Calculating thermal horsepower ratings for gear reducers

C.O. Engineering – BMH
12-16-2019
WP0308

Gear reducer drives that are used to transmit torque in industrial equipment applications, such as conveyors and other machinery, are rated by its mechanical and thermal capacity. Both are important and must be considered in the selection of a gear reducer.

The gear reducer thermal rating is the maximum input HP that will not cause the gear reducer to overheat. This is based on the maximum power that can be transmitted continuously without exceeding a specific oil sump temperature.

General considerations:
The gear reducer thermal rating must be equal to, or exceed, the actual motor input power. Service factors are not used in this determination. The AGMA thermal rating is based on a maximum 200° F oil sump temperature.

The thermal rating of a gear reducer is important because it affects the life of the oil and reducer. High oil temperatures increase the oxidation rate of the oil and decrease the viscosity of the oil in the reducer which could be detrimental to the gear reducer.

Manufacturers will list the thermal rating (usually in horsepower) in their catalog. This value will be based on a specific ambient temperature and altitude above sea level. It also assumes that there will be some air flow and the gear reducer will not be exposed to direct sunlight.

There are several factors that will affect this rating when considering a specific application.

Ambient temperature:
Manufactures may use 80° F (or other values) as the ambient temperature in their rating table. For ambient temperatures higher than this, the manufacturer will provide an additional factor listed in a table to de-rate the catalog rating and account for the higher temperature.

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Greenville, SC 29615
Phone: 864-297-4800
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Altitude:
The higher the application is above sea level, the more difficult it is for the gear reducer to eliminate heat. For higher altitudes, the manufacturer will provide a factor that will be used to de-rate the catalog rating to account for the higher altitude.

To calculate the thermal rating of a gear reducer, follow the manufacturer recommendations. In general, the formula is:

Actual Thermal HP = Published Thermal HP x Ambient temperature adjustment factor x Altitude adjustment factor x (other factors recommended by the manufacturer)

Other considerations are duty cycle and ambient air velocity.

Example:

Calculate the thermal HP rating for a Dodge Maxum XTR concentric gear reducer with the following parameters:

100º F ambient temperature
2500 feet altitude
Air velocity less than 100 feet per minute
Duty cycle is continuous, 100%
Published thermal HP for the gear reducer = 50HP

From the tables on page 73 of catalog CA1612, find the following:
Ambient temperature factor= Bref = 0.86
Altitude factor = Ba = 0.95
Air velocity = Bv =0.75
Duty cycle = Bd = 1.00

The equation to calculate the actual thermal HP according to the catalog is:

Actual Thermal HP = Published Thermal HP x Bref x Ba x Bd x Bv

Therefore:

Actual Thermal HP = 50HP x 0.86 x 0.95 x 1.00 x 0.75
Actual Thermal HP = 30.64HP

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For this example, if the application requires above a motor nameplate rating of 30HP, additional cooling options would be necessary. These options can help improve the thermal rating of the gear reducer and are listed below by increased effectiveness and cost.

Mechanical shaft fan:
A mechanical shaft fan can be added to the input shaft of the of the gear reducer to aid in cooling. This fan normally turns at the same RPM as the motor driving the gear reducer if direct coupled. There are usually two options, a bi-directional fan for applications that run in a CW or CCW direction and a uni-directional fan for application running in only one direction. The unidirectional fan is more effective at cooling, because the fan blade pitch allows more airflow in one direction (like an electric fan). Usually a uni-directional fan can provide increased cooling over a bi-directional fan if additional cooling is necessary.

Electric motor driven fan:
An electric motor driven fan can provide an improved cooling benefit over a shaft driven fan. Because it is powered by its own motor, the cooling provided by an electric fan is not relying on the gear reducer input shaft speed to maintain cooling.

Heat exchanger:
For extreme cases, a heat exchanger may be necessary to maintain the oil sump temperature of a gear reducer. Heat exchangers are available as an oil to air style or oil to water style system.

Trouble shooting:
If an existing gear reducer that was previously maintaining proper temperature is now overheating, the following may contribute to the possible cause:

1. Application/load/environment change
2. Input power/speed change
3. Dust or other contaminants insulating the gear reducer causing it to over heat
4. Too high or too low of oil level or using the wrong type of oil.
5. Broken fan or clogged cooling system or other issues with the supplemental cooling system.

In conclusion, the thermal rating of a gear reducer is affected by several factors including altitude, ambient temperature and other factors. The thermal HP is based on providing a maximum calculated sump temperature of 200º F. Maintaining the gear reducer sump temperature is important for the longevity of the gear reducer. There are several options for supplemental cooling to maintain proper temperature.

Reference:
Dodge Maxum XTR Catalog CA1612 5/14 pages 72-73

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