9.5. Studying the Thermal Displacement through Heat Generation

If the temperature of the screw shaft increases during operation, the screw shaft is elongated due to heat thereby to lower the positioning accuracy. The expansion and contraction of the screw shaft is calculated using the equation (38) below.

$$\Delta \ell = \rho \times \Delta t \times \ell \quad \cdots\cdots\cdots (38)$$

where

$\Delta \ell$: Axial expansion/contraction of the screw shaft (mm)
ρ : Thermal expansion coefficient (12×10^{-6}/℃)
Δt : Temperature change in the screw shaft (℃)
ℓ : Effective thread length (mm)

Thus, if the temperature of the screw shaft increases by 1℃, the screw shaft is elongated by 12 μm per meter. Therefore, the faster the Ball Screw travels, the more heat is generated. And, the higher the temperature, the lower the positioning accuracy become. Accordingly, if high accuracy is required, it is necessary to take a measure to cope with temperature increase.

9.5.1. Measures to Cope with Temperature Rise

Minimize Heat Generation

- **Minimize preloads on the Ball Screw and the support bearing.**
- **Increase Ball Screw lead and reduce rotation speed.**
- **Select a correct lubricant (see page A-109).**
- **Cool the circumference of the screw shaft with a lubricant or air.**

Avoid Effect of Temperature Rise through Heat Generation

- **Set a negative target value for the reference travel distance of the Ball Screw.**

Generally, set a negative target value for the reference travel distance assuming a temperature increase of 2℃ to 5℃ by heat.
(-0.02 mm to -0.06 mm/m)

- **Pretension the screw shaft (see Fig. 3 of the structure on page K-42).**