Operational flexibility and close process control help fluidized bed furnaces improve surface treatments

Fluidized Bed Furnaces Support Metal Surface Treatments

BY G.C. IKENS

Dynamic Metal Treating, Inc.'s (Royal Oak, MI) heat treating facility has put new surface treating processes on the front burner to meet its customer's metal treating needs.

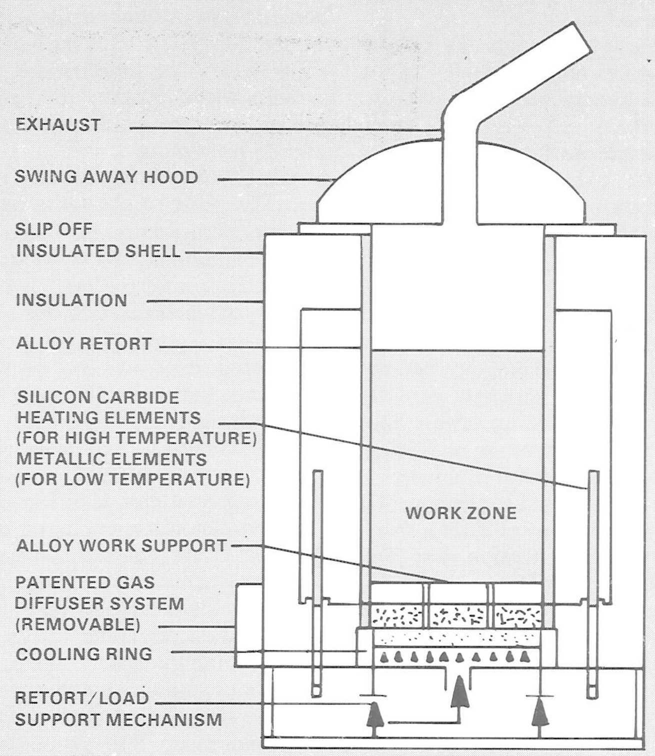
Employing fluidized bed furnaces designed by CAN-ENG, Ltd. (Niagara Falls, NY and Ontario), Dynamic executes advanced surface treating techniques in nitrocarburizing, nitriding, and steam blueing. The processes improve the wear, impact, yield strength, and lubricity of treated metal tools and parts composed of carbon, alloy, tool, high-speed, and stainless steels and cast irons.

Detroit Broach and Machine, Inc. approached Loren Epler, Jr., vice president and metallurgist at Dynamic, several months ago looking for a surface treatment to improve the performance and wear resistance of its broaches, while eliminating the warpage and corrosion normally associated with liquid nitriding.

Dyna-blue™, one of Dynamic's new nitrocarburizing processes, had already been used to boost the performance and life of, among other things, cutting tools, dies, and jigs, so Epler suggested it as an alternative for the broaches.

Harry Bell, retiring plant manager of Detroit Broach, recalls, "After Loren told us about his Dyna-blue process, we were expecting a lot. Dynamic can handle up to 95″ (2413 mm) broaches in its fluidized beds, and they come out consistent, end to end and batch to batch, every time. There's absolutely no growth, no distortions, and no problems."

Cross Section of a Typical Fluidized Bed Furnace



Fluidized bed furnaces

Affording exceptional process control and versatility, CAN-ENG fluidized bed furnaces turned out to be just the tool Dynamic required to serve the specific needs of customers like Detroit Broach. Technologically advanced, yet simple in design and operation, the fluidized bed furnaces house a bed (a container, or retort) containing very dry, uniformly sized particles of inert aluminum oxide. Air or blends of gases for specific treatment processes are introduced through a diffusion plate beneath the retort, separating and mobilizing the minute particles to give them fluid-like characteristics. Silicon carbide elements, between the retort wall and the furnaces's outer insulated wall, heat the flowing particles.

Into the fluidized bed, which resembles a vat of boiling liquid, are introduced metal parts or tools for heat treatment. The mobilized particles engulf the object and begin radiating a uniform heat.

The ability to alter temperature and atmosphere quickly gives the furnaces their superior flexibility. The fluidized particle medium conducts heat rapidly and uniformly to achieve quick heat-ups, reduced cycle times, and to provide efficient energy utilization. Complete atmosphere changes are performed in minutes. Because of this, numerous diverse treatment processes, including nitrocarburizing, nitriding, bright tempering, stress relieving, carbonitriding, carburizing,

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annealing, and hardening, can be performed daily in a single furnace.

Ferritic nitrocarburizing

Dynamic works with two ferritic nitrocarburizing processes, Dyna-blue and Nitroware™. Both are ideally suited to fluidized bed processing. These thermochemical processes involve a diffusional addition of nitrogen and carbon to the surface of metal parts and tools at a temperature below the metal's austenitic region. Beneath the hard, abrasion-resistant compound surface layer is a nitrogen-rich subsurface diffusion zone.

Processing involves immersing the part in a heated bed fluidized with nitrogen, ammonia, and carbon producing gases. Varying cycle times, temperatures, and the proportions of gases produces different surface hardnesses suited to various steels and cast irons. Surface hardnesses up to R_C 75-80 equivalent can be achieved.

Temperatures as low as 600°F (316°C) can be employed—far below the tempering temperatures of all high-speed and many other types of steel. Thus, ferritic nitrocarburizing can sometimes replace conventional processes, such as titanium nitriding, carbon nitriding, and nitriding.

The benefits of ferritic nitrocarburizing include increased wear and corrosion resistance; reduced friction, galling, and edge buildup; increased impact and yield strength; and additional lubricity. Because it is a diffusional process, actually embedding the hardening agents into the metal's surface, there are no flaking, adherence, or dimensional problems.

Nova Tool and Die Co. (Fraser, MI) uses the ferritic nitrocarburizing treatment on its H-13 extrusion dies. Ted Anderson, foreman at Nova, comments, "I like it because my customers like it. Their cleanup time has been cut from six to eight hours with gas nitriding down to a half hour with ferritic nitrocarburizing." He continues, "They want close tolerances, fast turnaround, and competitive prices. Ferritic nitrocarburizing helps us maintain all three. There are never size or distortion problems with the process. Dynamic performs the surface treating in one to two days, so we can deliver sooner. And ferritic nitrocarburizing costs no more than lesser processes."

Nitriding

Molten-salt baths have long been employed in the nitriding of high-speed steels. A major drawback of bath processing is that the cyanide-based salts used are corrosive, as well as highly toxic. As an alternative that avoids these problems, Dynamic uses fluidized beds, with their inert aluminum oxide heating medium, to nitride high-speed steels. Typically, the process is used in combination with a steam blueing operation to produce a resultant surface hardness of R_C 68-70.

In addition to being nontoxic and noncorrosive, Dynamic's fluidized bed nitriding provides greater case depth control through more precise cycle times. With salt baths, case depths vary because treated metals are brought to process temperature within the active nitriding salts, making it difficult to pin down exactly when nitriding begins. In a fluidized bed, on the other hand, the inception of nitriding is easily pinpointed, because treated parts are heated in the inert medium, and nitriding gases aren't released until the part has reached process temperature.

Cycle times can also be dramatically reduced with fluidized bed nitriding. Dynamic uses bed furnaces to achieve a case depth of 0.010-0.015" (0.25-0.38 mm) on tool and alloy steels in just 15-20 hours, compared to a normal cycle of 72-80 hours with pit nitriding. And, this is done while reducing the detrimental white layer commonly produced in gas nitride processing.

Moreover, fluidized bed nitriding provides most of the same benefits as ferritic nitrocarburizing—including increased surface hardness, wear, and corrosion resistance; reduced friction and galling; and increased lubricity—although to a lesser degree. Nitriding can, however, produce greater case depths.

Prince Industries (Farmington, MI), a manufacturer of inset dies for oil upset pipes, had tried numerous nitriding processes in the past six years but had recurring problems with inconsistency. Treated dies often exhibited scaly surfaces, less than required case depths, and even untreated areas. Harold Eklund, owner of Prince, heard about fluidized bed nitriding and contacted Dynamic to process some samples.

Eklund states, "Our dies were much cleaner than I had been used to and required much less processing time. Dynamic was able to hold a uniform 70 Rockwell hardness with a 0.012-0.014" (0.3-0.35 mm) case depth." He continues, "This fluidized bed nitriding is 2 ½ times cheaper than some supposedly competitive nitriding processes, and it's the best we've ever seen.

Steam blueing

Steam blueing is a controlled oxidation reduction process used on tools after nitriding or ferritic nitrocarburizing, and it can be performed in the same fluidized bed furnaces. The technique produces a highly adherent oxide film on the surface of ferrous metals. The porous, blue-black oxide layer, approximately 0.0002" (0.005 mm) thick, increases tool life and corrosion resistance through its ability to retain lubricants. The layer also improves appearance, signals wear, increases anti-galling properties, and reduces edge buildup.

Forward Industries (Dearborn, MI) manufactures nitrogen die cylinders and manifold systems for automotive applications. In many cases, its cylinders must perform in harsh environments with chemical agents. They must resist temperatures from 0-400°F (-18-204°C). The interchangeable cylinders and manifolds are finished and stocked for assembly and, so, must be identical in every way.

Forward had tried many surface treating processes, but none had met its exacting needs—until Dynamic recommended ferritic nitrocarburizing along with steam blueing in fluidized bed furnaces.

Larry Evans, Forward's general manager, explains, "We tested different nitriding processes but had scoring problems from insufficient hardness, distortion problems leading to dimensional instability, chemical reactions with the synthetic fluids or external chemical agents, and inconsistency, which for us is deadly. Our components are not machined after surface treating, so if they come back warped or a different size, we have to scrap them."

About ferritic nitrocarburizing and steam blueing, Evans notes, "It's uniform, dimensionally stable, durable, rust and corrosion resistant, priced right, and the best looking process we've seen. Consistency of color may seem like a strange prerequisite, but our customers get used to seeing the same thing and come to expect it after a while."

"We have a lot of cylinders out in the field that, in time, require servicing. We've only had to replace the seal kits on ferritic nitrocarburized cylinders. We've never had to rehone a scored wall yet. This surface treatment has become one less variable that we have to worry about," Evans adds.

"These results are typical," according to Epler of Dynamic, "of the performance that can be directly attributed to surface treating processes such as ferritic nitrocarburizing performed in fluidized bed furnaces. When you add the inherent cost and time savings to the performance results, it really adds up to an important development. And it's only the beginning. Just about any wear surface can be treated, such as machine ways, guides, wear plates, printing parts, conveyor components, mining tools, farm and construction equipment, pump parts, calculation machine and computer components, textile spindles, hydraulic parts, and even robot fingers. Industries' needs will surely stimulate further process development and refinement." **ME**