Corrosion properties of aluminium castings for automotive and marine applications

Astrid Bjørgum and Anne Lise Dons
SINTEF Materials Technology

Introduction

Due to high material thickness corrosion is not considered as a big problem for aluminium castings. Usually, corrosion resulting in small pits and discolouring in the outer surface can be accepted as long as the mechanical properties are not affected. Additionally, nice surface appearance is not questioned. Corrosion properties of aluminium castings are therefore not investigated to the same extent as wrought aluminium alloys, and few systematic investigations are available.
Due to global warming and other environmental problems, weight reduction of vehicles has become a demand. Weight reduction is achieved by introduction of light metal components resulting in an increased use of aluminium in the automotive industry. In future vehicles further weight loss reduction can be achieved by reducing the material thickness. Thus, corrosion properties will be of vital importance for the properties and life time of such components.
In the NorLight project Shape Castings of Light Metal corrosion properties of aluminium casting alloys of interest for the automotive industry are investigated. The effect of alloy composition, variation in microstructure and surface properties are focused.

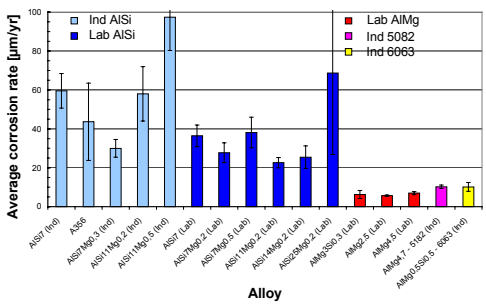
Test materials

Alloy	Foundry alloys		Laboratory cast alloys			
	DC cast alloys	Net shape castings	Unmodified variants	P(Cu) - modified	Sr modified	Mg content
AlSi	AlSi7 AlSi11	AlSi7 AlSi11	AlSi5 AlSi7 AlSi11 AlSi14 AlSi25	AlSi7 AlSi11 AlSi14 AlSi25	AlSi7	0,2 0,01 - 0.5 0,2 0,2 0,2
Alloy	DC cast alloys	Net shape castings	Laboratory variants	Si content	Mn content	
AlMg(Si)	AA6063 AA5082	AlMg3	AlMg2.5 AlMg4.5	0.1 - 0.8 0.2 - 1.2	0.2 - 1.0 0.3 - 1.3	

Corrosion testing
Corrosion testing is carried out by immersion in natural sea water and in an acetic acid acidified synthetic sea water solution (ASTM G85). Corrosion susceptibility is evaluated by weight loss measurements and pitting corrosion studies.

Results

Corrosion of AlSi and AlMg in natural sea water



As expected, AlMg(Si) alloys had low corrosion rates in natural sea water. The corrosion rate of AlSi castings were higher. The effect of Si on corrosion susceptibility of AlSi was not clear.

Addition of Mn and Si had a minor effect on corrosion susceptibility of AlMg(Si) although a distinct difference in microstructure was observed.

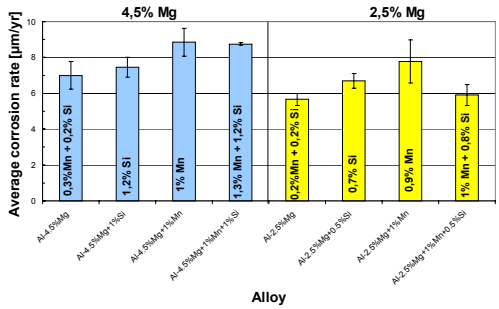
The effect of increased Mg content (0 - 0.5%) on AlSi alloys was negligible. Modification of AlSi had a minor effect on the corrosion susceptibility. An apparently increase in corrosion rate for P(Cu) modified alloys is probably resulted by the increase in Cu content.

Effect on environmental conditions on corrosion of AlMg and AlSi net shape castings

Differences in surface morphology had a negligible effect on corrosion susceptibility of AlSi in natural sea water. A more porous microstructure was probably the main reason for higher corrosion rate of net shape AlMg castings compared to machined AlMg castings.

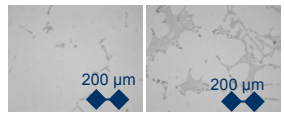
Exposure in the acidified SWAAT solution resulted in increased corrosion rates, particularly for the AlMg castings. The protective Mg containing oxide resulting in high corrosion resistance for such alloys in natural sea water, is not stable in acidic

Effect of Si and Mn on corrosion of AlMg(Si) in natural sea water

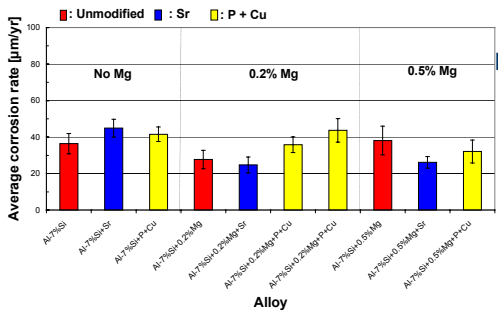


Microstructure of AlMg4.5

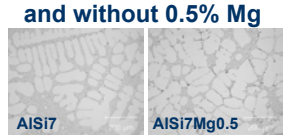
0.2% Si+0.3% Mn1% Si+1% Mn



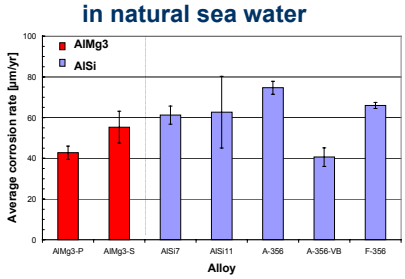
Effect of Mg and modification on corrosion of AlSi7 in natural sea water



Microstructure of AlSi7 with and without 0.5% Mg



Corrosion of net shape castings in natural sea water



Corrosion of net shape castings in SWAAT solution