

3.3 Gear materials and Heat treatments

Refer to Table 5 for suitable materials and its method of heat treatment for load. Also refer to Table 6 for hardness range of heat treatment.

Table 5. Loads, Materials and Heat treatment methods

| Load | | Material number | Methods of heat treatment |
|--------------|---|---|---|
| Light load | Light impact load and minute wear off | S35C ~ S45C | Thermal refining (Quenching and Tempering) |
| | Slight wear resistance needed | S15CK | Carburizing, Quenching and Tempering (Depth of hardness 0.2 to 0.4mm) |
| Medium load | Medium strength and wear resistance needed | S35C ~ S45C | Induction hardening is lightly applied after Thermal refining. Hardness of Tooth tip is HRC47 to 56 ⁽¹⁾ |
| | | SCM415 SCr415 | Carburizing, Quenching and Tempering (Depth of hardness 0.6 to 1.0). Surface hardness is from HRC 55 to 60. |
| | Fatigue strength needed | S40C ~ S45C | Induction hardening ⁽²⁾ is applied after Thermal refining. Depth of hardness should be slightly deeper. Apply Induction hardening to Root diameter. Hardness of Tooth tip surface is HRC47-56 ⁽¹⁾ . |
| | | SCM435 SCM440 | Nitriding treatment, Gas nitrocarburizing, Tufftriding and etc. are applied after Thermal refining. |
| Heavy Load | Special impact resistance if needed | SNC815 SNCM420 SNCM815 | Carburizing, Quenching and Tempering. Surface Hardness from HRC 58 to 64 |
| | Wear resistance needed | SNCM420 SCM421 SCM822 | Carburizing, Quenching and Tempering. Surface hardness is for HRC 62 and above |
| | Wear resistance and Fatigue strength needed | S45C S48C | Apply Induction hardening ⁽²⁾ to area of root diameter after Thermal refining. Hardness of Tooth tip is HRC 56-60 ⁽¹⁾ |
| Special load | Sand burning resistance needed | Nitriding steel | Apply Nitration treatment after Thermal refining |
| | | Alloyed steel SCM435 | Apply Nitration treatment after Thermal refining |
| | Anti-corrosion needed | Austenite, Ferrite, Martenstic group, Stainless steel | Consider other properties together with Anti-corrosion when selecting suitable heat treatment. |
| | Heat resistance needed | Fe-Cr-Ni Alloy | Apply suitable Heat treatment as required |

Note

(1) Area of tooth flank near Bottomland is HRC 5-10 lower than HRC47-56.

(2) Motor generator system (MG) with low frequency is suitable for relatively large size gear.

Table 6. Hardness of Heat treatment

| Name of steels | Material numbers | Hardness for Thermal refining Hs | Full quenching Hs | Induction hardening H _R C | Surface hardness of Case hardening H _R C | Core hardness of Case hardening H _B |
|--------------------------------|------------------|----------------------------------|-------------------|--------------------------------------|---|--|
| Nickel-chrome steel | SNC631 | 37-40 | 50-55 | 50-55 | - | - |
| | SNC836 | 38-42 | 50-55 | 50-55 | - | - |
| | SNC415 | - | - | - | 55-60 | 217-321 |
| | SNC815 | - | - | - | 58-64 | 285-388 |
| Nickel chrome molybdenum steel | SNCM439 | 43-51 | 65-70 | - | - | - |
| | SNCM447 | 45-53 | 65-70 | - | - | - |
| | SNCM220 | - | - | - | 58-64 | 248-341 |
| | SNCM415 | - | - | - | 58-64 | 255-341 |
| | SNCM420 | - | - | - | 58-64 | 293-375 |
| | SNCM815 | - | - | - | 58-64 | 311-375 |
| Chrome steel | SCr415 | - | - | - | 58-64 | 217-300 |
| | SCr420 | - | - | - | 58-64 | 235-320 |
| Chrome molybdenum steel | SCM435 | 37-40 | 45-50 | 45-50 | - | - |
| | SCM440 | 38-42 | 50-55 | (50-53)(2) | - | - |
| | SCM415 | - | - | - | 58-64 | 235-321 |
| | SCM420 | - | - | - | 58-64 | 262-341 |
| | SCM421 | - | - | - | 58-64 | 285-263 |
| Carbon steel | S15CK | - | - | - | 55-62 ⁽³⁾ | 131 ⁽⁴⁾ |
| | S35C | 25-35 | 35-45 | 35-40 | - | - |
| | S45C | 31-40 | 45-55 | 40-45 | - | - |
| | S55C | 33-42 | 55-65 | 45-50 | - | - |

Note

(1) Refer to Table 5 for Load, Material and Heat treatment. Core hardness is equivalent to Thermal refining hardness.

(2) Applying Induction hardening to teeth is not advisable.

(3) Hardness is (50-53) for water cooling and 50 - 55 is for oil cooling.

(4) Maximum hardness.

Guide

Table 7. Sizes of tooth and depth of Carburizing

| Module mm | Range from m1.0 to m1.5 | Range from m1.5 to m2.0 | Range from m2.0 to m2.75 | Range from m2.75 to m4.0 | Range from m4.0 to m6.0 | Range from m6.0 to m9.0 | Range from m9.0 to m12.0 |
|-------------------------|-------------------------|-------------------------|--------------------------|--------------------------|-------------------------|-------------------------|--------------------------|
| Depth of Carburizing mm | 0.2-0.5 | 0.4-0.7 | 0.6-1.0 | 0.8-1.2 | 1.0-1.4 | 1.2-1.7 | 1.3-2.0 |

Note: Depth of Carburizing is rough outline for standard value for Gas carburizing. Solid or liquid Carburizing adopts a smaller amount than the above chart.