Real-Life Stories

Grinding Replaces Machining in Automotive Applications

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Success stories: when milling and machining are replaced with peel and creep-feed grinding.

While machining processes dominate metal removal for automotive parts manufacturing, trends toward smaller pieces with higher form and finish tolerances are leading manufacturers to consider alternatives. Advances in abrasive grinding materials and processes have made the technology more suited to a range of manufacturing applications.

Cost savings can come from many places – reduced capital expenditure, consumable tooling, logistics, and cycle time. In particular, creep-feed and peel grinding have applications suited to motor vehicle production. The following are examples of customers replacing machining processes with abrasive grinding.

Creep-feed grinding

An alternative to machining, creep feed grinding uses diamond rolls to dress the grinding wheel for accurate form and finish.

Steering rack

Project requirements: High volumes, low cycle times

Traditional process stages

- Bar stock turned, cut
- Drilling, milling
- Rack teeth broached
- Heat treatment
- Straightening, polishing

Process challenge

If the time to cut the teeth in the rack (about 30 sec.) is taken separately, then it would be difficult for grinding to complete the part. Broaches take up a lot of floor space, and large, sharp broaching tools require special care during handling. Shimming or manual adjustments by skilled operators are needed to get the required accuracy once a broach is in the machine. Once the setup is complete and production starts, part quality degrades as the tool dulls. As a rack tooth forms, pitch and surface finish change, then steering assembly performance suffers. Tool maintenance, storage, planning, and logistics add to the cost of each rack.

Switch to grinding results

- Tooling cost: Grinding 18% of broaching
- Setup time: Grinding 38% lower than broaching
- Total process costs: Grinding 53% of broaching
- Secondary benefits: Improved quality, process stability, surface finish; tooth-spacing variance cut

in half

Stainless steel exhaust manifold

Project requirements: Reduce tool cost, simplify multiple machining stages

Machining processes

- Rough-, finish-milling passes machined two flat surfaces – 70 sec. for large surface, 40 sec. for smaller surface
- Face mill tool life: 10 parts per corner adding time for indexing inserts, projected annual insert cost: <$2 million

Process challenges

Inclusions in the castings caused milling inserts to break unpredictably; flatness problems around ports due to tool deflection; large burrs around holes in manifold required additional operations

Switch to grinding results

- Large surface finished in same time as milling
- Improved part quality
- Reduced tooling costs, tool change time, de-burring time
- Total cost saving: $250,000 per year before accounting for fewer scrapped parts, reduced need for inspection

Peel grinding

Narrow cubic boron nitride (cBN) or diamond wheels work in conjunction with high-wheel and work speeds for high removal rates.

Large shaft manufacturing

Project requirements: Peel grinding replaces hard turning

Results

- Metal removal rate: 13in³ of HRc 57 material
- Grind time: 16 min.; equivalent of 0.020" depth of cut (DOC) at 500fpm, 0.006ipr

Large bearings

Project requirements: Switch to peel grinding from fard turning

Process challenges

Manufacturer struggled to achieve required form and finish on rollers with hard turning prior to finishing,

Grinding process

- 2.7" diameter roller x 3.25" ground at 0.004"DOC, 13ipm feed rate: 15 sec. cycle time
- Material: 62HRC, 52100 steel
- Removal rate: 0.46in³/min.
- Surface finish: <16µin Ra
- Profile, roundness: >0.0002"

Results

Abrasive cost: $0.18/in3 of material removed; >5% of total operation cost

Have you had success with replacing machining processes with abrasive grinding?

