

Black Oxide Finishing for Gears

By Mark Ruhland

An automated in-house black oxide process line allows the manufacturer to finish machined gear components and ship them out the same day. Here's how.

THE TRUE COST OF OUTSOURCING

Due to the hazardous nature of most black oxide processes, manufacturers have traditionally been forced to ship parts to an outside plant for black oxide finishing. In the process they incur extra costs and turnaround times that make it difficult to satisfy customer shipping demands. In addition, this outsourcing requires higher in-process inventory levels and makes it impossible to have direct control over quality.

By contrast, in-house finishing streamlines workflow and lowers inventory levels, thereby freeing up cash for other uses. An automated in-house black oxide process line allows the manufacturer to machine gear components, black oxide finish quantities the same day, and then immediately proceed to assembly or shipping without delay. It allows the manufacturer to focus on fabricating components (the highest-value contribution) and then quickly and efficiently handle the black oxide finishing (the lowest-value contribution) without disrupting the smooth flow of components through assembly, packaging, and shipping (fig. 2).

Black oxide adds value and sales appeal to gear and power transmission components without altering dimensions or interfering with part assembly or operation. In addition, black oxide finishes are quite durable and offer long-term corrosion resistance in storage or in service. In-house black oxide enhances ISO and “lean manufacturing” programs because inventory stays in the plant. Black oxide—particularly the low temperature process—is supplied in a variety of pre-engineered systems, complete with operator training, described as follows.

MAKING THE RIGHT PROCESS CHOICE


With three types of blackening in common use, it's important to weigh the benefits of each before choosing one for an in-house installation. The first is traditional caustic black oxidizing which utilizes a boiling caustic soda bath operating at 290°F.

This system forms a black iron magnetite finish in 20 to 30 minutes. Overall finish quality is usually good, except on cast iron or MIM parts (red coatings are common) or parts with blind holes or recesses (white salt leaching occurs).

The second is room temperature blackening utilizing copper/selenium chemistry. This system operates without heat

and forms a black conversion coating in two to five minutes. These finishes can replace traditional hot black oxide in many applications, but the finish is not as durable or as black. Because room temperature blackening requires copper and selenium (both EPA regulated), the process lines require ion exchange add-on systems to purify and recycle the rinse waters for zero-discharge operation.

The third, newest, and most-desirable black finishing option is low temperature black oxide. The process, known as TRU TEMP® low temp black oxide, forms a durable black magnetite finish with a short 10 minute blackening time. Since the process contains no EPA regulated metals, the rinse waters are non-hazardous and are usually sewerable without waste treatment. The low temperature eliminates the severe hazards of the 290 degree black oxide, making it easier and far



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Fig. 1: Sprockets, universal joints, and PT components take on a protective and attractive black oxide finish when treated with TRU TEMP low temperature, non-polluting black oxide.



Fig. 2: Automated low temperature black oxide finishing is user proven to be an effective control of quality, scheduling, and costs done in-house.



Fig. 3: Gears and similar power transmission components like these can be blackened, assembled, and shipped to order same day with an in-house low temperature black oxide system.

safer to operate. The process also avoids the red coatings and white salt leaching problems commonly seen with conventional black oxide because the overall concentration of caustic soda is 80 percent lower than that of regular black oxide (fig. 3). In short, the TRU TEMP process offers a high quality black oxide capability without the severe hazards, thereby making it safe to operate in-house.

All three of these processes provide good corrosion protection (50-200 hours salt spray resistance) through the use of a rust preventive topcoat that is absorbed by the porous structure of the black finish. Several types of rust preventives are available. All three blackening processes provide dimensional uniformity and stability. Black oxide finishes have a uniform thickness of about 0.000020 inches, making them ideal finishes for precision manufactured components that cannot tolerate the variable thickness of paint or electroplating. Each of the three black oxide processes has different heat and chemical requirements that must be considered when designing a blackening system.

LOW TEMPERATURE, HIGH QUALITY

For today's conscientious manufacturer the in-house black oxide process itself must be safe to operate, non-polluting, and produce the highest quality finishes. The low temperature TRU TEMP process does all this and more. The process forms a non-dimen-



Fig. 4: High density part finishing, putting maximum parts through for finishing at one time, is easy with this pre-programmed TRU TEMP CNC system.

sional deep black finish with long-term corrosion resistance—the ideal surface finish for all types of gear, power transmission, and related components. The finish also prevents galling on thread surfaces and other critical part features. This high level of corrosion protection is important for both part storage and shipment in corrosive atmospheres including ocean shipment.

This low temperature process operates at just 200° F and uses mild alkaline chemistry that does not embrittle steel components. Manufacturers using this low temperature process in a CNC system setup report part finishing went from five days to same day, so 24-hour order fulfillment became possible, providing an important marketing edge. Operating cost, including chemical and heating cost, averaged just \$.01 to .03 per pound of finished work.

SIMILAR BENEFITS TO CNC MACHINING

To maximize the in-house black oxide function for highest quality, fastest turnaround time at the lowest cost, the TRU TEMP CNC finishing system was developed. Like virtually all other CNC metalworking equipment, these systems are operated by a touchscreen numeric control rather than a live operator. When applied to a black oxide finishing line, CNC control provides similar benefits as other CNC metalworking equipment: fast handling of part loads, consistent quality, elimination of human error, and tight control of operating costs (fig. 4).

Ruggedly designed for high volume continuous service, a CNC low temperature

black oxide line usually consists of eight process tanks and 10 stations overall. For example, in one installation the operator of the deburring station loads parts onto the black oxide racks and then wheels them into the pickup station. From there the hoist automatically processes the load through the various stations of the black oxide line and deposits the finished load in the setdown station 25 minutes later. They are then picked up by the operator in the inspection/assembly station. Configured in this manner, the blackening operation requires zero labor input—all labor is contributed by the adjoining departments. Consequently, total operating costs are extremely low. Low temperature black oxide line utilizes the following stations:

Cleaning: Prior to finishing parts must be cleaned of machining fluids, coolants, and other soils, most of which are water-soluble materials.

Rinsing: A clean water rinse (30 seconds) after cleaning is important, but ordinary tap water is all that is needed for most lines.

Surface conditioning: A mild acid surface conditioner removes minor oxides and deposits a primer coat that aids in formation of the final black oxide finish.

Rinsing: A second rinse removes any residues of the surface conditioner.

Blackening: High temperature (290° F) black oxides form an adherent coating in 20 to 30 minutes, in most cases. Low temp (200° F) black oxide typically requires only 10 minutes. The black finish is permanently bonded to the substrate.

Rinsing: A final rinse removes any black-



Fig. 5: Carts carry unfinished parts to the CNC process line where an automated hoist takes over, moving the rack through the finishing tanks with accurate timing.

ening residue from the parts. For high temperature (290°F) black oxide, the rinse water has a high pH and must be neutralized before discharge.


Sealing: There are several different types of rust preventives available, water-based and solvent-based, with different properties as appropriate to the intended end use of the gear or part.

EASY TO MODIFY FOR APPLICATIONS

Though many installations operate with a standard process sequence, the design of the process line can be changed to accommodate different production conditions:

- The volume of parts per shift will determine the overall size of the blackening tanks (fig. 5);
- The method of parts handling required (racks, baskets, rotating barrels) affect the way in which the parts are processed through the line;
- Parts that carry heavy oils or oxides (rust, heat treat scale, or hot-rolled mill scale) often require aggressive cleaning or descaling treatment utilizing chemical or grit-blasting methods;
- The performance requirements of the final finish will indicate which sealant is needed to achieve the necessary appearance, gloss, and level of corrosion resistance.

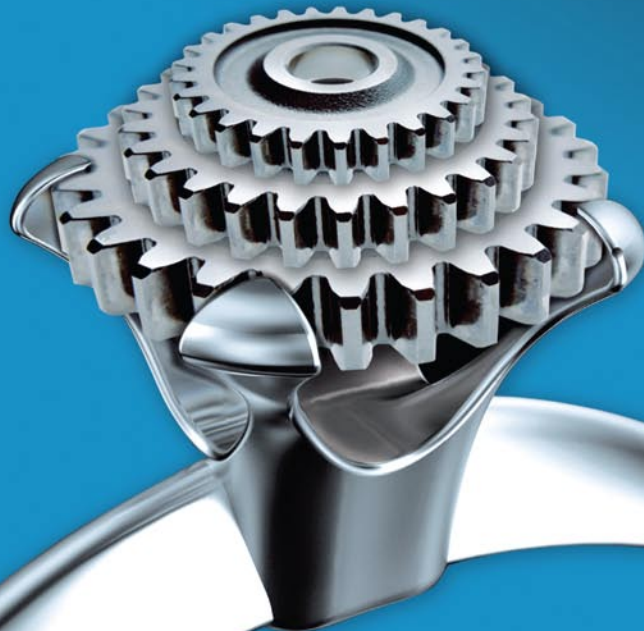
A well-designed tank layout can accom-

modate all the factors listed here, and the supplier of the system can provide guidance. In-house low temperature black oxide finishing has a proven value to modern manufacturing because it enhances product quality and customer service capabilities while lowering costs. 

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