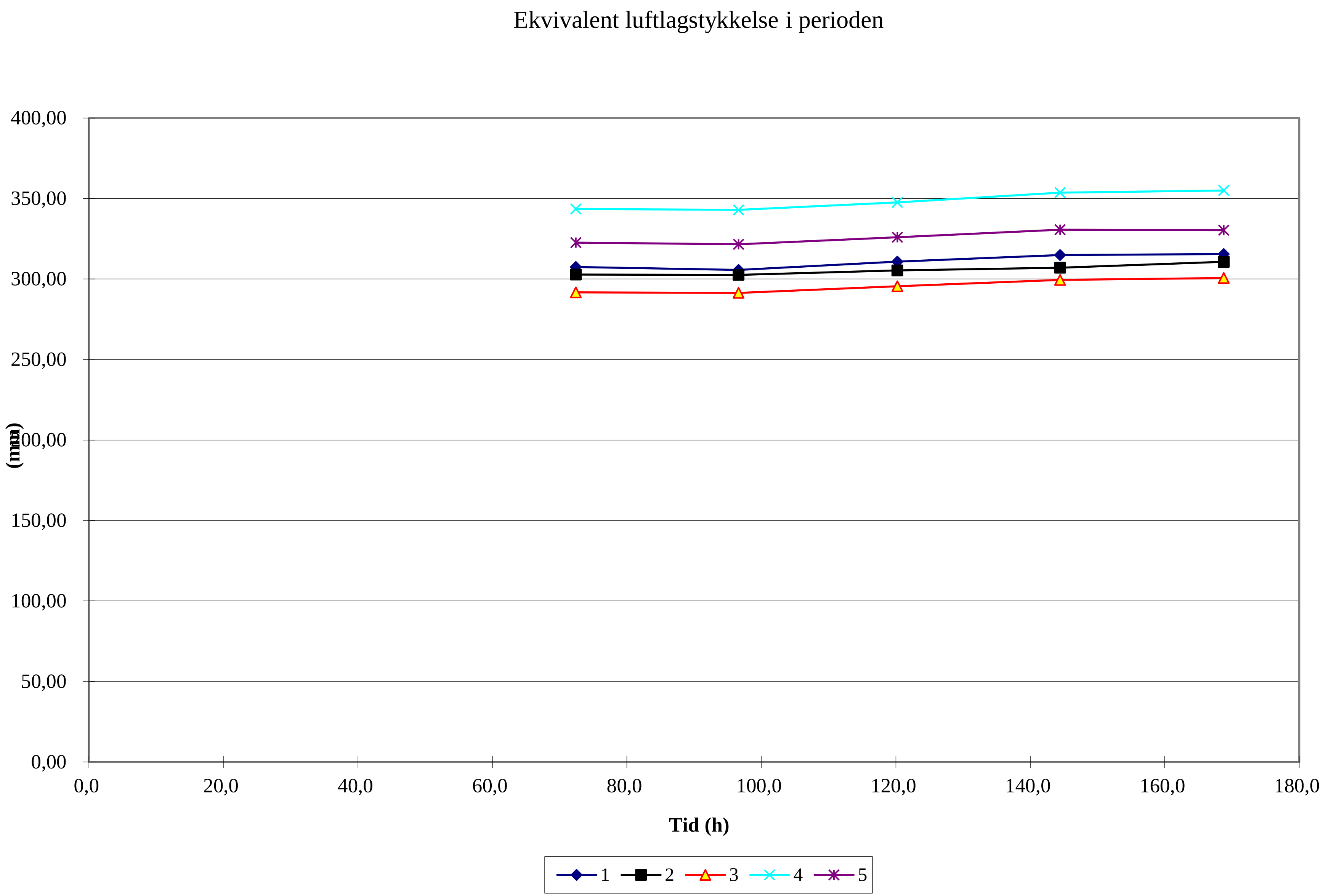
Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

SIGN:

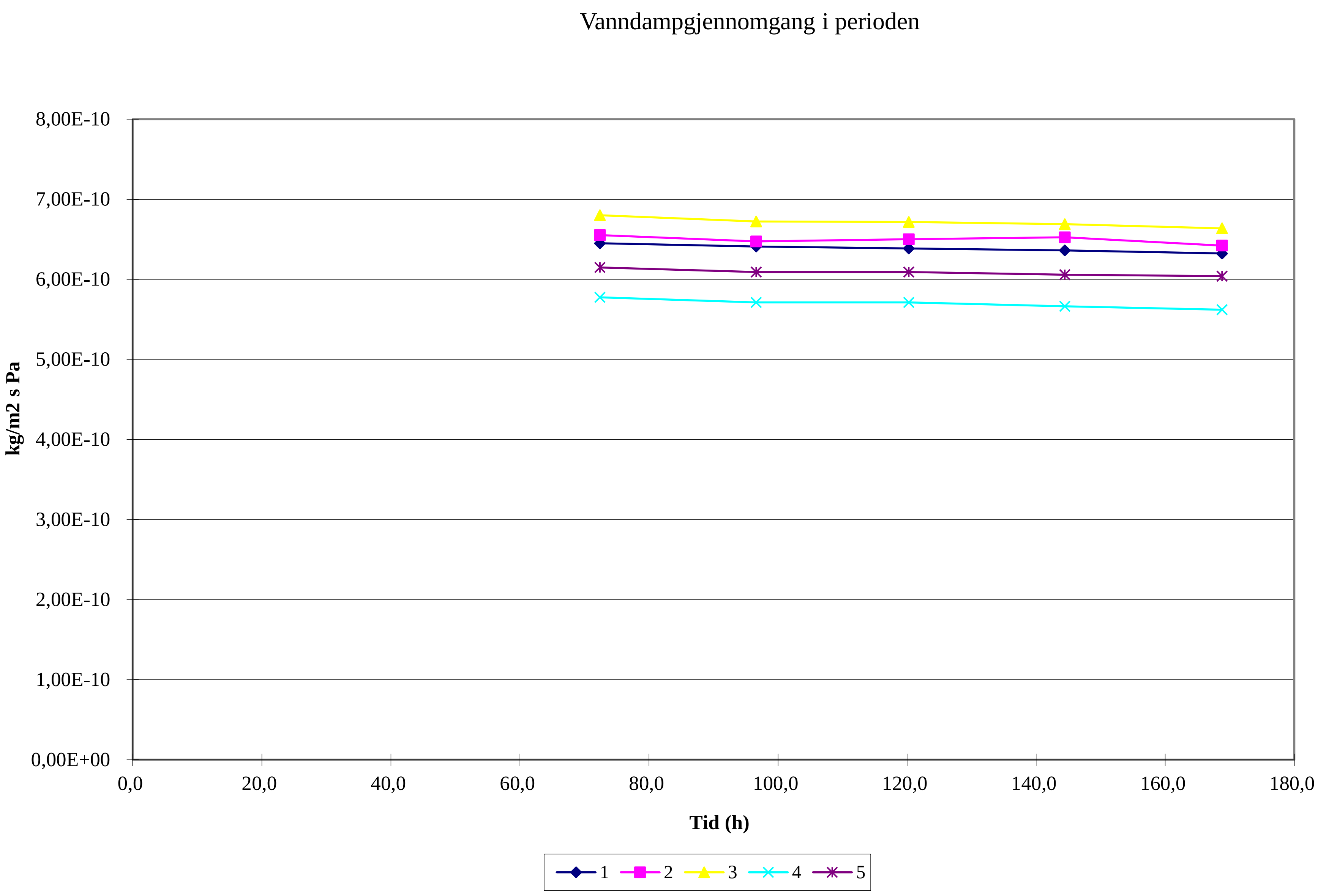
Produkt C

Inndata og resultater fra laboratorieforsøkene til «Produkt C».

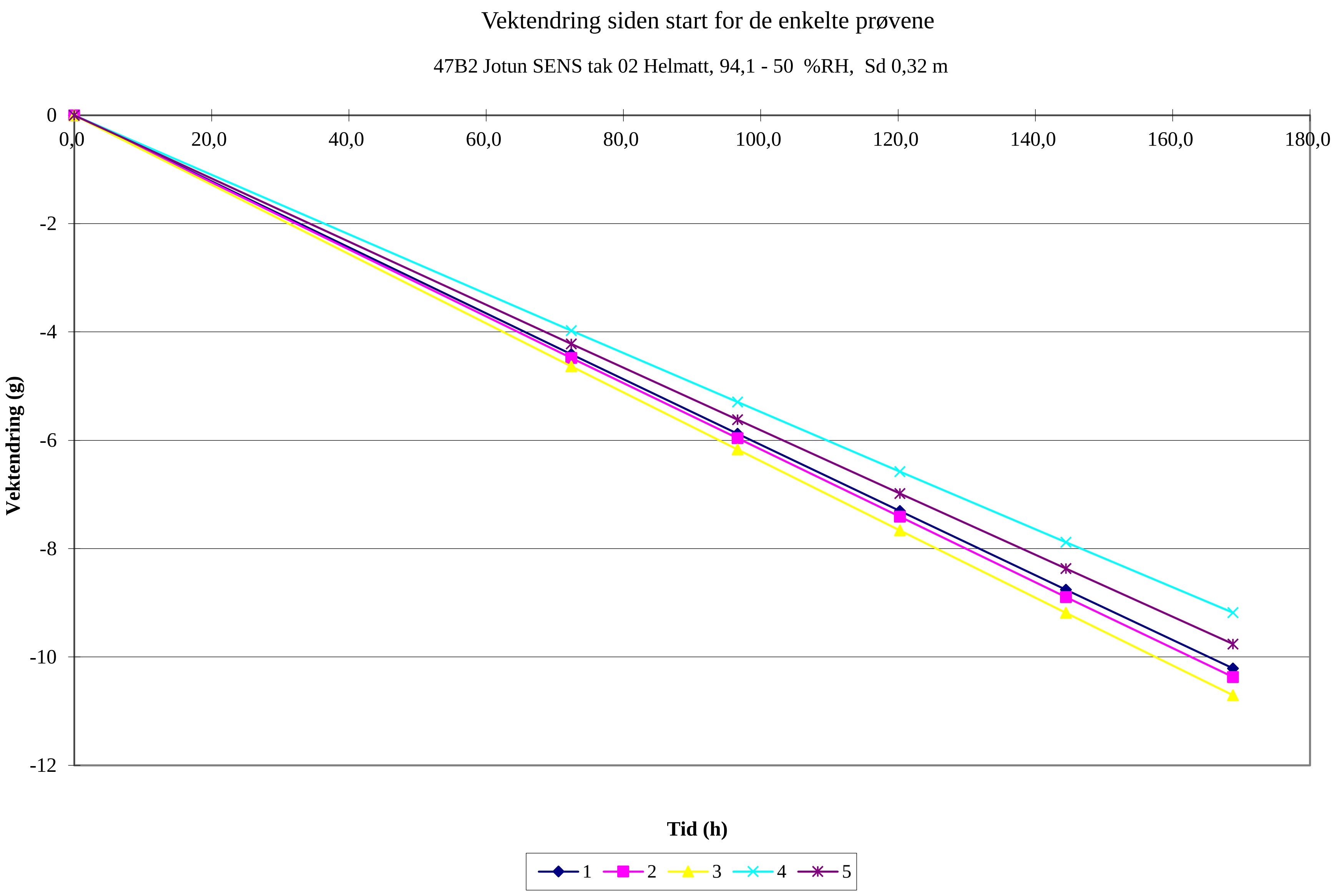
Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	C2				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side inn	
(4)Produktype:	Gipsplate 12,5				Prøvest. diameter(mm):		0,174	Ferskt/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		27-09-2022	
(6)Målenummer:	C2				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		30.09.2022	03.10.2022	04.10.2022	05.10.2022	06.10.2022	07.10.2022				
(13)Tid (CTRL+SHIFT+ :)		08:17	08:41	08:54	08:32	08:44	09:04				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		1001,43	1009,79	1003,78	996,4	986,52	989,89				
(16)Barometertrykk i perioden, hPa:		1001,43	997,26	1009,98	996,84	987,64	991,56				
(17)Temperatur luft over boks,°C:		23	23,03	23,04	23,05	23,03	23,03				
(18)Temperatur i saltløsning, °C:		23	23,03	23,04	23,05	23,03	23,03				
(19)RF i rommet, %		50	49,53	49,48	49,6	49,61	49,6				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		1000,002	999,999	1000,002	1000	999,998	999,999				
(22)Vekt,g prøve nr:	1	710,576	706,157	704,702	703,275	701,824	700,362				
(23)Vekt,g prøve nr:	2	706,804	702,32	700,851	699,4	697,914	696,431				
(24)Vekt,g prøve nr:	3	712,282	707,64	706,118	704,622	703,101	701,572				
(25)Vekt,g prøve nr:	4	647,842	643,858	642,553	641,268	639,967	638,657				
(26)Vekt,g prøve nr:	5	679,899	675,674	674,287	672,922	671,536	670,135				
(27)Vekt,g kontrolllodd etter veiing:		1000,001	1000,002	1000,005	999,999	1000,001	999,999				
Tekst i diagrammet Vektendring	47B2 Jotun SENS tak 02 Helmatt, 94,1 - 50 %RH, Sd 0,32 m										



Ekvivalent luftlagstykkelse i perioden
400,00
350,00
300,00
250,00
200,00
150,00
100,00
50,00
0,00
(mm)
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5



Vanndampgjennomgang i perioden
8,00E-10
7,00E-10
6,00E-10
5,00E-10
4,00E-10
3,00E-10
2,00E-10
1,00E-10
0,00E+00
kg/m2 s Pa
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5


Vektendring siden start for de enkelte prøvene
47B2 Jotun SENS tak 02 Helmatt, 94,1 - 50 %RH, Sd 0,32 m
0
-2
-4
-6
-8
-10
-12
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Vektendring (g)
Tid (h)
1
2
3
4
5

SINTEF

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	C2	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	C2
Prosjektnummer:	C2	Prøvediameter: (mm)	164
Produktype:	Gipsplate 12,5	Salttype i boksen:	KNO3
		Prøveperiode: fra:	03.10.2022
		til:	07.10.2022

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,6
Temperatur i boksen (°C)	23,0
Temperatur i rommet (°C)	23,0
Barometertrykk (hPa)	996,7

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52
2	12,52
3	12,52
4	12,52
5	12,52
6	12,52

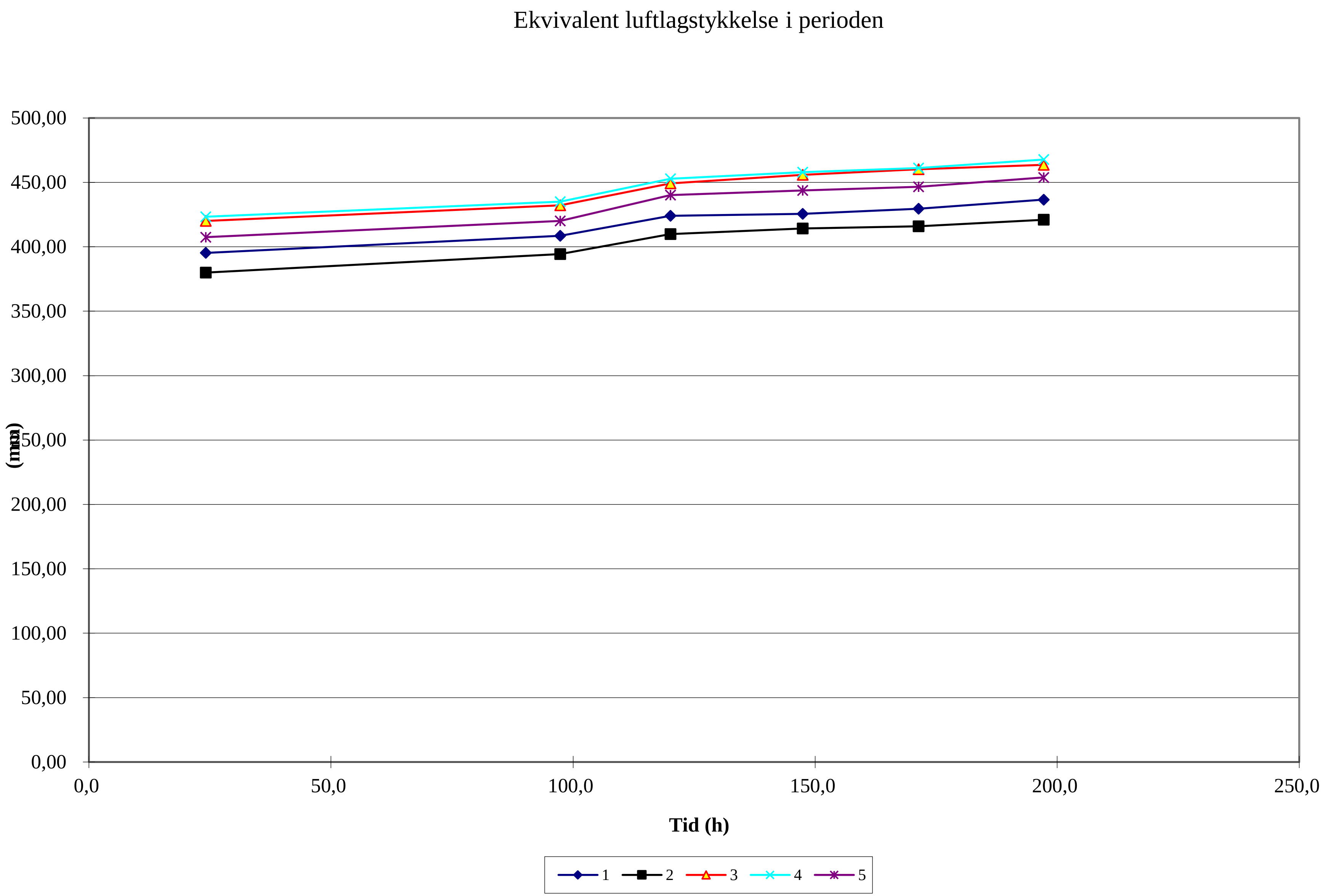
Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	6,40E-10	0,310	1,56E+09
2	6,51E-10	0,305	1,54E+09
3	6,74E-10	0,295	1,48E+09
4	5,72E-10	0,347	1,75E+09
5	6,10E-10	0,325	1,64E+09
Middel	6,29E-10	0,315	1,59E+09
Std. dev. mean. value	1,76629E-11	0,009	4,61E+07

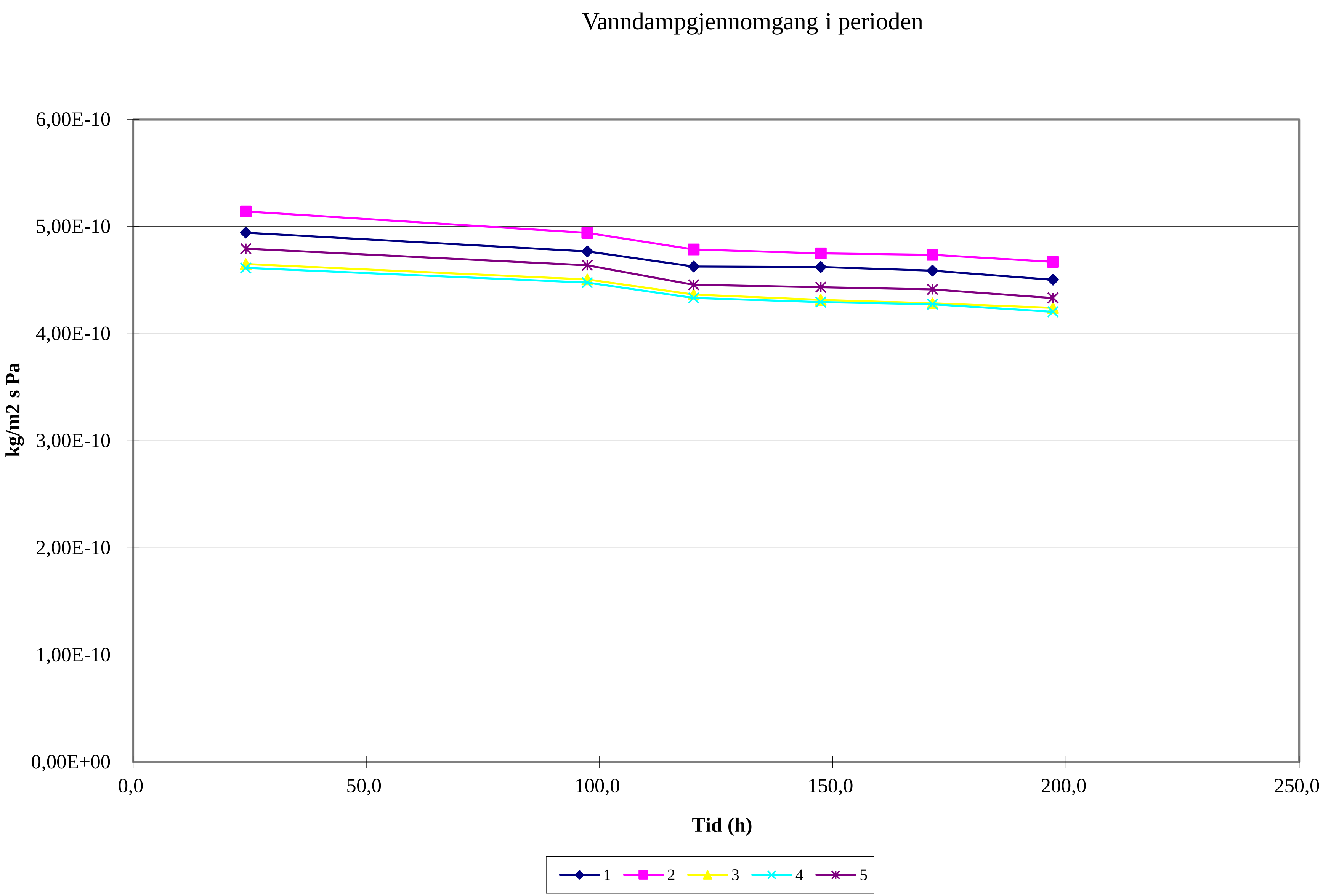
Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

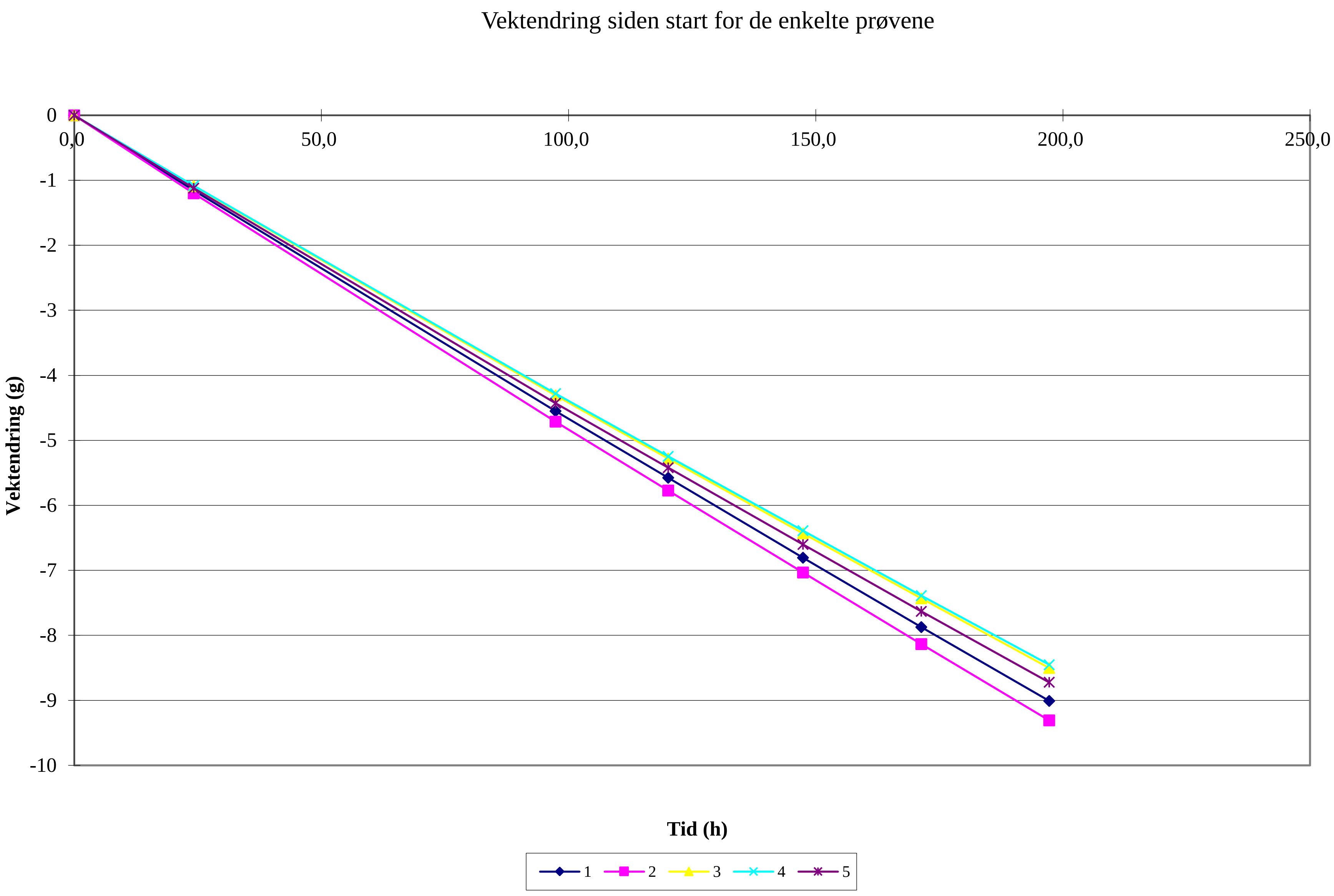
SIGN:

Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	C4				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferkst/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		15.11.2022	
(6)Målenummer:	C4				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		17.11.2022	18.11.2022	21.11.2022	22.11.2022	23.11.2022	24.11.2022	25.11.2022			
(13)Tid (CTRL+SHIFT+ :)		09:10	09:19	10:32	09:19	12:35	12:32	14:23			
(14)Beregning fra veiing:	3										
(15)Barometertrykk ved veiing, hPa:		1011,33	1015,45	1009,87	1006,33	1004,19	1003,96	1008,31			
(16)Barometertrykk i perioden, hPa:		1011,33	1012,61	1015,46	1008,31	1005,45	1003,76	1005,99			
(17)Temperatur luft over boks,°C:		23	23,07	23,06	23,05	23,05	23,05	23,04			
(18)Temperatur i saltløsning, °C:		23	23,07	23,06	23,05	23,05	23,05	23,04			
(19)RF i rommet, %		50	49,22	49,02	49,02	49	49,04	49,06			
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		1000,001	999,999	1000	1000,004	1000,002	1000,001	999,999			
(22)Vekt,g prøve nr:	1	719,483	718,325	714,937	713,912	712,682	711,609	710,472			
(23)Vekt,g prøve nr:	2	673,462	672,26	668,755	667,696	666,434	665,328	664,151			
(24)Vekt,g prøve nr:	3	707,012	705,919	702,708	701,738	700,586	699,581	698,507			
(25)Vekt,g prøve nr:	4	683,161	682,076	678,885	677,922	676,775	675,772	674,707			
(26)Vekt,g prøve nr:	5	726,174	725,049	721,749	720,76	719,578	718,544	717,448			
(27)Vekt,g kontrolllodd etter veiing:		999,998	1000	1000,001	1000,005	1000,004	1000	1000			
Tekst i diagrammet Vektendring											



Ekvivalent luftlagstykkelse i perioden
500,00
450,00
400,00
350,00
300,00
250,00
200,00
150,00
100,00
50,00
0,00
(mm)
0,0
50,0
100,0
150,0
200,0
250,0
Tid (h)
1
2
3
4
5


Vanndampgjennomgang i perioden
6,00E-10
5,00E-10
4,00E-10
3,00E-10
2,00E-10
1,00E-10
0,00E+00
kg/m2 s Pa
0,0
50,0
100,0
150,0
200,0
250,0
Tid (h)
1
2
3
4
5


Vektendring siden start for de enkelte prøvene
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
0,0
50,0
100,0
150,0
200,0
250,0
Vektendring (g)
Tid (h)
1
2
3
4
5

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	C4	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	C4
Prosjektnummer:	C4	Prøvediameter: (mm)	164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:	KNO3
		Prøveperiode: fra:	21.11.2022
		til:	25.11.2022

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,0
Temperatur i boksen (°C)	23,1
Temperatur i rommet (°C)	23,1
Barometertrykk (hPa)	1007,8

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52	
2	12,52	
3	12,52	
4	12,52	
5	12,52	
6		0

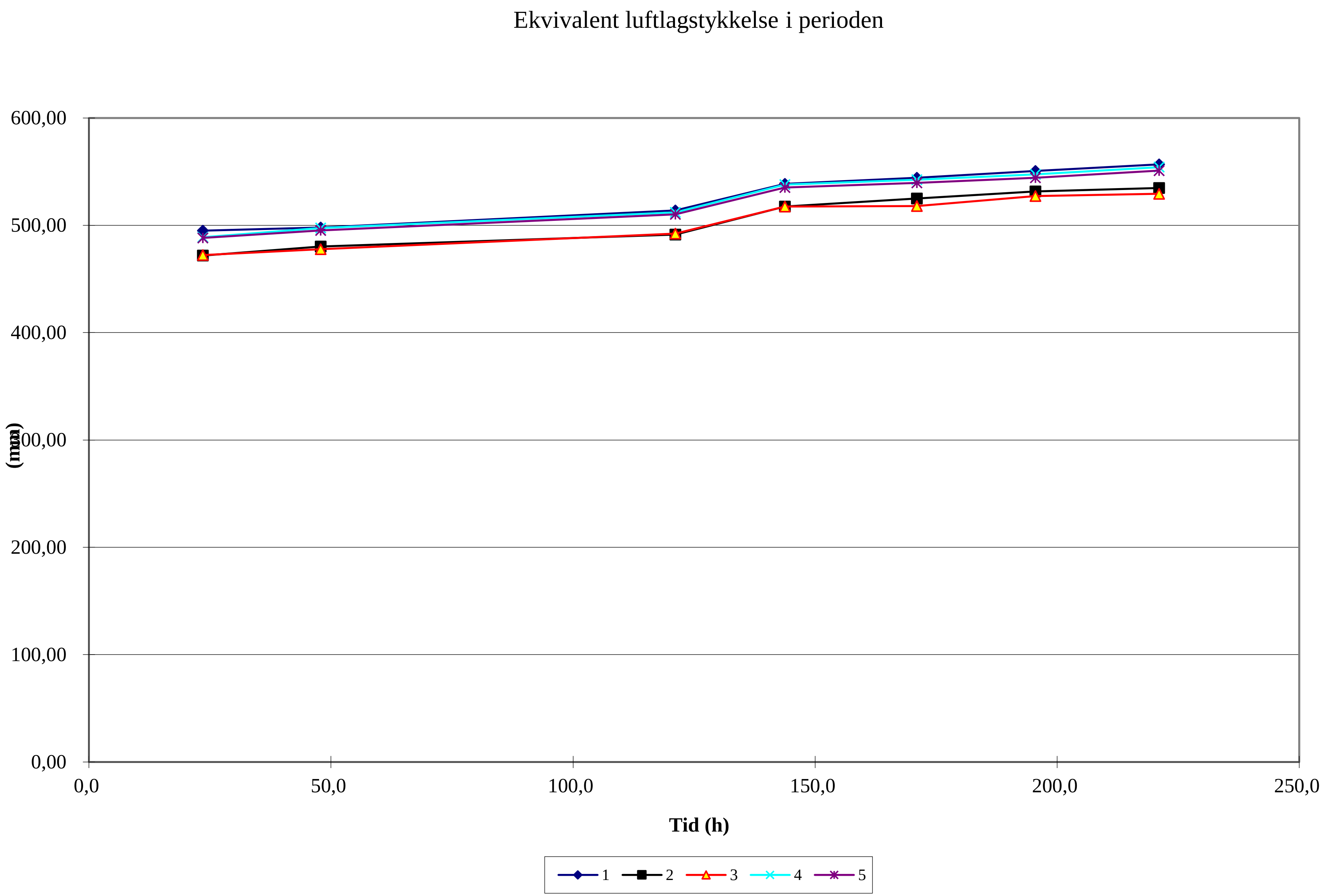
Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	4,66E-10	0,421	2,14E+09
2	4,82E-10	0,407	2,07E+09
3	4,39E-10	0,447	2,28E+09
4	4,36E-10	0,450	2,29E+09
5	4,51E-10	0,436	2,22E+09
Middel	4,55E-10	0,432	2,20E+09
Std. dev. mean. value	8,68208E-12	0,008	4,14E+07

Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

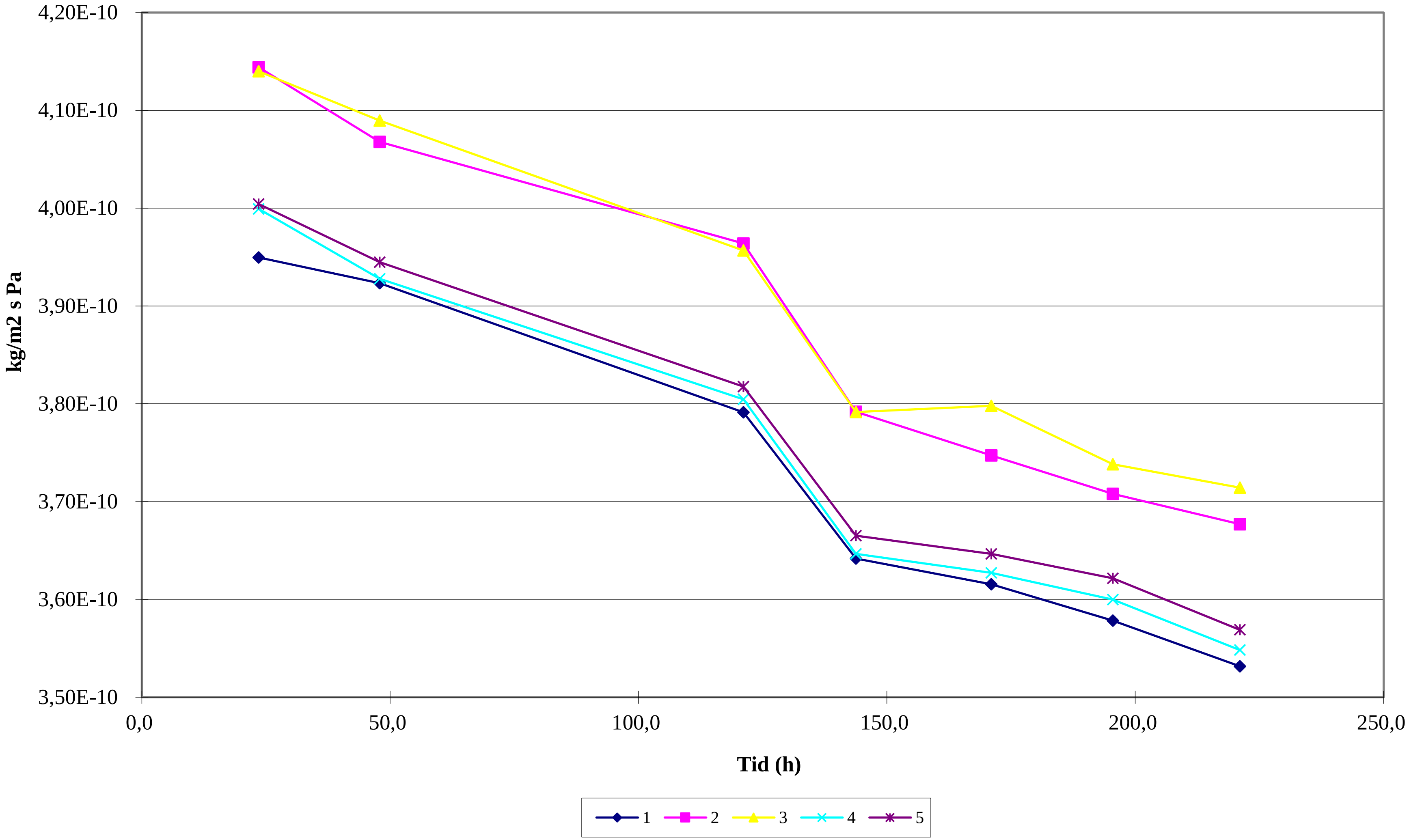
SIGN:

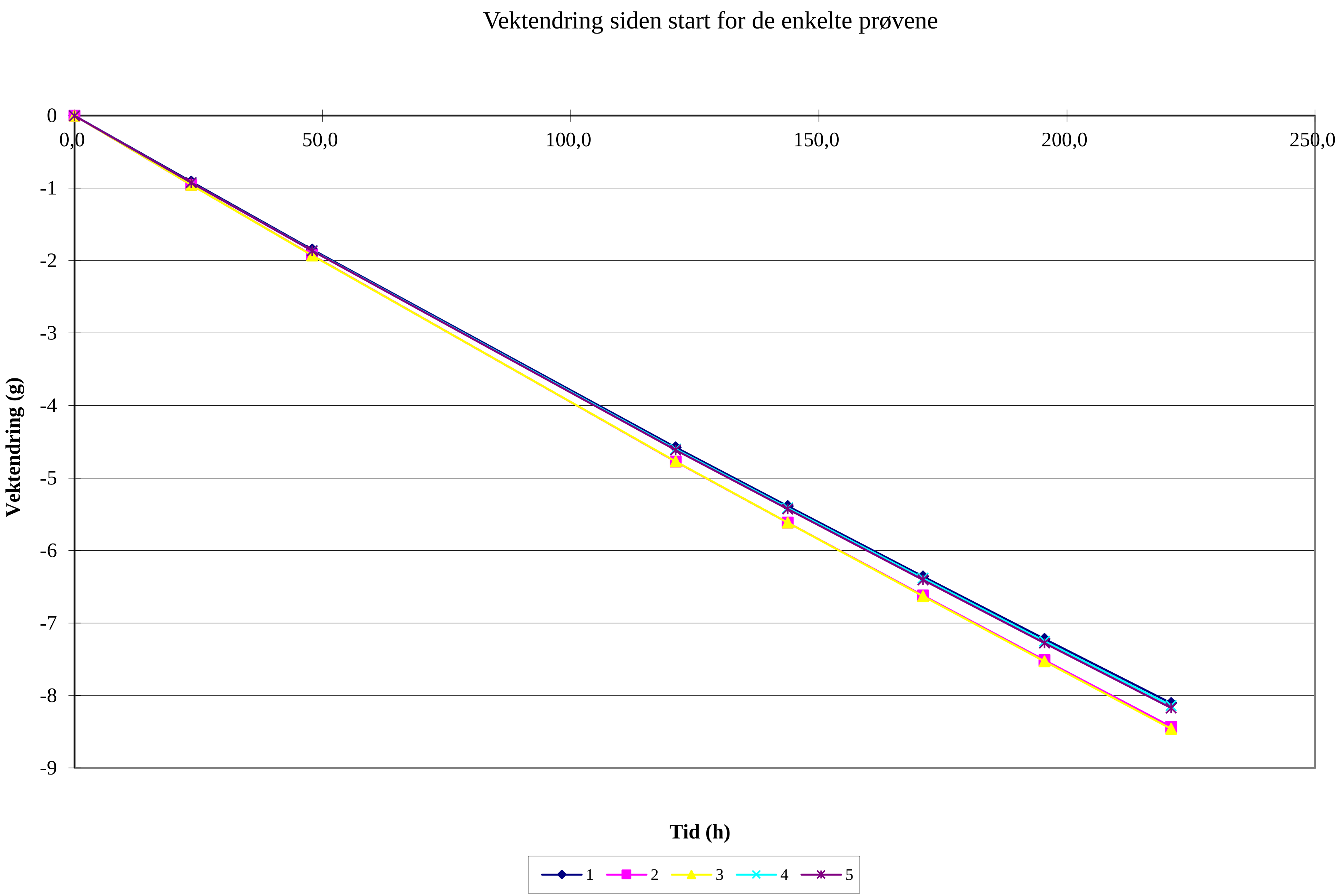
Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	C6				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferkst/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		14.11.2022	
(6)Målenummer:	C6				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		16.11.2022	17.11.2022	18.11.2022	21.11.2022	22.11.2022	23.11.2022	24.11.2022	25.11.2022		
(13)Tid (CTRL+SHIFT+ :)		09:30	09:01	09:23	10:38	09:15	12:30	13:00	14:32		
(14)Beregning fra veiing:	4										
(15)Barometertrykk ved veiing, hPa:		1012,81	1011,33	1015,45	1009,87	1006,33	1004,19	1003,96	1008,31		
(16)Barometertrykk i perioden, hPa:		1012,81	1011,79	1012,61	1015,46	1008,31	1005,45	1003,76	1005,99		
(17)Temperatur luft over boks,°C:		23	23,05	23,07	23,06	23,05	23,05	23,05	23,04		
(18)Temperatur i saltløsning, °C:		23	23,05	23,07	23,06	23,05	23,05	23,05	23,04		
(19)RF i rommet, %		50	49,01	49,12	49,02	49,02	49	49,04	49,09		
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		1000	999,997	1000	1000,001	1000,001	1000,000	1000	1000,001		
(22)Vekt,g prøve nr:	1	733,069	732,157	731,218	728,496	727,685	726,713	725,849	724,96		
(23)Vekt,g prøve nr:	2	754,036	753,081	752,109	749,268	748,425	747,419	746,525	745,601		
(24)Vekt,g prøve nr:	3	723,969	723,015	722,038	719,202	718,359	717,34	716,439	715,506		
(25)Vekt,g prøve nr:	4	736,187	735,264	734,324	731,593	730,781	729,806	728,937	728,044		
(26)Vekt,g prøve nr:	5	702,3	701,376	700,432	697,692	696,876	695,896	695,022	694,124		
(27)Vekt,g kontrolllodd etter veiing:		1000,001	999,999	1000,001	1000	1000,002	1000	1000	1000		
Tekst i diagrammet Vektendring											



Ekvivalent luftlagstykkelse i perioden
600,00
500,00
400,00
300,00
200,00
100,00
0,00
(mm)
0,0
50,0
100,0
150,0
200,0
250,0
Tid (h)
1
2
3
4
5

Vanndampgjennomgang i perioden




Vektendring siden start for de enkelte prøvene
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
0,0
50,0
100,0
150,0
200,0
250,0
Vektendring (g)
Tid (h)
1
2
3
4
5

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	C6	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	C6
Prosjektnummer:	C6	Prøvediameter: (mm)	164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:	KNO3
		Prøveperiode: fra:	21.11.2022
		til:	25.11.2022

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52	
2	12,52	
3	12,52	
4	12,52	
5	12,52	
6		0

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,0
Temperatur i boksen (°C)	23,1
Temperatur i rommet (°C)	23,1
Barometertrykk (hPa)	1007,8

Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	3,68E-10	0,534	2,72E+09
2	3,83E-10	0,513	2,61E+09
3	3,84E-10	0,511	2,60E+09
4	3,69E-10	0,532	2,71E+09
5	3,71E-10	0,530	2,70E+09
Middel	3,75E-10	0,524	2,67E+09
Std. dev. mean. value	3,61049E-12	0,005	2,55E+07

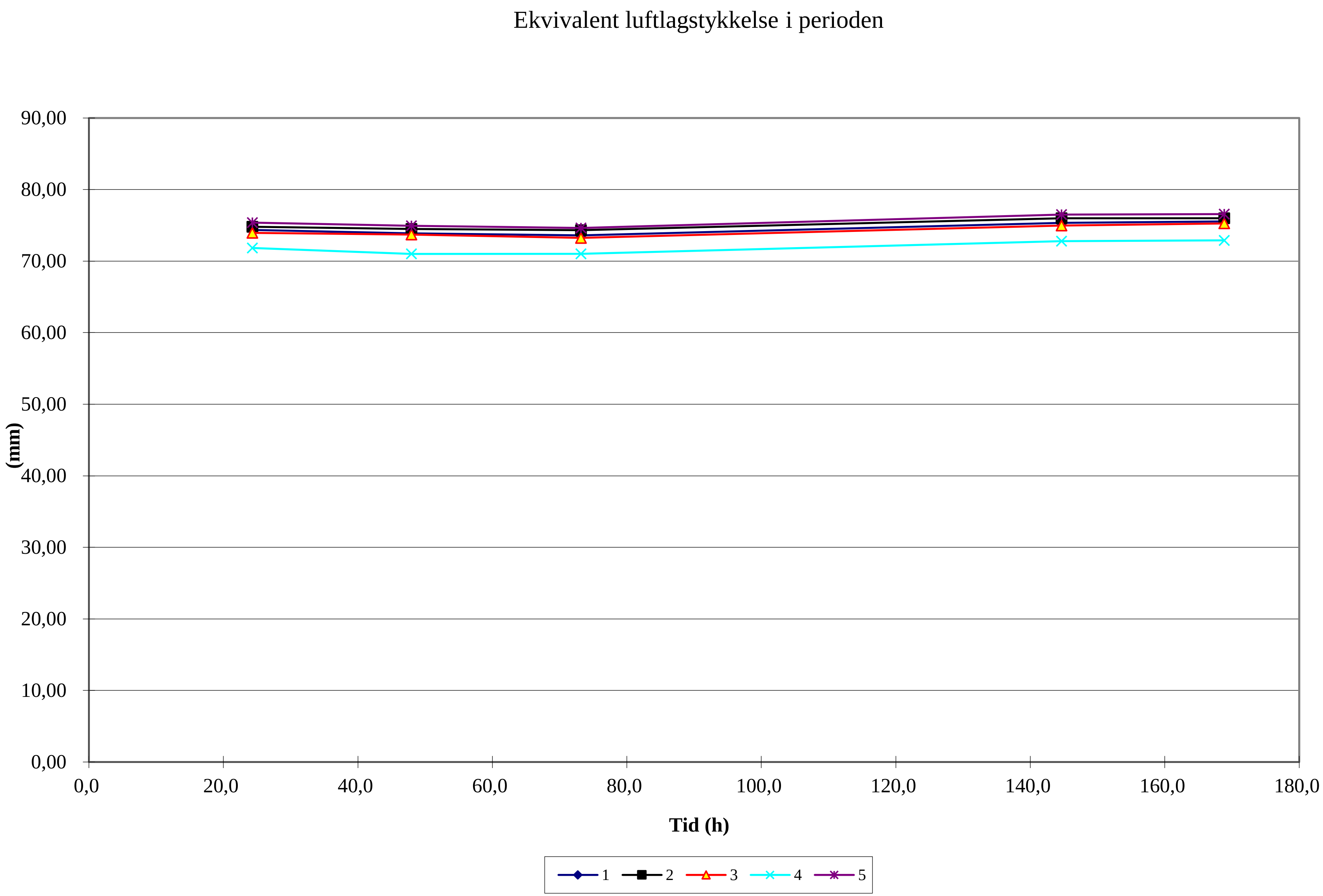
Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

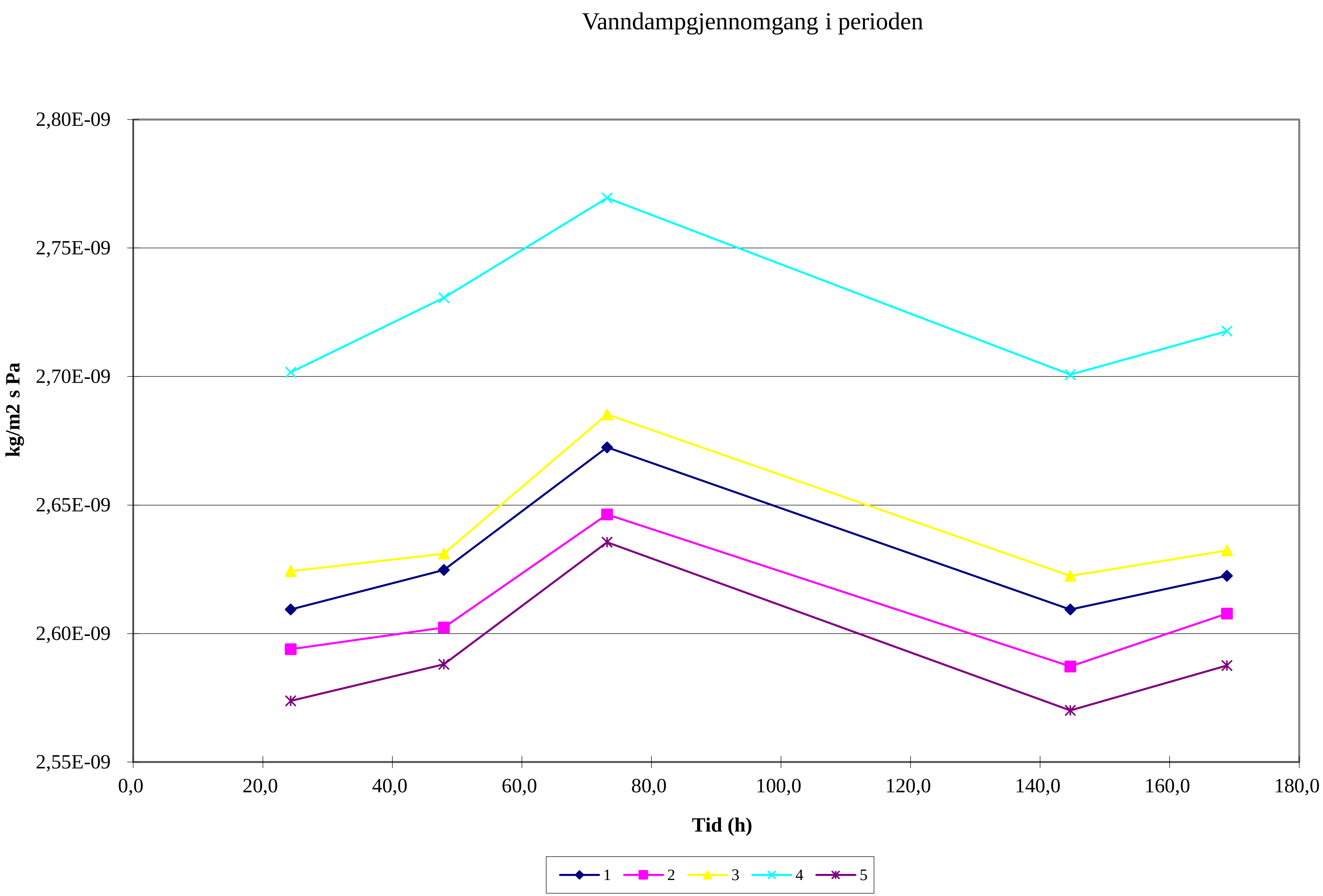
SIGN:

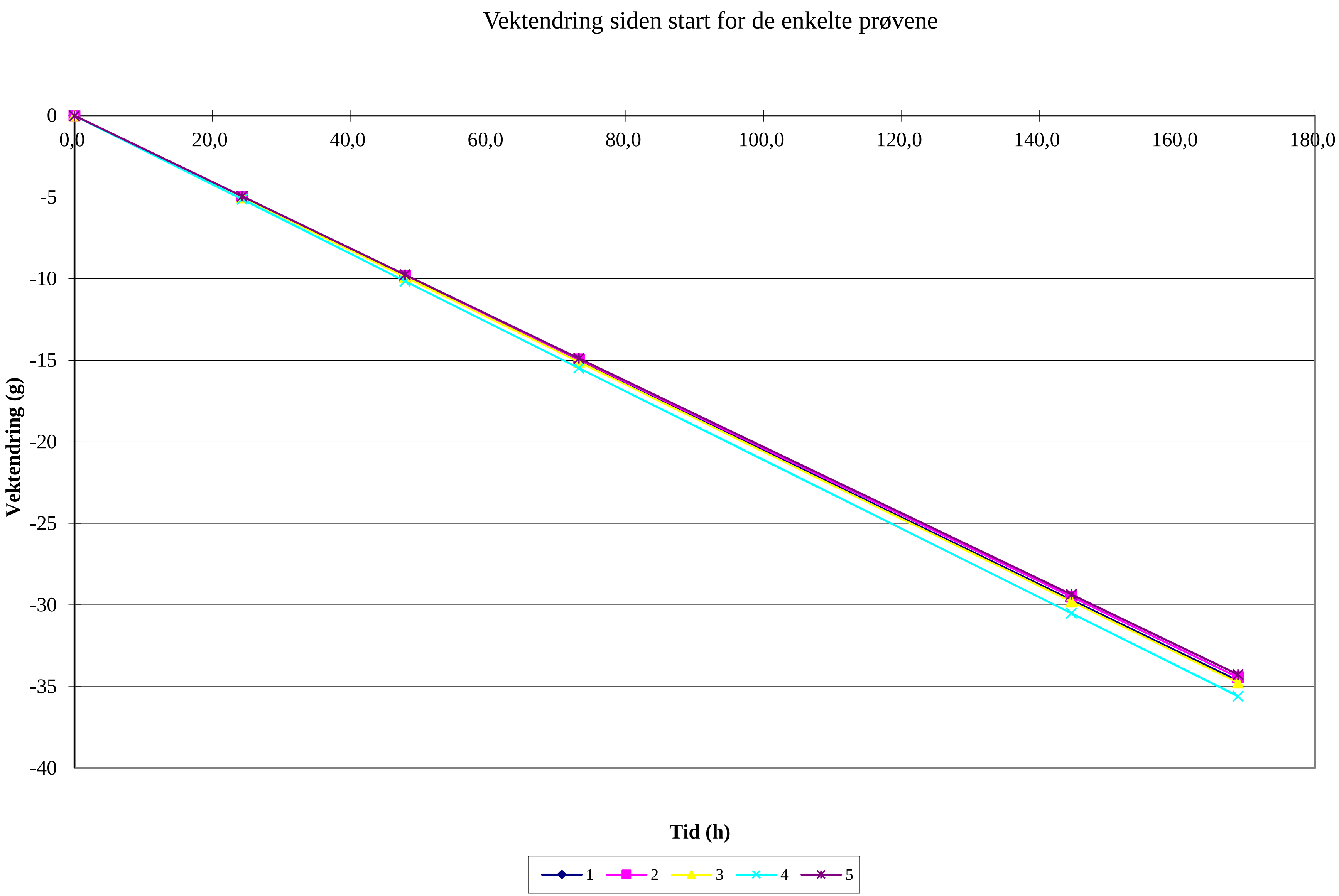
Produkt D

Inndata og resultater fra laboratorieforsøkene til «Produkt D».

Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	D2				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferskt/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		27.09.2022	
(6)Målenummer:	D2				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		18.10.2022	19.10.2022	20.10.2022	21.10.2022	24.10.2022	25.10.2022				
(13)Tid (CTRL+SHIFT+ :)		08:37	08:56	08:35	09:47	09:16	09:27				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		1012,21	1022,27	1017,65	1010,72	1003,81	995,76				
(16)Barometertrykk i perioden, hPa:		1012,21	1019,46	1020,4	1004,36	1006,31	998,54				
(17)Temperatur luft over boks,°C:		23	23,04	23,09	22,54	23,08	23,07				
(18)Temperatur i saltløsning, °C:		23	23,04	23,09	22,54	23,08	23,07				
(19)RF i rommet, %		50	49,51	49,5	48,92	49,33	49,35				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		999,997	999,997	1000,005	1000,001	1000,006	1000,001				
(22)Vekt,g prøve nr:	1	708,933	703,936	699,077	693,901	679,252	674,295				
(23)Vekt,g prøve nr:	2	690,498	685,524	680,697	675,56	661,006	656,07				
(24)Vekt,g prøve nr:	3	707,144	702,125	697,257	692,062	677,357	672,386				
(25)Vekt,g prøve nr:	4	759,078	753,945	748,936	743,617	728,58	723,488				
(26)Vekt,g prøve nr:	5	720,154	715,21	710,404	705,283	690,803	685,896				
(27)Vekt,g kontrolllodd etter veiing:		999,997	999,996	1000,007	1000,003	1000,005	1000,001				
Tekst i diagrammet Vektendring											


Ekvivalent luftlagstykkelse i perioden
90,00
80,00
70,00
60,00
50,00
40,00
30,00
20,00
10,00
0,00
(mm)
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5


Vanndampgjennomgang i perioden
kg/m2 s Pa
2,80E-09
2,75E-09
2,70E-09
2,65E-09
2,60E-09
2,55E-09
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5


Vektendring siden start for de enkelte prøvene
0
-5
-10
-15
-20
-25
-30
-35
-40
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Vektendring (g)
Tid (h)
1
2
3
4
5

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	D2	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	D2
Prosjektnummer:	D2	Prøvediameter: (mm)	164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:	KNO3
		Prøveperiode: fra:	19.10.2022
		til:	25.10.2022

Lufth. over pr.(m/s): 0,3

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,3
Temperatur i boksen (°C)	23,0
Temperatur i rommet (°C)	23,0
Barometertrykk (hPa)	1009,8

Tykkelse prøve nr

1	12,52
2	12,52
3	12,52
4	12,52
5	12,52
6	12,52

Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

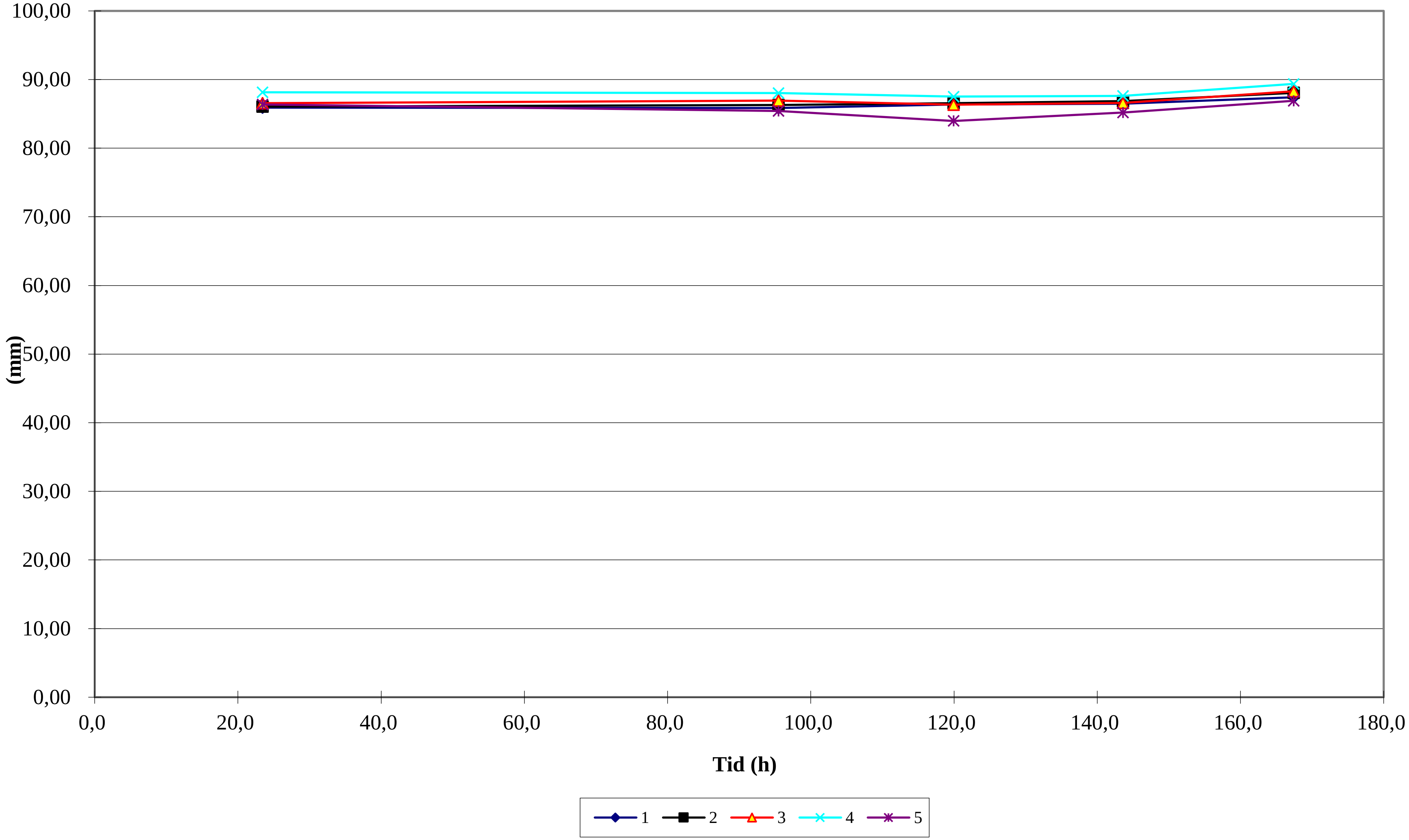
Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	2,62E-09	0,075	3,81E+08
2	2,60E-09	0,075	3,84E+08
3	2,63E-09	0,074	3,80E+08
4	2,72E-09	0,072	3,68E+08
5	2,59E-09	0,076	3,87E+08
Middel	2,63E-09	0,074	3,80E+08
Std. dev. mean. value	2,29285E-11	0,001	3,25E+06

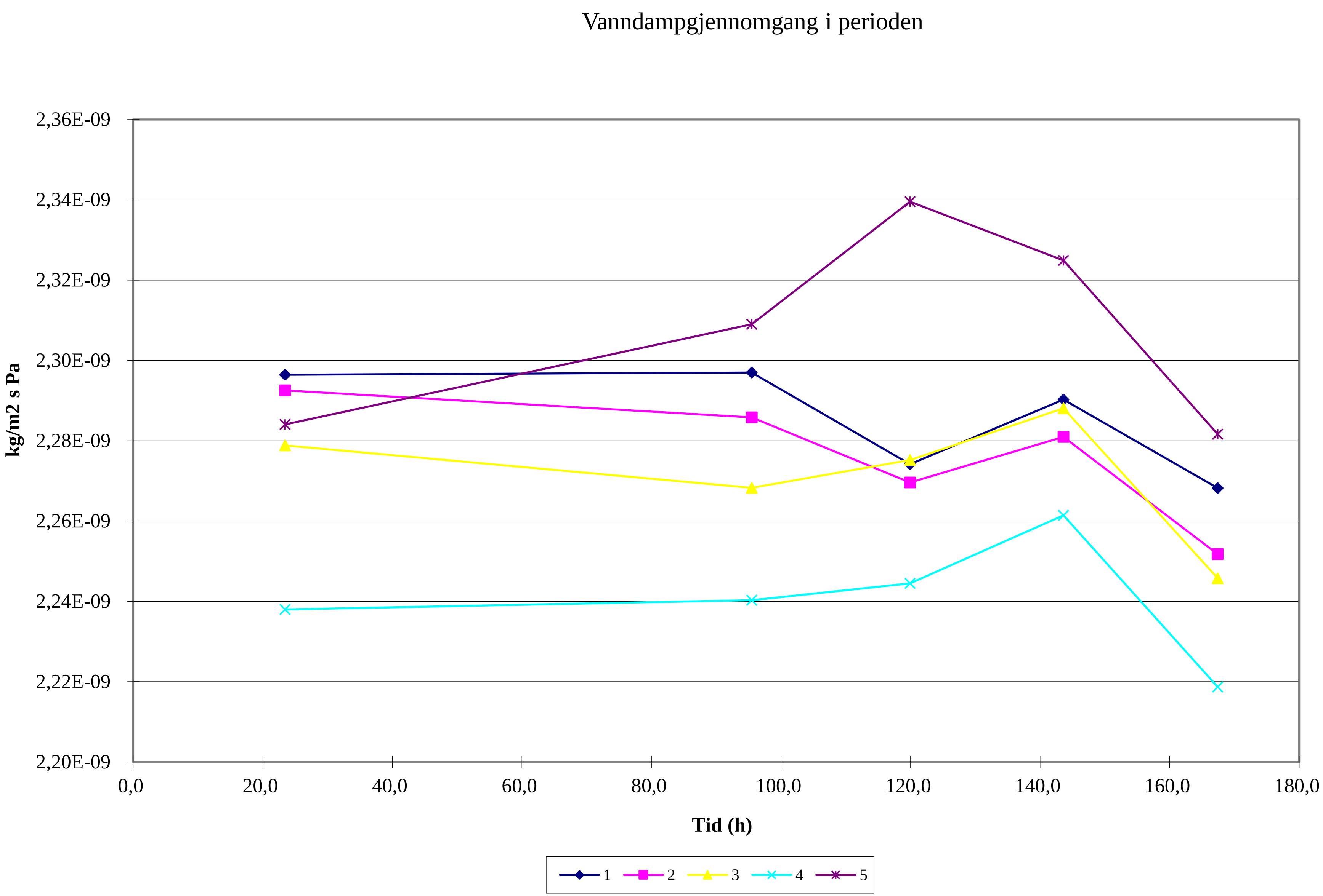
Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

SIGN:

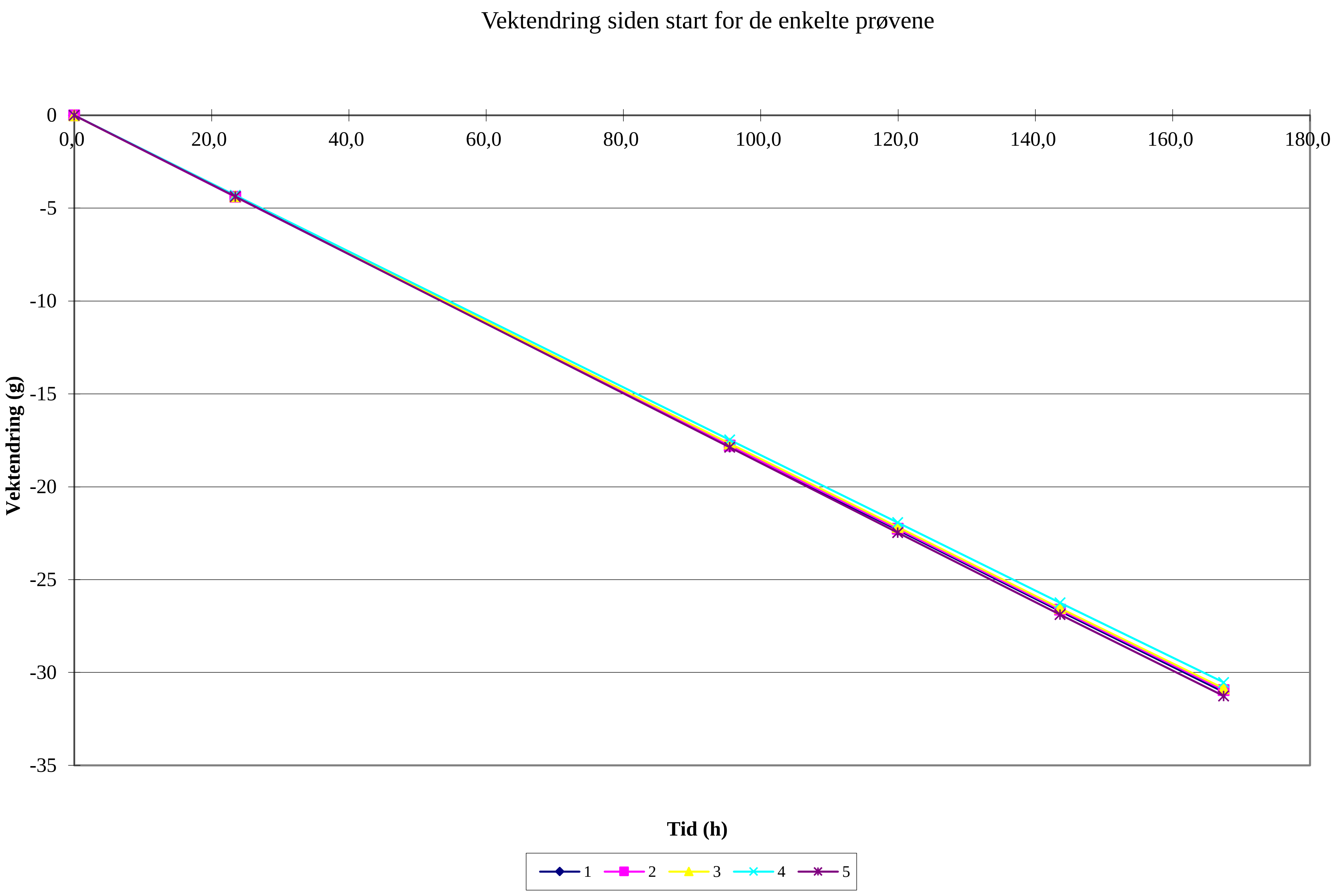
Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	D4				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferkst/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		28.09.2022	
(6)Målenummer:	D4				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		27.10.2022	28.10.2022	31.10.2022	01.11.2022	02.11.2022	03.11.2022				
(13)Tid (CTRL+SHIFT+ :)		09:23	08:50	08:52	09:19	08:59	08:48				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		1002,31	1002,44	1005,15	1006,39	996,48	995,49				
(16)Barometertrykk i perioden, hPa:		1002,31	1002,81	1003,18	1007,07	998,57	997,69				
(17)Temperatur luft over boks,°C:		23	23,07	23,06	23,05	23,04	23,04				
(18)Temperatur i saltløsning, °C:		23	23,07	23,06	23,05	23,04	23,04				
(19)RF i rommet, %		50	49,32	49,27	49,37	49,36	49,36				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		1000	1000,003	1000,001	1000,001	1000,003	1000,004				
(22)Vekt,g prøve nr:	1	701,493	697,102	683,657	679,166	674,805	670,444				
(23)Vekt,g prøve nr:	2	699,913	695,528	682,135	677,651	673,304	668,968				
(24)Vekt,g prøve nr:	3	707,487	703,123	689,812	685,319	680,961	676,634				
(25)Vekt,g prøve nr:	4	692,413	688,112	674,932	670,487	666,169	661,883				
(26)Vekt,g prøve nr:	5	715,52	711,148	697,647	693,054	688,641	684,26				
(27)Vekt,g kontrolllodd etter veiing:		1000,002	1000,001	1000,002	1000,001	1000,001	1000,002				
Tekst i diagrammet Vektendring											

Ekvivalent luftlagstykkelse i perioden





Vanndampgjennomgang i perioden
2,36E-09
2,34E-09
2,32E-09
2,30E-09
2,28E-09
2,26E-09
2,24E-09
2,22E-09
2,20E-09
kg/m2 s Pa
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5


Vektendring siden start for de enkelte prøvene
0
-5
-10
-15
-20
-25
-30
-35
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Vektendring (g)
Tid (h)
1
2
3
4
5

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	D4	Tykkelse, mm:		12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:		D4
Prosjektnummer:	D4	Prøvediameter: (mm)		164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:		KNO3
		Prøveperiode:	fra:	28.10.2022
			til:	03.11.2022

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,3
Temperatur i boksen (°C)	23,1
Temperatur i rommet (°C)	23,1
Barometertrykk (hPa)	1001,9

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52	
2	12,52	
3	12,52	
4	12,52	
5	12,52	
6		0

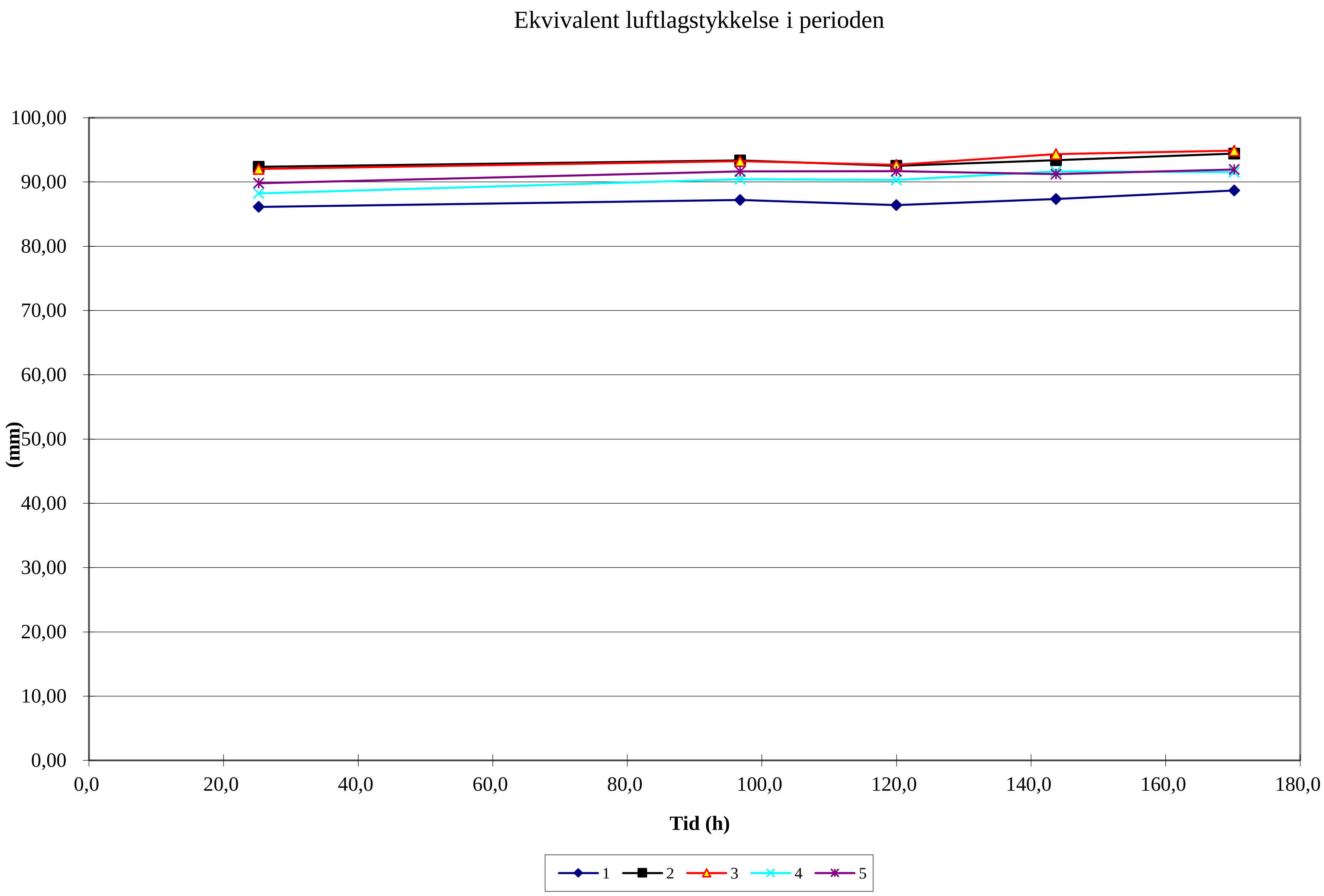
Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	2,29E-09	0,086	4,37E+08
2	2,28E-09	0,087	4,39E+08
3	2,27E-09	0,087	4,40E+08
4	2,24E-09	0,088	4,46E+08
5	2,31E-09	0,086	4,33E+08
Middel	2,28E-09	0,087	4,39E+08
Std. dev. mean. value	1,11677E-11	0,000	2,16E+06

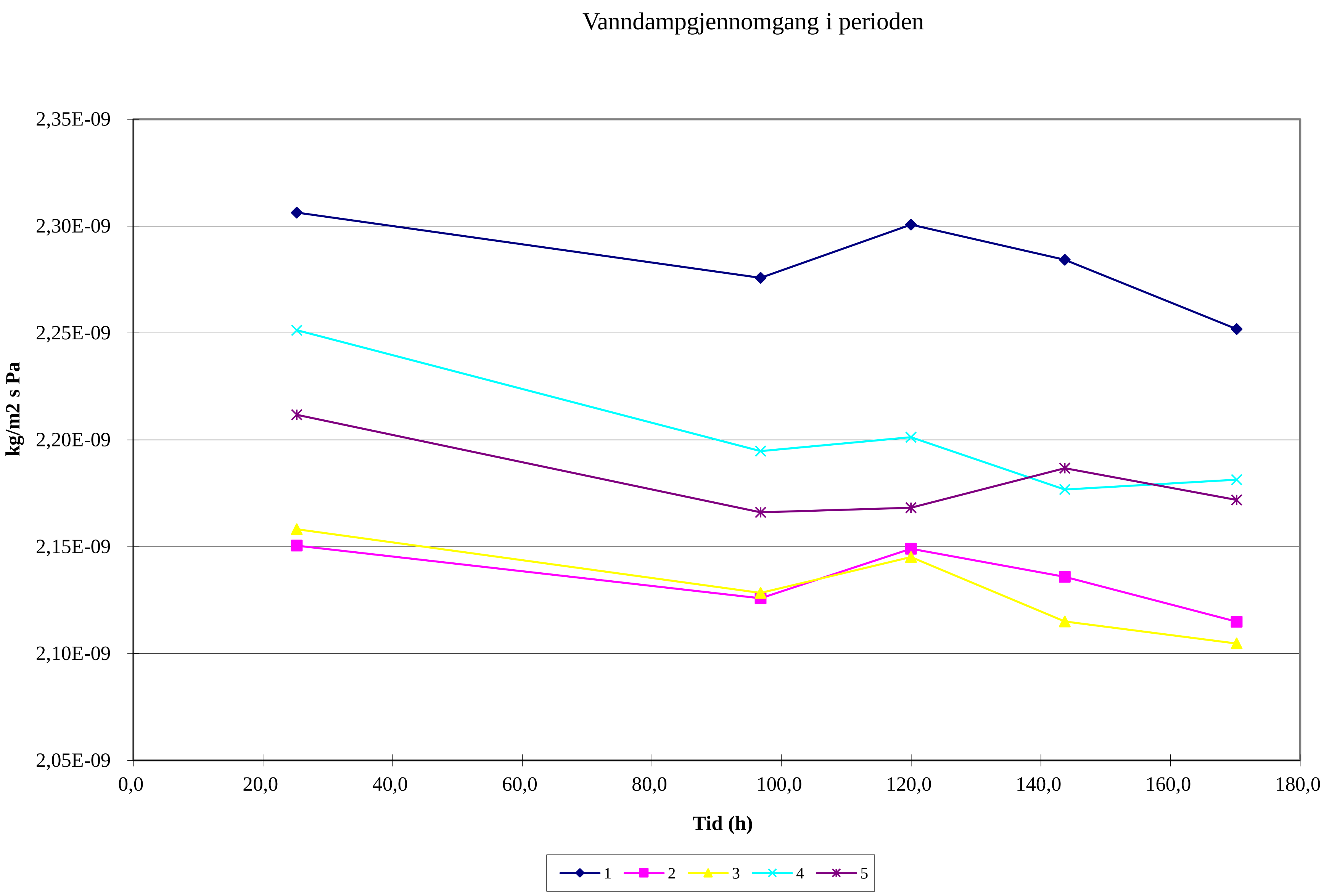
Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene. Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport. Resultatene er korrigert for overgangsmotstanden over prøven, damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

SIGN:

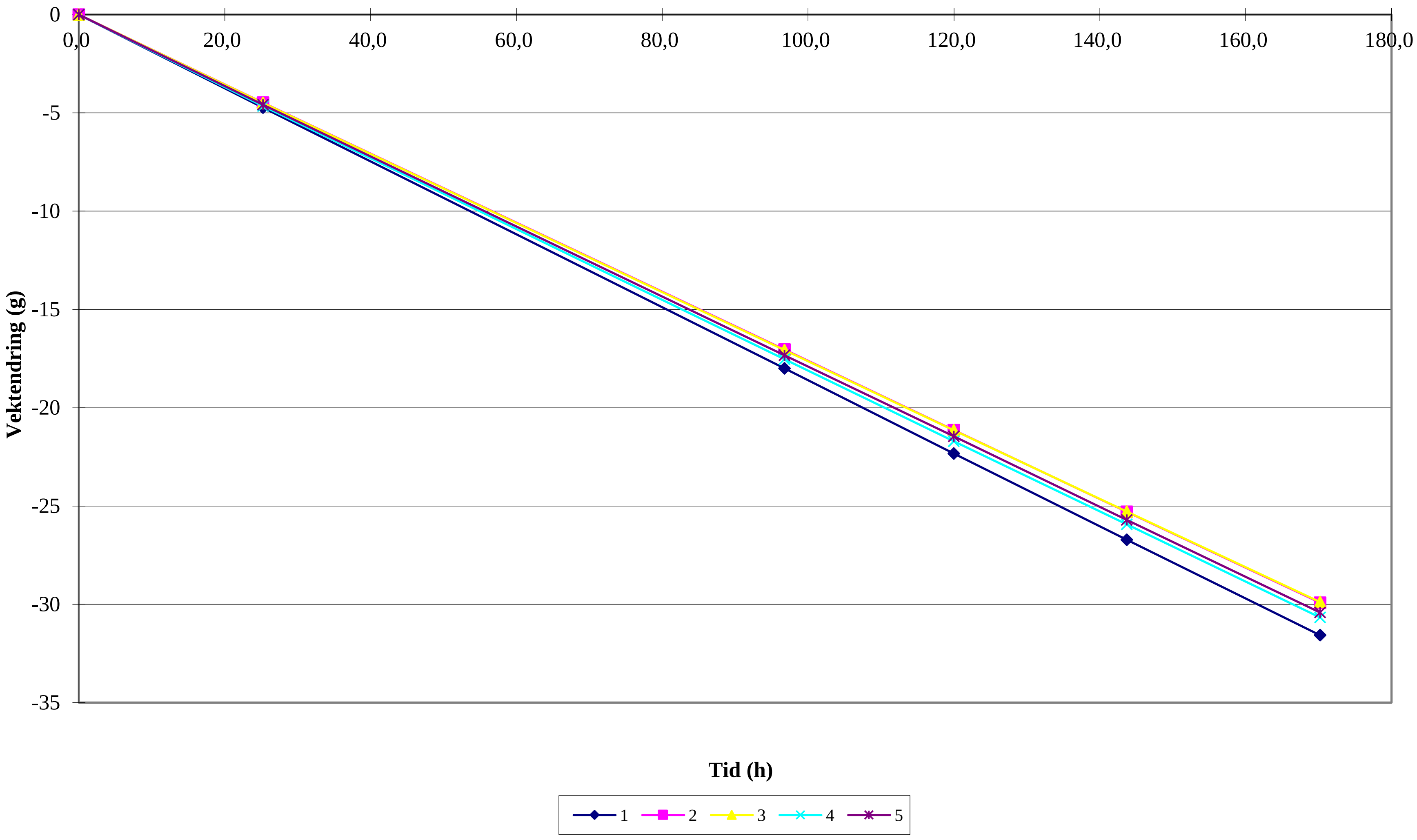
Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	D6				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferskt/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		28.09.2022	
(6)Målenummer:	D6				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		03.11.2022	04.11.2022	07.11.2022	08.11.2022	09.11.2022	10.11.2022				
(13)Tid (CTRL+SHIFT+ :)		08:57	10:11	09:43	08:55	08:39	11:09				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		995,49	997,77	995,23	995,93	998,61	995,33				
(16)Barometertrykk i perioden, hPa:		995,49	995,92	996,64	994,93	991,6	990,62				
(17)Temperatur luft over boks,°C:		23	23,05	23,07	23,05	23,06	23,06				
(18)Temperatur i saltløsning, °C:		23	23,05	23,07	23,05	23,06	23,06				
(19)RF i rommet, %		50	49,38	49,3	49,27	49,22	49,16				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		1000,004	1000,002	1000	1000,002	1000,002	1000,003				
(22)Vekt,g prøve nr:	1	757,645	752,906	739,643	735,319	730,922	726,075				
(23)Vekt,g prøve nr:	2	738,597	734,118	721,561	717,465	713,296	708,684				
(24)Vekt,g prøve nr:	3	736,001	731,509	718,94	714,85	710,714	706,12				
(25)Vekt,g prøve nr:	4	746,637	741,989	729,106	724,931	720,699	715,972				
(26)Vekt,g prøve nr:	5	749,699	745,117	732,369	728,244	723,996	719,285				
(27)Vekt,g kontrolllodd etter veiing:		1000,002	1000,001	1000,001	999,999	1000,004	1000,005				
Tekst i diagrammet Vektendring											



Ekvivalent luftlagstykkelse i perioden
100,00
90,00
80,00
70,00
60,00
50,00
40,00
30,00
20,00
10,00
0,00
(mm)
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5


Vanndampgjennomgang i perioden
kg/m2 s Pa
2,35E-09
2,30E-09
2,25E-09
2,20E-09
2,15E-09
2,10E-09
2,05E-09
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5

Vektendring siden start for de enkelte prøvene



PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	D6	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	D6
Prosjektnummer:	D6	Prøvediameter: (mm)	164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:	KNO3
		Prøveperiode: fra:	04.11.2022
		til:	10.11.2022

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52	
2	12,52	
3	12,52	
4	12,52	
5	12,52	
6		0

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,3
Temperatur i boksen (°C)	23,1
Temperatur i rommet (°C)	23,1
Barometertrykk (hPa)	993,9

Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	2,28E-09	0,087	4,38E+08
2	2,13E-09	0,093	4,69E+08
3	2,13E-09	0,093	4,70E+08
4	2,20E-09	0,090	4,55E+08
5	2,18E-09	0,091	4,59E+08
Middel	2,18E-09	0,091	4,58E+08
Std. dev. mean. value	2,77173E-11	0,001	5,71E+06

Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

SIGN:

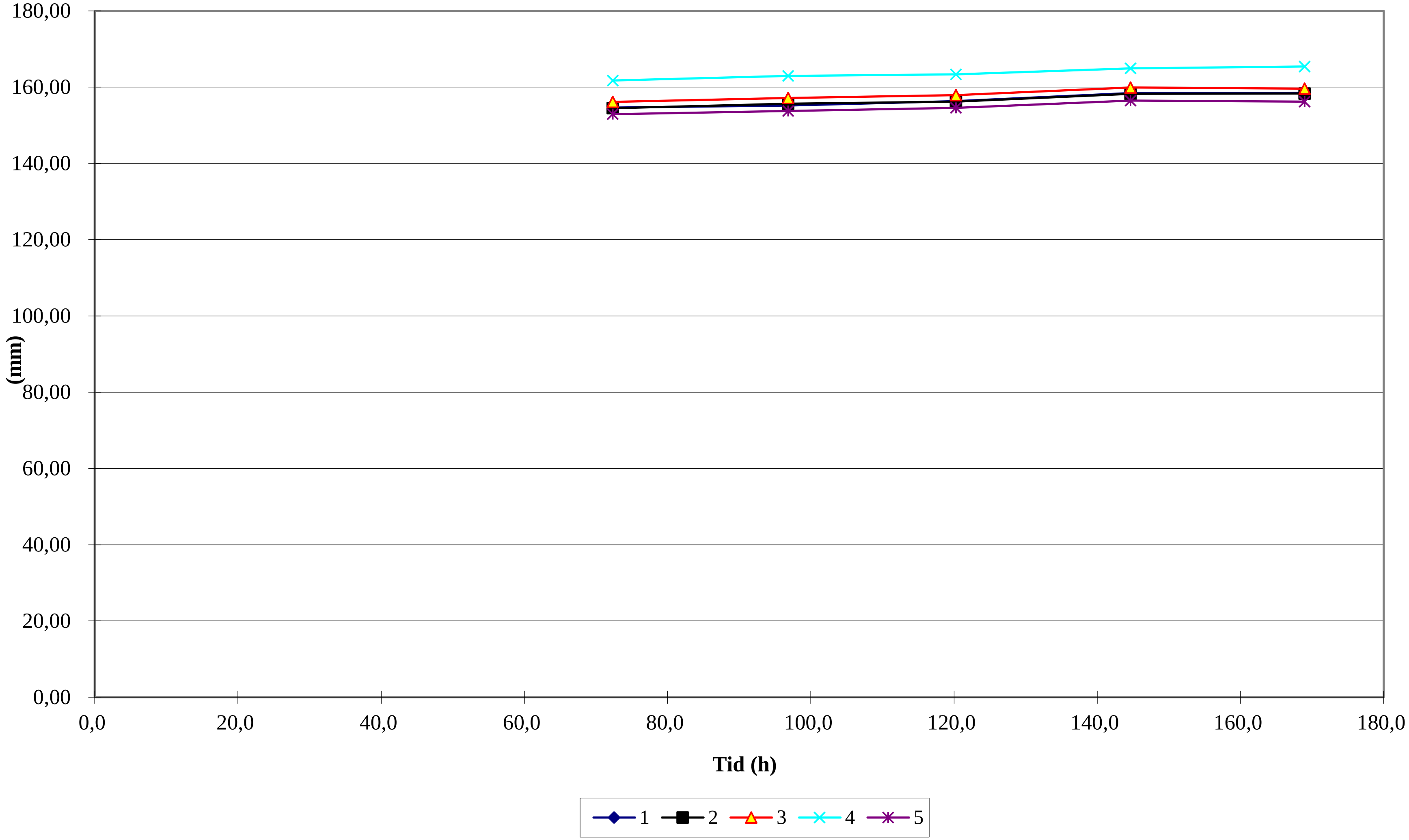
Produkt E

Produkt E

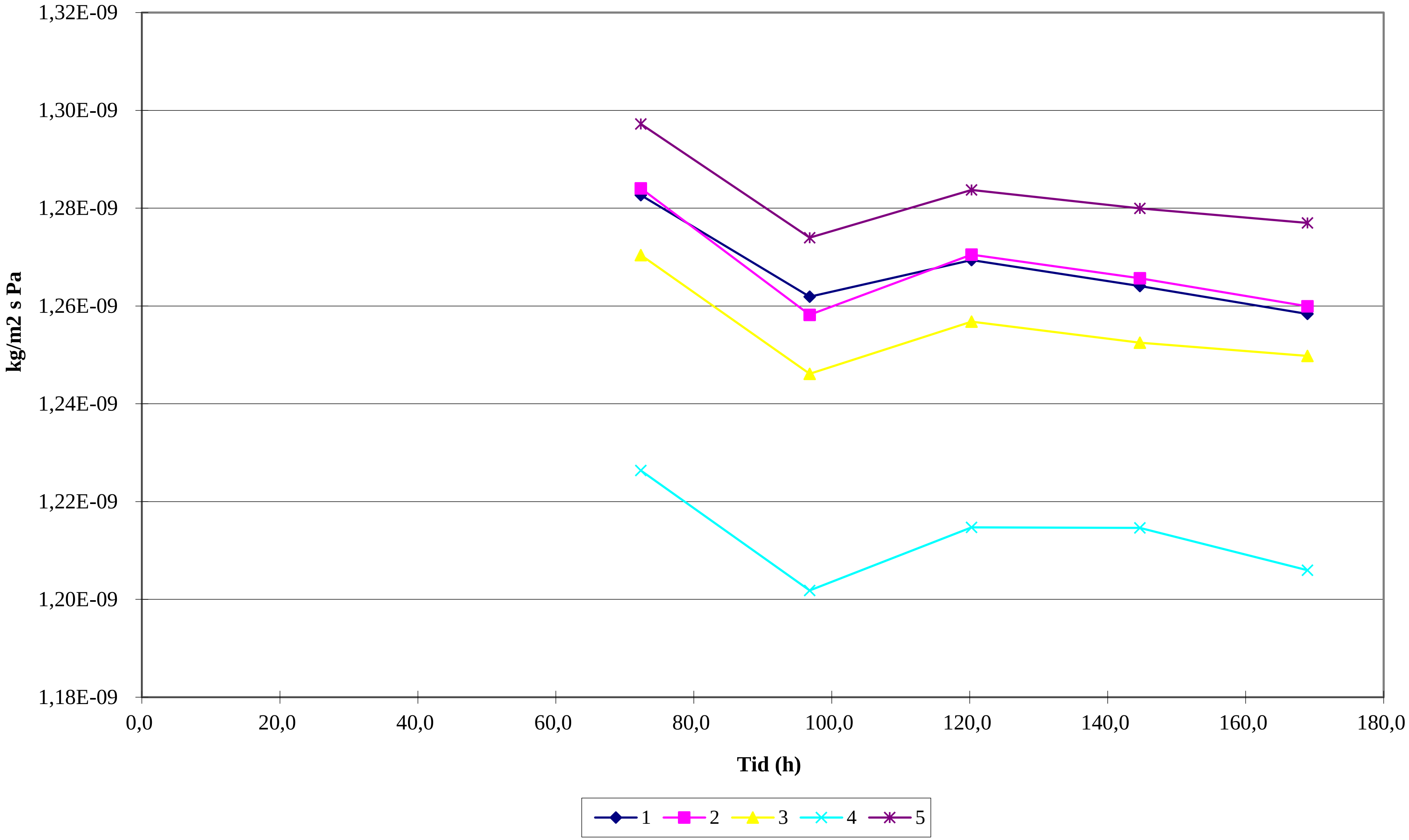
Inndata og resultater fra laboratorieforsøkene til «Produkt E».

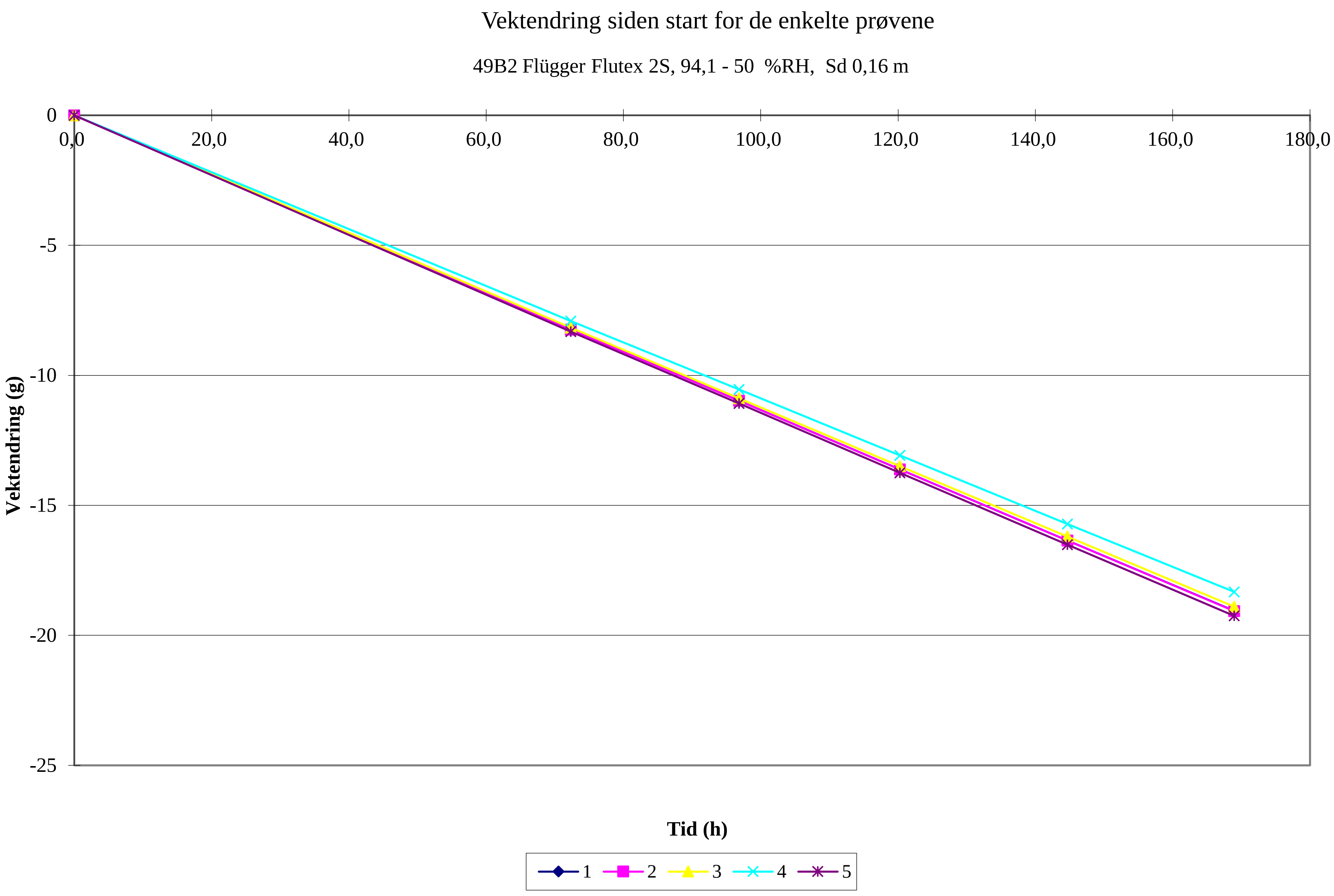
Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	E2				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side inn	
(4)Produktype:	Gipsplate 12,5				Prøvest. diameter(mm):		0,174	Ferskt/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		27-09-2022	
(6)Målenummer:	E2				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		30.09.2022	03.10.2022	04.10.2022	05.10.2022	06.10.2022	07.10.2022				
(13)Tid (CTRL+SHIFT+ :)		08:10	08:30	08:59	08:26	08:50	09:08				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		1001,43	1009,73	1003,78	996,4	986,52	989,89				
(16)Barometertrykk i perioden, hPa:		1001,43	997,26	1009,98	996,84	987,64	991,56				
(17)Temperatur luft over boks,°C:		23	23,03	23,04	23,05	23,03	23,03				
(18)Temperatur i saltløsning, °C:		23	23,03	23,04	23,05	23,03	23,03				
(19)RF i rommet, %		50	49,53	49,48	49,6	49,61	49,6				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		1000,004	999,999	999,997	999,997	1000,002	999,999				
(22)Vekt,g prøve nr:	1	683,908	675,664	672,929	670,293	667,565	664,846				
(23)Vekt,g prøve nr:	2	703,854	695,602	692,874	690,236	687,505	684,783				
(24)Vekt,g prøve nr:	3	706,693	698,518	695,813	693,2	690,494	687,791				
(25)Vekt,g prøve nr:	4	692,49	684,565	681,945	679,409	676,775	674,155				
(26)Vekt,g prøve nr:	5	697,399	689,073	686,315	683,653	680,895	678,141				
(27)Vekt,g kontrolllodd etter veiing:		1000,002	999,998	999,996	1000	1000,003	1000				
Tekst i diagrammet Vektendring	49B2 Flügger Flutex 2S, 94,1 - 50 %RH, Sd 0,16 m										

Ekvivalent luftlagstykkelse i perioden



Vanndampgjennomgang i perioden




Vektendring siden start for de enkelte prøvene
49B2 Flügger Flutex 2S, 94,1 - 50 %RH, Sd 0,16 m
0
-5
-10
-15
-20
-25
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Vektendring (g)
Tid (h)
1
2
3
4
5

SINTEF

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	E2	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	E2
Prosjektnummer:	E2	Prøvediameter: (mm)	164
Produktype:	Gipsplate 12,5	Salttype i boksen:	KNO3
		Prøveperiode: fra:	03.10.2022
		til:	07.10.2022

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,6
Temperatur i boksen (°C)	23,0
Temperatur i rommet (°C)	23,0
Barometertrykk (hPa)	996,7

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52
2	12,52
3	12,52
4	12,52
5	12,52
6	12,52

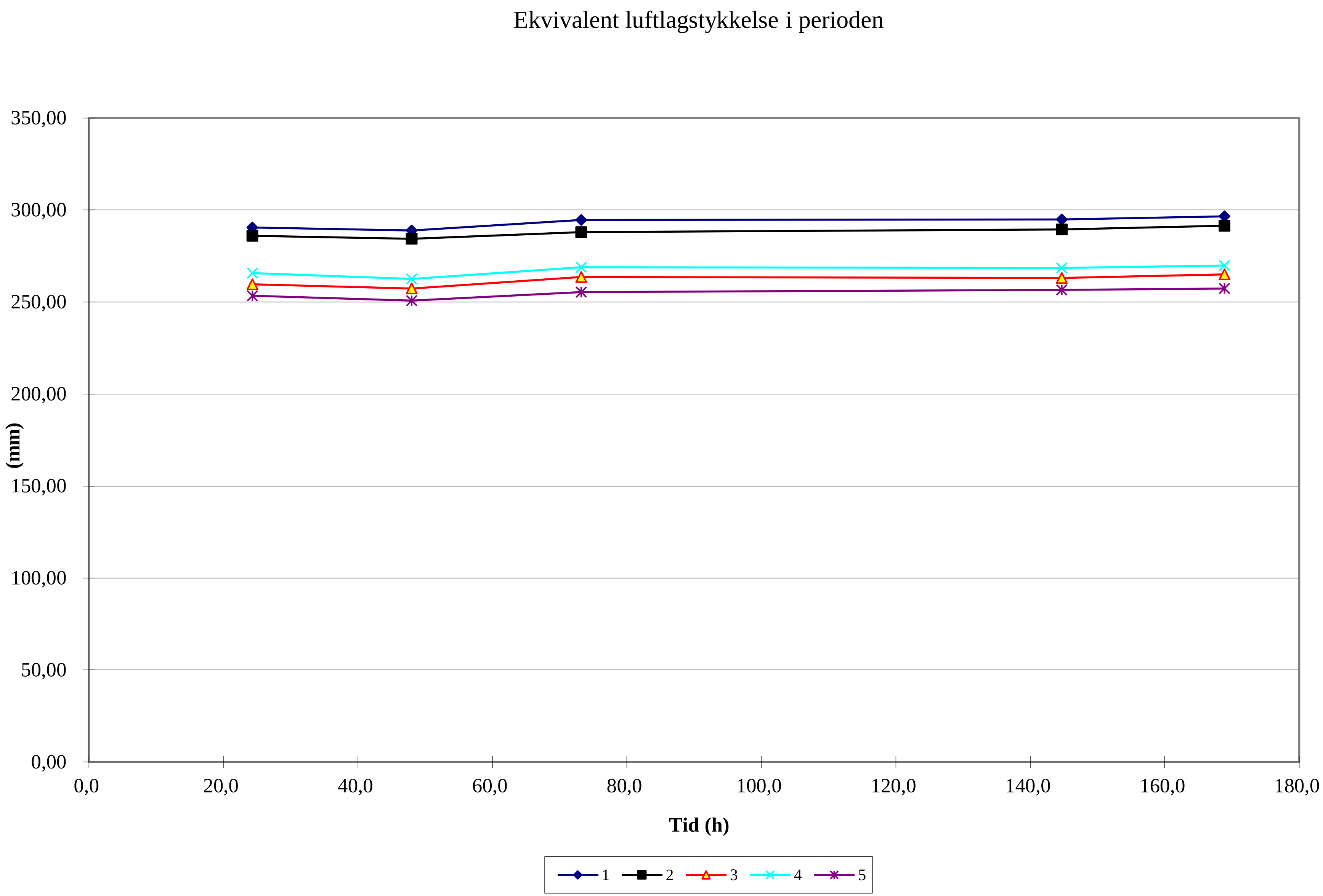
Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

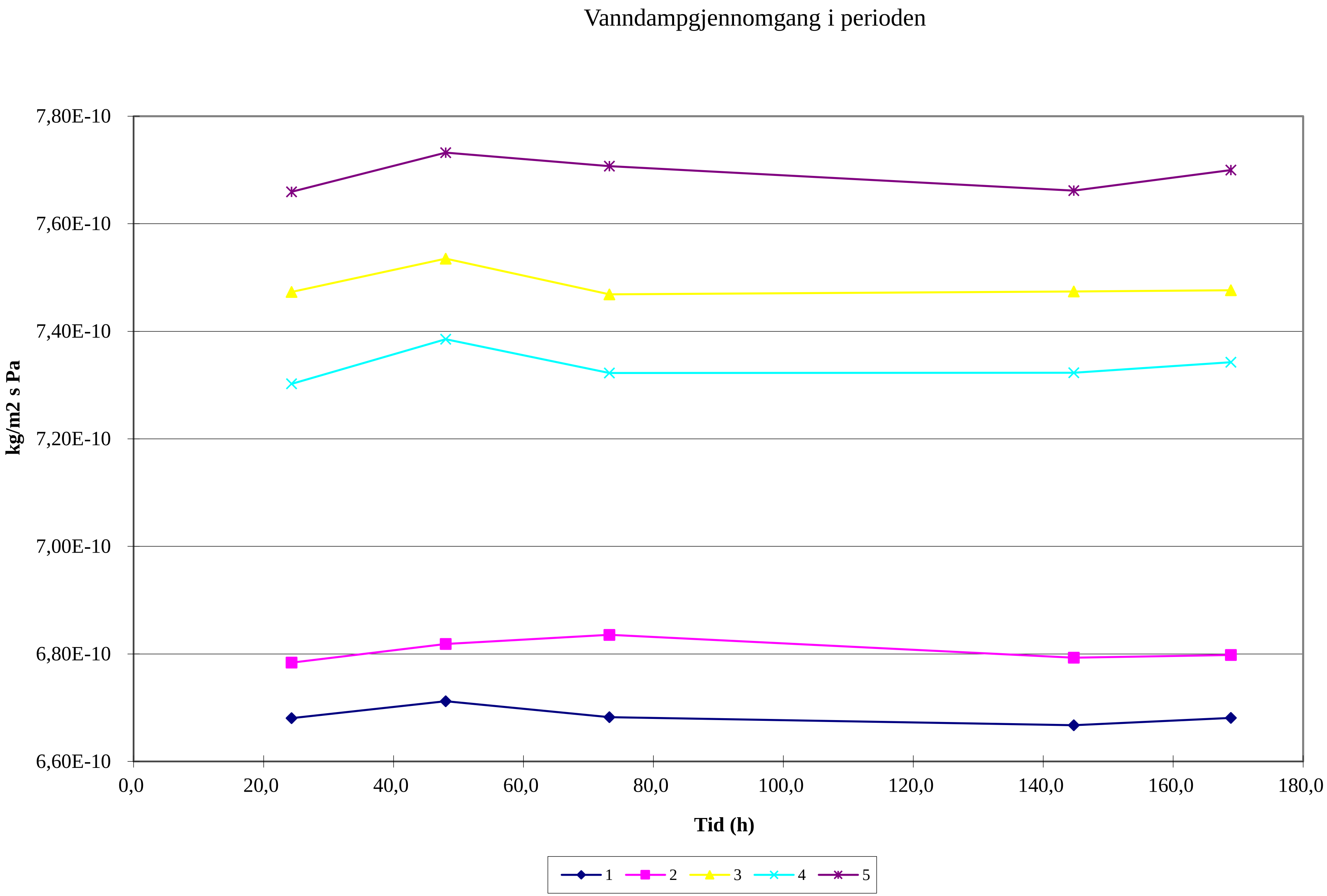
Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	1,27E-09	0,156	7,86E+08
2	1,27E-09	0,156	7,86E+08
3	1,26E-09	0,158	7,94E+08
4	1,22E-09	0,163	8,22E+08
5	1,29E-09	0,154	7,77E+08
Middel	1,26E-09	0,157	7,93E+08
Std. dev. mean. value	1,19839E-11	0,002	7,69E+06

Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

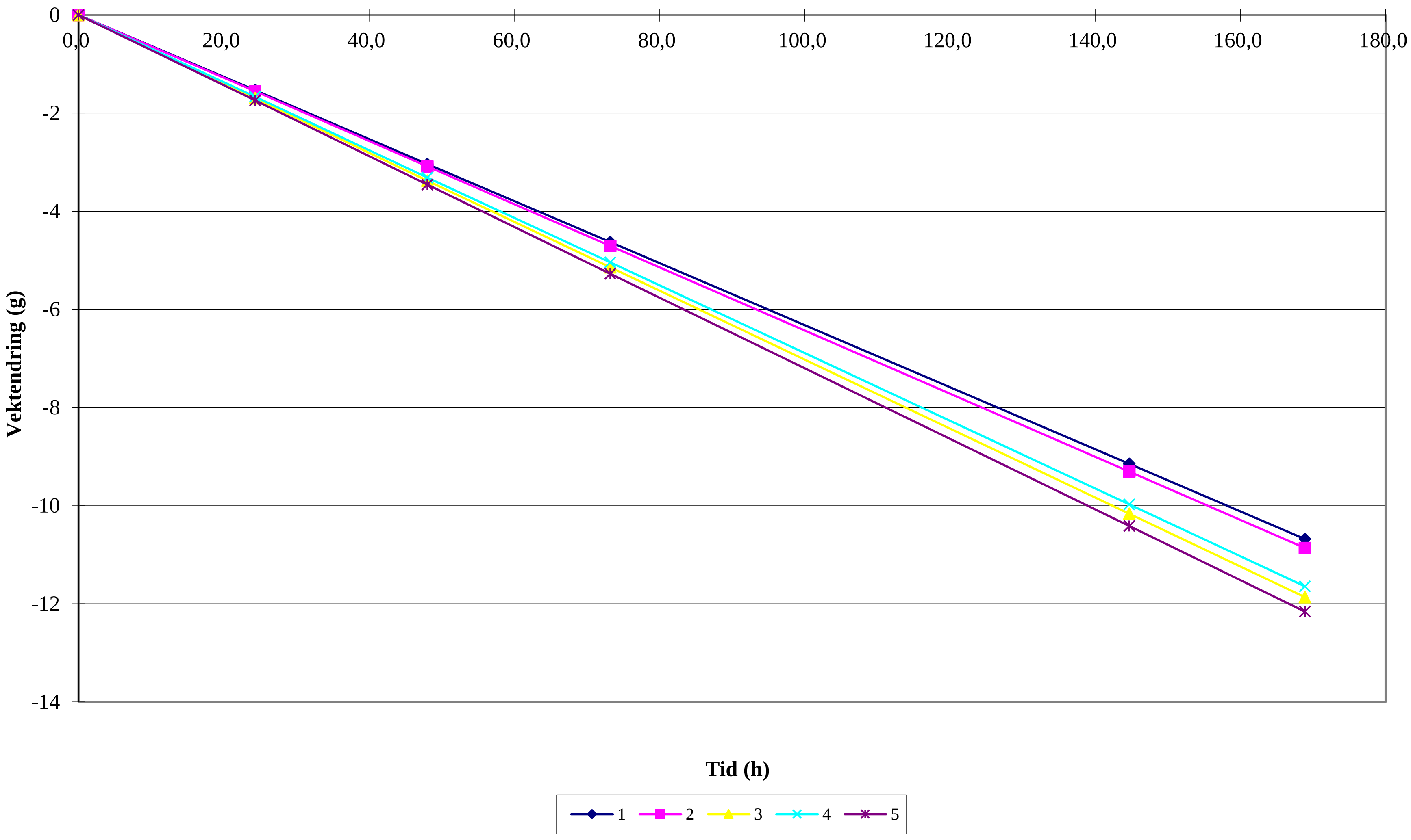
SIGN:

Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	E4				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferkst/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		28.09.2022	
(6)Målenummer:	E4				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		18.10.2022	19.10.2022	20.10.2022	21.10.2022	24.10.2022	25.10.2022				
(13)Tid (CTRL+SHIFT+ :)		08:41	09:00	08:42	09:54	09:23	09:34				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		1012,21	1022,27	1017,65	1010,72	1003,81	995,76				
(16)Barometertrykk i perioden, hPa:		1012,21	1019,46	1020,4	1004,36	1006,31	998,54				
(17)Temperatur luft over boks,°C:		23	23,04	23,09	22,84	23,08	23,07				
(18)Temperatur i saltløsning, °C:		23	23,04	23,09	22,84	23,08	23,07				
(19)RF i rommet, %		50	49,51	49,35	48,92	49,33	49,35				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		999,996	999,998	1000,004	1000,004	1000,006	1000,002				
(22)Vekt,g prøve nr:	1	748,311	746,774	745,282	743,692	739,173	737,641				
(23)Vekt,g prøve nr:	2	787,703	786,144	784,63	783,006	778,408	776,851				
(24)Vekt,g prøve nr:	3	711,496	709,791	708,128	706,365	701,341	699,641				
(25)Vekt,g prøve nr:	4	729,604	727,935	726,303	724,572	719,642	717,97				
(26)Vekt,g prøve nr:	5	778,696	776,952	775,249	773,434	768,294	766,547				
(27)Vekt,g kontrolllodd etter veiing:		999,998	999,999	1000,007	1000,004	1000,005	1000,003				
Tekst i diagrammet Vektendring											


Ekvivalent luftlagstykkelse i perioden
350,00
300,00
250,00
200,00
150,00
100,00
50,00
0,00
(mm)
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5


Vanndampgjennomgang i perioden
7,80E-10
7,60E-10
7,40E-10
7,20E-10
7,00E-10
6,80E-10
6,60E-10
kg/m2 s Pa
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5

Vektendring siden start for de enkelte prøvene



SINTEF

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	E4	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	E4
Prosjektnummer:	E4	Prøvediameter: (mm)	164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:	KNO_3
		Prøveperiode: fra:	19.10.2022
		til:	25.10.2022

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52
2	12,52
3	12,52
4	12,52
5	12,52
6	12,52

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,3
Temperatur i boksen (°C)	23,0
Temperatur i rommet (°C)	23,0
Barometertrykk (hPa)	1009,8

Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

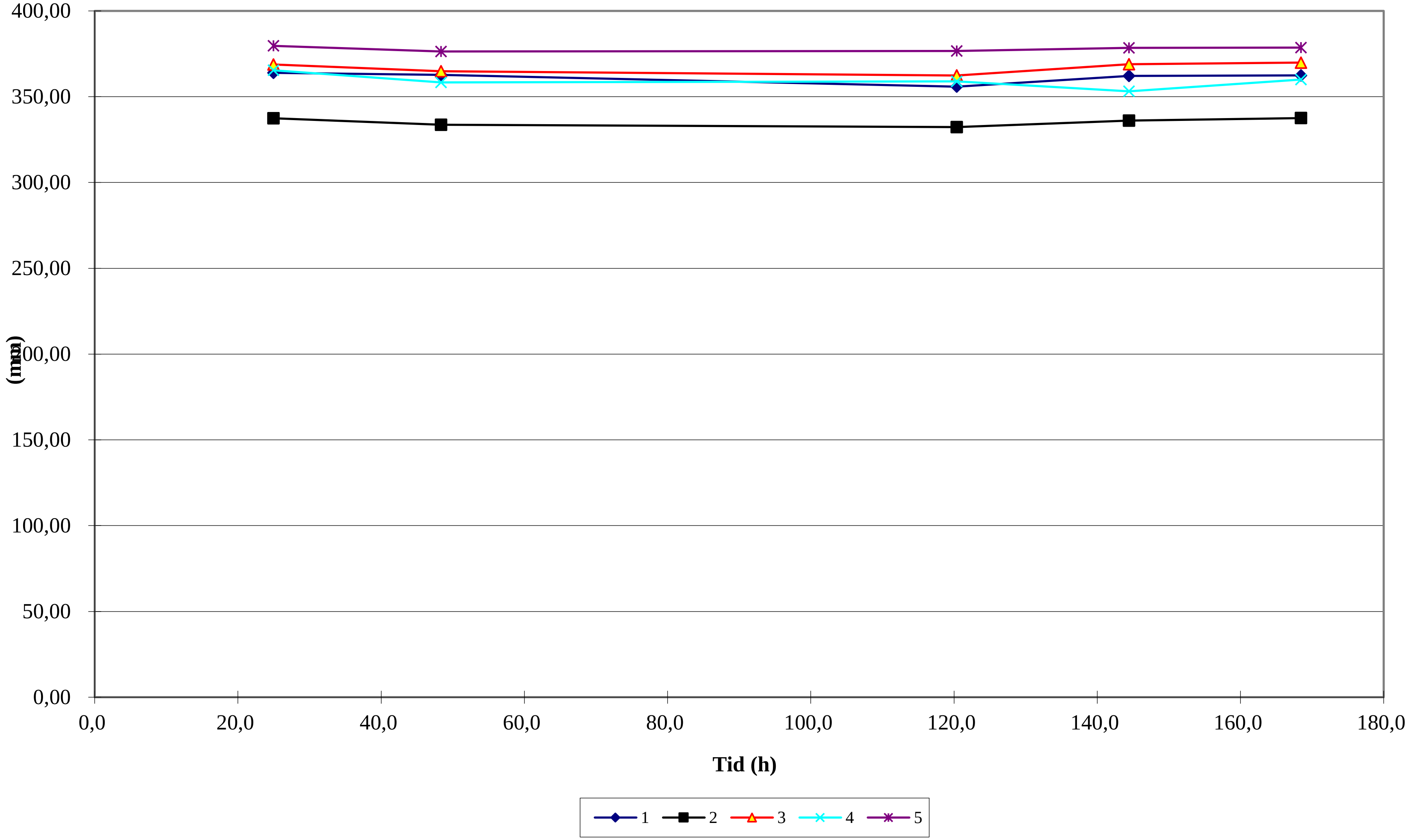
Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	6,68E-10	0,293	1,50E+09
2	6,80E-10	0,288	1,47E+09
3	7,48E-10	0,262	1,34E+09
4	7,33E-10	0,267	1,36E+09
5	7,68E-10	0,255	1,30E+09
Middel	7,20E-10	0,272	1,39E+09
Std. dev. mean. value	1,9486E-11	0,007	3,82E+07

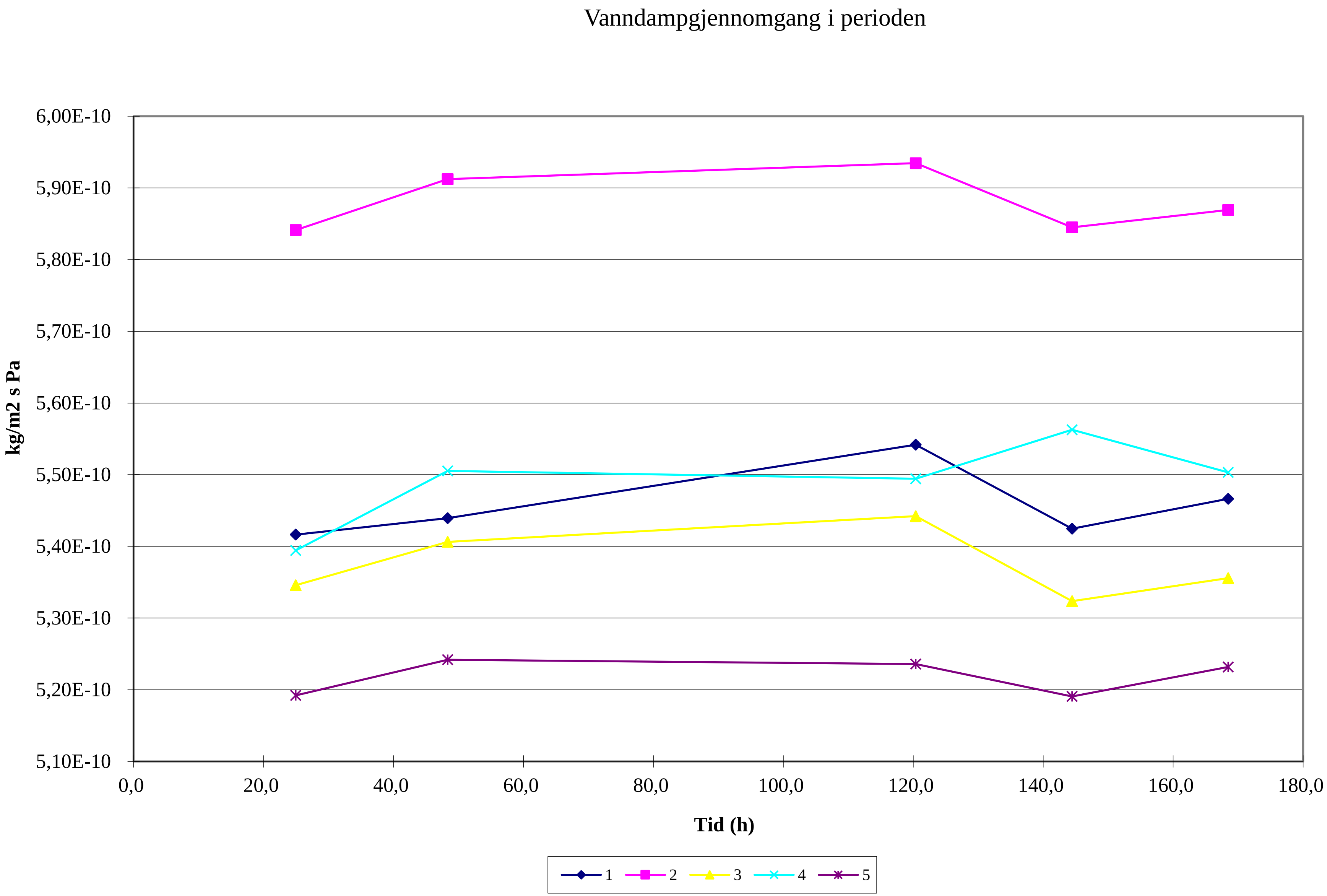
Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

SIGN:

Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	E6				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferskt/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		28.09.2022	
(6)Målenummer:	E6				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		26.10.2022	27.10.2022	28.10.2022	31.10.2022	01.11.2022	02.11.2022				
(13)Tid (CTRL+SHIFT+ :)		08:39	09:36	09:00	09:01	09:05	09:06				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		1003,49	1002,31	1002,44	1005,15	1006,39	996,48				
(16)Barometertrykk i perioden, hPa:		1003,49	1003,73	1002,81	1003,18	1007,07	998,57				
(17)Temperatur luft over boks,°C:		23	23,08	23,07	23,06	23,05	23,04				
(18)Temperatur i saltløsning, °C:		23	23,08	23,07	23,06	23,05	23,04				
(19)RF i rommet, %		50	49,28	49,32	49,27	49,37	49,36				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		1000,003	1000	1000,001	1000,002	1000	1000,003				
(22)Vekt,g prøve nr:	1	724,79	723,49	722,265	718,433	717,183	715,936				
(23)Vekt,g prøve nr:	2	725,964	724,568	723,243	719,156	717,815	716,481				
(24)Vekt,g prøve nr:	3	720,407	719,123	717,905	714,138	712,91	711,687				
(25)Vekt,g prøve nr:	4	716,736	715,441	714,202	710,401	709,121	707,866				
(26)Vekt,g prøve nr:	5	722,831	721,582	720,399	716,767	715,568	714,372				
(27)Vekt,g kontrolllodd etter veiing:		1000,001	1000,004	1000	1000,003	1000,004	1000,007				
Tekst i diagrammet Vektendring											

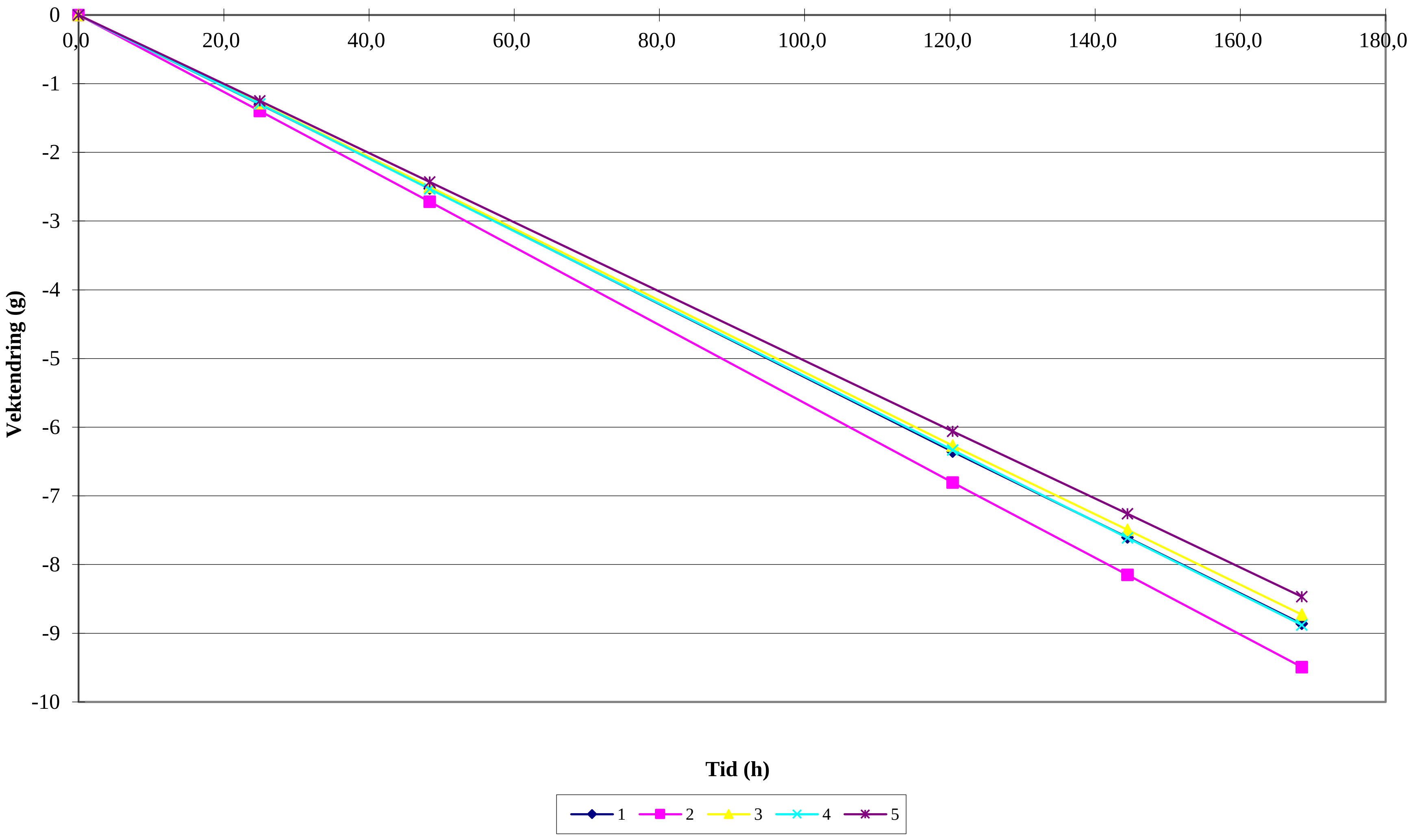
Ekvivalent luftlagstykkelse i perioden





Vanndampgjennomgang i perioden
kg/m2 s Pa
6,00E-10
5,90E-10
5,80E-10
5,70E-10
5,60E-10
5,50E-10
5,40E-10
5,30E-10
5,20E-10
5,10E-10
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5

Vektendring siden start for de enkelte prøvene



PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	E6	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	E6
Prosjektnummer:	E6	Prøvediameter: (mm)	164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:	KNO3
		Prøveperiode: fra:	27.10.2022
		til:	02.11.2022

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52	
2	12,52	
3	12,52	
4	12,52	
5	12,52	
6		0

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,3
Temperatur i boksen (°C)	23,1
Temperatur i rommet (°C)	23,1
Barometertrykk (hPa)	1003,1

Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	5,48E-10	0,360	1,82E+09
2	5,90E-10	0,335	1,70E+09
3	5,39E-10	0,366	1,85E+09
4	5,49E-10	0,359	1,82E+09
5	5,22E-10	0,378	1,91E+09
Middel	5,50E-10	0,359	1,82E+09
Std. dev. mean. value	1,10621E-11	0,007	3,57E+07

Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

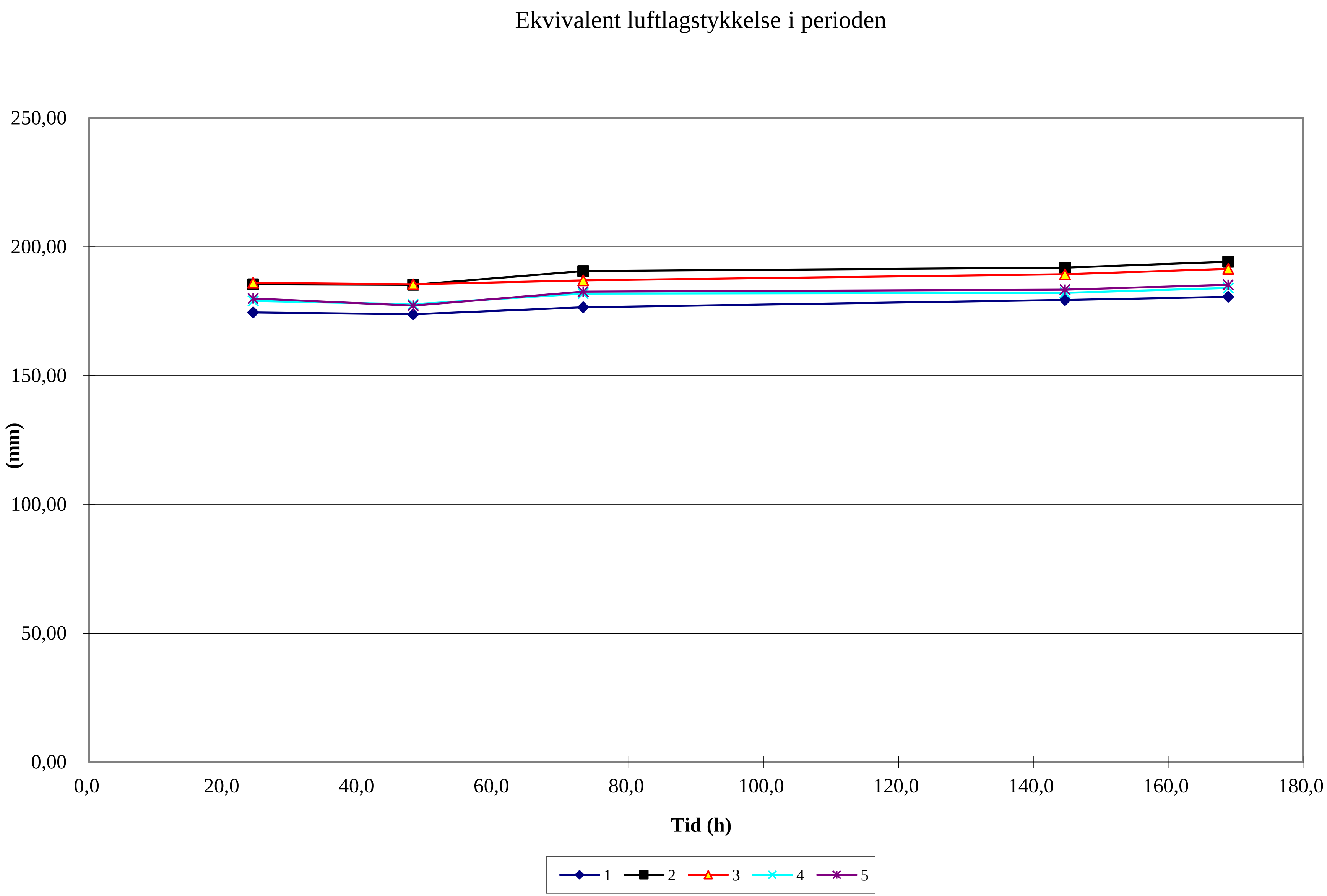
SIGN:

Produkt F

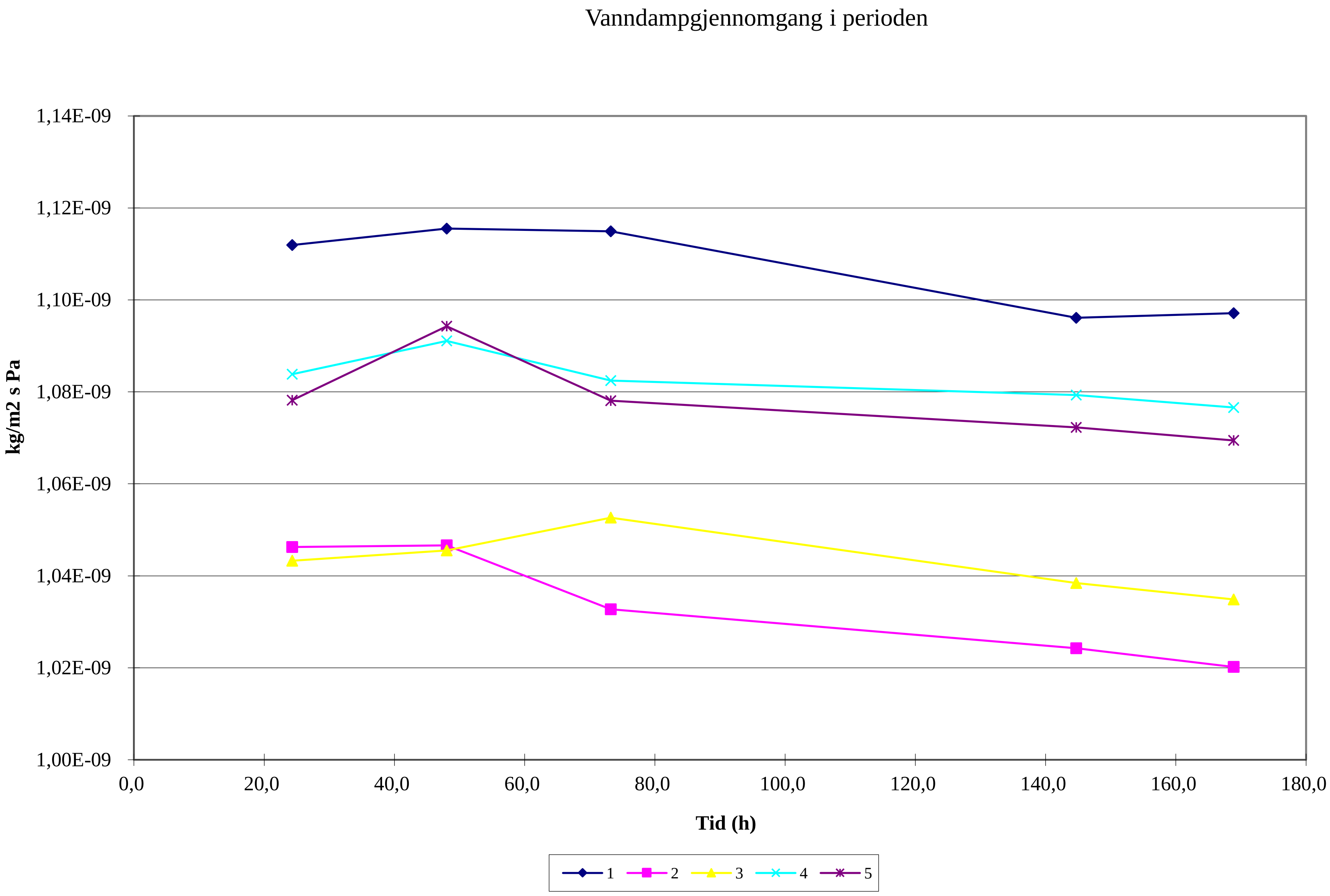
Produkt F

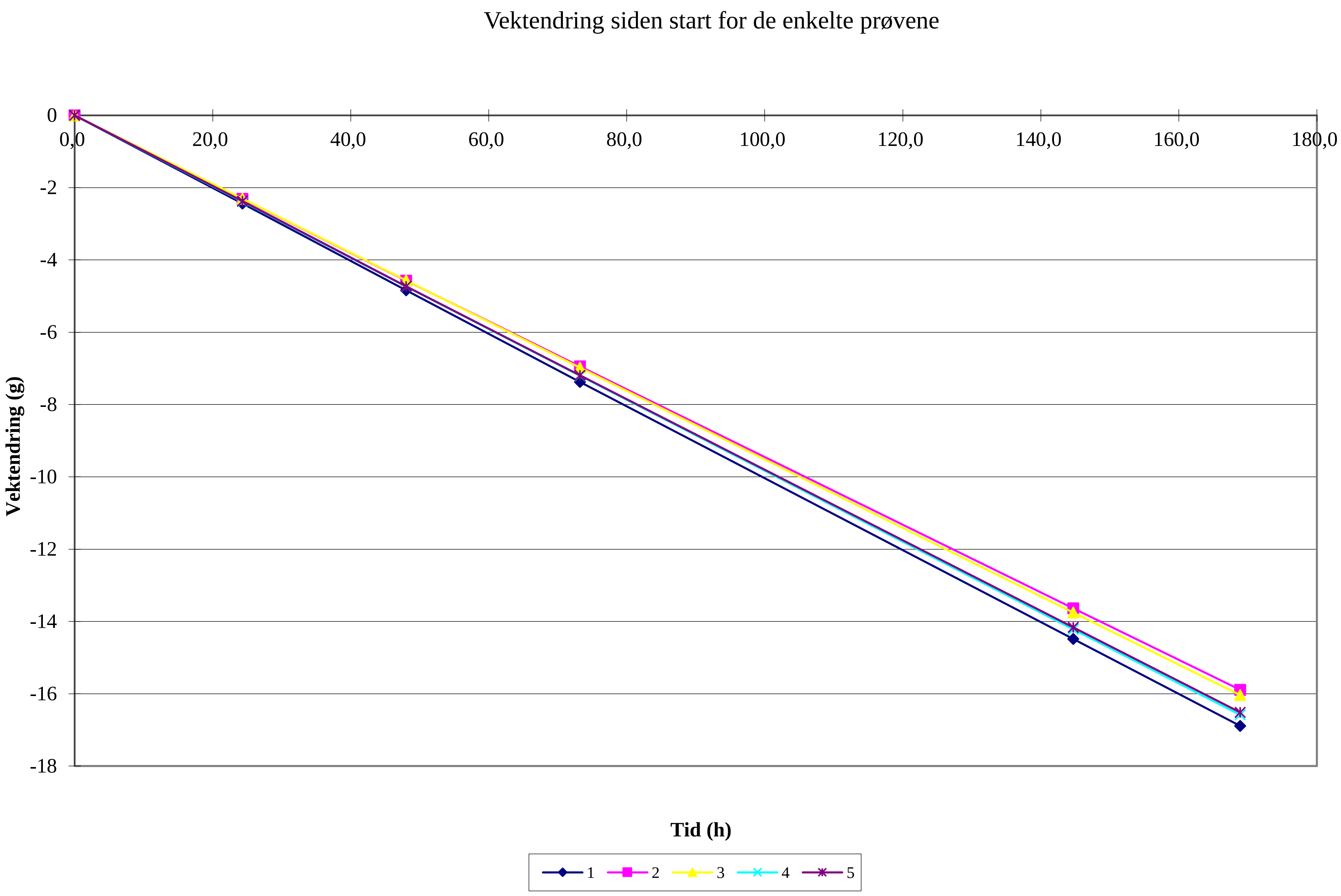
Inndata og resultater fra laboratorieforsøkene til «Produkt F».

Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	F2				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferkst/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		27.09.2022	
(6)Målenummer:	F2				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		18.10.2022	19.10.2022	20.10.2022	21.10.2022	24.10.2022	25.10.2022				
(13)Tid (CTRL+SHIFT+ :)		08:46	09:05	08:48	10:00	09:28	09:39				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		1012,21	1022,27	1017,65	1010,72	1003,81	995,76				
(16)Barometertrykk i perioden, hPa:		1012,21	1019,46	1020,4	1004,36	1006,31	998,54				
(17)Temperatur luft over boks,°C:		23	23,04	23,09	22,84	23,08	23,07				
(18)Temperatur i saltløsning, °C:		23	23,04	23,09	22,84	23,08	23,07				
(19)RF i rommet, %		50	49,51	49,35	48,92	49,33	49,35				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		999,999	999,996	1000,004	1000,006	1000,005	1000,003				
(22)Vekt,g prøve nr:	1	739,596	737,148	734,766	732,231	725,12	722,714				
(23)Vekt,g prøve nr:	2	777,805	775,486	773,237	770,87	764,177	761,922				
(24)Vekt,g prøve nr:	3	758,864	756,551	754,304	751,896	745,12	742,836				
(25)Vekt,g prøve nr:	4	758,733	756,34	754,005	751,536	744,522	742,156				
(26)Vekt,g prøve nr:	5	776,474	774,092	771,751	769,291	762,318	759,966				
(27)Vekt,g kontrolllodd etter veiing:		1000,002	999,997	1000,004	1000,005	1000,006	1000,003				
Tekst i diagrammet Vektendring											



Ekvivalent luftlagstykkelse i perioden
250,00
200,00
150,00
100,00
50,00
0,00
(mm)
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5


Vanndampgjennomgang i perioden
1,14E-09
1,12E-09
1,10E-09
1,08E-09
1,06E-09
1,04E-09
1,02E-09
1,00E-09
kg/m2 s Pa
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5


Vektendring siden start for de enkelte prøvene
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Vektendring (g)
Tid (h)
1
2
3
4
5

SINTEF

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	F2	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	F2
Prosjektnummer:	F2	Prøvediameter: (mm)	164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:	KNO3
		Prøveperiode: fra:	19.10.2022
		til:	25.10.2022

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,3
Temperatur i boksen (°C)	23,0
Temperatur i rommet (°C)	23,0
Barometertrykk (hPa)	1009,8

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52
2	12,52
3	12,52
4	12,52
5	12,52
6	12,52

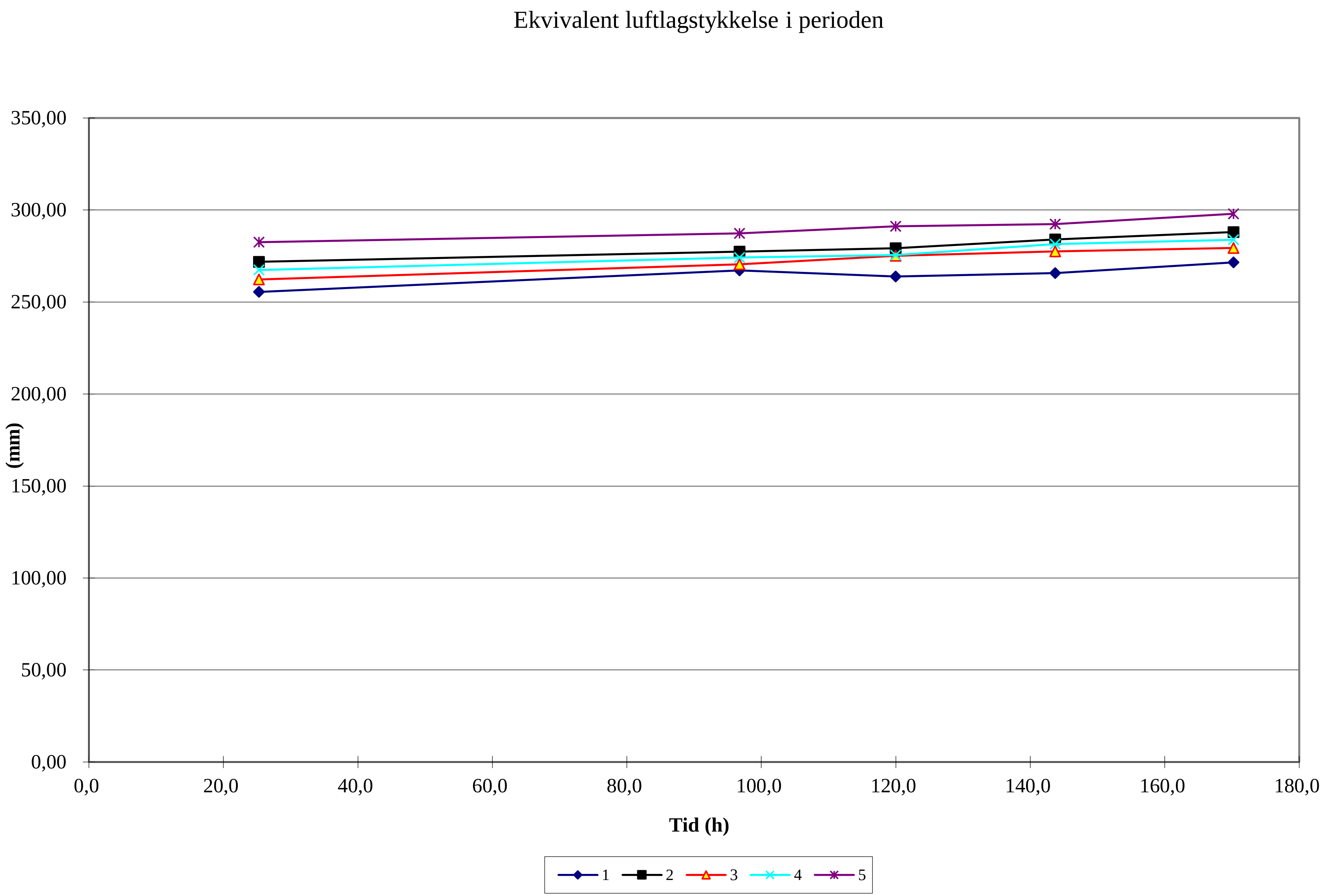
Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	1,10E-09	0,177	9,06E+08
2	1,03E-09	0,190	9,70E+08
3	1,04E-09	0,188	9,60E+08
4	1,08E-09	0,181	9,24E+08
5	1,08E-09	0,182	9,29E+08
Middel	1,07E-09	0,184	9,37E+08
Std. dev. mean. value	1,34185E-11	0,002	1,18E+07

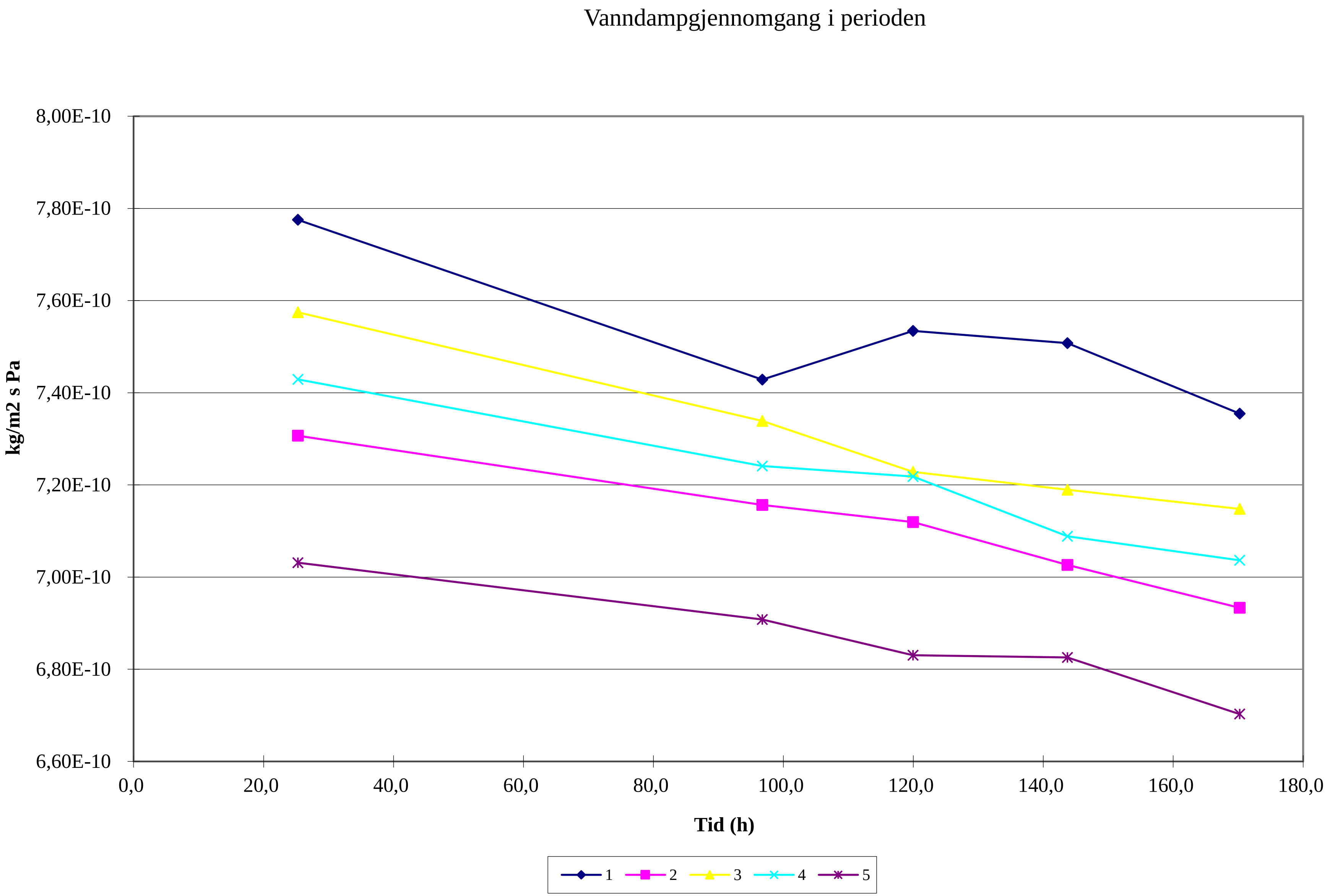
Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

SIGN:

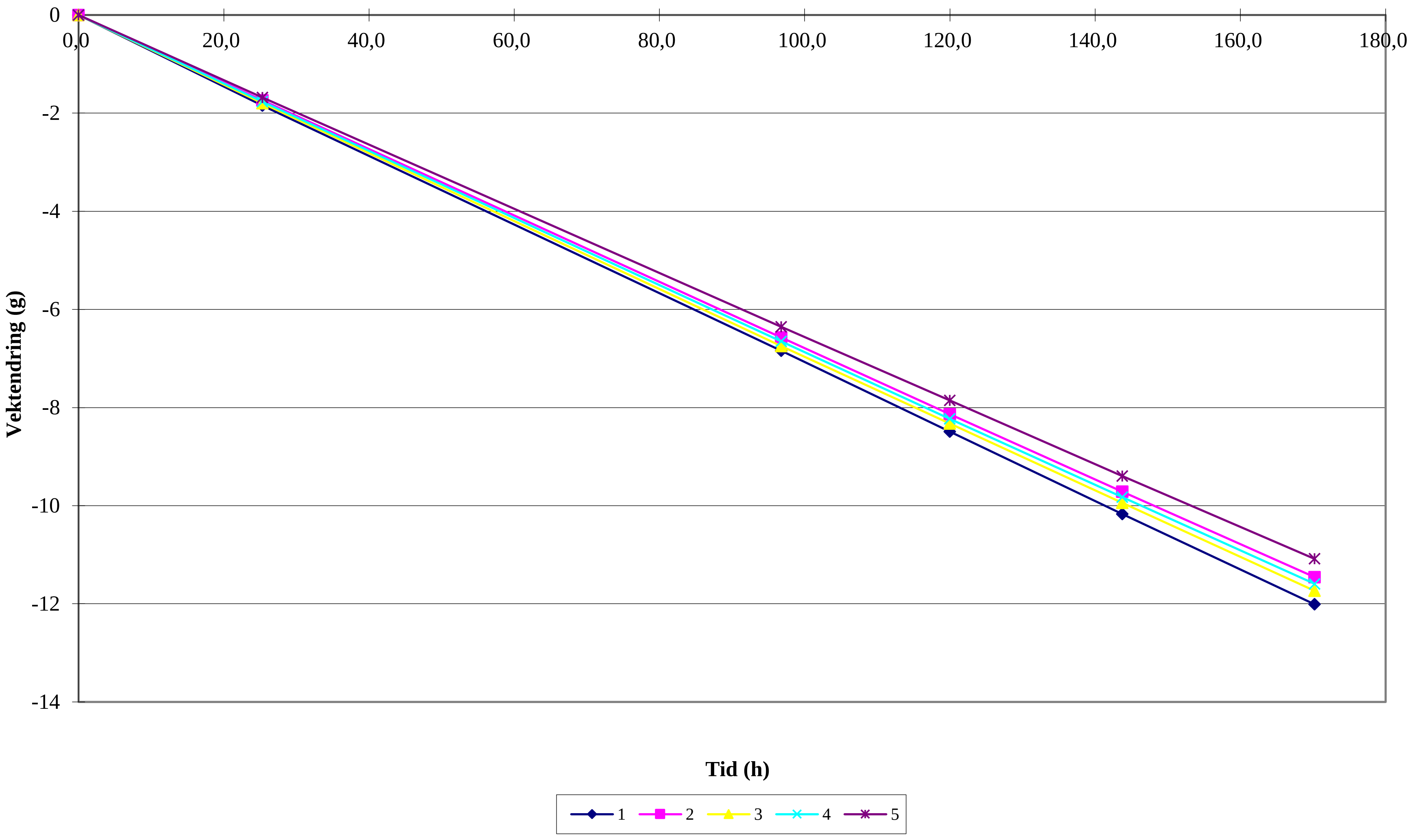
Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	F4				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferkst/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		28.09.2022	
(6)Målenummer:	F4				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		03.11.2022	04.11.2022	07.11.2022	08.11.2022	09.11.2022	10.11.2022				
(13)Tid (CTRL+SHIFT+ :)		09:01	10:19	09:46	08:59	08:44	11:14				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		995,49	997,77	995,23	995,93	988,61	995,33				
(16)Barometertrykk i perioden, hPa:		995,49	995,92	996,64	994,93	991,6	990,62				
(17)Temperatur luft over boks,°C:		23	23,05	23,07	23,05	23,06	23,06				
(18)Temperatur i saltløsning, °C:		23	23,05	23,07	23,05	23,06	23,06				
(19)RF i rommet, %		50	49,38	49,3	49,27	49,22	49,16				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		1000,003	1000,003	1000,002	1000,001	1000,002	1000,000				
(22)Vekt,g prøve nr:	1	708,354	706,51	701,51	699,863	698,19	696,337				
(23)Vekt,g prøve nr:	2	695,447	693,706	688,876	687,313	685,74	683,985				
(24)Vekt,g prøve nr:	3	707,426	705,626	700,682	699,097	697,49	695,685				
(25)Vekt,g prøve nr:	4	684,028	682,26	677,377	675,794	674,208	672,429				
(26)Vekt,g prøve nr:	5	684,772	683,092	678,418	676,914	675,383	673,682				
(27)Vekt,g kontrolllodd etter veiing:		1000,002	1000,004	999,999	1000,001	1000,004	1000,001				
Tekst i diagrammet Vektendring											



Ekvivalent luftlagstykkelse i perioden
350,00
300,00
250,00
200,00
150,00
100,00
50,00
0,00
(mm)
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5


Vanndampgjennomgang i perioden
kg/m2 s Pa
8,00E-10
7,80E-10
7,60E-10
7,40E-10
7,20E-10
7,00E-10
6,80E-10
6,60E-10
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Tid (h)
1
2
3
4
5

Vektendring siden start for de enkelte prøvene



PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	F4	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	F4
Prosjektnummer:	F4	Prøvediameter: (mm)	164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:	KNO3
		Prøveperiode: fra:	04.11.2022
		til:	10.11.2022

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,3
Temperatur i boksen (°C)	23,1
Temperatur i rommet (°C)	23,1
Barometertrykk (hPa)	993,9

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52	
2	12,52	
3	12,52	
4	12,52	
5	12,52	
6		0

Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

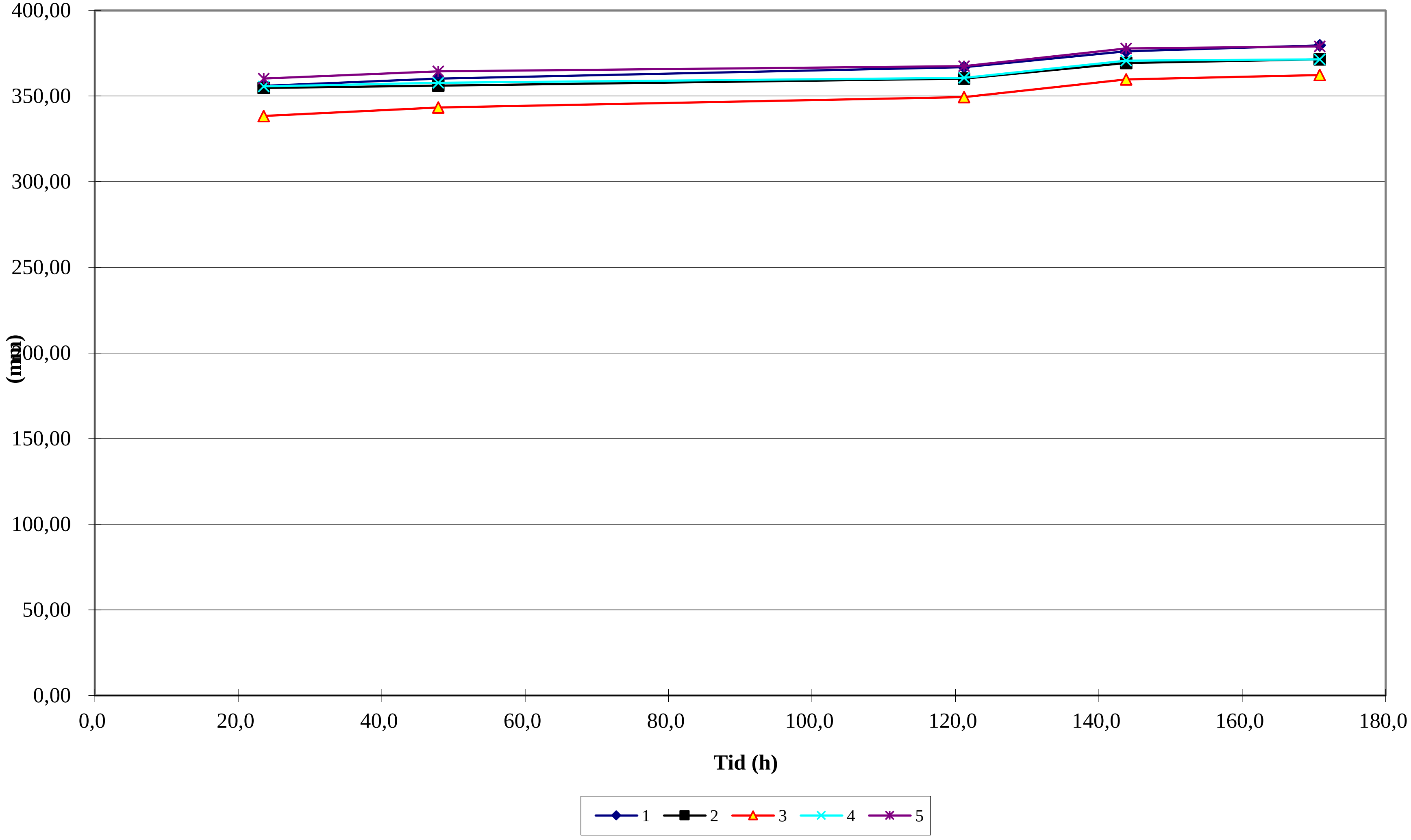
Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	7,49E-10	0,270	1,33E+09
2	7,12E-10	0,280	1,40E+09
3	7,31E-10	0,270	1,37E+09
4	7,21E-10	0,280	1,39E+09
5	6,87E-10	0,290	1,46E+09
Middel	7,20E-10	0,280	1,39E+09
Std. dev. mean. value	1,02958E-11	0,004	2,00E+07

Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

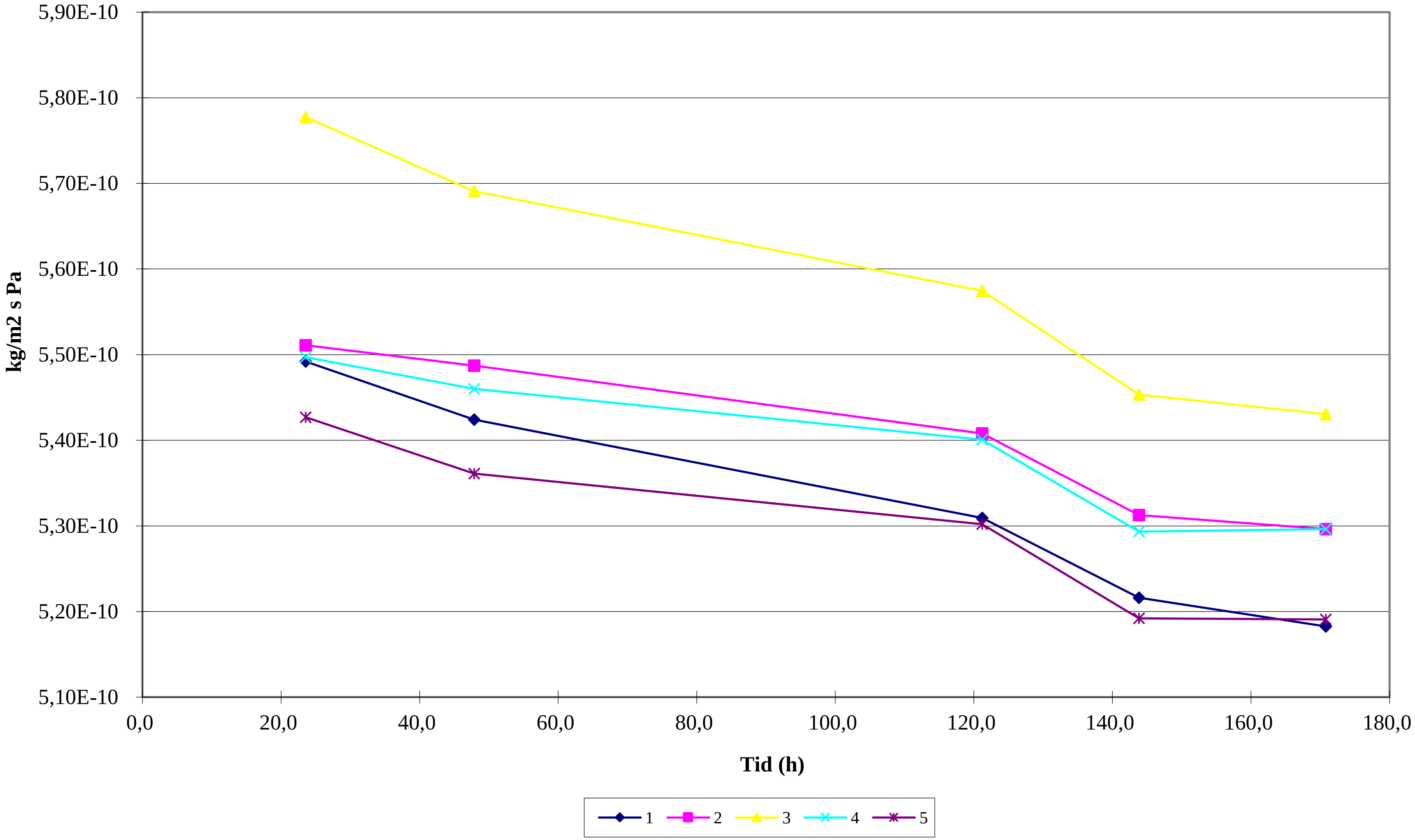
SIGN:

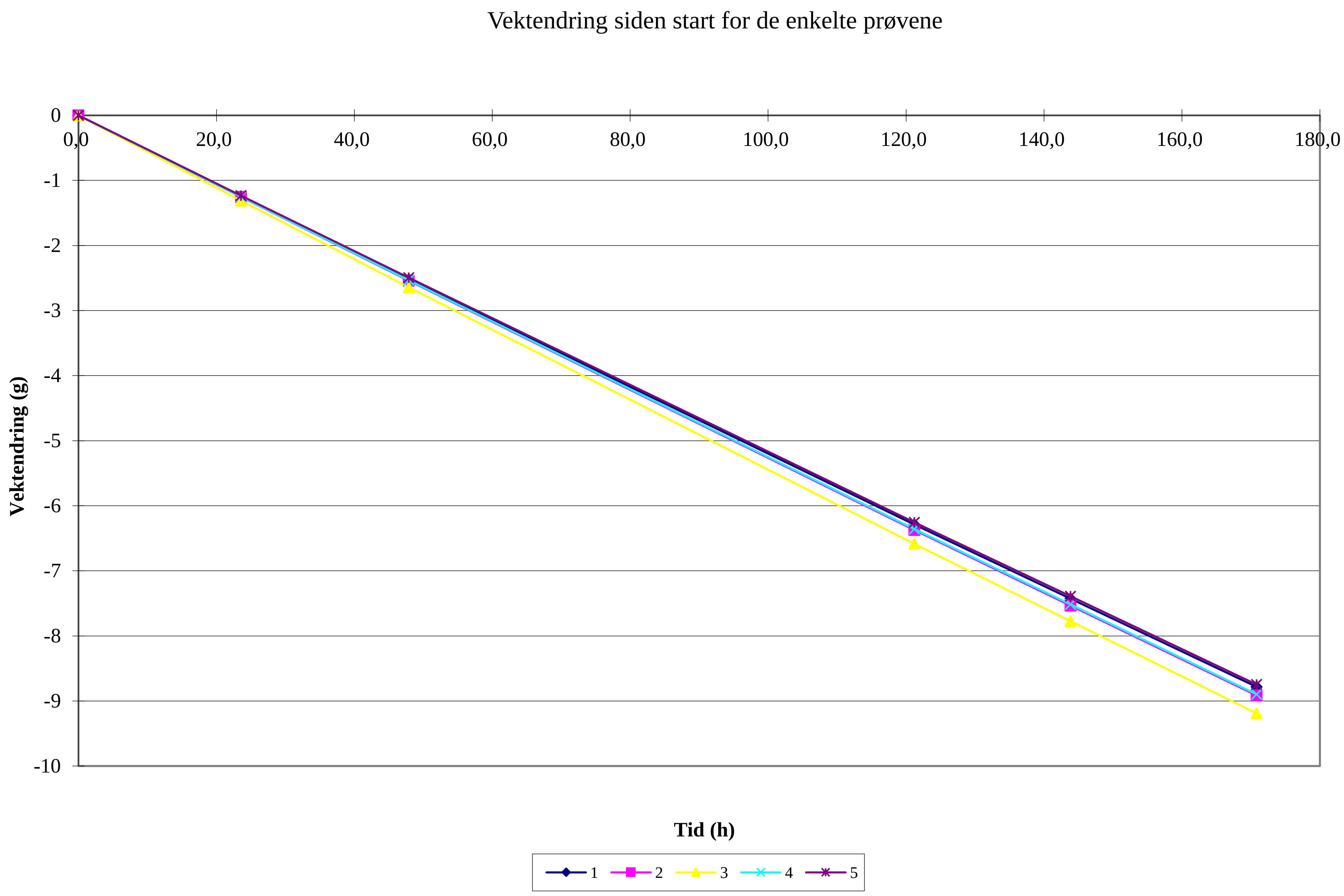
Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	F6				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side	
(4)Produktype:	Malt gipsplate 12,5mm				Prøvest. diameter(mm):		0,174	Ferkst/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		28.09.2022	
(6)Målenummer:	F6				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		16.11.2022	17.11.2022	18.11.2022	21.11.2022	22.11.2022	23.11.2022				
(13)Tid (CTRL+SHIFT+ :)		09:33	09:06	09:26	10:45	09:23	12:21				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		1012,81	1011,33	1015,45	1009,87	1006,33	1004,19				
(16)Barometertrykk i perioden, hPa:		1012,81	1011,79	1012,61	1015,46	1008,31	1005,45				
(17)Temperatur luft over boks,°C:		23	23,05	23,07	23,06	23,05	23,05				
(18)Temperatur i saltløsning, °C:		23	23,05	23,07	23,06	23,05	23,05				
(19)RF i rommet, %		50	49,01	49,12	49,02	49,02	49				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		1000,002	999,999	1000,001	1000,002	1000	1000,000				
(22)Vekt,g prøve nr:	1	730,062	728,812	727,536	723,777	722,634	721,279				
(23)Vekt,g prøve nr:	2	703,27	702,016	700,726	696,901	695,738	694,355				
(24)Vekt,g prøve nr:	3	702,561	701,25	699,915	695,979	694,787	693,371				
(25)Vekt,g prøve nr:	4	701,161	699,91	698,626	694,806	693,647	692,264				
(26)Vekt,g prøve nr:	5	721,481	720,245	718,983	715,229	714,091	712,734				
(27)Vekt,g kontrolllodd etter veiing:		1000,003	1000	1000,002	999,997	1000,001	999,999				
Tekst i diagrammet Vektendring											

Ekvivalent luftlagstykkelse i perioden



Vanndampgjennomgang i perioden




Vektendring siden start for de enkelte prøvene
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
0,0
20,0
40,0
60,0
80,0
100,0
120,0
140,0
160,0
180,0
Vektendring (g)
Tid (h)
1
2
3
4
5

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	F6	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	F6
Prosjektnummer:	F6	Prøvediameter: (mm)	164
Produktype:	Malt gipsplate 12,5mm	Salttype i boksen:	KNO3
		Prøveperiode: fra:	17.11.2022
		til:	23.11.2022

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,0
Temperatur i boksen (°C)	23,1
Temperatur i rommet (°C)	23,1
Barometertrykk (hPa)	1010,7

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52	
2	12,52	
3	12,52	
4	12,52	
5	12,52	
6		0

Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	5,32E-10	0,368	1,88E+09
2	5,40E-10	0,362	1,85E+09
3	5,58E-10	0,351	1,79E+09
4	5,39E-10	0,363	1,85E+09
5	5,30E-10	0,370	1,89E+09
Middel	5,40E-10	0,363	1,85E+09
Std. dev. mean. value	5,00616E-12	0,003	1,69E+07

Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

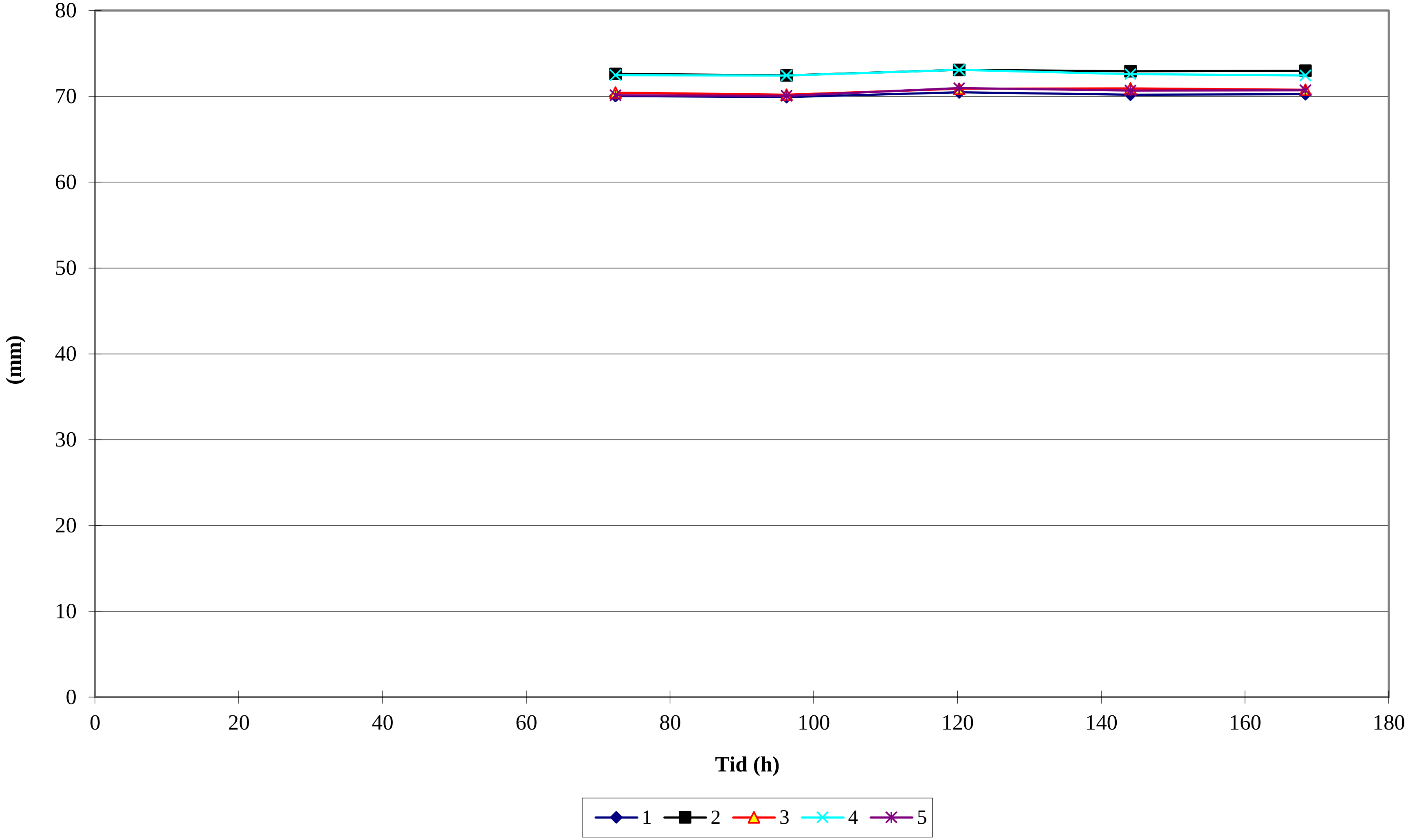
SIGN:

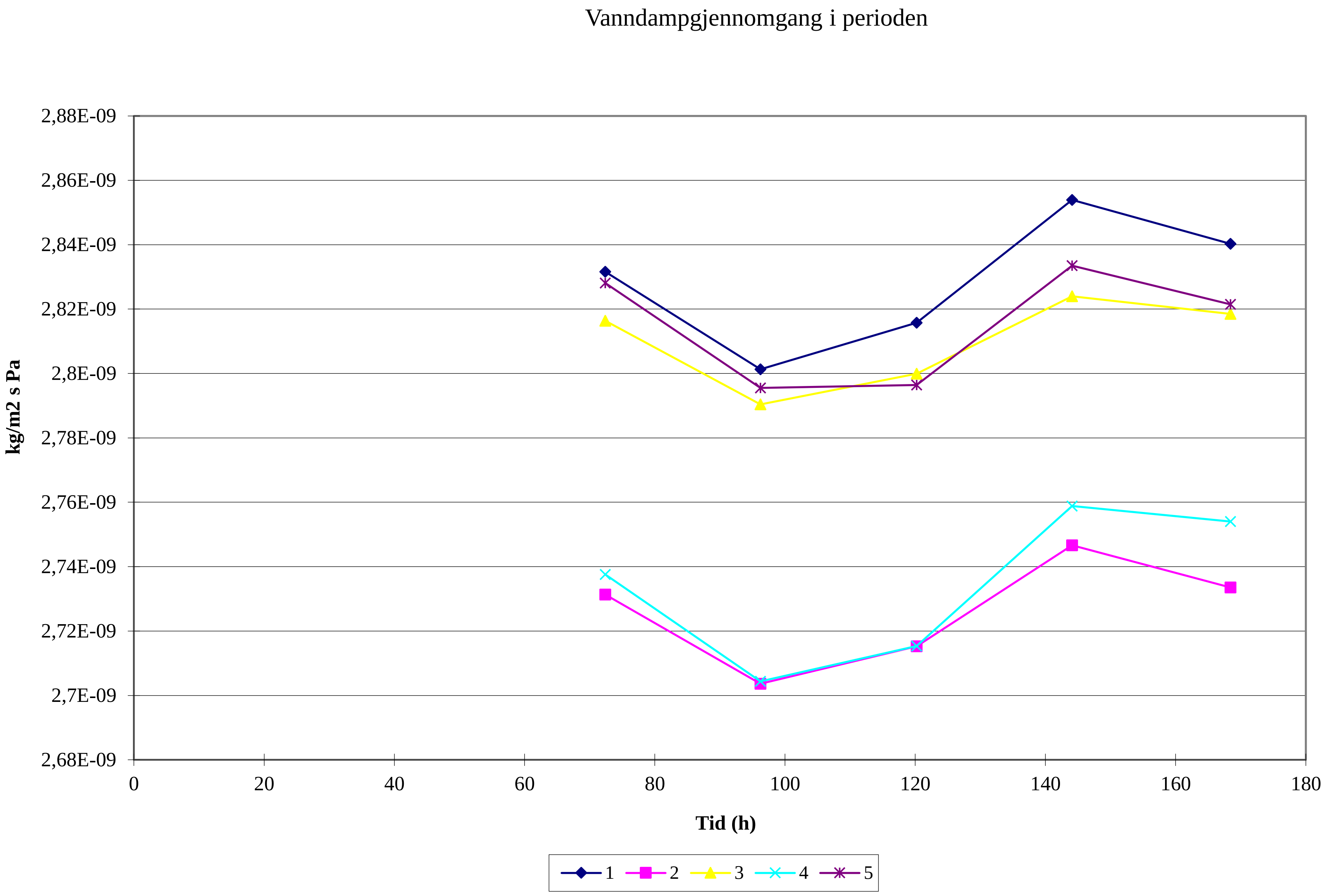
Produkt G

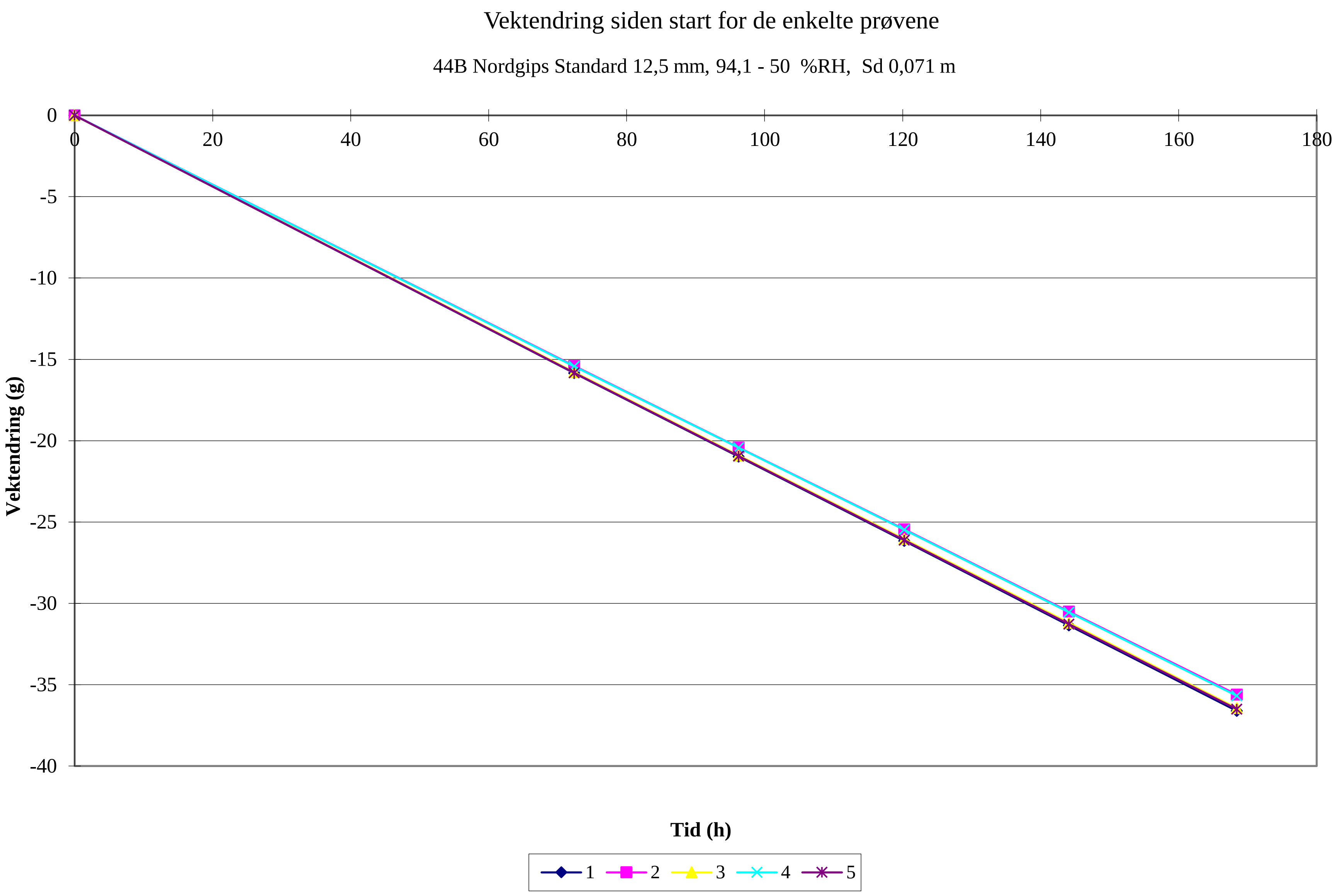
Inndata og resultater fra laboratorieforsøkene til «Produkt G».

Veiing nummer		1	2	3	4	5	6	7	8	9	10
(1)Produktnavn:					Salttype:		KNO3	Prøvestykke:	1	2	3
(2)Oppdragsgiver:	Masteroppgave_Jørgen		Jørgen		Prøvediameter (mm):		0,164	Tykkelse:	12,52	12,52	12,52
(3)Prosjektnummer:	G				Luftlag salt/prøve (mm):		15	Side mot saltløsning:		Brun side inn	
(4)Produktype:	Gipsplate 12,5				Prøvest. diameter(mm):		0,174	Ferskt/Aldret:		Ferskt	
(5)Tykkelse, mm:	12,5200				Lufth. over pr.(m/s):		0,3	Start kondisjonering:		27-09-2022	
(6)Målenummer:	G				RF/Temp:		Vekt:		Tykkelsesmåler:		Stanse:
(12)Dato (CTRL+SHIFT+ ;)		30.09.2022	03.10.2022	04.10.2022	05.10.2022	06.10.2022	07.10.2022				
(13)Tid (CTRL+SHIFT+ :)		08:28	08:52	08:42	08:42	08:33	08:53				
(14)Beregning fra veiing:	2										
(15)Barometertrykk ved veiing, hPa:		1001,43	1009,73	1003,78	996,4	986,52	989,89				
(16)Barometertrykk i perioden, hPa:		1001,43	997,26	1009,98	996,84	987,64	991,56				
(17)Temperatur luft over boks,°C:		23	23,03	23,04	23,05	23,03	23,03				
(18)Temperatur i saltløsning, °C:		23	23,03	23,04	23,05	23,03	23,03				
(19)RF i rommet, %		50	49,53	49,48	49,6	49,61	49,6				
(20)Veiing nummer:		1	2	3	4	5	6	7	8	9	10
(21)Vekt,g kontrolllodd før veiing:		1000,001	1000,002	999,998	999,998	999,999	999,999				
(22)Vekt,g prøve nr:	1	704,823	688,975	683,849	678,668	673,477	668,209				
(23)Vekt,g prøve nr:	2	668,113	652,696	647,706	642,665	637,621	632,501				
(24)Vekt,g prøve nr:	3	714,349	698,566	693,455	688,296	683,146	677,908				
(25)Vekt,g prøve nr:	4	693,251	677,807	672,816	667,775	662,714	657,565				
(26)Vekt,g prøve nr:	5	712,434	696,601	691,483	686,329	681,166	675,924				
(27)Vekt,g kontrolllodd etter veiing:		1000,004	999,996	999,998	999,999	999,998	1000,001				
Tekst i diagrammet Vektendring	44B Nordgips Standard 12,5 mm, 94,1 - 50 %RH, Sd 0,071 m										

Ekvivalent luftlagstykkelse i perioden




Vanndampgjennomgang i perioden
kg/m2 s Pa
2,88E-09
2,86E-09
2,84E-09
2,82E-09
2,8E-09
2,78E-09
2,76E-09
2,74E-09
2,72E-09
2,7E-09
2,68E-09
0
20
40
60
80
100
120
140
160
180
Tid (h)
1
2
3
4
5


Vektendring siden start for de enkelte prøvene
44B Nordgips Standard 12,5 mm, 94,1 - 50 %RH, Sd 0,071 m
0
-5
-10
-15
-20
-25
-30
-35
-40
0
20
40
60
80
100
120
140
160
180
Vektendring (g)
Tid (h)
1
2
3
4
5

PRØVINGS RAPPORT
Prøving av vanndamppermeans etter ISO/DIS 12572

Produktnavn:	G	Tykkelse, mm:	12,52
Oppdragsgiver:	Masteroppgave_Jørgen	Målenummer:	G
Prosjektnummer:	G	Prøvediameter: (mm)	164
Produktype:	Gipsplate 12,5	Salttype i boksen:	KNO3
		Prøveperiode: fra:	03.10.2022
		til:	07.10.2022

Lufth. over pr.(m/s): 0,3

Tykkelse prøve nr

1	12,52
2	12,52
3	12,52
4	12,52
5	12,52
6	12,52

	Middel i prøveperioden
Relativ luftfuktighet i boksen (%RF)	94,1
Relativ luftfuktighet i rommet (%RF)	49,6
Temperatur i boksen (°C)	23,0
Temperatur i rommet (°C)	23,0
Barometertrykk (hPa)	996,7

Tabell 1 Temperatur, relativ luftfuktighet og barometertrykk i prøveperioden.

Prøve nummer	Vanndamppermeans Wp	Vanndampmotstand sd	Zp
	(kg/m²sPa)	(m)	(m²sPa/kg)
1	2,83E-09	0,070	3,53E+08
2	2,73E-09	0,073	3,67E+08
3	2,81E-09	0,071	3,56E+08
4	2,74E-09	0,073	3,66E+08
5	2,82E-09	0,070	3,55E+08
Middel	2,78E-09	0,071	3,59E+08
Std. dev. mean. value	2,19281E-11	0,001	2,85E+06

Tabell 2 Vanndamppermeans og vanndampmotstand for de fem prøvestykkene.
Enkeltresultatene er et middel over fem tidsintervall med stabil fukttransport.
Resultatene er korrigert for overgangsmotstanden over prøven,
damptransport gjennom overlappsonen, og motstanden i luftlaget i boksen.

SIGN:

NTNU
Kunnskap for en bedre verden