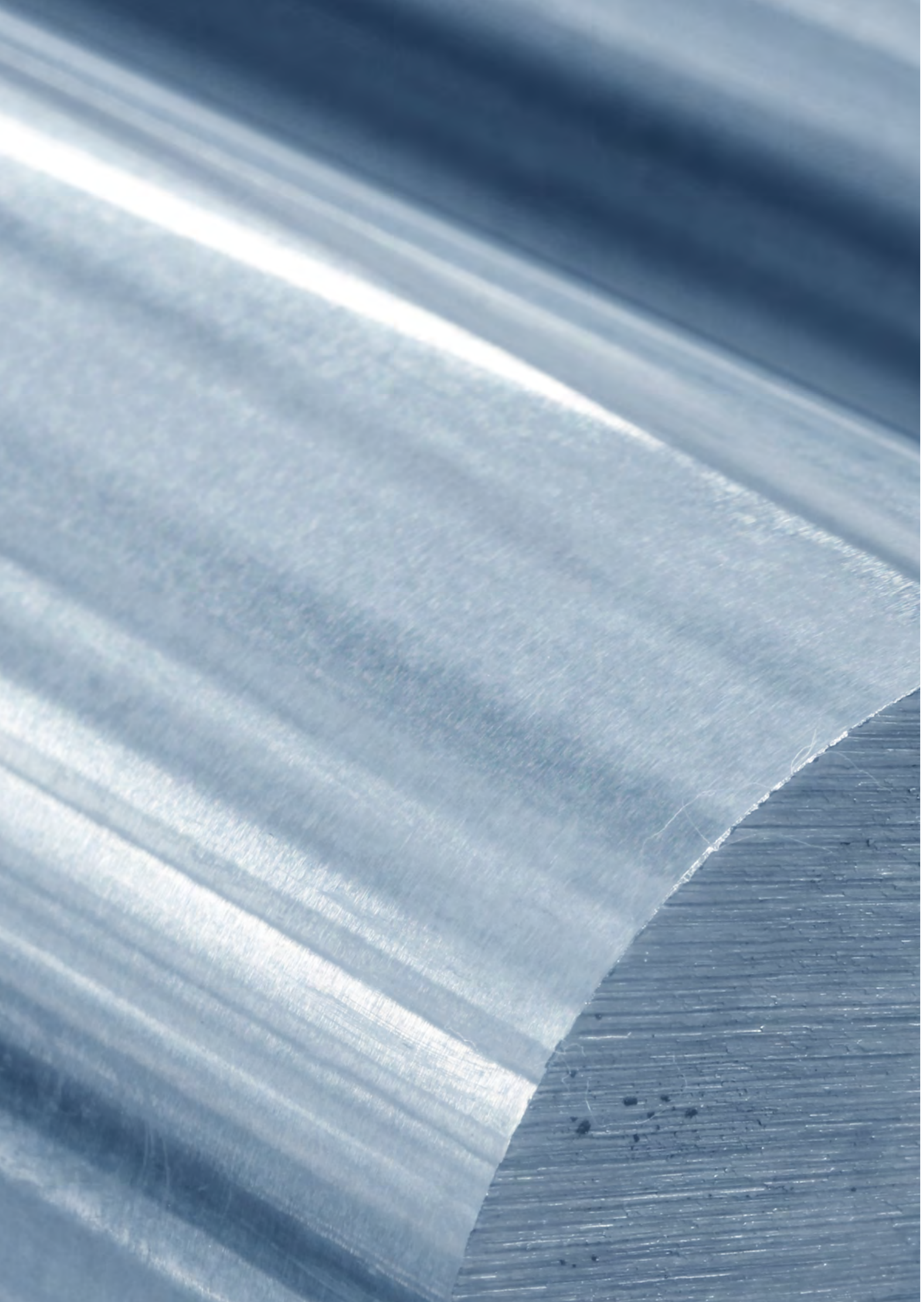
6060 MAXIFLOW BILLET
PRODUCT DATA SHEET

Ultimate productivity exceeding
6060 T66 strength

≥240 MPa

Tensile Strength, 12-14 HW



Product description

Maxiflow alloys are a new range of High Speed 6000 series extrusion alloys developed by RUSAL. Maxiflow alloys offer an optimum combination of extrusion speed and peak aged mechanical properties. 6060 Maxiflow alloys are heat treatable Al-Mg-Si alloys that are designed for maximum extrusion speed while still meeting the highest strength requirements such as EN 755 6060-T66. Peak aged mechanical properties are comparable to those of 6063 alloy. 6060 Maxiflow alloys have excellent surface finish by all surface finishing treatments, including anodizing. These characteristics are appropriate for architectural end uses as well as a variety of other end uses.

Types of 6060 Maxiflow billets

Type	Feature of each category
Type1	6060 Type 1 was developed for high speed extrusion of solid & hollow shapes which require excellent surface finish at "as extruded" as well as after anodizing treatment. This alloy is designed to be robust and is tolerant to process variation such as slow quenching, variable natural aging time and short aging. The chemical composition complies with Marine requirements for filiform corrosion. Target Magnesium content of this alloy is 0.40wt%.
Type2	6060 Type 2 was developed for higher extrusion speed of solid and hollow shapes while still being compliant with the stringent standard requirements such as EN 755-2 T66 temper. Target Magnesium content of this alloy is 0.37wt%.

Recommended condition at extrusion operation

In order to produce desirable extruded products the following conditions are recommended to be carefully controlled and monitored during the extrusion operation

Billet condition, prior to processing
Billet surface should be clean without any foreign materials, e.g. sand, mud & any other substances, for minimizing the cause of surface defects on the extruded shape and for avoiding the damage to the die bearing which will make the die life shorter.

Starting procedure with new die
As it is not easy to get a uniform temperature in the whole die, ideally within 5ºC, by regular die heaters, it is recommended to extrude 1-2 billets hotter than usual (480-500ºC) for making the die temp uniform. Then start the extrusion operation with regular preheat temp & extrusion speed.

Preheating with Induction heater or gas-fired furnace

a) Induction heater
Prior to extrusion, billet should be preheated to approx.420-480ºC, depending upon the die shape with the taper heat of 0.5ºC/cm.(Front temp should be higher than Back-end)

b) Gas-fired furnace
Under longer preheating at 400ºC or higher, a lot of ß-Mg_2Si would be precipitated and would have a negative influence on the Mechanical properties & Anodizing response. Therefore, preheating times longer than 20 mins in Tunnel type preheater should be avoided with the best efforts.

c) Re-use of billet with longer preheating at 350-450ºC
If billet is kept longer than 60 mins at 350-450ºC, billet should be heated up to over 500ºC for 30 mins at minimum for dissolving ß-Mg_2Si, for avoiding the negative influence of ß-Mg_2Si to Mechanical properties (lower mechanical properties) & Anodizing response (dull surface finish after anodizing).

Container temperature
The container temperature should be maintained in the range of 25-50ºC lower than the billet temp after preheating since:

a) In case of 0-25ºC lower:
Container wall is not cool enough and billet skin would not be kept in the dead zone/ into the butt discard and will tend to flow into the extruded product through the back-end as "Back-end defects".

b) In case of more than 50ºC lower:
Excessive heat loss can occur through the Container wall. The press exit temperature would not increase as expected and there would be a higher risk of the die exit temperature not reaching 500ºC resulting in poor Mechanical properties & slower extrusion speed.

Extrusion speed
As maximum extrusion speed is strongly influenced by the Die shape, it should be judged/controlled by the surface appearance of the extruded shape & Die exit temperature which should be maintained in the range of 500ºC (min) – 580ºC (max) & 500 - 550ºC (preferable for surface finish).

Die exit temperature
Die exit temperature should be measured/ monitored with a thermocouple or a contactless pyrometer for ensuring mechanical properties. Die exit temp should be kept in the range of 500ºC (min) – 550ºC (preferable), 580ºC (max) with an adequate cooling speed after die exit for achieving good mechanical properties by aging operation. 500ºC at Die exit is an acceptable minimum exit temp to ensure that all of the Mg-Si goes into solid solution, which will ensure optimum mechanical properties & uniform anodizing response assuming cooling rate after die exit is sufficient. Temperatures lower than 550°C are best for ensuring the best surface finish.

Cooling after Die exit
Adequate cooling speed after Die exit is essential to produce good extruded products in terms of Mechanical properties, Anodizing response, Bending characteristics & Machinability.

Recommended cooling speed is > 1.5ºC/sec, with a minimum 1.0 ºC/sec between 500ºC and 200ºC at the extruded shape. This cooling speed can be achieved with high volume/low velocity fans along the Press run-out table, but Water mist cooling might be needed on thicker/hollow section.

Straightening
Approx. 0.5% of Stretching is recommended for Straightening, while over 1% of Stretching might result in Orange peel surface finish on the product.

Aging treatment
In order to achieve Maximum mechanical properties & good anodizing response, a very fine dispersion of ß" MgSi should be precipitated after the aging treatment as much as possible.

The following process is recommended to achieve this:

a) Natural aging (keeping As-extruded product at Room temperature)
Natural aging for 8 hrs, even 24 hrs, is effective to achieve fine/uniform ß"-MgSi precipitation during Artificial aging in the Aging furnace.

b) Artificial aging (aging Extruded shape around 170 - 200ºC for 2 - 8 hrs)
In order to precipitate fine & uniform ß" MgSi in the As-extruded shape, the Extruded shape after Natural aging is artificially aged in the aging furnace. Generally lower temperatures & longer aging time achieve finer/ more uniform ß"- MgSi precipitation, resulting in higher mechanical properties. Higher temperatures & shorter aging times have the opposite effect, as shown in the Aging curves attached in the reference. In addition slower heat up times (in excess of 1 hour) will promote higher peak aged strengths.

Typical Mechanical properties for Type 1 & 2
Following table shows typical mechanical properties with Type 1 & 2 billets in peak aged condition.

Type	Tensile strength	Yield strength	Elongation	Hardness (Webster"B")
Type1	240 MPa	210 MPa	13%	13-14 HW
Type2	230 MPa	200 MPa	13%	12-13 HW

NOTE:

(1) Samples used for the measurement
Thickness: 3.2 mm or less
Process: Forced air-quench and artificially aged.

(2) Hardness conversion table
Although Hardness chart is made by Webster "B", Hardness by other scale are shown in the table, attached in the reference.

Recommended procedure & check-points for Anodizing, Bending & Welding process

Following is brief recommendation for Anodizing, Bending & Welding operation.

Anodizing
Anodizing treatment should be made as soon as possible after the Aging treatment, preferably within 12 hrs. Prior to the Anodizing treatment, the shapes should be kept clean, at ambient temperature and in a low humidity area as much as possible. In particular Acidic/ Alkaline environments should be carefully avoided.

Bending
In order to obtain good bending characteristics, the following steps are recommended.

a) The recommended timing is to bend the extruded shape within 8 hrs after extrusion, before Aging

b) If the bending has to process over 8 hrs after extrusion, the stabilization with the condition of 165ºC x 2 hrs is recommended to avoid the natural strengthening process. By this procedure, the characteristics of predicable spring back would be obtained at any time.

c) After bending, the shapes can be aged to obtain the maximum mechanical properties by normal artificial aging.

Welding
Al extruded shapes can be joined by various welding procedure, eg Arc, Gas & Resistance spot welding.

Regarding Filler alloy, 5000 series filler alloy is recommended, though 4000 series Filler alloy can also be used.

When detailed information is needed, “The Al association welding book” is recommended.

REFERENCE:

1. Trend of Aging curves for Type 1 & Type 2
Typical aging curves for Type 1 and Type 2 are shown in the reference. Note the aging curves were obtained after separate solution treatment and quenching prior to aging. Aging treatment parameters should be selected using these charts according to customer requirements.

2. Hardness conversion chart
Hardness conversion chart of Webster “B”, Rockwell “E”, Rockwell “F”, Vickers HV is shown in the Table, attached.

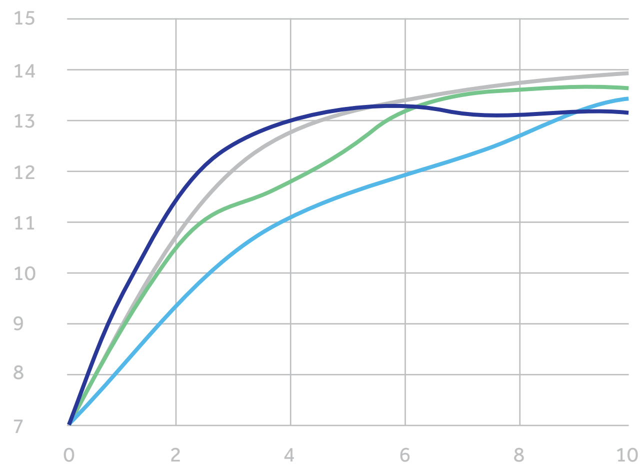
REFERENCE 1:

Mechanical Properties VS Aging condition for 6060 MF T1*

*All aging curves were created from the profiles sample which were produced in real extrusion process

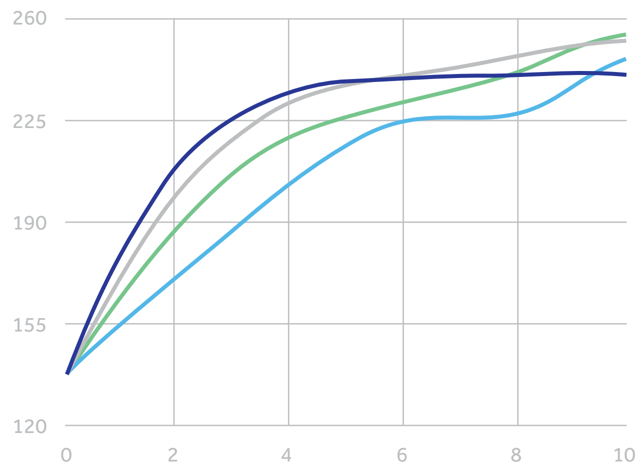
HARDNESS — WEBSTER

Hardness, HW; Holding time, hr



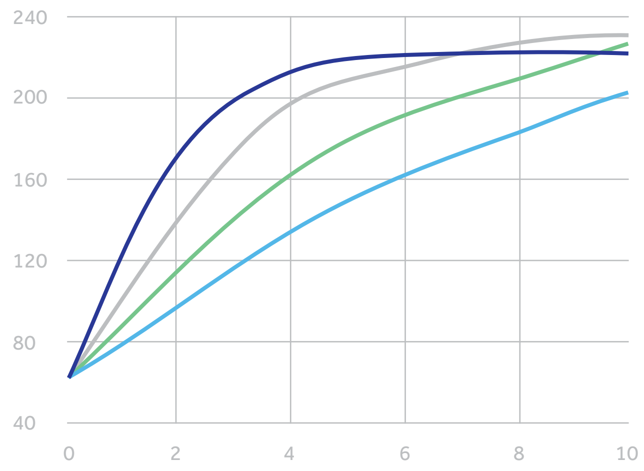
TENSILE STRENGTH

UTS, MPa; Holding time, hr



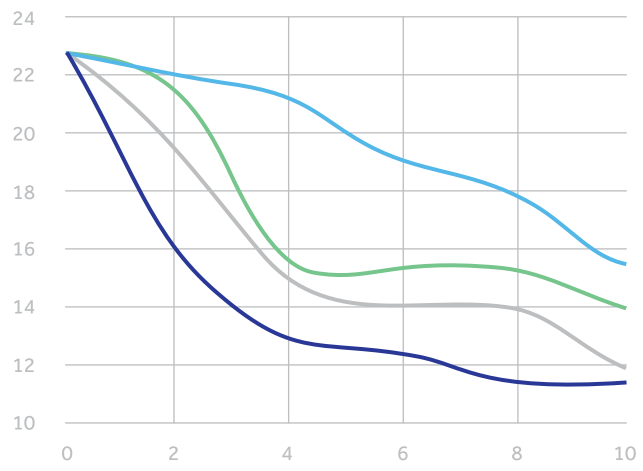
YIELD STRENGTH

YS, MPa; Holding time, hr



ELONGATION

EL, %; Holding time, hr



160 170 180 190

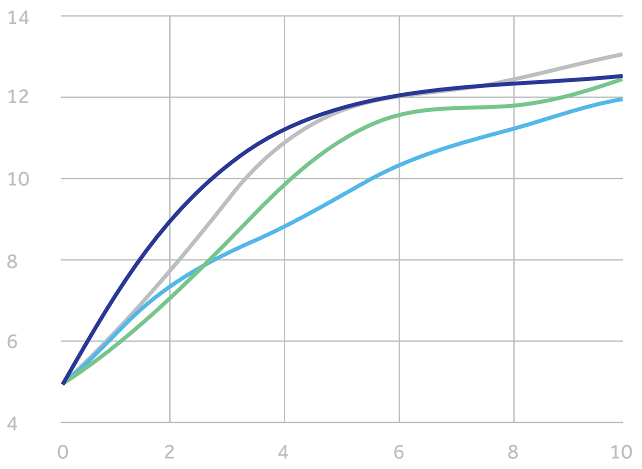
REFERENCE 1:

Mechanical Properties VS Aging condition for 6060 MF T2*

*All aging curves were created from the profiles sample which were produced in real extrusion process

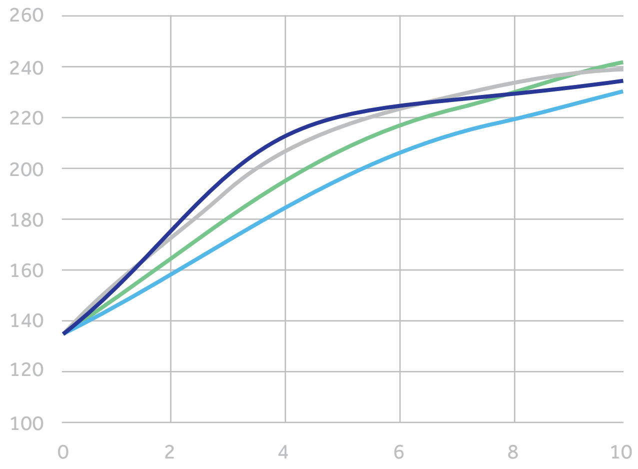
HARDNESS — WEBSTER

Hardness, HW; Holding time, hr



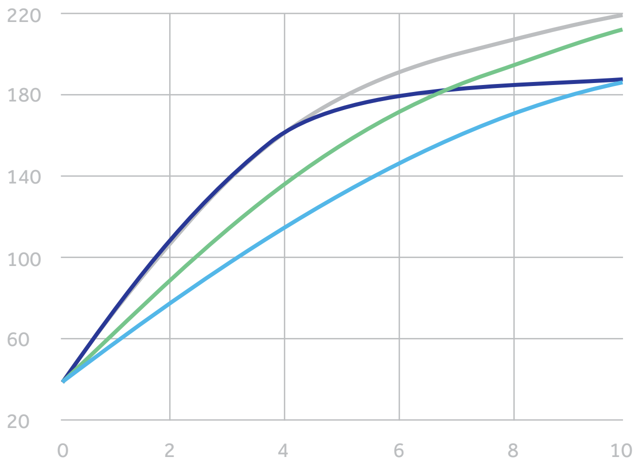
TENSILE STRENGTH

UTS, MPa; Holding time, hr



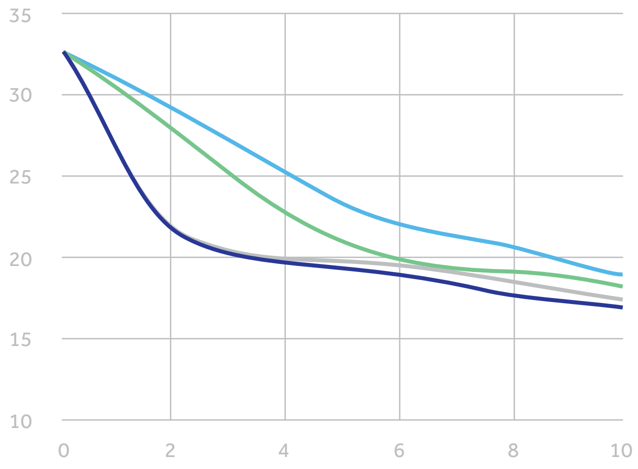
YIELD STRENGTH

YS, MPa; Holding time, hr



ELONGATION

EL, %; Holding time, hr



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REFERENCE 2:

Hardness Conversion Table

WEBSTER HW	ROCKWELL E HRE	ROCKWELL F HRF	VICKERS HV	BRINELL HB
18	101	98.5	131	114
17	97	95	119	106
16	92.5	87.2	108	94
15	88	83	99	82
14	84	78	91	74
13	79.5	74	83	65
12	75	70	78	60
11	71	66	73	55
10	67	62.5	69	53
9	62.5	58	65	
8	58	54	61	
7	54	50	58	
6	49.5	46.5		
5	45			
4	41			

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