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ARNOLD Umformtechnik: Alufast[®] fastens lightweight structures

Lightweight structures are in increasing use in industry – magnesium and aluminium prove to be an ideal pairing – Alufast[®] screws demonstrate their benefits

(Forchtenberg) In the case of moved masses, lightweight materials require considerably less

has been making use of “slim” component structures in their series production lines. In vehicle structures aluminium and magnesium have proved to be innovation drivers, because they ensure a distinct improvement to the economy of the systems. And at the same time, the need for fasteners

The Arnold Group is a wholly owned subsidiary of the Würth Group, which, with over 60,000 employees and with 384 companies world-wide operates on a global basis with earnings of over 7 billion euros.



energy and material than do conventional alternatives. This is why for the past ten years or so the automotive industry in particular

and screw fasteners to join these materials together has also increased.

In almost every area of industrial production, aluminium and magnesium are now established as innovative structural materials for use in multiple combinations. For example, magnesium has the appropriate mechanical and physical properties needed to manufacture thin-walled die-cast parts. To ensure that housing sections, brackets and stiffeners made from magnesium can be securely fitted and assembled, Arnold Umformtechnik has developed a range of Alufast[®] screws. The Al 6065 alloy used has consistently proved to possess the properties required to fasten magnesium components.

With Alufast[®] the fastener specialists have reacted to the requirement for an optimised pairing of materials, distinctive mainly for heat expansion and anti-corrosion properties and for recycling.

At the same time Alufast[®] products comply with the high specifications regarding clamp load, stability at temperature and weight saving. Comprehensive trials have shown that

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Characteristic	Clamping part + screw-in component		Bolt		Evaluation
	Mg	Al	Steel (>=8.8)		
Guideline values for p_limit [N/mm ²]	180	230	> 600		Bolt dimensioning: With steel bolts the head setting must be extremely big; with Al, a standard design is sufficient.
Shear strength tau_B [N/mm ²]	130	140	> 500		Bolt dimensioning: Screw-in depth for steel screw – 3 x d; for Al – 1.5 x d
Rp0.2Elongation limit [N/mm ²]	150	360	> 640		Parameters of bolted joint: The steel bolt requires a considerably greater tightening torque MA in order to achieve the necessary assembly pre-tensioning.
Therm. Elongation coeff. [10-6 K - 1]	27	21	11,1		Loss of preload force: due to the different heat elongation characteristics of St/Mg, there is a risk of loss of preload force at different temperatures.
Density [kg/dm ³]	1,8	2,7	7,85		Weight saving: Al -> St = 65% weight saving. With smaller dimensioning, even more!
E-module [N/mm ²]	45000	75000	205000		Fatigue limit: Steel bolt can accept higher operating forces
Normal potential (fe)	-2,4	-1,66	-0,44		Contact corrosion: Due to lower difference in potential Al has less corrosion potential than St.

Result:

The series of tests shows that the best results are achieved by making an optimum pairing of materials. In order to meet these wide-ranging requirements, Arnold Umformtechnik has developed the Alufast[®] bolt. This is a bolt made of aluminium, adapted to market requirements.

Alufast[®] meets the markets' needs to the fullest extent.

Alufast[®] in place of steel

Magnesium elements place special challenges on the screw fastening. When steel screws are used, the low rigidity values of the backing run and the nut thread require deep penetration depths or large head support surfaces. This creates screw lengths than can rapidly counter the weight advantage gained from the material. The very differing heat expansion characteristics of the combined materials can also quickly result in loss of clamp force, putting the functional properties in jeopardy. Contact corrosion places a further burden on the quality of the fastening.

High-strength aluminium screws in Arnold's Alufast[®] range are the proven answer to the challenges mentioned above. Alufast[®] fasteners are distinctive for the appropriate aluminium alloy selected for use, combined with a perfected heat treatment process for the screws. Alufast[®] products are particularly suitable for creating screw fastenings on magnesium components under corrosive and thermal load. The Al 6056 alloy, together with the adapted heat treatment process, assure the process reliability, tensile strength and expansion properties of the screw. While steel screws require very large head settings for fastening magnesium, with Alufast[®] a standard design is sufficient.

Grafik 1: Technological comparison of Al and St bolts in conjunction with bolt joints in Al/MG alloys

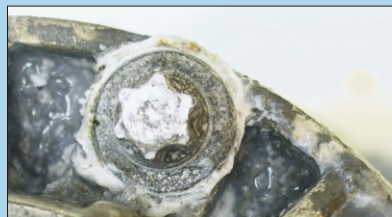
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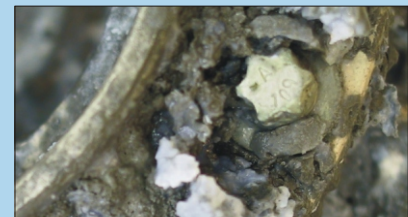
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Stable mechanical properties

Moreover Alufast[®] is convincing for its good corrosion properties in contact with magnesium. Lower potential differences mean much lower corrosion potential compared with the steel versions. The mechanical properties of the screws remain fairly stable over a long-term period of load, up to a temperature of around 150 degrees Celsius. Short-term temperatures of up to around 180 degrees Celsius likewise produce no critical incidents. Alufast[®] screws can be used uncoated to fasten standard magnesium die-cast alloys – such as Az91 HP. They require no further



Bolt joint in magnesium housing (Az91 HP) with Alufast[®] 6056 bolt: *No significant appearance of corrosion around the bolt joint*



Bolt joint in magnesium housing (Az91 HP) with steel bolt – M8 10.9 with zinc lamella coating + seal: *Heavy decomposition in the area surrounding the bolt joint*

Figure 2

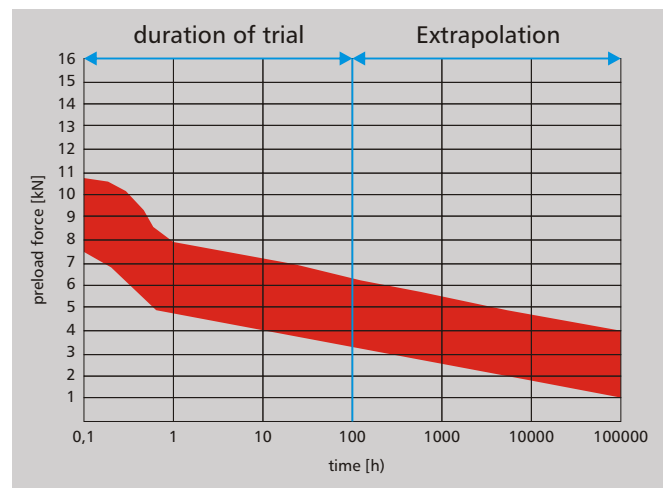
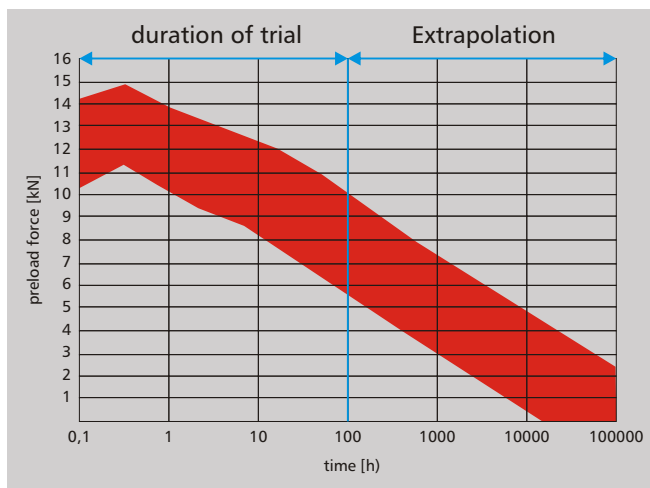


Figure 3

surface coating. The corrosion resistance of the parts remains stable throughout the entire operating period.

Low loss of clamp load

Relaxation processes, especially in screwed magnesium parts, can lead to loss of clamp load, particularly where the location of the fasteners is subjected to a high temperature loading. This is caused by the higher expansion coefficients of magnesium against steel – higher by a factor of two. Particularly where the temperatures to which ob-

jects in applications such as engines and gear boxes are subjected - between -30°C and 150°C – the difference in temperature at the screw fastening may be as much as 180°C. So when steel screws are used at these high temperatures the screw fastening is subjected to a thermally induced additional load, which would then normally result in a relaxation process in the magnesium – possibly even causing plastification. These instances of relaxation in magnesium (particularly on threads and screw head settings) will create a drop

in clamp load at higher operating temperatures. However, cold temperatures (for example at the beginning of a journey in winter) can cause the gauge of the clamped magnesium component to be thicker than the length of the steel screw. When steel screws are used this results in a conspicuous loss of clamp load, which can in some circumstances cause the fastening to fail. With their similar heat expansion behaviour Alufast[®] screws indicate a much lower loss of clamp load in fluctuating temperature ranges than do conventio-

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Weight comparison between Al bolts (alloy 6056) and St bolts, structurally designed for Mg housings									
Material	Dia.	Length	Head	Reqd. screw-in depth	Screw-in depth [mm]	Clamping thickness [mm]	m bolt [g]	m al. cup [g]	m ZSB bolt [g]
St	M8	35	External torx	2,7 x d	21,6	10	17,9	1,87	19,77
Al	M8	20	External torx	1,2 x d	9,6	10	4,8		4,8
Weight saving: Al-bolt compared with St. bolt with al. cup									14,97

Grafik 2

nal steel screws, which shows that they are ideal for use in high-temperature zones.

Alufast[®] aluminium screws are three times lighter than the steel alternatives. The weight-saving in a gear box with 20 screws in each box can be as much as 340 grams. The weight can be reduced even further because when Alufast[®] fasteners are used, it is possible to select a much smaller size of screw, without loss of quality.

The conclusion:

Alufast[®] screws demonstrate their advantages in particular for assembling housing sections, brackets and stiffeners made from magnesium. The reliability of the fastening, which makes use of optimum pairing of materials, is much greater – particularly under the effects of heat. Alufast[®] screws have proven to be of particular value under thermal and corrosive loads. They achieve process reliability, high strength and expansion characteristics, and also possess excellent anti-corrosion properties. The weight advantage can result in potential savings of several tons of steel a year – especially when ordered in large quantities, as in the case of gear box manufacturing.

Your contact:

Arnold Umformtechnik GmbH & Co. KG
 Michel Pult
 Marketing and Communications
 Manager
 Master of Science (MSc) /
 Dipl. Betriebswirt
 (Business Administration) (FH)
 Carl-Arnold-Strasse 25
 D-74670 Forchtenberg-Ernstbach
 Telephone: 0049-(0)7947-821-170
 Fax: 0049-(0)7947-821-111
 Mobile: 0049(0)160/98908602
 e-mail: michael.pult@arnold-
 umformtechnik.de
 www.arnold-umformtechnik.de