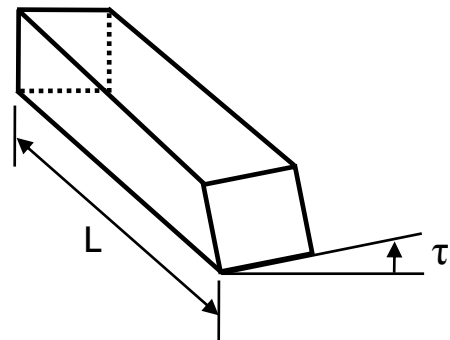
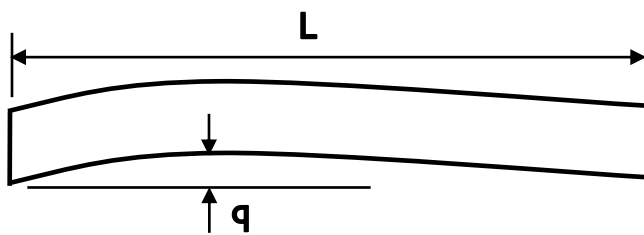
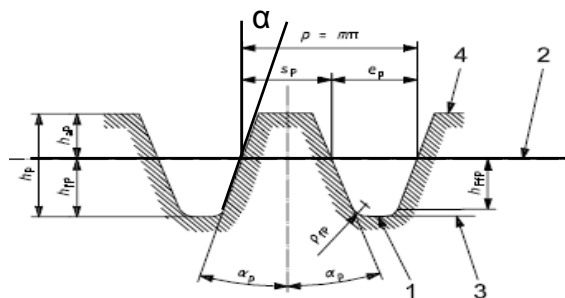
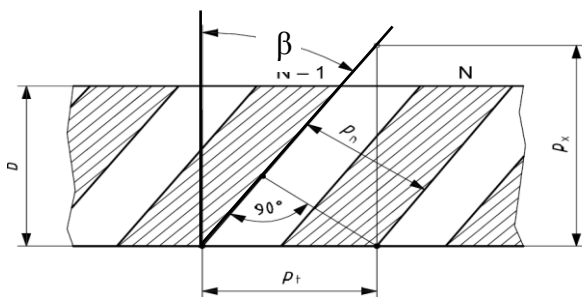
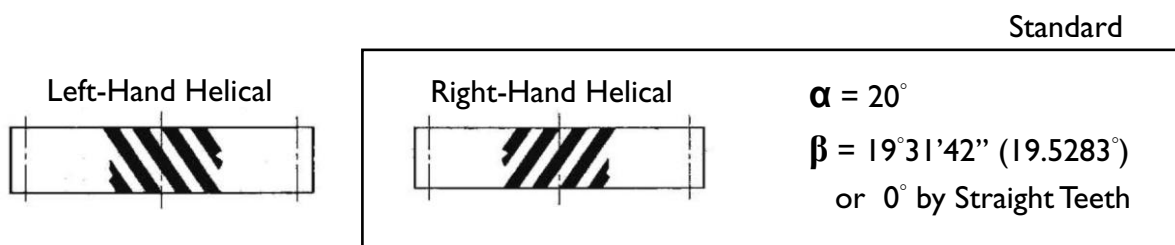


Requirement of High-Precision Rack

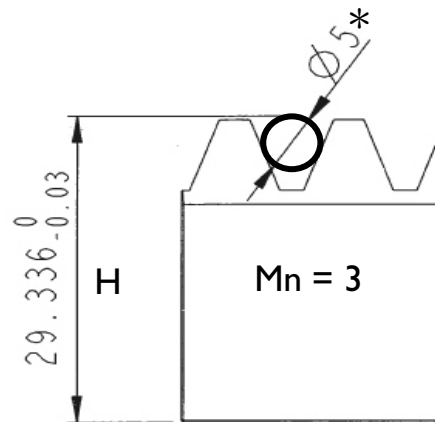
| Requirement and Reason | Technology needed |
|---|--|
| <p>Good Straightness, Less Torsion</p> <ul style="list-style-type: none"> • Influence the accuracy of pressure angle, helical angle and pitch error, hence Influence the gear coupling with pinion. • To avoid re-straightening work after long-term stock due to slowly out-let of internal tension | <ul style="list-style-type: none"> ➤ Heat-treatment ➤ Straightening ➤ Machining on all sides ➤ Teeth milling and grinding ➤ Teeth induction hardening |



| Requirement and Reason | Technology needed |
|---|--|
| <p>Accurate Pressure Angle α and Helical Angle β</p> <ul style="list-style-type: none"> • Optimizing gear-coupling with pinion • Optimizing transmission of torque or feed force • For high speed, low noise, less wearing, longer life-time | <ul style="list-style-type: none"> ➤ Heat-treatment ➤ Straightening ➤ Machining on all sides ➤ Teeth milling and grinding ➤ Teeth induction hardening |



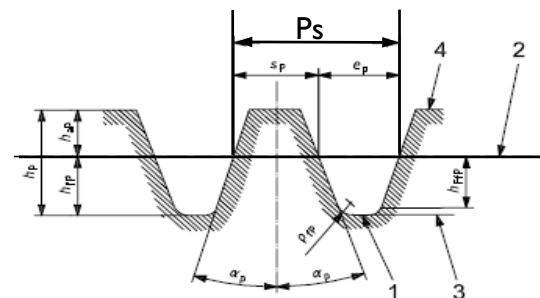
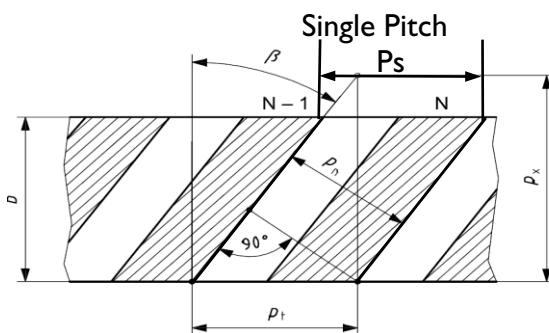
| Requirement and Reason | Technology needed |
|---|--|
| Accurate Over Pin Height H <ul style="list-style-type: none"> • A measure of accuracy of teeth profile • Optimizing gear-coupling with pinion • Influence on backlash between rack and pinion | <ul style="list-style-type: none"> ➤ Heat-treatment ➤ Straightening ➤ Machining on all sides ➤ Teeth milling and grinding ➤ Teeth induction hardening |



* Pin Diameter depending on Mn.

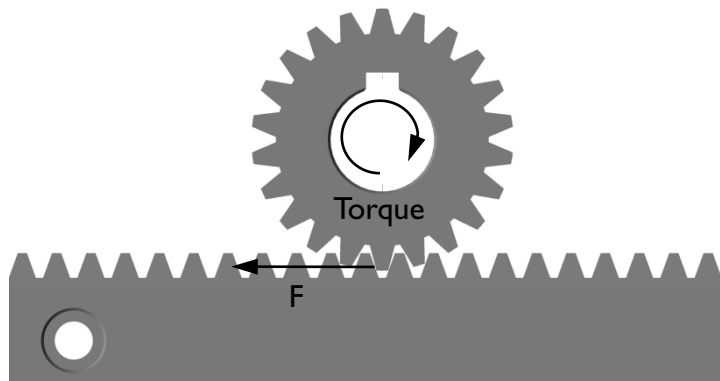
| Requirement and Reason | Technology needed |
|---|--|
| Low Single Pitch Error Es / Low Total Pitch Error Et <ul style="list-style-type: none"> • Optimizing gear-coupling with pinion • Low noise, less wearing, longer life-time • High positioning accuracy • Influence on backlash | <ul style="list-style-type: none"> ➤ Heat-treatment ➤ Straightening ➤ Machining on all sides ➤ Teeth milling and grinding ➤ Teeth induction hardening |

- Pitch = $\pi \times$ Module No.
- Total Pitch Error Et is to be measured between the first and the last tooth of a rack.



Requirement of High-Precision Rack

| Requirement and Reason | Technology needed |
|---|---|
| Rigidity / Material Hardness <ul style="list-style-type: none"> • No deformation during gear coupling with Pinion • High strength of rack / High strength of teeth • Transmission of high torque or high feed force • High speed, less wearing, long life-time | <ul style="list-style-type: none"> ➤ Heat-treatment ➤ Teeth induction hardening |



| Requirement and Reason | Technology needed |
|--|---|
| High Surface Hardness <ul style="list-style-type: none"> • High strength of rack / High strength of teeth • Transmission of high torque or high feed force • High wearing resistance | <ul style="list-style-type: none"> ➤ Heat-treatment ➤ Induction hardening ➤ Teeth grinding |
| Thickness of Hardened-Layer <ul style="list-style-type: none"> • Preserve accuracy and long lift-time | |
| Symmetry of Hardened-Layer on teeth profiles <ul style="list-style-type: none"> • Preserve accuracy and long lift-time in both moving directions on the rack | |

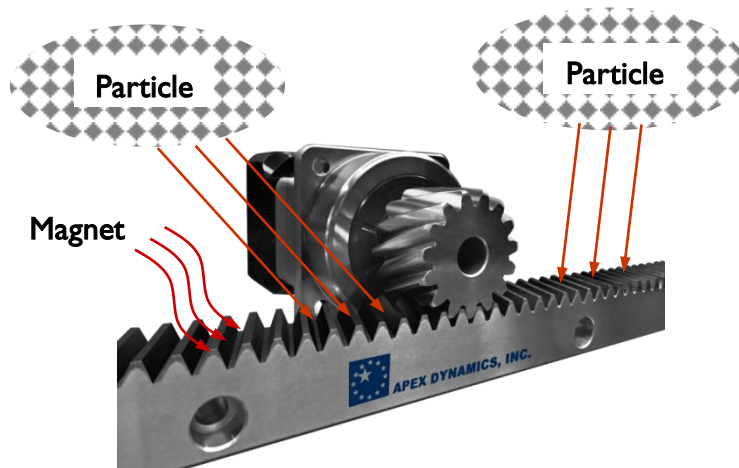


Qualified induction hardening and teeth grinding



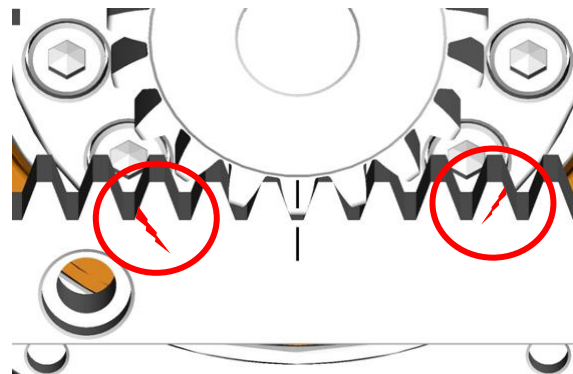
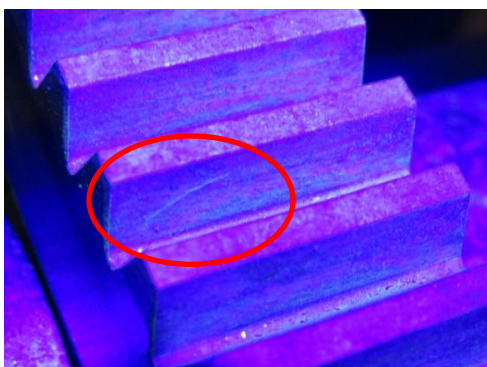
Bad induction hardening and / or bad teeth grinding

| Requirement and Reason | Technology needed |
|---|-------------------------|
| <p>Low Remaining Magnet</p> <ul style="list-style-type: none"> • Prevent adhesion of particles between the rack and pinion which leads to pitting and damage the teeth profile. • Smooth running • Preserve accuracy and long lift-time | <p>➤ Degauss device</p> |



APEX rack has been degaussed until 10 ± 3 Gauss!

| Requirement and Reason | Technology needed |
|--|---|
| <p>Magnetic Crack Inspection</p> <ul style="list-style-type: none"> • Preserve accuracy • Guarantee of long life-time | <p>➤ Magnetic crack inspection device</p> |



APEX rack has been checked by Magnetic Crack Inspection Device!