STAINLESS STEEL IN THE SUN

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RT tensile testing, Standards

RT Tensile testing	Proof strength		After proof strength (2%)
Allowable test speed according to	Strain rate [(mm/mm)/s]	Stress rate [MPa/s]	Strain rate [(mm/mm)/s]
(Old EN 10002-1)	0.00025 – 0.0025	6 – 60	< 0.008
EN ISO 6892-1 (Meth A)	0.00020 – 0.00030 (R2)	N/A	0.0054 – 0.0080 (R4)
ASTM A370	< 0.00104	1.15 – 11.5	0.00083 – 0.0083
(Old EN) combined with ASTM	0.00025 – 0.001	6 – 11.5	0.0008 – 0.0080
EN-ISO combined with ASTM	0.00025 – 0.00030	N/A	0.0054 - 0.0080

HT tensile testing, Standards

HT Tensile testing	Proof strength		After proof strength (2%)
Allowable test speed according to	Strain rate [(mm/mm)/s]	Stress rate [MPa/s]	Strain rate [(mm/mm)/s]
(Old EN 10002-5)	0.0000167 – 0.000083	N/A	0.0003 – 0.0033
EN ISO 6892-2 Meth. A	0.000056 – 0.000084 (R1)	N/A	0.00112 – 0.00168 (R3)
ASTM E21	0.000050 - 0.000117	N/A	0.00067 - 0.0010
(Old EN) combined with ASTM	0.00005 - 0.000083	N/A	0.0003 – 0.001
EN-ISO combined with ASTM	0.000056 - 0.000084	N/A	No overlap

RT – HT – Remarks, Mill perspective

HT at RT
- Too time consuming for release testing

HT - Lower proof strength due to lower strain rate

RT – HT – Same test parameters

HT Tensile testing	Proof strength		After proof strength (2%)
Allowable test speed according to	Strain rate [(mm/mm)/s]	Stress rate [MPa/s]	Strain rate [(mm/mm)/s]
EN ISO 6892-1 Meth. A RT	0.00020 – 0.00030 (R2)	N/A	0.0054 – 0.0080 (R4)
EN ISO 6892-2 Meth. A HT	0.00020 – 0.00030 (R2)	N/A	0.0054 – 0.0080 (R4)

It´s possible to make the same ”standardised” test for both RT and HT!

Other combinations also available.

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New tests made at RT and HT

RT: Tested at strain rate 0.001/s up to 2% and then changed to 0.008/s

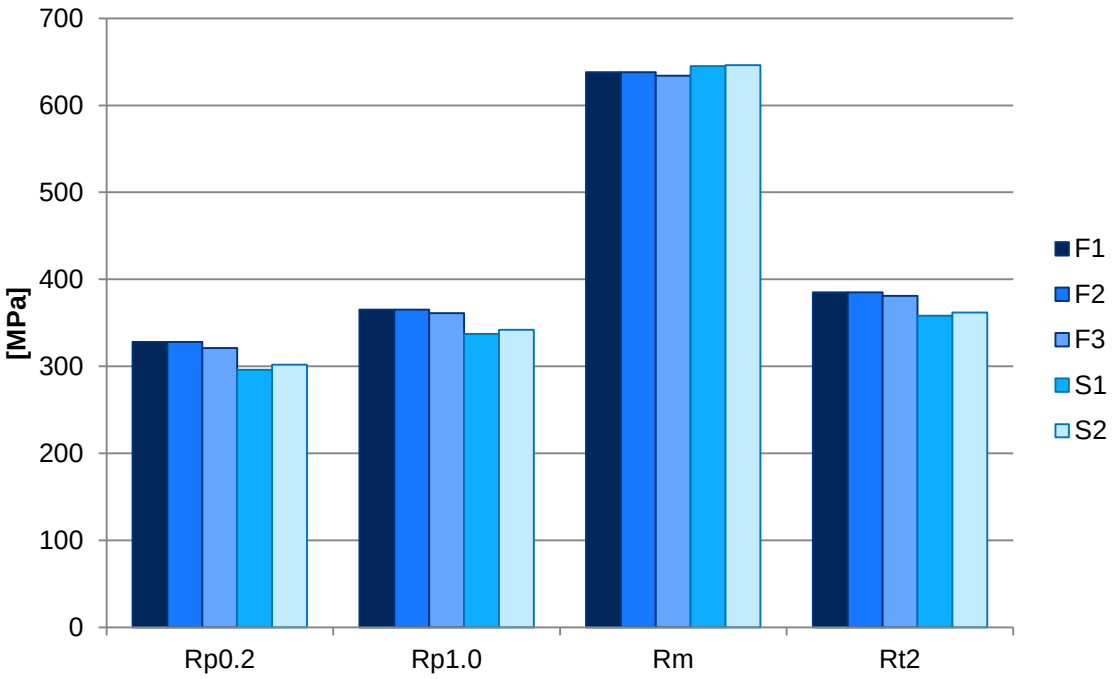
HT: Tested at strain rate 0.000083/s up to 2% and then changed to 0.001/s

Test parameters used at Outokumpu ARC.

Influence of testing speed 1.4301 at RT

	Rp0.2	Rp1.0	Rm	Rt2
RT (F)	326	364	637	384
HT (S)	299	340	646	360
Diff	-27	-24	+9	-24

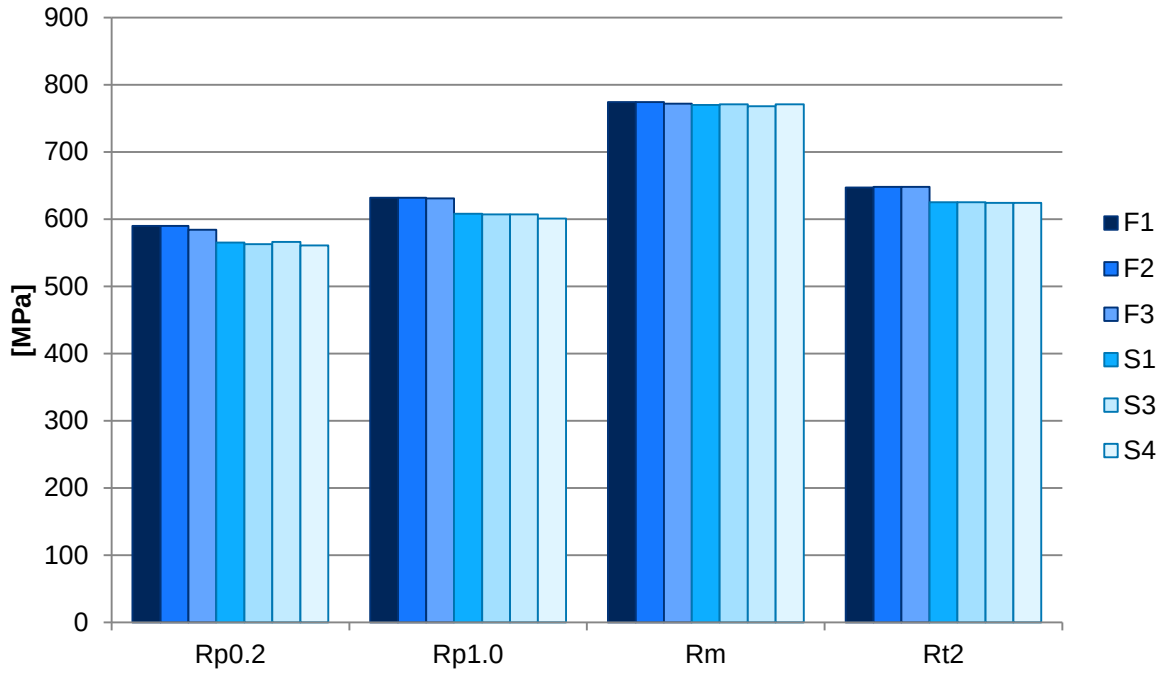
All in [MPa]



Influence of testing speed LDX 2101® at RT

	Rp0.2	Rp1.0	Rm	Rt2
RT (F)	588	632	773	648
HT (S)	564	606	770	625
Diff	-24	-26	-3	-23

All in [MPa]



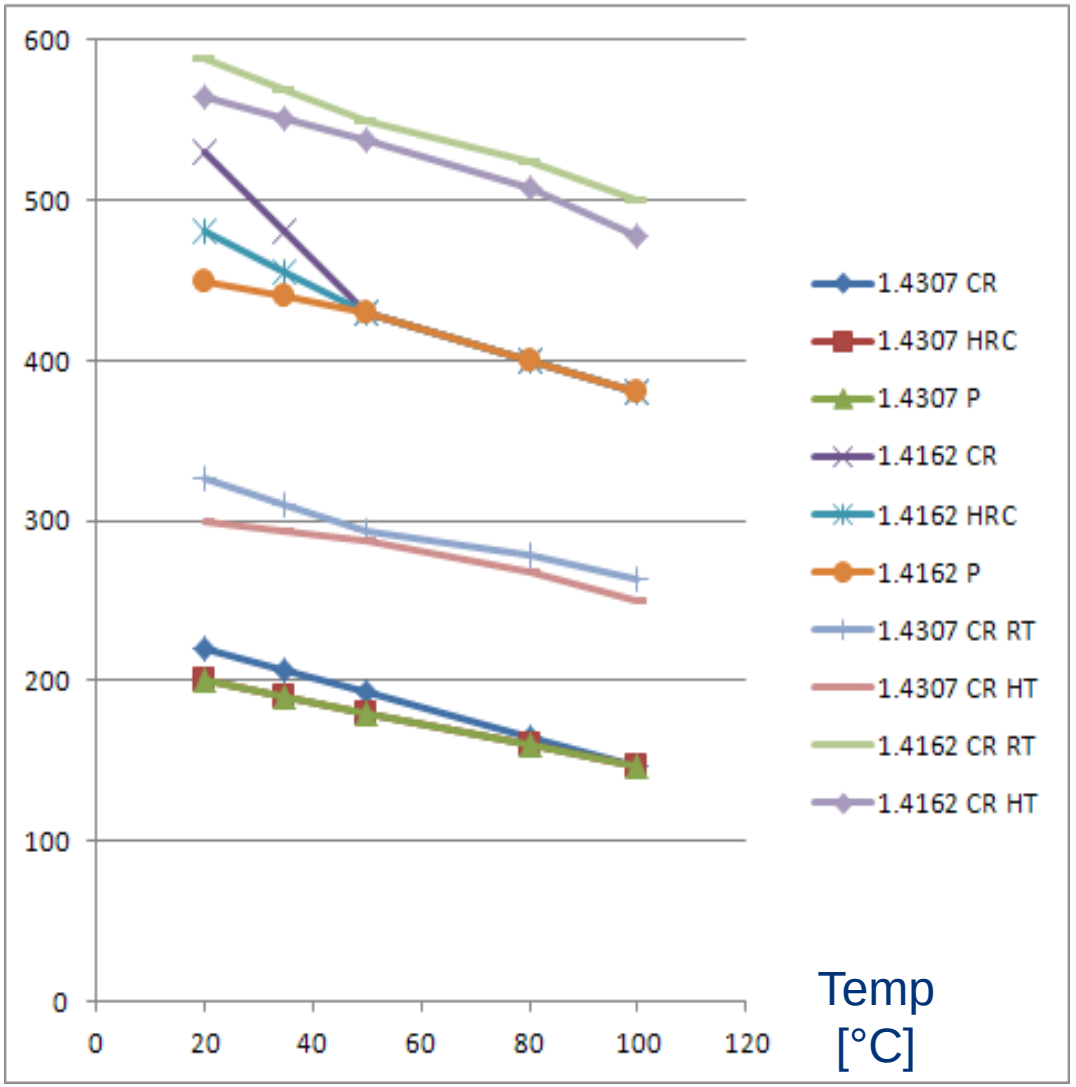
Influence of testing speed

Difference in $R_{p0.2}$ roughly 25 MPa less for HT compared to RT in the tests.

According to experience: in the range 20 – 40 MPa and Rm not influenced.

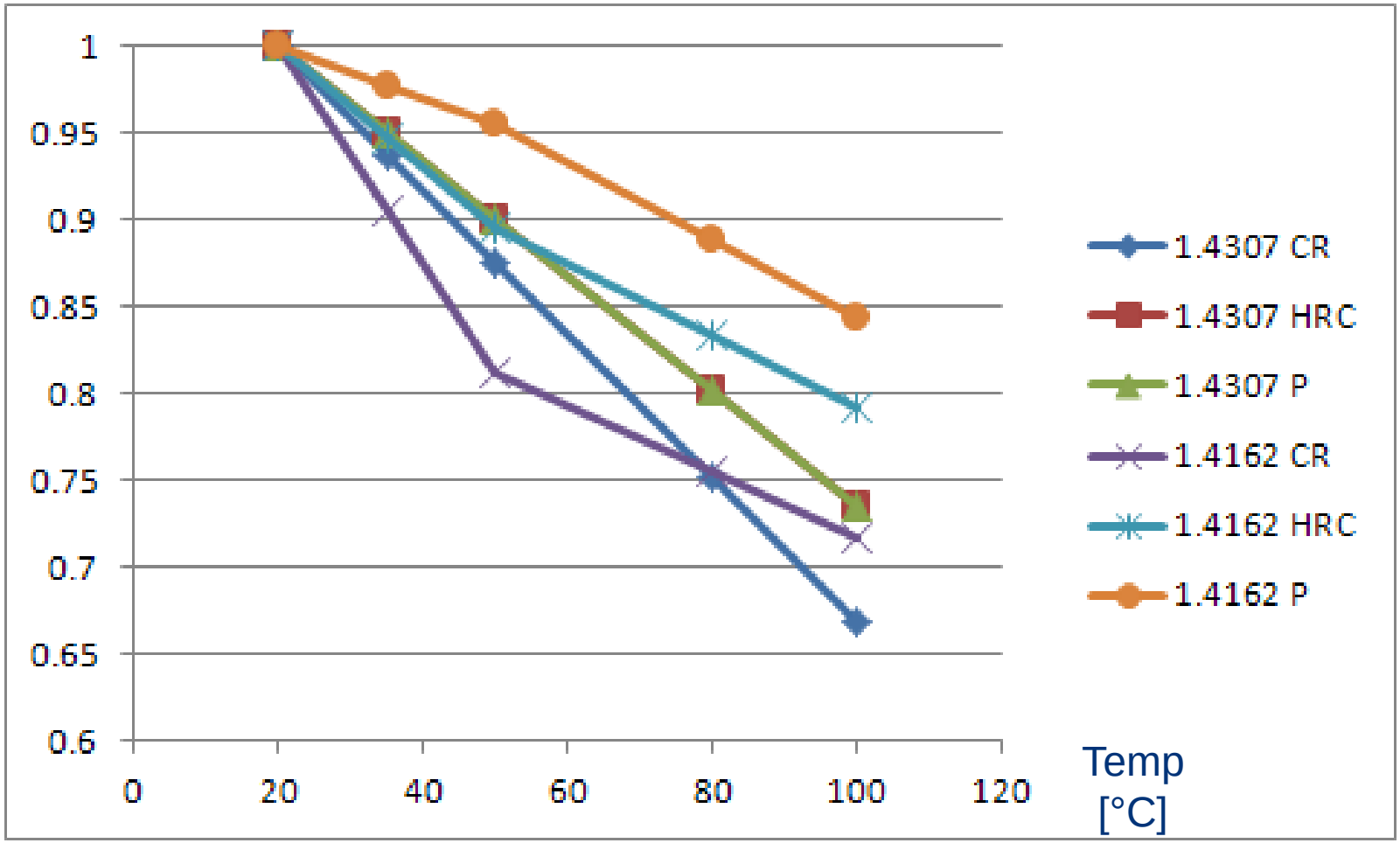
RT – HT ”In the Sun”, EN + tests

$R_{p0.2}$ [MPa]

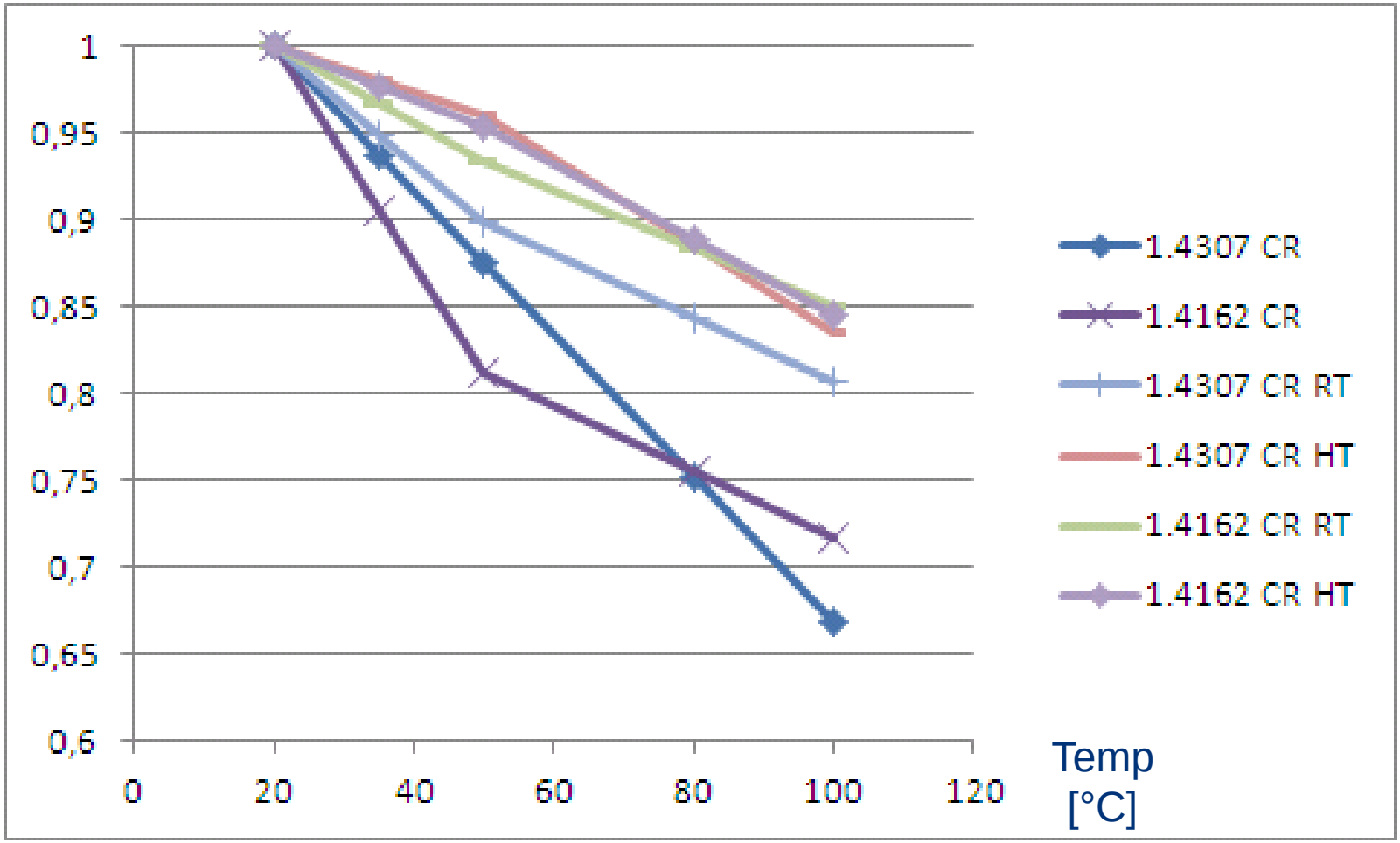


No HT-data for 1.4162 or other Duplex in EN 10088-4 !

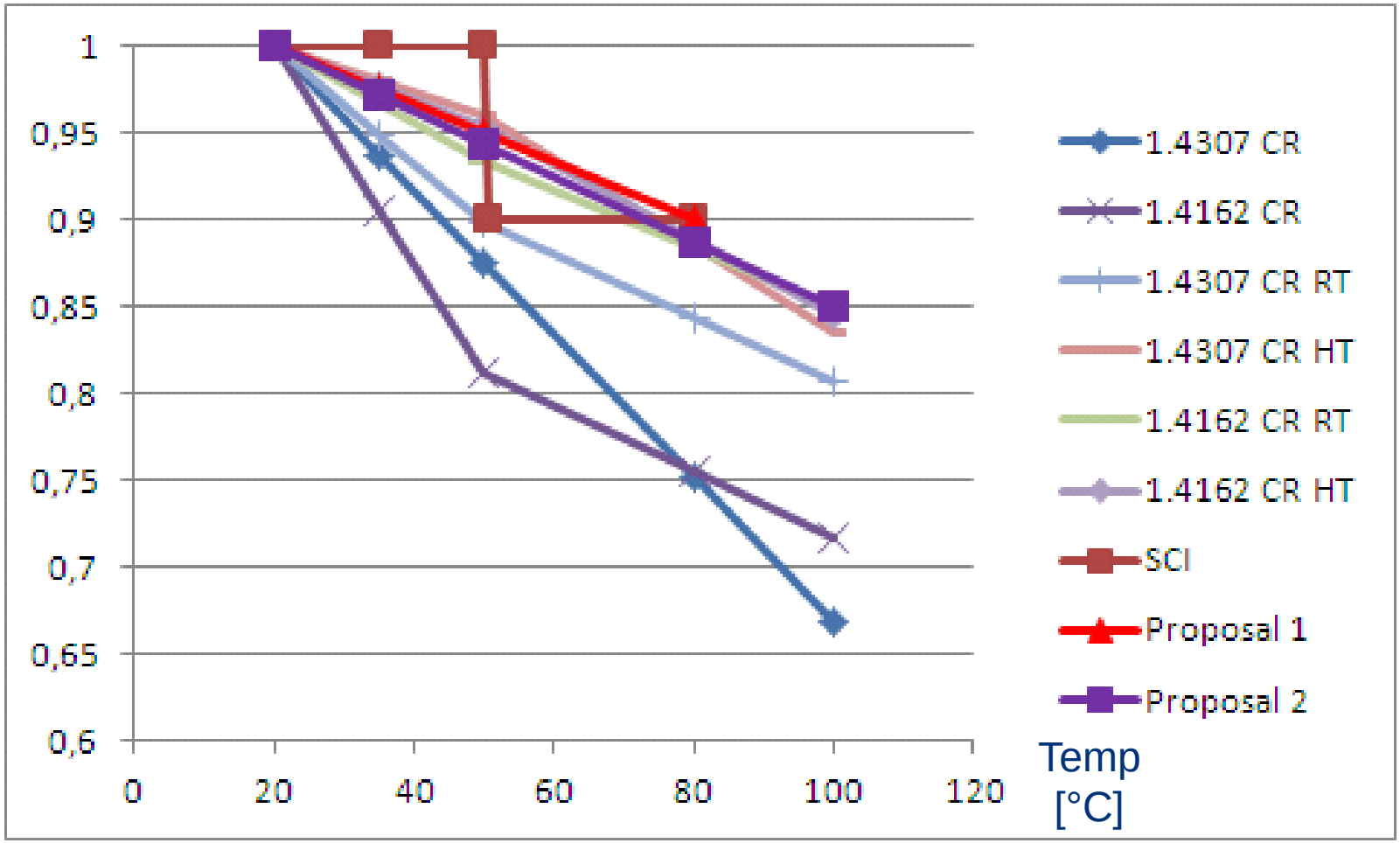
RT – HT ”In the Sun”, Retention, EN



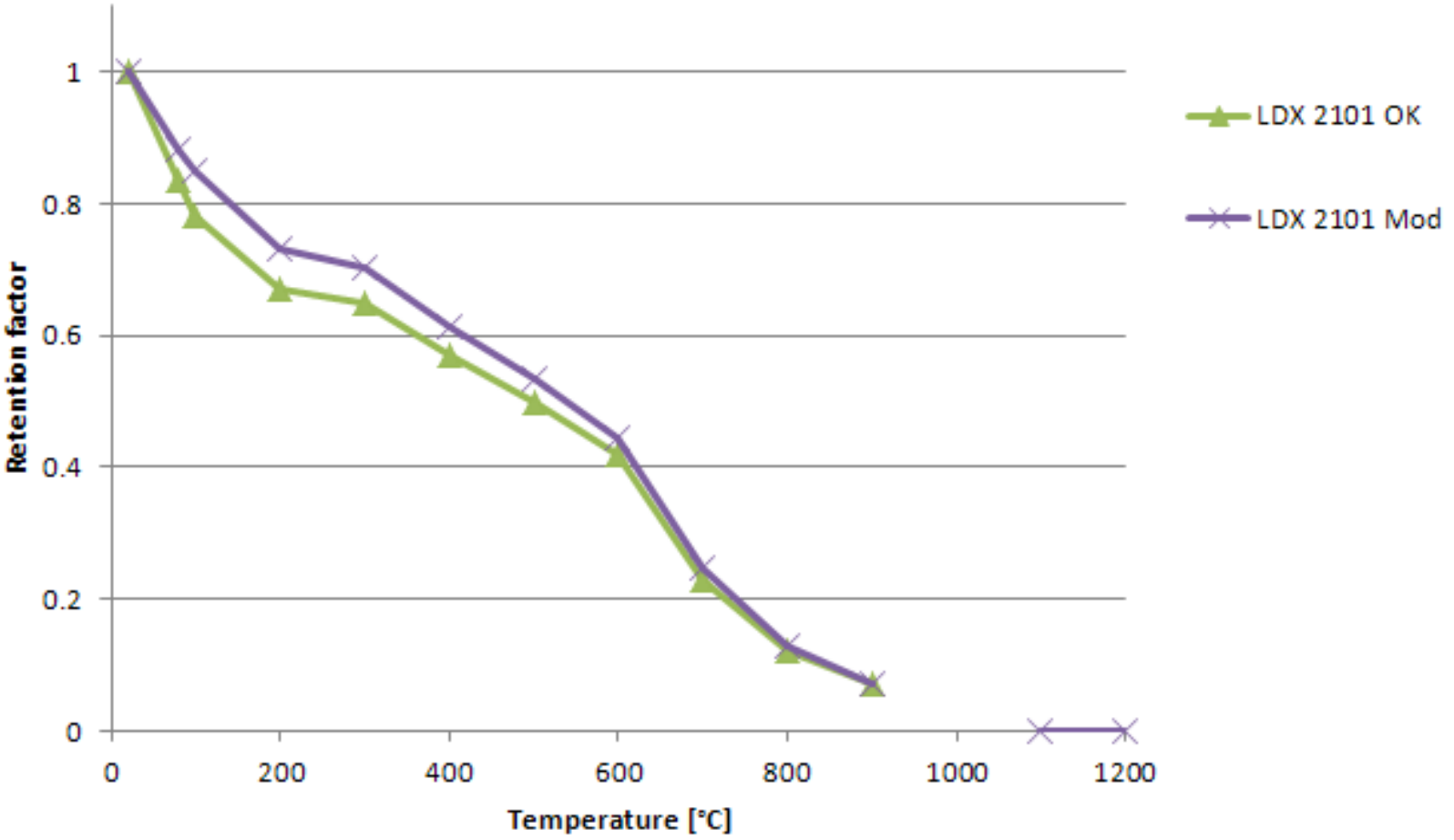
”In the Sun”, Retention, CR EN - Testing



Retention, CR EN – Testing - Proposals



Correction: Fire Design Curve, 1.4162



Conclusions ”In the Sun”

1. The drop in strength from RT to +35/50°C is a consequence of the test standards.
2. Standardized HT testing is a mess! (ISO)
3. Test “In the Sun” with own procedure using same parameters. Let this be separated from HT-testing/data. Keep as a separate issue!
4. Make proper design curve to new and old data based on steel type/grade. Three possibilities at least. To be further discussed.
5. Retention increase 0.15 at 80°C and between 0.08 – 0.15 at 50°C. (Prop 1 & 2) Significant improvement.

Thank You!

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