VÅR VISION VISION

Vi streber alltid etter det aller beste vann

PROJECT «REMOVAL OF LIME IN WATER PIPES»

DATE:
Report written: July 5, 2022.

GOAL:
Effects of DabV units in dissolving lime deposits on the inside of water pipes.

INTRODUCTION

Water hardness is a challenge caused by the precipitation of minerals such as calcium (Ca^{2+}) and Magnesium (Mg^{2+}) with carbonate (CO_3^{2-}) resulting in calcium carbonate ($CaCO_3$). The conditions at which the precipitation and aggregation occur lead to deposition of minerals on the surfaces is known as scaling or limescale.

Calcium is one of the most abundant minerals found in nature (Ashley 1974). Precipitation of these minerals to calcium carbonate and magnesium carbonate in undesired locations like heat transfer surfaces and conveyance systems poses serious problems.

Scale in evaporators, boilers or heaters is one of the difficult problems to solve in many industries (Nasser et al. 2013). One of the problems is reduced heat transfer capacity, which can lead to severe economic losses.

Ultrasound is one of the technologies used to reduce the scale problem. As referred by Hu et al. (2006), experimental results indicated that ultrasound could not only inhibit the formation of scale, but also remove scale efficiently. In experiments presented by Hu et al. (2006) ultrasonic treatment removed scale with the efficiency of ranging from 65% to 98%, with average of 76.4%. The time of cleaning an evaporator was reduced to 38–75% of that without ultrasound.

It is important to be aware that some of the method for analyzing water hardness only measures the level of the minerals, Ca and Mg, as an approximation. However, this does not reflect if the mineral ions (Ca^{2+} and Mg^{2+}) are bunded to carbonate (CO_3^{2-}) and thereby causing a water hardness problem. A correct analysis method requires quantification to what degree the minerals is bounded to carbonate.

The present report describes an experiment where DabV was tested for limescale removal. The aim was to investigate if DabV can dissolve calcium carbonate and magnesium carbonate that sticks to water distribution pipes in areas with severe water hardness problems.

SAMPLING:

Water sampling was taken in Østfold in Norway, an area known to have severe water hardness challenges. Water was allowed to tap for 2 minutes, a sample was taken, and DabV was mounted on the tap. Samples was taken after 2 min and 4 minutes while the water was running.

The samples were taken by Erik Kilaas, Microhelse AS and Linn Kuremyr, Laborant Denofa Lilleborg following the procedure given in **Appendix 1**. Sampling date: 22. June 2022

METHOD:
Sampling procedure is described in detail in **Appendix 1**. The assignment with the analyses of the water samples was performed by ALS Laboratory Group Norway AS, which has forwarded the samples for chemical analyzes to: ALS Czech Republic, s.r.o., Na Harfe 336/9 Prague 9 – Vysocany (**Appendix 2**). The analyzes were performed in anonymized randomized order.

Statistical processing is performed by analysis of variance where the p-value is adjusted for multiple comparisons using false detection rate.

RESULTS AND DISCUSSION:
Analyses of water before the onset of DabV, and 2 and 4 minutes after installing DabV outside the waterpipes are given in **Appendix 3**. There were significant increases in the parameters: calcium, magnesium, hardness, calcium hardness, magnesium hardness and hardness such as $CaCO_3$ over the time period of 2 and 4 minutes resulting from the effects of DabV.

The results are presented as a box plot in **Figure 1**, showing clear increases over time with little spread between the replicants. In **Figure 2**, the average values within each time point are presented as changes in percentage of the initial value before the installation of DabV. These results indicate that DabV has led to dissolving coating of limescale on the inside of the pipes, and that significant changes occurs after only a few minutes.

The immediately effect of DabV is that the parameters reflecting the limescale increases in the water until the lime scale inside the pipes is reduced, as shown in the present study. From practical experiences on DabV for removal of limescale it has been seen that water softness is achieved after a short exposure to DabV. The severity of the mineral composition of the raw water and the limescale inside the water distribution pipes influences how fast the resulting water responds the DabV treatment to soften the water.

CONCLUSION:
The discovery that DabVs can dissolve limescale on the inside of the water pipe will have practical consequences for various purposes - in washing machines, in dishwashers, water heaters etc.

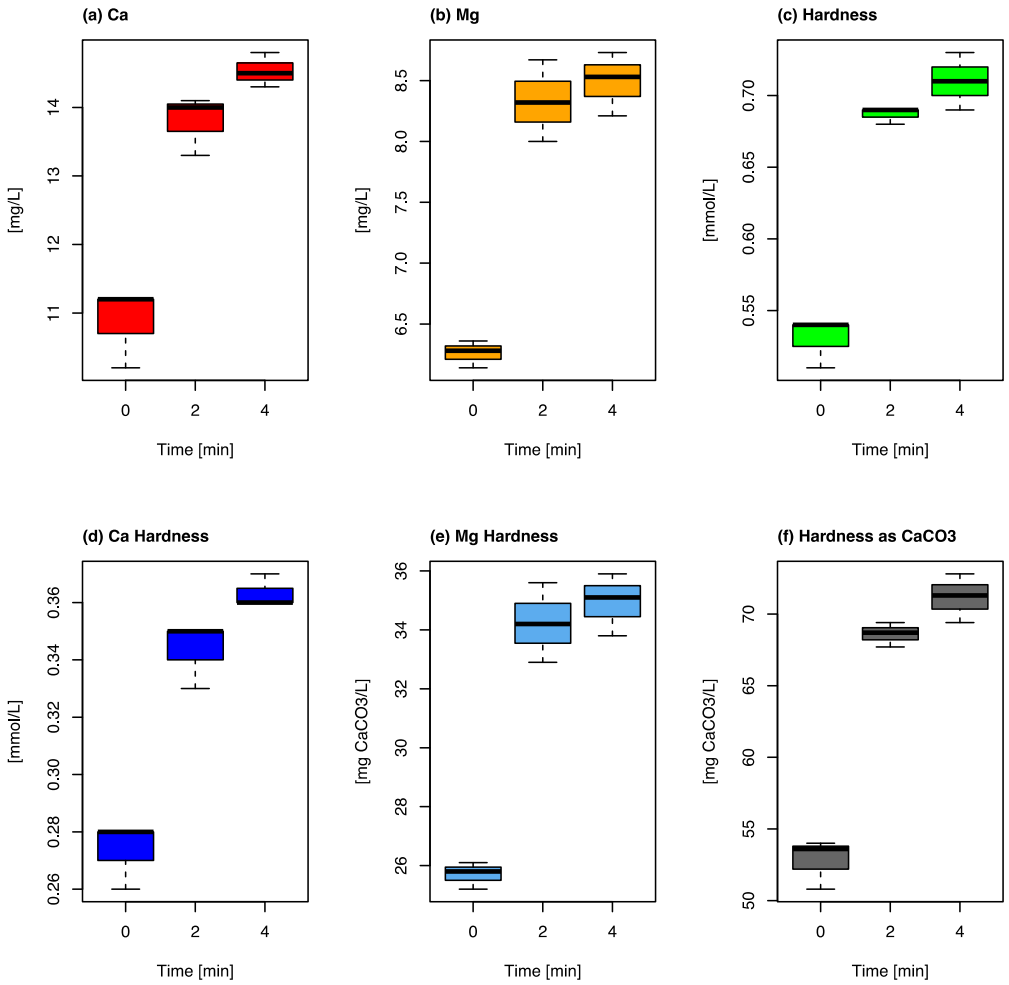


Figure 1. Boxplot of changes in water due to DabV placed outside the water pipe reveals increases in the parameters calcium (Ca), magnesium (Mg), hardness, calcium hardness, magnesium hardness and hardness such as $CaCO_3$. Time 0 is before DabV was applied, and times 2 and 4 show results of samples taken 2 and 4 minutes after DabV was applied. Within each time point, the spread between the three replicates at each time point are displayed. The elevated expression of these parameters reflect that limescale has been dissolved from the water distribution pipes and that this occur after a very short period.

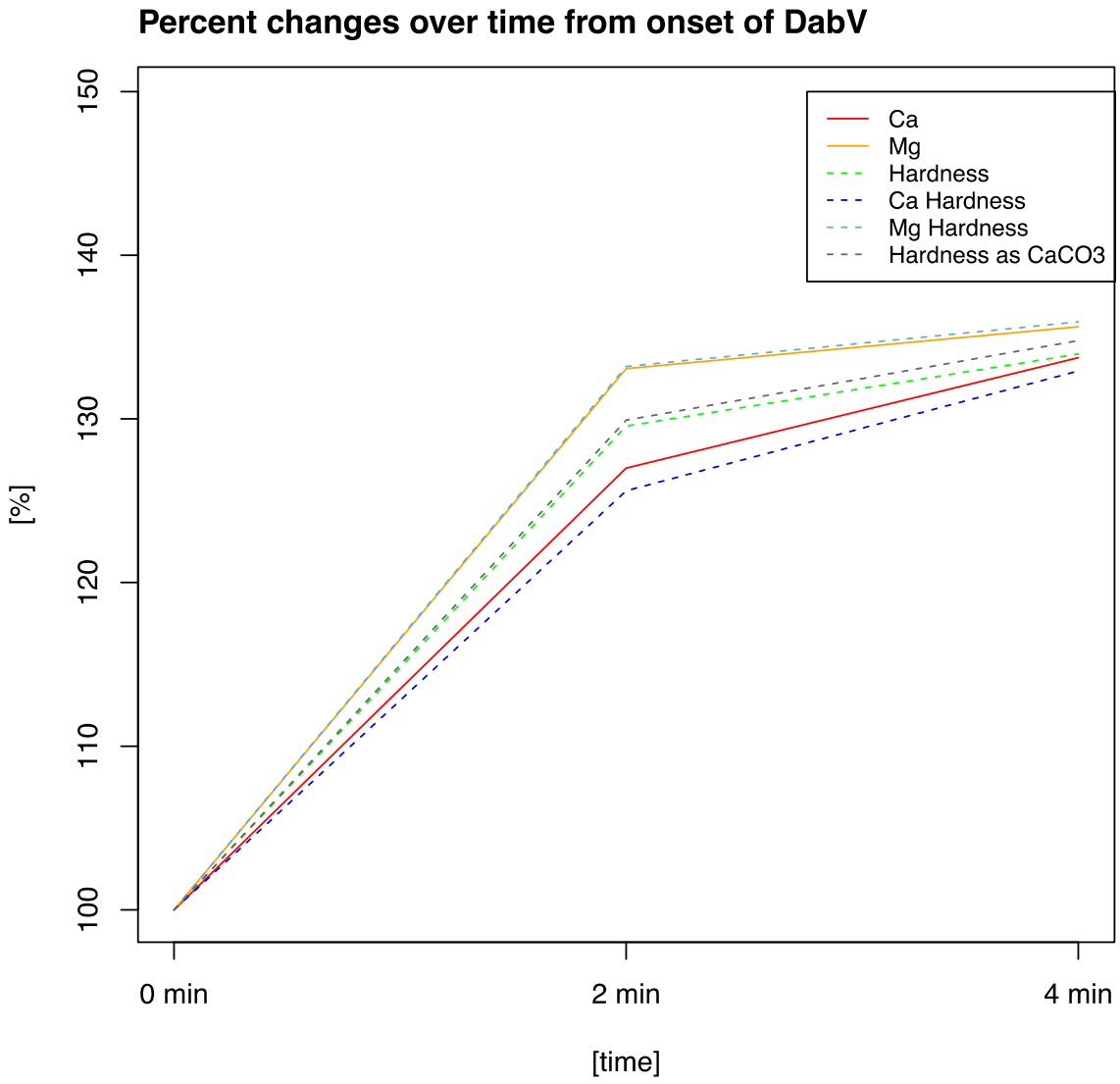


Figure 2. Line plot of increases caused by DabV placed the outside the water pipe for the parameters calcium (Ca), magnesium (Mg), hardness, calcium hardness, magnesium hardness and hardness such as $CaCO_3$. Time 0 is before DabV was applied, and times 2 and 4 show results of samples taken 2 and 4 minutes after DabV was applied. The lines show percentage increases from the initial value before DavB was applied (0 min) as average values at each time point.

References:

Ashley 1974. Preventing deposition on heat exchanger surfaces with ultrasound, Ultrasonics 9, 215–221.

Hu et al. 2006. Industrial experiments for the application of ultrasound on scale control in the Chinese sugar industry. Ultrasonic Sonochemistry, 13, 329-333.

Nasser et al. 2013. Monitoring of aggregation and scaling of calcium carbonate in the presence of ultrasound irradiation using focused beam reflectance measurement. Powder Technology, 238, 151-160

Appendix 1.

Procedure for sampling for project Lime 2

1) Bring 3 60ml, 3 100ml and 3 500ml bottles marked no. 1022-1035-1012 from the car to enter the test site, open the cold-water tap, wait 2 minutes and fill the bottles.

2) Take all the bottles out to the car and place them in cooler bag no. 1 in the front of the car.

3) Then bring 1 DabV water improver into the sample room and mount it on the cold-water pipe under the same sink. Also bring cooler bag no. 2 with bottles marked no. 1019-1025-1015-1032-1021-1018 in.

4) Then open the cold water tap to let the water run for 2 minutes at the same time as you take out 3 pcs 60 ml, 3 pcs 100ml 3 pcs 500ml bottles marked no. 1019-1025-1015.

5) After 2 minutes, fill the 9 bottles while the water is still flowing and place them in cooling bag no. 2.

6) Wait another 2 minutes and fill 3 pcs 60ml, 3 pcs 100ml 3 pcs 500ml bottles marked with no. 1032-1012-1018 while the water is still flowing. Then place them in cooling bag no. 2

7) Then close the tap and remove the DabV unit from the pipe.

8) Take cooler bag no. 2 and the DabV unit out in the car and place them at the opposite end of the car as cooler bag no. 1 was placed.

9) Drive to ALS Laboratory Group Norway AS Drammensveien 264 0283 Oslo

Appendix 2. Analyze certificate from ALS Laboratory Group Norway AS,

Work Order Reference NO N02211437

BESTILLING? på mine sider via

Analysebestilling

Besøksadresse: Avdeling Oslo, Drammensveien 264, 0283 Oslo. Avdeling Sarpsborg, Tverveien 17

Åpningstid (man-fredag): Oslo: 09:00 - 17:00, Sarpsborg: 08:00 - 16:00

Kontakt: Tlf: +47 22 13 18 00, e-post: info.on@alsglobal.com

FYLLES UT AV ALS

FYLLES UT AV KUNDE

Kunde nr: DABEVA-NO Tilbuds nr: OF220612

Firma: Det Aller Beste Vann AS

Kontakt person: Rune Nilsen

Adresse: Austre Vardane 5B, 5306 Erdal

Telefon: Mobil: 94832830

E-post: rune@detallerbestevann.com

Faktura adr. (epost): allerbestevann@krfaktura.no

Prosjekt nummer: 202

Prosjekt navn: kalk2

Ansvarlig registrering: EMC

Mottatt: 14 JUN 2022

Opplysninger om prøven(e):

Prøvetakningsdato: 13.06.2022

Andre opplysninger:

Bruk rett analysekode for hardhet (skal til PR)

Ekstra e-post sendes også til:

Rapporteringstid

Ekspress må avtales spesielt. Pris avhenger av antall dager fra ankomst hos ALS til ønsket rapporteringsdato, og teknisk analysetid. Rapporteringstid for en ekspressanalyse kan være på ettermiddagen.

☐ Ingen hast ☑ Standard rapporteringstid ☐ Delt standard rapporteringstid ☐ Ekspress! Ønsket rapporteringsdato:

MERK! Rapporteringstid regnes i arbeidsdager fra dagen ALS mottar prøven. Ingen hast: 10-15 dagers rapporteringstid (evt. lenger dersom teknisk analysetid tilsier så). Standard rapporteringstid: analysen med lengst rapporteringstid avgjør rapporteringsdato. Delt standard rapporteringstid: ulike rapporter avhengig av analysens rapporteringstid.

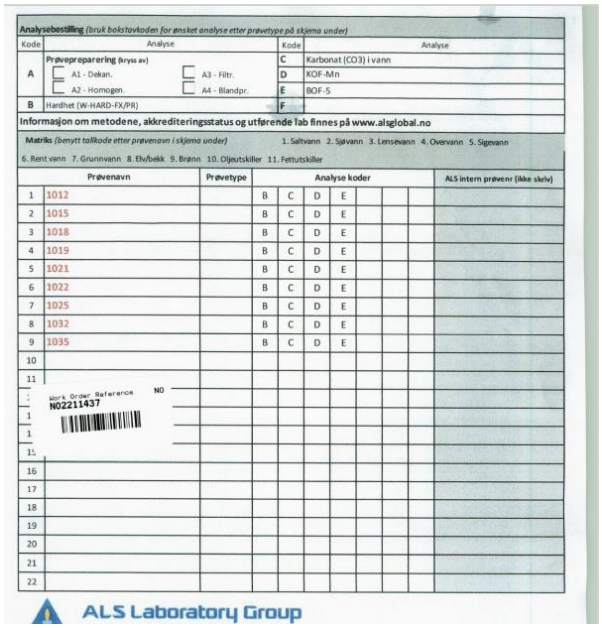
Dato: Signatur:

FORSENDELSE AV PRØVER

TIL OSLO

Pakker og brevpost: ALS Laboratory Group Norway AS, Postboks 643 Skøyen, 0214 Oslo

Bring bedriftspakke: ALS Laboratory Group Norway AS, Drammensveien 264, 0283 Oslo



Analysebestilling (bruk bokstavkoden for ønsket analyse etter prøvetype på skjema under)

Kode	Analyse	Kode	Analyse
A	Prøvepreparering (kryss av): ☐ A1 - Dekan. ☐ A2 - Homogen. ☐ A3 - Filtr. ☐ A4 - Blandpr.	C	Karbonat (CO3) i vann
		D	KOF-Mn
		E	BOF-5
B	Hardhet (W-HARD-FX/PR)	F	

Informasjon om metodene, akkrediteringsstatus og utførende lab finnes på www.alsglobal.no

Matriks (benytt tallkode etter prøvenavn i skjema under) 1. Saltvann 2. Sjøvann 3. Lensevann 4. Overvann 5. Sigevann 6. Rent vann 7. Grunnvann 8. Elv/bekk 9. Brønn 10. Oljeutskiller 11. Fettutskiller

	Prøvenavn	Prøvetype	Analyse koder							ALS intern prøvenr (ikke skriv)
1	1012		B	C	D	E				
2	1015		B	C	D	E				
3	1018		B	C	D	E				
4	1019		B	C	D	E				
5	1021		B	C	D	E				
6	1022		B	C	D	E				
7	1025		B	C	D	E				
8	1032		B	C	D	E				
9	1035		B	C	D	E				
10										
11										
1										
1										
15										
16										
17										
18										
19										
20										
21										
22										

Work Order Reference NO N02211437

ALS Laboratory Group

Appendix 3. Results of water analysis sorted by time

	Short names	Units	0_1012	0_1022	0_1035	2_1015	2_1025	2_1019	4_1021	4_1018	4_1032
Time [min]	Time	[min]	0	0	0	2	2	2	4	4	4
Sample names	Id	Sample names	1012	1022	1035	1015	1025	1019	1021	1018	1032
Bicarbonate (HCO3) [mg/L]	HCO3	[mg/L]	270.00	271.00	270.00	272.00	269.00	271.00	272.00	268.00	273.00
Ca (Calcium) [mg/L]	Ca	[mg/L]	10.20	11.20	11.20	14.10	13.30	14.00	14.80	14.50	14.30
Mg (Magnesium) [mg/L]	Mg	[mg/L]	6.14	6.36	6.28	8.32	8.67	8.00	8.73	8.53	8.21
Alkalinity pH 4.5 [mmol/L]	Alk	[mmol/L]	4.42	4.44	4.42	4.46	4.41	4.44	4.45	4.40	4.48
Hardness [mmol/L]	Hardness	[mmol/L]	0.51	0.54	0.54	0.69	0.69	0.68	0.73	0.71	0.69
Calcium Hardness [mmol/L]	Ca Hardness	[mmol/L]	0.26	0.28	0.28	0.35	0.33	0.35	0.37	0.36	0.36
Magnesium Hardness [mg CaCO3/L]	Mg Hardness	[mg CaCO3/L]	25.20	26.10	25.80	34.20	35.60	32.90	35.90	35.10	33.80
Hardness as CaCO3 [mg CaCO3/L]	Hardness as CaCO3	[mg CaCO3/L]	50.80	54.00	53.60	69.40	68.70	67.70	72.80	71.30	69.40
KOF-Mn [mg/L]	KOF-Mg	[mg/L]	0.86	0.89	1.49	1.19	1.13	1.64	0.95	1.25	1.07
Carbon dioxide (CO2) [mg/L]	CO2	[mg/L]	200.00	200.00	199.00	201.00	198.00	201.00	201.00	199.00	202.00
Carbon dioxide-free CO2 [mg/L]	CO2 free	[mg/L]	5.94	4.71	4.75	4.80	4.00	5.06	5.41	5.37	5.02