AMERICAN GEAR MANUFACTURERS ASSOCIATION

Gear Reducers - Thermal Capacity Based on ISO/TR 14179-1

AGMA ISO 14179-1

AGMA INFORMATION SHEET

(This Information Sheet is NOT an AGMA Standard)

American
Gear
Manufacturers
Association

Gear Reducers - Thermal Capacity Based on ISO/TR 14179-1
AGMA ISO 14179-1
[ISO/TR 14179-1:2001 (Mod)]

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[Tables or other self-supporting sections may be referenced. Citations should read: See AGMA ISO 14179-1, *Gear Reducers - Thermal Capacity Based on ISO/TR 14179-1,* published by the American Gear Manufacturers Association, 500 Montgomery Street, Suite 350, Alexandria, Virginia 22314, http://www.agma.org.]

Approved March 4, 2004

ABSTRACT

This information sheet utilizes an analytical heat balance model to provide a means of calculating the thermal transmittable power of a single- or multiple-stage gear drive lubricated with mineral oil. The calculation is based on standard conditions of 25° C maximum ambient temperature and 95° C maximum oil sump temperature in a large indoor space, but provides modifiers for other conditions.

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Foreword

[The foreword, footnotes and annexes, if any, in this document are provided for informational purposes only and are not to be construed as a part of AGMA ISO 14179-1, *Gear Reducers - Thermal Capacity based on ISO/TR 14179-1*.]

This thermal rating method was the American proposal to ISO/TR 14179. It utilizes an analytical heat balance model to calculate the thermal transmittable power for a single or multiple stage gear drive lubricated with mineral oil. Many of the factors in the analytical model can trace their roots to published works of various authors. The procedure is based on the calculation method presented in AGMA Technical Paper 96FTM9 by A.E. Phillips [1]. The bearing losses are calculated from catalogue information supplied by bearing manufacturers, which in turn can be traced to the work of Palmgren. The gear windage and churning loss formulations originally appeared in work presented by Dudley, and have been modified to account for the effects of changes in lubricant viscosity and amount of gear submergence. The gear load losses are derived from the early investigators of rolling and sliding friction who approximated gear tooth action by means of disk testers. The coefficients in the load loss equation were then developed from a multiple parameter regression analysis of experimental data from a large population of tests in typical industrial gear drives. These gear drives were subjected to testing which varied operating conditions over a wide range. Operating condition parameters in the test matrix included speed, power, direction of rotation and amount of lubricant. The formulation has been verified by cross checking predicted results to experimental data for various gear drive configurations from several manufacturers.

AGMA ISO 14179-1 is not identical to ISO/TR 14179-1:2001, *Gears - Thermal capacity - Part 1: Rating gear drives with thermal equilibrium at 95 °C sump temperature.* Differences in this information sheet include:

- In table 2, the second equation for P_1 for spherical roller bearings was changed to correctly indicate the condition $(F_r/F_a) \geq Y_2$;
- Text and a figure were added to clause 6 to assist in illustrating Method A testing;
- Text and a figure were added to 7.1 to assist in illustrating the thermal calculation procedure;
- . Figures A.1 and A.2 were revised to accurately reflect dimensions shown;
- An annex was added to provide example calculations.

The first draft of AGMA ISO 14179-1 was made in December, 2002. It was approved by the AGMA membership in March, 2004

Suggestions for improvement of this standard will be welcome. They should be sent to the American Gear Manufacturers Association, 500 Montgomery Street, Suite 350, Alexandria, Virginia 22314.

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1 Scope

This information sheet utilizes an analytical heat balance model to provide a means of calculating the thermal transmittable power of a single- or multiple-stage gear drive lubricated with mineral oil. The calculation is based on standard conditions of 25° C maximum ambient temperature and 95° C maximum oil sump temperature in a large indoor space, but provides modifiers for other conditions.

2 Symbols and units, term and definitions

For the purposes of this information sheet, the symbols and units given in table 1, and the following terms and definitions, apply.

2.1 Thermal rating

Thermal rating is the maximum power that can be continuously transmitted through a gear drive without exceeding a specified oil sump temperature.

NOTE: Thermal rating must equal or exceed the actual service transmitted power.

NOTE: Service factors are not used when determining thermal requirements.

NOTE: The magnitude of the thermal rating depends upon the specifics of the drive, operating conditions, maximum allowable sump temperature, as well as the type of cooling employed.

Table 1 – Symbols and units

Symbol	Definition	Units	Where first used	Reference
A	Load modifying exponent	- -	Eq 9	Table 3
A_c	Gear case surface area exposed to ambient air	m^2	Eq 33	7.12
A_g	Arrangement constant for gearing	- -	Eq 22	7.9
B	Diameter modifying exponent	- -	Eq. 9	Table 3
B_A	Altitude modifier	- -	Eq. 34	Table 10
B_D	Operation time modifier	- -	Eq. 34	Table 12
B_{ref}	Ambient temperature modifier	- -	Eq. 34	Table 8
B_T	Allowable sump temperature modifier	- -	Eq. 34	Table 11
B_V	Ambient air velocity modifier	- -	Eq. 34	Table 9
b_w	Face width in contact with mating element	mm	Eq. 19	7.4
C_0	Basic static load rating	N	- -	Table 2
C_1	Mesh coefficient of friction constant	- -	Eq 18	7.4
D	OD of element for gearing, windage and churning	mm	Eq 22	7.9
D_{OR}	Bearing diameter over rolling elements	mm	Eq 27	Figure 5
D_s	Shaft diameter	mm	- -	Figure 4
d_i	Bearing bore diameter	mm	Eq 10	7.3.1
d_m	Bearing mean diameter	mm	Eq 9	7.3.1
d_o	Bearing outside diameter	mm	Eq 10	7.3.1
E_P	Electric power consumed	kW	Eq 32	7.11

(continued)