Heat ageing
– test methods, precision and ageing ovens

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Heat ageing – Old ageing oven

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Cabinet ovens

Heraeus 5042

Heraeus 5060

Salvis TSW 60

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Ageing ovens

Cell ageing oven

Cabinet ageing oven

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Heat Ageing

Ageing test reproducibility

12 laboratories, ITP 1988	mean	s	R	(R)
Change in tensile strength, %	-18	5,3	15	83
Change in elongation at break, %	-40	5,8	16	40
Change in micro hardness, IRHD	-13	3,8	10	77

s= std deviation
R= reproducibility in actual units of measurements
(R)= reproducibility in %

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Investigations of ovens

- Temperature uniformity in time
- Temperature uniformity in space
- Air speeds
- Air exchange rates
- Ageing results in different ovens

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Temperature influence

Temperature tolerances in ISO 23529 are
± 1 °C up to and including 100 °C
± 2 °C 100 °C and up
± 2 h time tolerance at test times 1 week or longer

1 °C wrong temperature corresponds to 10 % in testing time at an Arrhenius factor of 2, or 15 % at a factor of 2,5.

This means that two laboratories can be 60 % from each other at a test at 125 °C and still be within the specification.

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Closer investigations of the factors

- Temperature
- Air speed

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Measured ovens

Heraeaus UT 5042

Heraueus UT 5060 E

Salvis TSW 60

Elastocon EB 01

Elastocon EB 04

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Temperature variations in time

Ovens	**5042**	**5060E**	**TSW 60**	**EB 01**	**EB 04**
°C	13,8	0,1	0,2	0,1	0,1

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Temperature variations in space

Location	5042	5060E	TSW 60	EB 01	EB 04
Inner	0,9	0,5	1,3	NA	0,4
Centre	0,7	1,7	1,3	NA	0,3
Outer	0,7	1,1	2,7	NA	0,2
Total	1,2	1,7	3,1	0,5	0,4

Values in °C

NA = not applicable

The table shows the difference between five points in each location and the total difference (all points all locations)

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Set, shown and actual temperatures

Temp	5042	5060E	TSW 60	EB 01	EB 04
Set	99	97,5	97,2	100,1	100,0
Shown	96-104	97,5	96,0	100,1	99,9
Actual	96-103	100,0	100,0	100,0	100,0

Values in °C

The ovens were set to 100,0 °C in the center of each oven.

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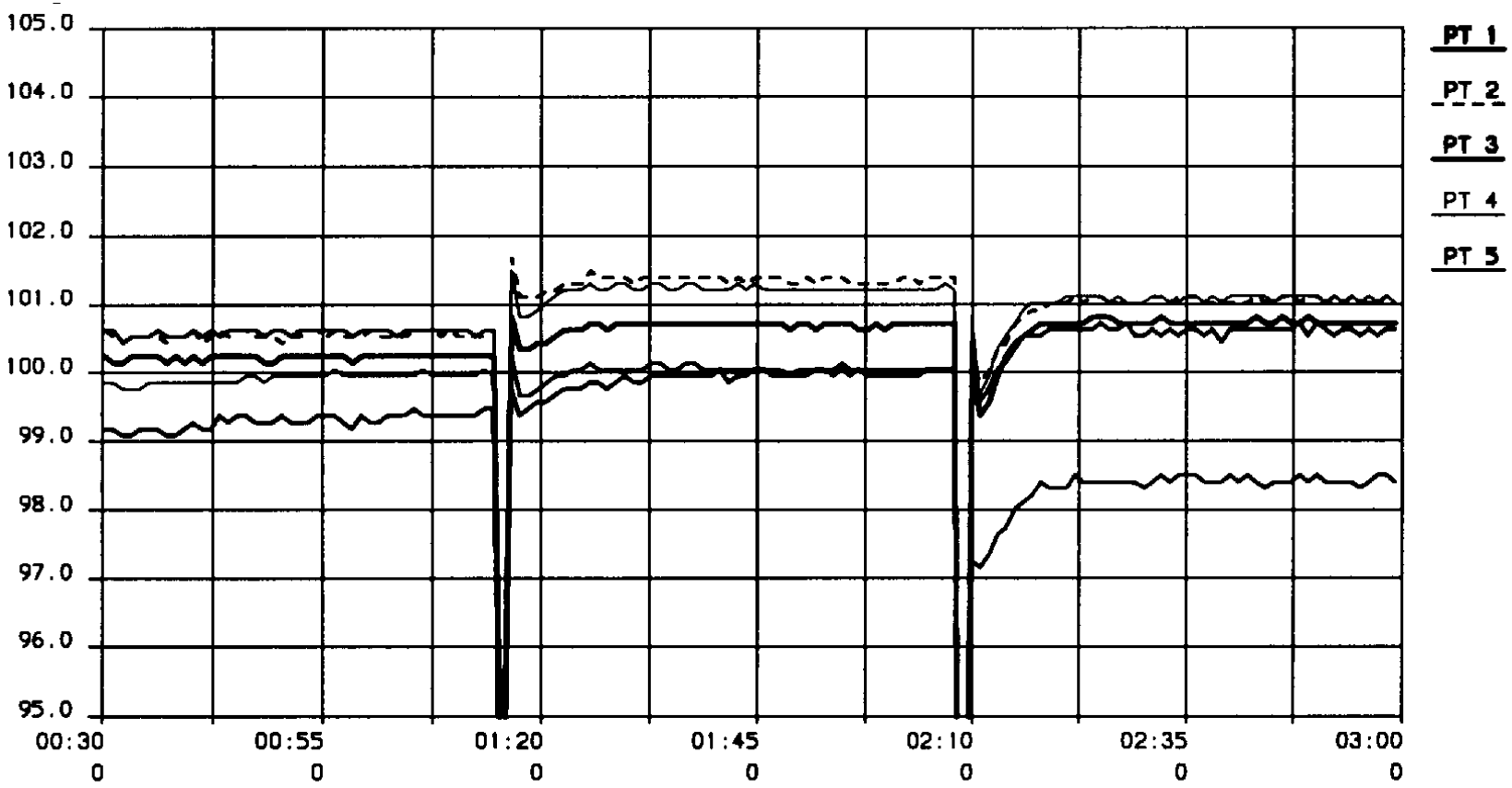
Salvis TSW 60



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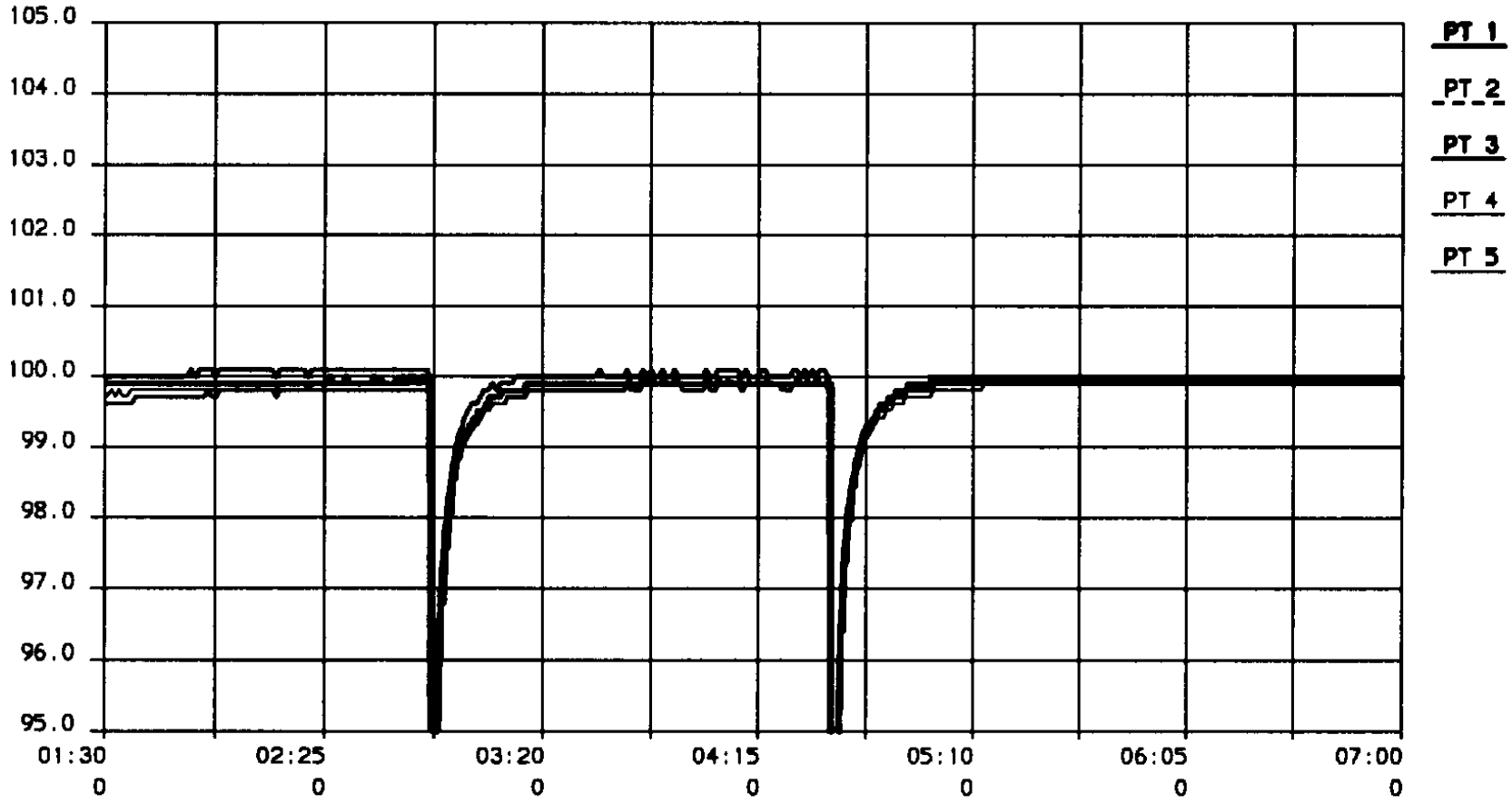
Elastocon EB 04



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Air speeds

Speed	5042	5060E	TSW 60	EB 01	EB 04
Min speed	0,5	0,0	0,4	<0,001	<0,001
Max speed	2,6	4,5	3,0	<0,001	<0,001

Speed in m/s

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Air exchange rates

Oven	5042	5060E	TSW 60	EB 01	EB 04
Open	~160	~40	~300	20	16
Closed	0	0	~20	0	0

Values in air changes per hour

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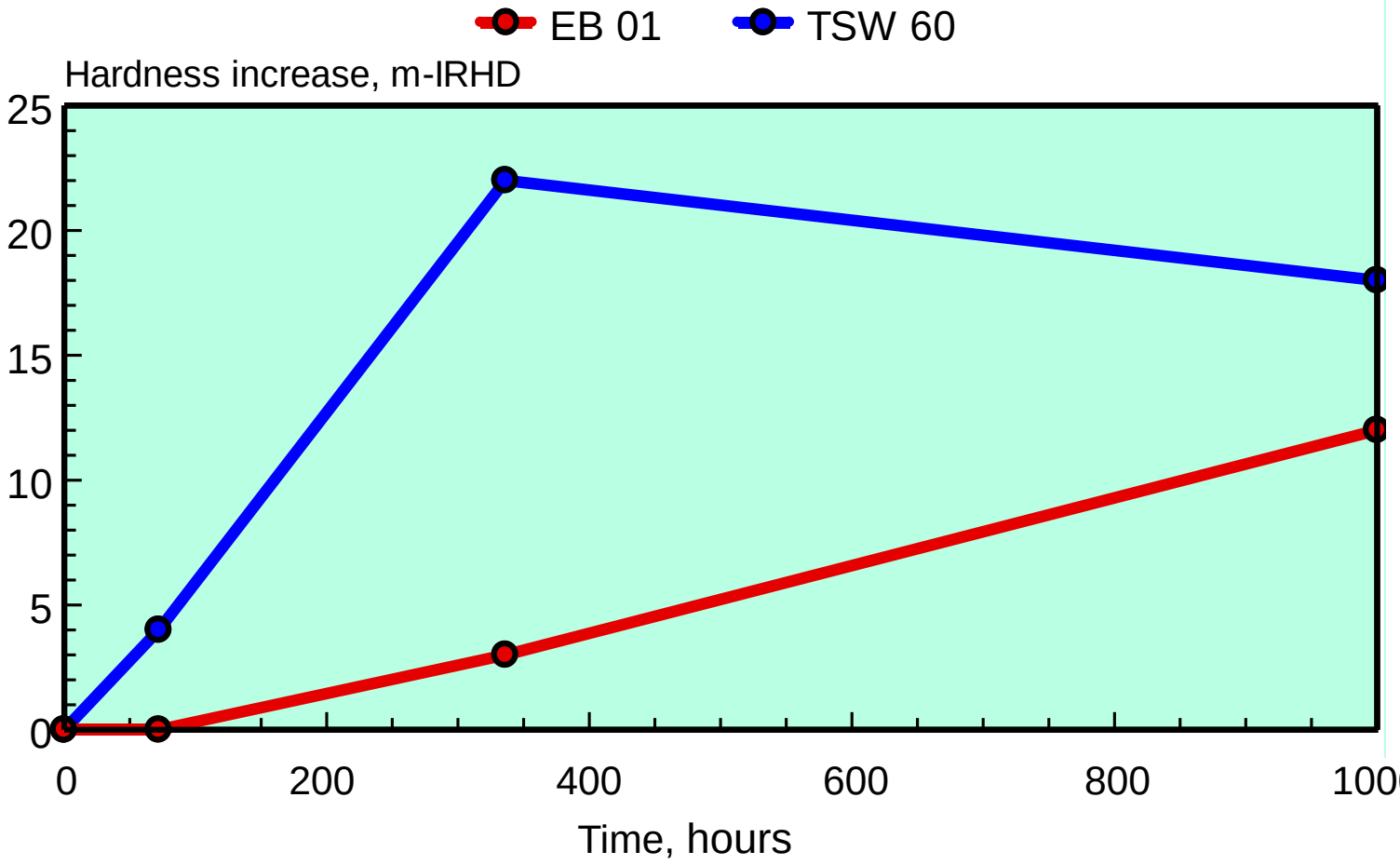
Ageing in different ovens

NBR/PVC at 100 °C



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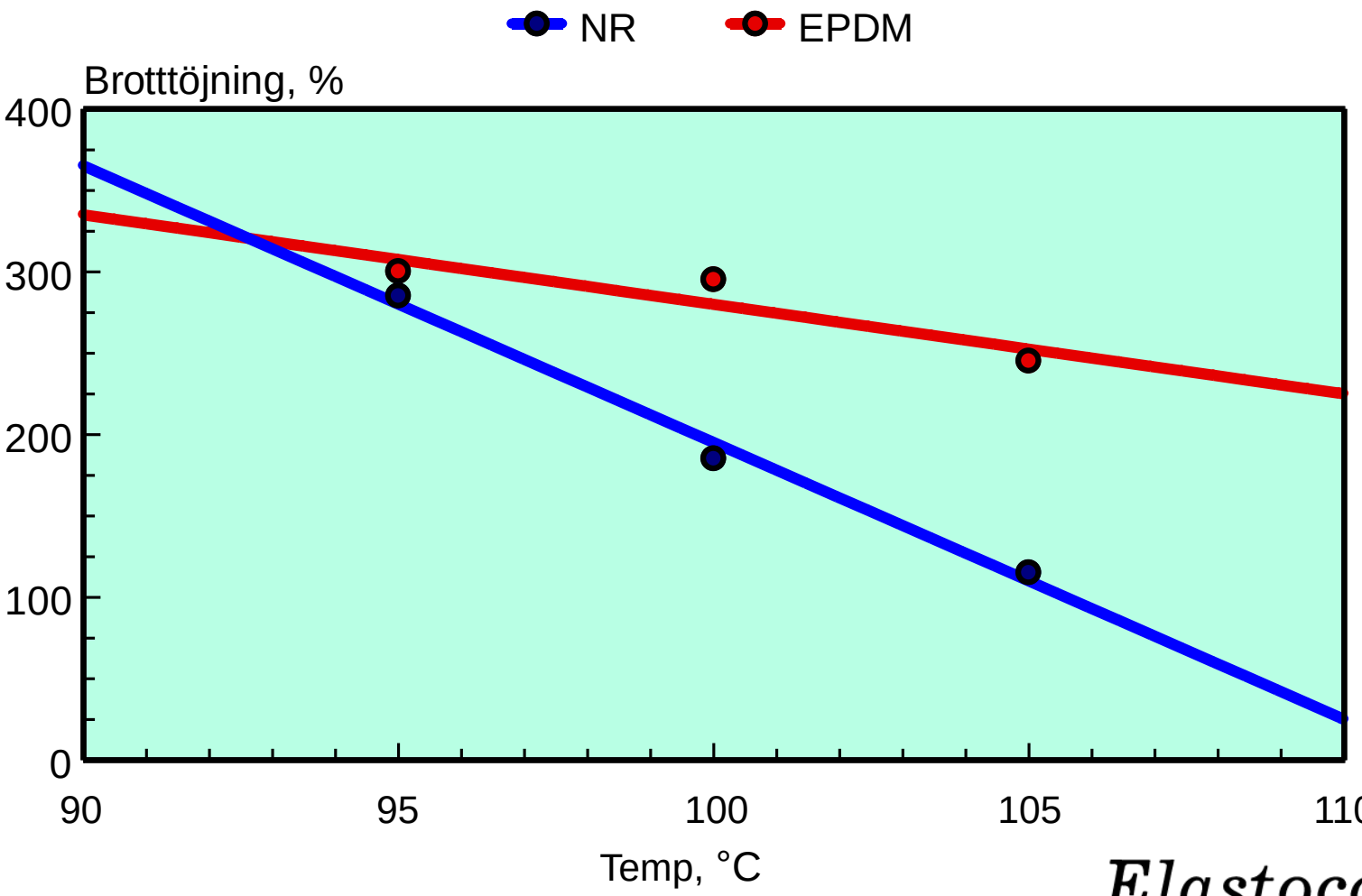
Ageing, different temperatures



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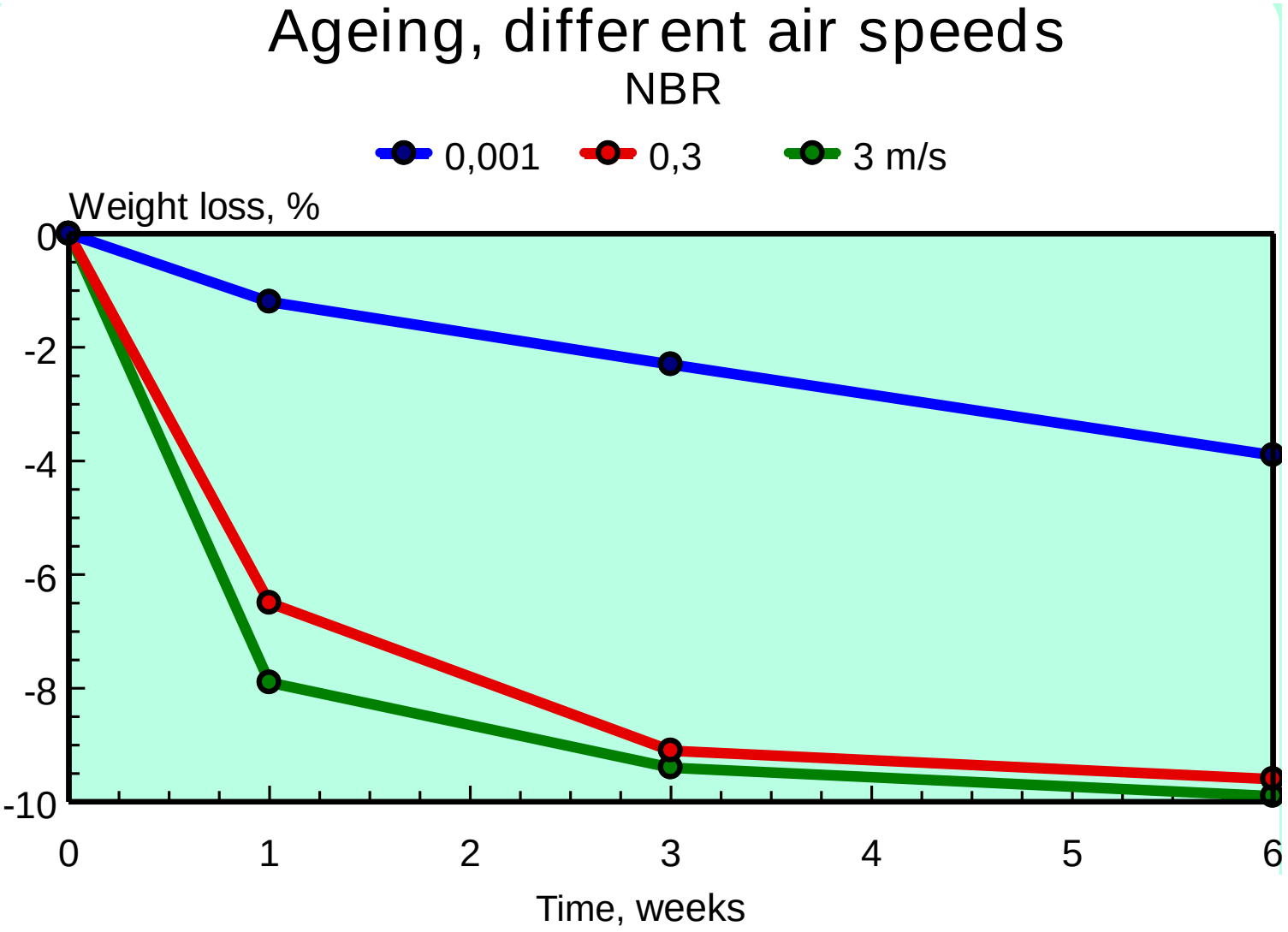
Ageing, different air speeds



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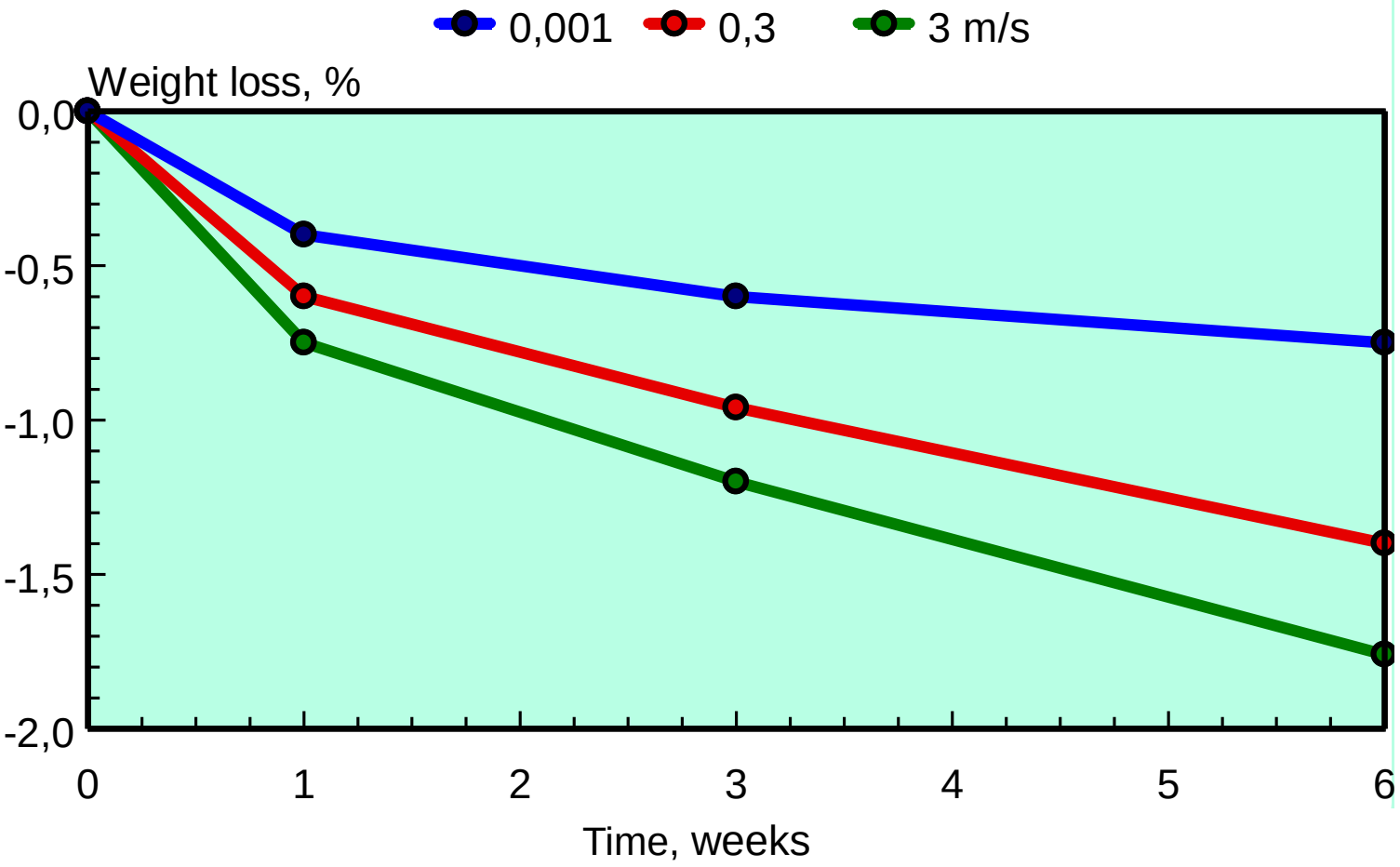
Ageing, different air speeds

EPDM



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Ageing test precision

10 laboratories, ISO ITP 1997	mean	r	(r)	R	(R)
Change in tensile strength, %	-7	8,5	121	11,7	167
Change in elongation at break, %	-24	9,2	38	12,2	50
Change in micro hardness, IRHD	-8,3	4,4	53	6,3	76

r= repeatability in actual units of measurements
r= repeatability in %
R= reproducibility in actual units of measurements
(R)= reproducibility in %

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Recent changes in ISO 188

- Method A clarified, no fans allowed in the test space
- Temperature sensor close to the samples
- Addition of method B1, oven with high laminar air
- Addition of method B2, oven with high turbulant air and a carousel
- Addition of a calibration schedule

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Comparison ageing ovens – lab ovens

Requirement	Ageing ovens	Lab ovens, heating, drying
Temperature accuracy in time	yes, high	yes
Temperature accuracy in space	yes	no
Specified air speed	yes	no
Specified air direction	yes	no
Specified air exchange rate	yes	no
Specified extra temp sensor	yes	no

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Summary

The results from the experiments made shows that the following factors are very important.

1. Temperature accuracy
2. Air speed
3. Air exchange rate

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Ageing ovens, second generation

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Testing with precision