NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL NOTE

No. 979

EFFECT OF AGING AIRCRAFT STRUCTURES ON MAGNESIUM PARTS

By A. W. Winston
The Dow Chemical Company

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During the past year a procedure has been initiated by some aircraft manufacturers for artificially aging assemblies and subassemblies to improve the strength properties of the wrought aluminum alloys comprising their principal structure. The effect of the treatment of 10 hours at 375° F on other materials used in component parts is of interest. In this paper, information is given on magnesium alloys which may be present. In some cases data are lacking on the effect of this exact time and temperature, but are available on conditions in the vicinity, permitting interpolation with sufficient accuracy for the purpose.

The forms in which magnesium alloys may be encountered are castings, extrusions, forgings, and sheet. The alloys commonly used in aircraft structures in the various forms and the effects of the aging treatment are discussed under separate headings below.

Castings

The composition most generally used is that of Dowmetal H (AM-265)(Aeronautical Material Specifications 4420, 4422, 4424 and Specification AN-QQ-M56, composition A). For airframe applications, this ordinarily is furnished in the heat-treated condition in which it will have high ultimate strength and elongation and moderate yield strength and will have the greatest toughness and resistance to shock. For applications requiring a higher yield strength and for which shock resistance is less important, the castings are aged. The normal aging treatment is 15 hours at 350° F. The properties of cast Dowmetal H are given in table I for various conditions.

If Dowmetal H castings in the heat-treated condition are parts of an aircraft structure subjected to an aging treatment of 10 hours at 375° F, it may be expected that

they will become almost completely aged and will be equivalent to the usual heat-treated and aged castings of this composition. If normally heat-treated and aged castings are subjected to the additional aging in an airframe, the resulting properties will be approximately equivalent to those in the last line of the table.

Extrusions and Forgings

Extrusions and forgings are considered together as the latter usually are made from extruded bar stock and have properties generally equivalent to extrusions.

The extruded compositions generally used in aircraft structural applications are those of Dowmetals J-1 and O-1 (AM-C57S and AM-C58S)(AAF Spec. 11321A, 11335, and 11345), the properties of which are given in table II. Dowmetal J-1 is hot extruded at temperatures well above the 375° F aging temperature, and it is believed that subsequent exposure to this temperature for 10 hours would have no significant effect upon the properties.

While Dowmetal O-1 is hot extruded at temperatures above 375° F, it is subject to change in properties on aging because of the precipitation of magnesium-aluminum compound left in solution in the extruded condition. This material will be aged almost completely by 10 hours at 375° F and the properties obtained will correspond quite closely with those for the standard Dowmetal O-1 extruded and aged material. Magnesium extrusions of this composition used in aircraft are usually furnished in the extruded and aged condition in order to secure the advantage of high tensile and compressive yield strengths. The effect of subsequent aging for 10 hours at 375° F is, therefore, to add additional aging treatment. The properties will correspond roughly to those in the last line of table II.

If Dowmetal J-1 or O-1 forgings are being aged, the same general remarks will apply and the same effect will be experienced, but the actual properties attained may not be as high as in the case of extrusions, as forgings possess slightly lower initial properties.

Sheet

For structural applications in aircraft, sheet compositions corresponding to Dowmetal FS-1 and Dowmetal J-1 ordinarily are used (AM-52S and AM-C57S)(AAF Specification 11340 and 11338). If sheet of either composition is present in the soft or annealed condition, as will have been required if the parts were subjected to severe forming during manufacture, a subsequent aging of 10 hours at 375° F will have no effect upon the properties. If the sheet of either composition is present in the hard-rolled condition, the aging treatment will result in annealing or softening of the sheet. In the case of Dowmetal FS-1 this softening will be complete and the final properties obtained will correspond to those for the annealed condition shown in table III.

If Dowmetal J-1h sheet is present, aging 10 hours at 375° F will result in only a slight softening or annealing as indicated in the table. The sheet may still be considered as being in the hard-rolled condition.

The Dow Chemical Company,
Midland, Mich., October 30, 1944.

TABLE I.- PROPERTIES OF CAST DOWMETAL H[1]

Typical Values Based on Production Experience[2]			
Condition	Tensile strength (psi)	Tensile yield strength (psi)	Elongation in 2 in. (percent)
As cast (AC)	27,000	14,000	5
Heat treated (HT)	39,000	14,000	12
Heat treated and aged (HTA)	38,000	19,000	5

Effect of Aging Heat-Treated Dowmetal H at 375° F Experimental Values[2]			
Condition	Tensile strength (psi)	Tensile yield strength (psi)	Elongation in 2 in. (percent)
HT + 5 hours at 375° F	40,900	19,700	7.6
HT + 15 hours at 375° F	39,500	22,200	5.6
HT + 25 hours at 375° F	38,500	21,100	4.7

[1]AM-265 is of similar composition.

[2]Above values are for separately cast test bars.

TABLE II.- PROPERTIES OF EXTRUDED MAGNESIUM ALLOYS

Typical Values Based on Production Experience				
Dowmetal alloy	Condition	Tensile strength (psi)	Tensile yield strength (psi)	Elongation in 2 in. (percent)
J-1[1]	As extruded	45,000	30,000	17
O-1[2]	As extruded	49,000	33,000	11
O-1	Extruded and aged	50,000	34,000	7

Effect of Aging Extruded Dowmetal O-1 at 375° F Experimental Values				
Dowmetal alloy	Condition	Tensile strength (psi)	Tensile yield strength (psi)	Elongation in 2 in. (percent)
O-1	As extruded	49,000	33,000	13.5
O-1	Extruded + 5 hr at 375° F	54,000	37,500	8
O-1	Extruded + 10 hr at 375° F	54,800	38,000	5.5
O-1	Extruded + 24 hr at 375° F	55,200	37,800	5

[1]AM-C57S is of similar composition.

[2]AM-C58S is of similar composition.

TABLE III.- PROPERTIES OF MAGNESIUM-ALLOY SHEET

Typical Values Based on Production Experience				
Dowmetal alloy	Condition	Tensile strength (psi)	Tensile yield strength (psi)	Elongation in 2 in. (percent)
FS-1[1]	Hard-rolled	43,000	33,000	10
FS-1	Annealed	37,000	21,000	21
J-1[2]	Hard-rolled	45,000	35,000	9
J-1	Annealed	42,000	26,000	16
Effect of Aging Dowmetal J-1 Hard-Rolled Sheet 10 Hours at 375° F - Experimental Values				
Dowmetal alloy	Condition	Tensile strength (psi)	Tensile yield strength (psi)	Elongation in 2 in. (percent)
J-1	Before aging	48,000	36,000	10.1
J-1	After aging	47,000	33,200	12.0

[1]AM-52S is of similar composition.
[2]AM-C57S is of similar composition.