



Vad ska vi göra för att skidor ska
glida snabbare?



Mittuniversitetet

MID SWEDEN UNIVERSITY

Eller snarare,
vad vi inte
ska göra
för att
skidor ska
glida
snabbare?



Två revolutioner

1917




2006

200603

LICENTIATE THESIS **L**

Investigation of the most essential factors influencing ski glide



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Department of Applied Physics and Mechanical Engineering
Division of Computer Aided Design

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och reaktioner,

- svt.se
- www.n24.se
- www.gp.se
- www.newsdesk.se
- dalademokraten.com
- www.smp.se
- www.svd.se
- www.motalatidning.se
- Corren.se - Skidvalla ger sämre glid
- www.vk.se
- www.ltz.se
- www.norran.se
- www.op.se
- Norrbottens-Kuriren
- www.forskning.se
- www.freeride.nu
- economist.com
- www.sweden.se
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- www.fof.se
- www.vasaloparen.se
- www.nyteknik.se



TV4



och reaktioner



Glidvallning helt onödig enligt Kuzmin

LULEÅ, KURIREN.

Forskaren Leonid Kuzmins avhandling, där han hävdar att glidvalla oftast är överflödig, väcker upprörda känslor hos både skidåkare och tillverkare av valla.

Vissa hot har också framförts, framförallt mot Mittuniversitetet, där han bedrivit sin forskning.

– Folk från ett stort vallaföretag har pratat med min dekanus, och sagt att om jag inte slutar med mitt arbete ska de förstöra universitetets renommé. Det tycker jag är ett märkligt sätt att reagera på seriös forskning. Man borde istället komma till mig direkt och framföra argument mot mina forskningsresultat, säger Kuzmin till Norrbottens-Kuriren.

Reaktionerna har också fått Luleå tekniska universitet att tänka på säkerhetsfrågor i samband med att Leonid Kuzmin den 9 februari lägger fram sin licentiatuppsats, och håller licentiatseminarium vid universitetet i Luleå.

Vår ledtråd (vår guide)



Why is ice and snow slippery? The Tribo-physics of skiing

Lars Karlöf¹, Leif Torgersen Axell¹, Dag Slotfeldt-Ellingsen²

¹ Swix Sport AS, Research and Development, Servicebox, 2626 Lillehammer, Norway.

² SINTEF, Box 124, 0314 Oslo, Norway.




In memory of Martin Matsbo (1911-2002)


Oslo, 30. September, 2005

Ett hemligt manuskript

531.44 g 525g

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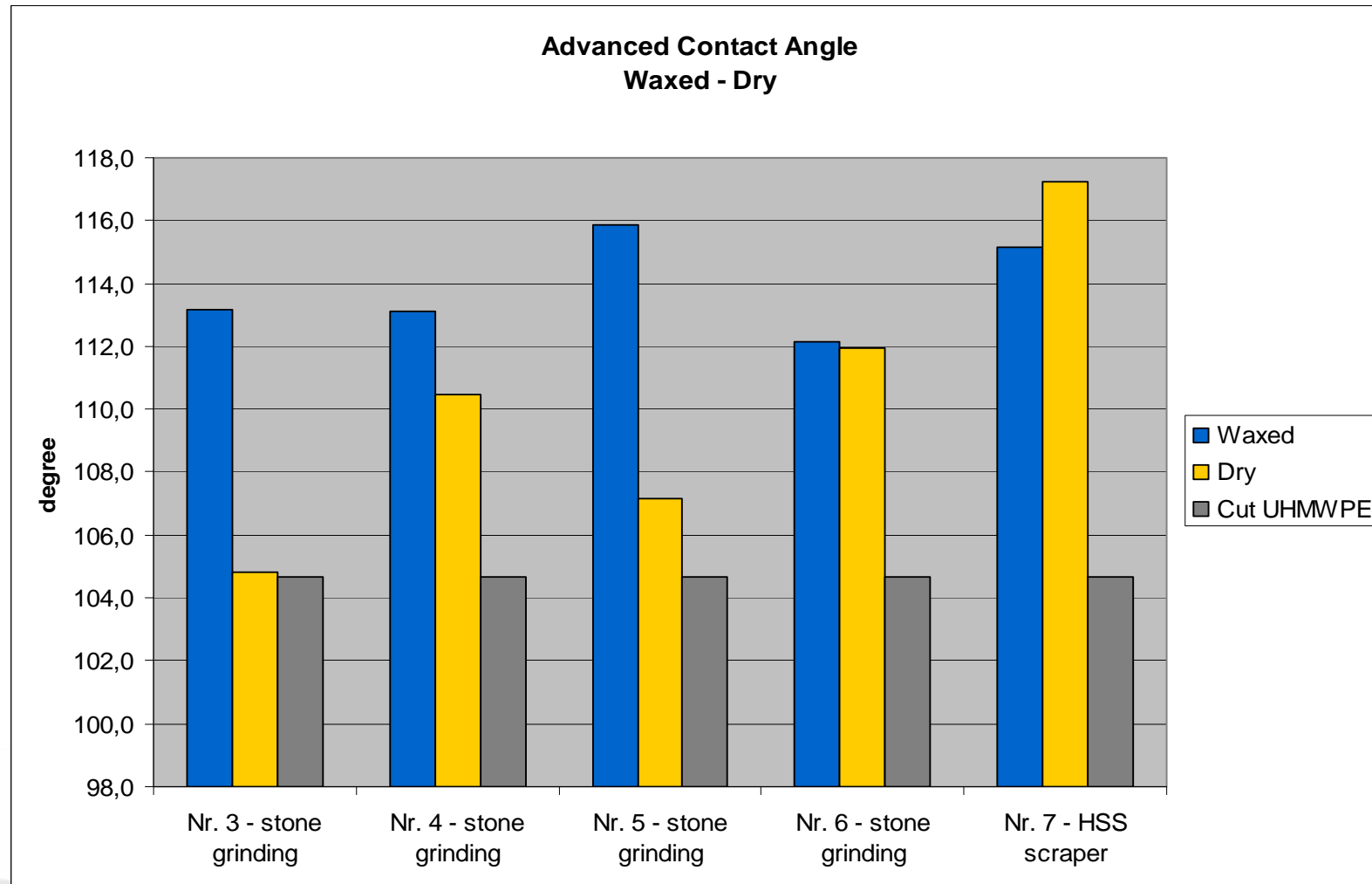
1-skema 17

En forskning från 1982,
som är aktuell även i
dag.

Sidor 14-15 i vår guide

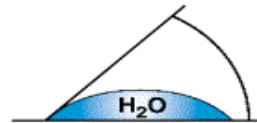
- The purpose of ski wax is to reduce adhesion forces, to reduce surface tension, and to prevent ploughing by adjusting the slider base hardness to the hardness of the snow;
- For example, by applying harder waxes the slider surface hardness is increased;
- Further, by making the surface more hydrophobic, adhesion is reduced at the contact points;

Ett stålsicklade skidbelag är extremt vattenavvisande utan någon glidvalla.



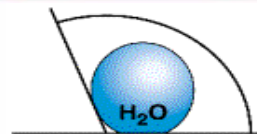
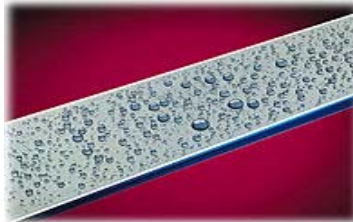
Hur kan man få en kontakt vinkel som är lägre än på hyvlat furu? <http://www.swix.no/NorD413.htm>

SÅLE PREPARERT MED TRADISJONELL GLIDER



Vannets kontaktvinkelen er mindre enn 90°.

SÅLE PREPARERT MED CERA F



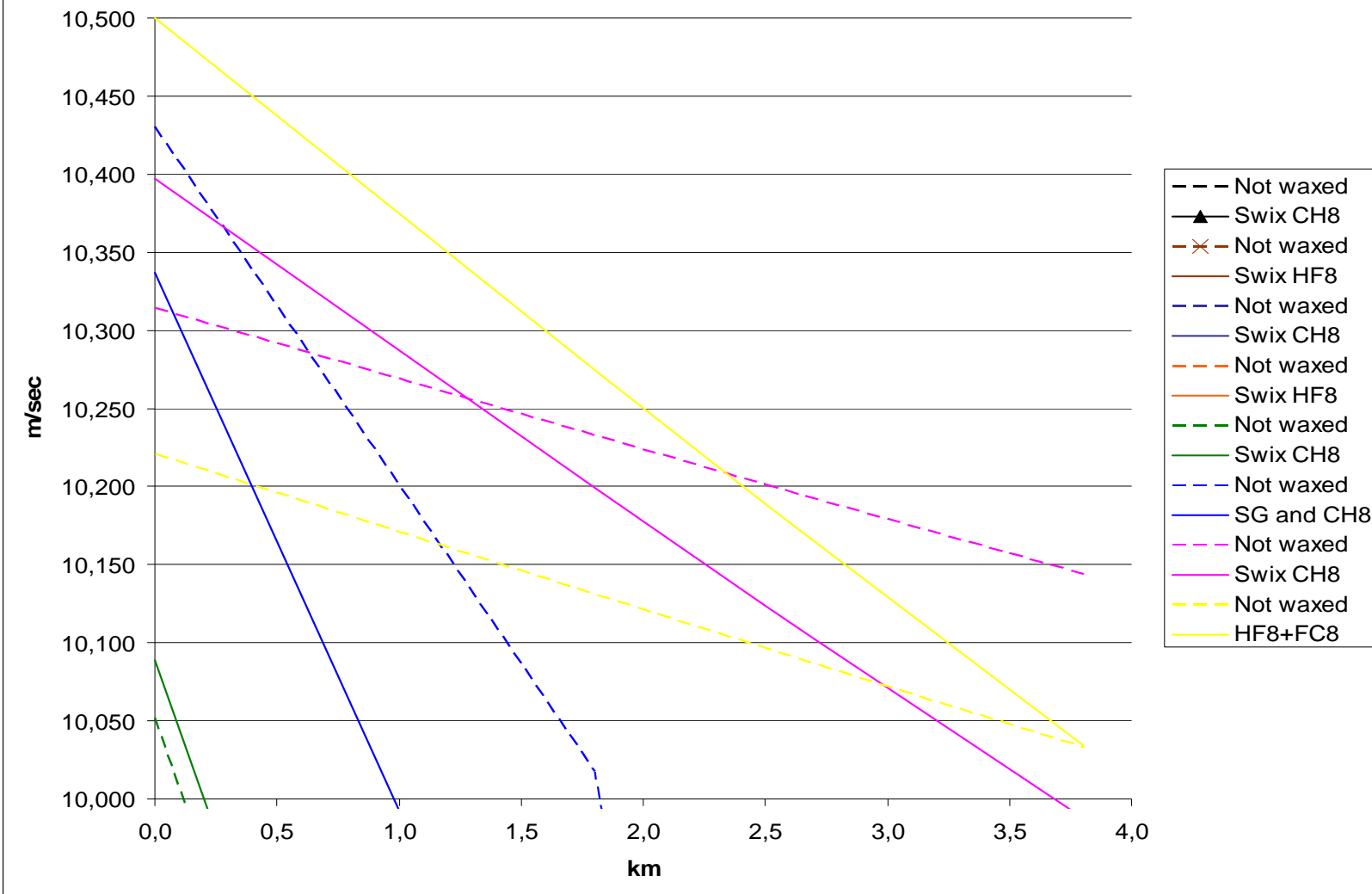
Vannets kontaktvinkel er større enn 90°; gir mindre friksjon mellom såle og snø.

Sida 11 i vår guide

- In fact, PE is one of the polymeric materials having the lowest surface energy (more hydrophobic). Only fluoropolymers have lower surface energy.

Detta betyder att bara högfluor glidvallor kan öka skidbelags vattenavvisande egenskaper. Stämmer väldigt bra med vår resultat (<http://epubl.ltu.se/1402-1757/2006/03/LTU-LIC-0603-SE.pdf>, Paper A).

Average gliding velocity on the test slope and passed distance (zoomed in)



Det hemliga manuskriptet sida 55

Vi har studert hvordan smuss fester seg på gliflaten på en normalt vokset for- og bakski.

Undersøkelsen viste at smusset fester seg i ujevnheter på skisålen (hakk, groper, riper, hår, ruglete flater osv.). Våtføreskiene bør derfor under forhold med mye smuss overflatebehandles på en måte som gir en mest mulig glatt flate. Sålen bør være hard og slitesterk.

Stämmer väldigt bra med vårt resultat

(<http://epubl.ltu.se/1402-1757/2006/03/LTU-LIC-0603-SE.pdf>, Paper B).

Ett exempel av extrem snabb försämring av glidet.

Number of 100 m descent	Time of descent [sec]	
	Nr. 60 - Do not waxed	Nr. 59 - SG and CH8
1	9,567	9,529
2	9,573	9,716
3	9,623	9,778

Stone grinded skis waxed with Swix CH8 after 5,3 km. Air temperature +7,7°C.



Ett stålsicklade belag är inte blank.

Ski and kind of treatment	Contact Angle	Ra	Rq	Rz	Rt
Nr. 3 Stone grinding - pattern 1A. Dry.	104,83	3,66	4,52	31,69	41,33
Nr. 3 Stone grinding - pattern 1A, CH8.	113,14	3,19	4,13	28,79	33,80
Nr. 4 Stone grinding - pattern 1B. Dry.	110,48	4,75	5,72	31,46	35,26
Nr. 4 Stone grinding - pattern 1B, CH8.	113,14	4,78	6,08	35,08	36,84
Nr. 5 Stone grinding - pattern 2A. Dry.	107,18	2,76	3,51	26,10	31,62
Nr. 5 Stone grinding - pattern 2A, CH8.	115,88	2,73	3,49	23,94	26,50
Nr. 6 Stone grinding - pattern 2B. Dry.	111,92	3,12	4,02	27,48	30,14
Nr. 6 Stone grinding - pattern 2B CH8.	112,15	3,07	3,89	24,78	29,63
Nr. 7 Treated with HSS scraper. Dry.	117,26	4,60	5,71	32,11	34,69
Nr. 7 Treated with HSS scraper, CH8.	115,17	3,75	4,64	28,91	33,03

- Ra is the average roughness, Rq is the root-mean-squared roughness, Rt is the peak-to-valley difference, and Rz is the average of the ten greatest peak-to-valley separations on the sample.

Sida 25 i vår guide

- Since ice is harder than PE in most temperatures and has a larger change in hardness as well one of the purposes of wax is to adjust the hardness of the sliding surface to match the hardness of the snow.

	Hardness
STAR Ski Wax (NA):	- Shore D
0°/-4°C	13,90
-2°/-6°C	28,40
-4°/-12°C	40,10
-8°/-20°C	48,60
P-Tex® 2000	64,20
P-Tex® 4000	67,30
P-Tex® 5000	68,60

Kan ett mjukare material härda den hårdare material?

- Men med tanke på att man ska många gånger ”mätta” sina skidor;
- Med tanke på olika värmelådor;

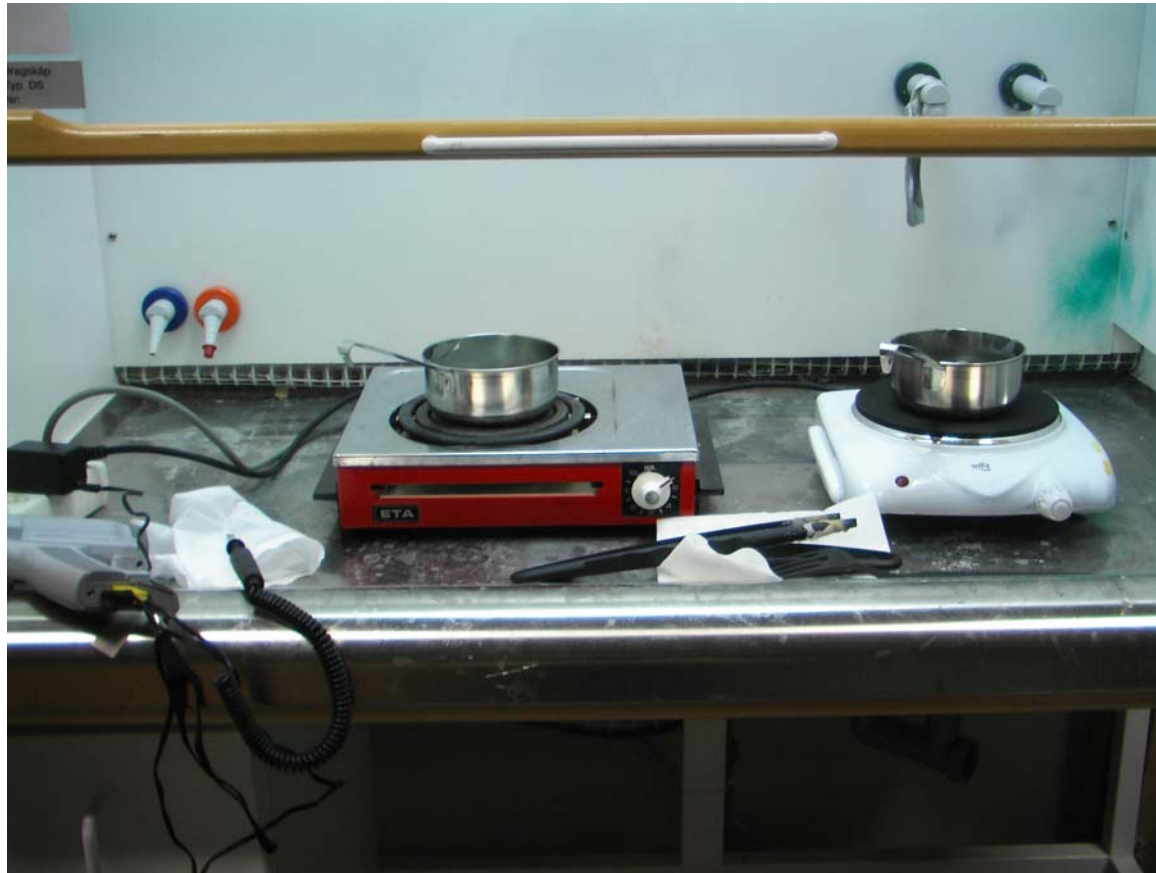


Vi bestämde oss
att genomföra ett
enkelt experiment

Ett simpelt experiment

Soft glide wax
STAR NA
0 - -4°C

Melted by
106°C



Hard glide wax
STAR NA
-8 - -20°C

Melted by
128°C

Ett simpelt experiment

- P-Tex[®] 2000 prover från den mjukglidvalla badet och Shore[®] S1 Portable Digital Durometer



Visuellt resultat

After 22 hours in soft glide wax
STAR NA 0 - -4°C melted by
 106°C



After 22 hours in hard glide wax
STAR NA -8 - -20°C melted by
 128°C



Parametriska resultat

	Hard glide wax STAR NA -8 - -20°C		Soft glide wax STAR NA 0 - -4°C	
	After 15 s		After 15 s	
Base	Hardness Shore D		Hardness Shore D	Weight [g]
Graphite	64,0		64,8	5,806
Transparent	62,2		62,0	5,467
	After 22 h		After 22 h	
Graphite	47,3		44,1	12,038
Transparent	47,0		57,2	7,012

Belaget blev mjukare och samtidigt väldigt skört.
Materialet blev helt obrukbar som ett skidbelag.

Det hemliga manuskriptet sida 15

Det er imidlertid viktig å merke seg at hvis man i stor grad smelter materialet og "fyller det" med parafinvoks, vil de mekaniske egenskapene (slitestykke o.a.) bli drastisk redusert.

- QED. Stämmer väldigt bra med vårt experiment

Sida 14 i vår guide

- During sliding, first the thin wax layer at the surface wears off, then the “stored” wax in the base is “sweating” due to a reversed diffusion process and supplies the gliding interface with lubricating material

Detta betyder att skidbelaget har lagrat glidvalla, som spenderas under loppet.

En enkel beräkning

Distance covered $D = 10 \text{ km} = 10^4 \text{ m}$

Ski breadth $b = 40 \text{ mm} = 4 \times 10^{-2} \text{ m}$

Glide wax thickness $h = 10 \text{ }\mu\text{m} = 10^{-5} \text{ m}$

Glide wax volume $D \times h \times l = 0,004 \text{ m}^3 = 4 \text{ l}$

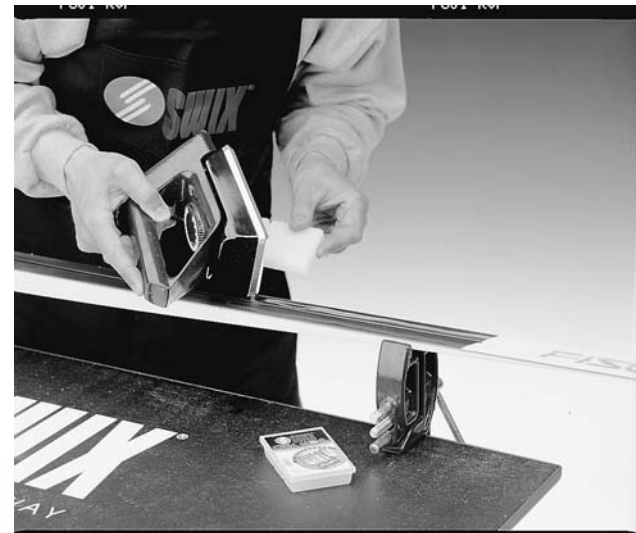
Vi behöver 4 liter glidvalla per en skida för att ordna en $10 \text{ }\mu\text{m}$ tjock paraffinhinna mellan skidbelag och snö. Är detta möjligt?



Det hemliga manuskriptet sida 16

Man tror at graden og hastigheten av denne "utsvettingen" har betydning for glien når det ytre vokslaget er slitt vekk. Da sikre undersøkelser om disse forhold ikke er utført, er man imidlertid henvist til spekulasjoner på dette punkt.

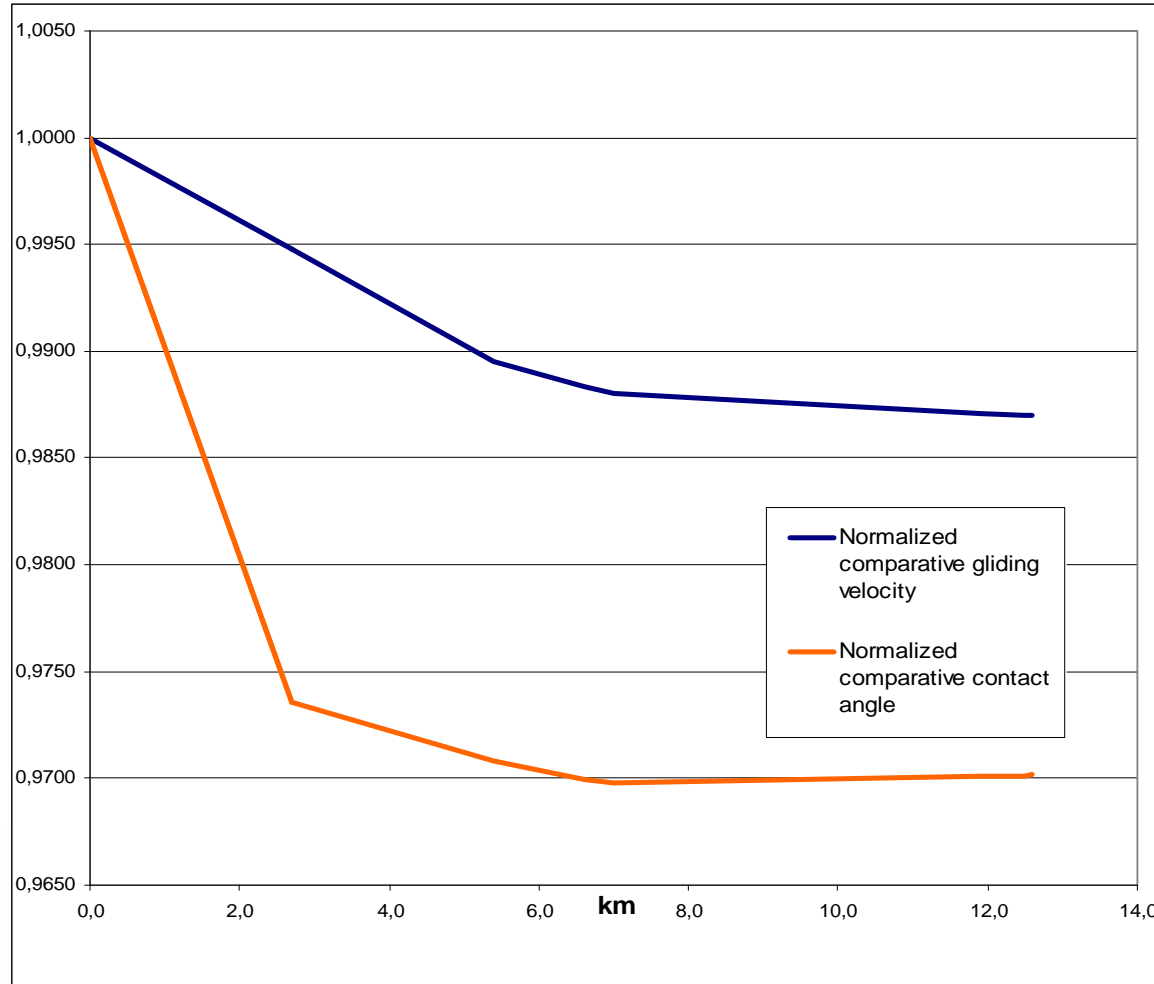
Med dessa (ovannämnda) kunskaper är det svart att förstå varför läger vi glidvallor på våra skidor.



Is stone grinding and waxing an optimum procedure?

- Dry stone ground surfaces have a low contact angle, much lower than the scraped surface ($104,83^\circ$ compared with $117,26^\circ$).
- Wax **has to be** applied to the stone grinded surface, that ever increases the attraction of dirt to the ski base.
- We may suppose that the manual scraping resulted in some kind of randomly rough surface.

Velocity and contact angle relative to distance on dry snow.

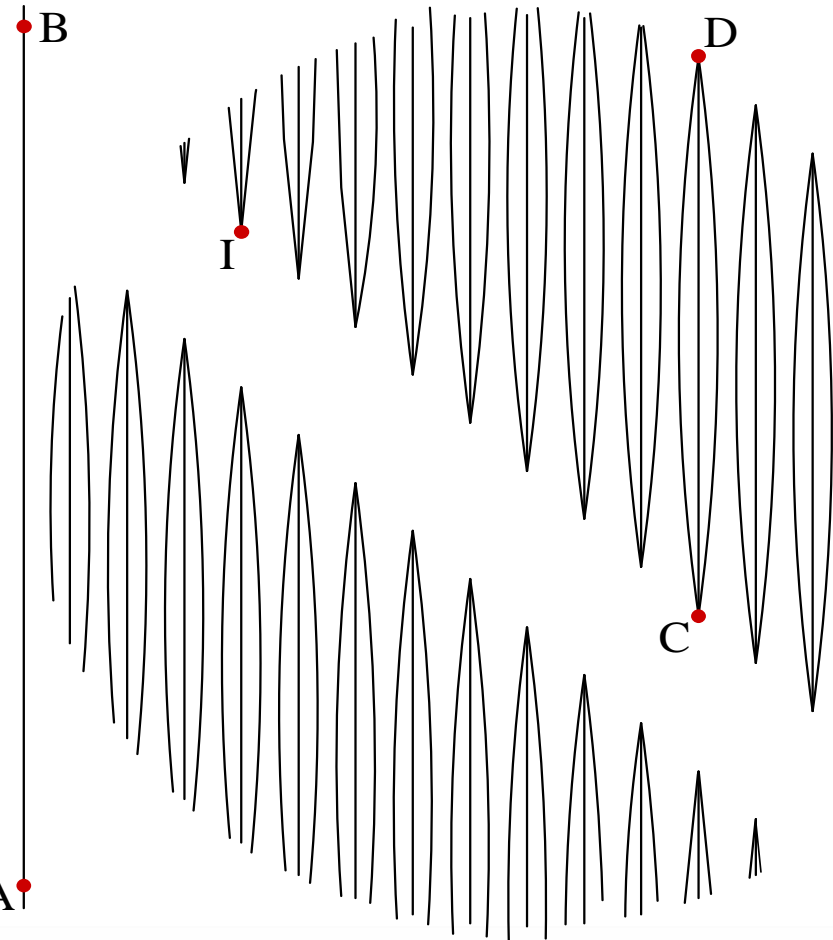


Discussion – dry snow.

- From our results we can draw the conclusion that the waxed (Star NA6) skis lose their glide ability faster than the reference skis (scraped skis).
- In (D.C. Sun, 1996) described accelerated ageing of UHMWPE at a heating rate of $0.6^{\circ}\text{C}/\text{min}$ to 80°C for either 11 or 23 days. This was considered to be equivalent to 4 to 6 or 7 to 9 years of ageing, respectively.
- From above we may see that heat impairs useful properties of the ski base.
- **Our hypothesis: the glide wax wears out quickly and then the ski running surface that has a poor glide ability gets in contact with the snow.**

Patterns orientation

- The minimum pattern element is always parallel to the long side of the ski, the line C-D is always parallel to the line A-B (long side).
- Ski wax technicians are talking about Λ -structure, V-structure and X-structure, but such structures (pattern) only exist as an optical illusion when many small elements follow line C-I, which is not parallel to A-B.
- A transverse structure should be beneficial at low temperatures, whereas a longitudinal structure should be better at high temperatures
- This limitation makes SG processing as deteriorative ski glide procedure under cold weather conditions.



Hälsoaspekten är mindre optimistisk

Exposure to Ski-Wax Smoke and Health Effects in Ski Waxers

M. Dahlqvist,^A R. Alexandersson,^A B. Andersson,^B K. Andersson,^B B. Kolmodin-Hedman,^C and H. Malker^D

^ADepartment of Work Science, The Royal Institute of Technology, Stockholm, Sweden; ^BNational Institute of Occupational Health, Research Department in Umeå, Analytical Chemistry Division, Umeå, Sweden; ^CDepartment of Occupational Medicine at the Karolinska Institute, Huddinge Hospital, Huddinge, Sweden; ^DNational Board of Occupational Safety and Health, Solna, Sweden

Downhill as well as cross-country skis have undergone revolutionary technical development in recent decades. Parallel with innovations in ski bottoms, new types of ski

mainly of tar has been replaced with waxes of paraffin supplemented by polytetrafluoroethylene (PTFE), silicone, and graphite. The method of application has also changed from common use nowadays

ly designed irons either out 130°C or adjustable to

good a glide in the track style—to get the skis to losing the glide. In Sweden 100 subjects are occupational. An intense smoke is applied to the skis. The iron temperatures. Usual waxing iron, leading to smoke.

egun to complain about of the eyes, nose, and y was to study the influence study was carried out championships for juven for one week in Feb-

ve male professional 1. Three were non-smokers and one had a pipe smoking

Foto: ERIK BERGLUND

per dag, and one had a pipe smoking



Smoke and Health Effects in Ski Waxers. *Appl. Occup. Environ. Hyg.* 7(10):689–693; 1992.

Paraffin wax (fume)

(CAS No: 8002-74-2)

Health-based Reassessment of Administrative Occupational Exposure Limits

Committee on Updating of Occupational Exposure Limits, a committee of the Health Council of the Netherlands



Pergamon

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TECHNICAL NOTE

FORMATION OF RESPIRABLE PARTICLES DURING SKI WAXING

Kaarle Hämeri, Pasi Aalto, Markku Kulmala, Esko Sammaljärvi, Erik Spring and Pekka Pihkala

University of Helsinki, Department of Physics, P.O. Box 9, FIN-00014 University of Helsinki, Finland

(First received 30 December 1994; and in final form 22 September 1995)

Abstract—The formation processes and the final size distributions of airborne particles produced by ski waxing with fluor-powder were investigated. For the present study the flow system for controlled production of inhalable particles from ski wax was constructed. The particle formation was studied as a function of time and temperature. The particle size distributions were obtained using both electrical (DMA) and optical method (OPC). The mean diameter of particles was some hundred nanometers and the mass concentration was found to be tens of milligrams per m³ in maximum.

Resumé

- Tyvärr, med tanke på allt ovannämnda fakta har vi inte så många alternativ för att få våra skidor glida bra. Men lyckligtvis det resterande alternativet är enkelt att utföra.



Så mycket belag går bort vid stålsicklingen

Ski base density $\rho = 1,0 \text{ mg/mm}^3$

Waste weight $w = 2812 \text{ mg}$

Waste volume $\frac{w}{\rho} = 2,812 \text{ cm}^3 = 2812 \text{ mm}^3$

Treated surface length $l = 1830 \text{ mm}$

Treated surface breadth $b = \frac{w}{l} = 40 \text{ mm}$

Surface skim thickness $x = \frac{\rho}{bl} = \frac{w}{\rho bl} = 3,8415 \times 10^{-2} \text{ mm} = 0,038415 \text{ mm}$

Så mycket (0,0384 mm) går bort vid första stålsicklingen på ca. 15 minuter. Ska man fräscha upp, då tar man bort bara ca. 0,001 mm.

Går det att hitta någon materielinnebörd av betydelse i dagens glidpreparering?



nr. 62 ROM Antal Zolt is in the lead



nr. 62 is caught up



abt 1 min. of descent



1'15'' of descent, but nr. 62 is still in the lead

Why 24 technicians and 8 millions NOK can not outperform one poor Romanian wax expert?

Credits

- Aftenposten
<http://www.aftenposten.no/nyheter/sport/langrenn/article1195443.ece> Foto: ERIK BERGLUND
- Toko USA http://www.tokous.com/thermo_bag.htm
- www.swix.no

Tack för visat intresse



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