

VALUE-ADDED THERMAL TREATMENT SOLUTIONS

FOR DEMANDING APPLICATIONS

Our industry-leading thermal treatment capabilities provide a diverse range of processing options to meet demanding strength and hardness requirements—regardless of order size. We continue to develop these capabilities and broaden our sophistication in custom thermal treat offerings so you can rely on innovative product designs and proven quality. With our combination of metallurgical and thermal treatment knowledge, we have set ourselves apart from the competition.

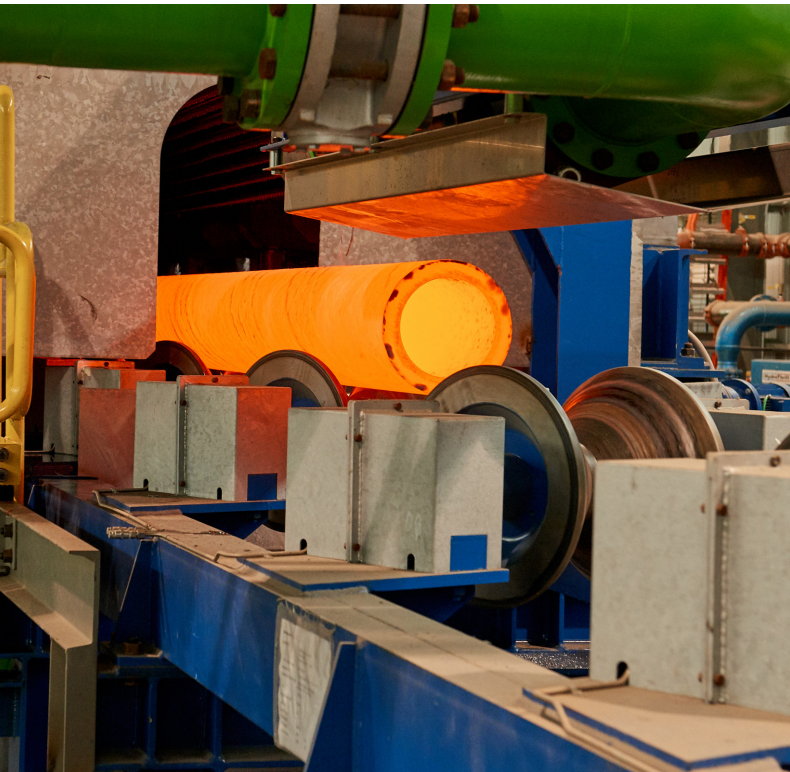
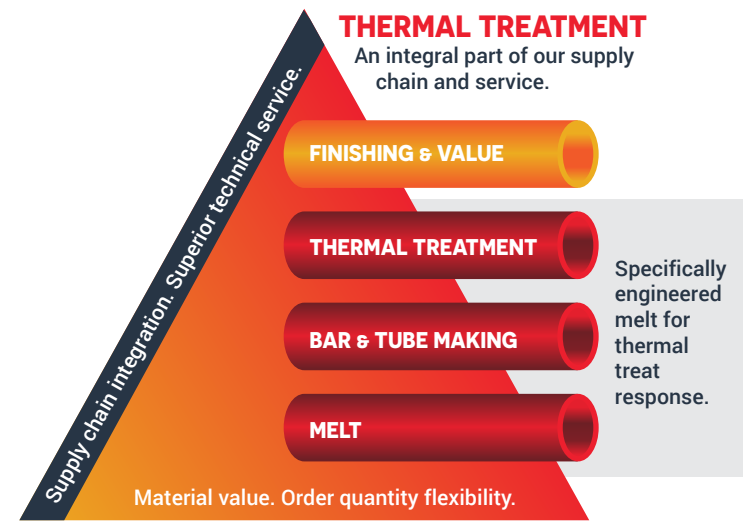
We meet our customers' needs through our value-added steel bars, tubes and billets for challenging applications. Our approach to manufacturing integrates our melting, rolling, piercing and finishing operations, ensuring a complete chemistry and economical solution from start to finish.

We tailor product properties to meet increasing demands from customers with tighter specifications. **Benefits of our value-added thermal treatment capabilities include:**

- Precisely controlled hardness and strength properties;
- Improved ductility and toughness;
- Annealing for subsequent forging or machining operations;
- Relieved stresses caused by cold straightening; and
- Development of low-alloy customized grades for unique applications.

THERMAL TREATMENT CAPABILITIES

We feature seven treatment processes across 20 assets, with more than 50 furnace cycles. These seven processes are anneal, normalize, quench-and-temper, special quench-and-temper, spheroidize anneal, stress relieve and temper. These capabilities allow us to offer extremely flexible “recipes” as well as sophisticated material planning and process controls.



QUENCH-AND-TEMPER, SPECIAL QUENCH-AND-TEMPER, NORMALIZE

The austenitizing and quenching process heats steel uniformly to a temperature above the critical range and cools it rapidly, using water to achieve a desired structure. Subsequent tempering results in desired mechanical properties. This treatment helps achieve specific levels of strength and toughness to meet customer requirements.

Special quench-and-tempering involves longer processing for the most stringent structure and mechanical properties. In the normalizing process, we heat steel uniformly to a temperature above the critical range, then cool in air to room temperature. This treatment produces a recrystallization and refinement of the grain structure, giving the product uniformity in hardness and structure.

Applications for oil and gas drilling and completion applications often take advantage of these capabilities.

ANNEAL AND SPHEROIDIZE ANNEAL

Annealing is heating uniformly to a temperature within or above the critical range and cooling at a controlled rate to a temperature under the critical range. We use this treatment to produce a definite microstructure, usually one designed for the best machinability and ductility. We also use annealing to remove stresses, induce softness and alter toughness or other mechanical properties. Spheroidize anneal uses a long heating cycle to produce carbide microstructures best for machinability and subsequent processing steps. Bearing and industrial and mining components especially benefit from these thermal treatment capabilities.

STRESS RELIEVE AND TEMPER

Stress relieve helps minimize distortion for machining, while tempering relieves stresses and softens the product prior to cold working. Gears and shafts benefit from these capabilities.

OUR THERMAL TREATMENT FACILITIES PROVIDE TAILORED SOLUTIONS TO MEET A WIDE RANGE OF CUSTOMER NEEDS.



THERMAL TREATMENT FACILITIES

Our thermal treatment facilities provide tailored solutions to meet a wide range of customer needs, allowing us to offer different capabilities to achieve uniformity and production speed.

These facilities are our Continuous Thermal Treatment Facility (CTTF), two Induction Thermal Treatment Facilities (ITTF), Quench Temper Facility (QTF), General Thermal Treatment Facilities (GTTF) and our Advanced Quench-and-Temper Facility (AQTF)—all at our Gambrinus Plant in Canton, Ohio.

CTTF: ADVANCED PROCESSES PRODUCE UNIFORM RESULTS

The CTTF is one of the world’s most advanced quench-and-temper operations. From the austenitizing furnace into the quench station and the tempering furnace to the five-roll straightener, the blend of computer/operator control allows us to customize properties for our customers. This helps us deliver the extraordinary bar and tube quality and uniformity you expect and rely on.

The CTTF features quenching versatility of outer diameter (OD) quench for bars and thin-walled tubing and our proprietary OD/inner diameter (ID) quench process for heavy-walled tubing. Depending on product features and desired mechanical properties, we determine the optimum quench cycle for precise control of as-quenched properties, with minimum distortion.

The CTTF process delivers:

- Constant product rotation for exceptional uniformity;
- Consistent bar and tube straightness;
- Elimination of cold straightening and stress relieving; and
- Flexible size range.

The CTTF accommodates size ranges up to 12.000 inches (304.80mm) in diameter.

- Bars: 2.375 – 11.000 inches (60.33 – 279.40mm) diameter
- Tubes: 2.375 – 12.000 inches (60.32 – 304.80mm) OD <= 3.250 inches (82.55mm) wall
- Lengths: 10 – 42 feet (3.05-12.80m)

AQTF: INCREASED CAPACITY TO SERVE DEMANDING APPLICATION NEEDS

Consistent innovation makes us an integral part of our customers’ success. We continue to develop our facilities, advance our capabilities and broaden our sophistication in thermal treatment offerings so you can rely on us for innovative product designs and proven performance.

Our Advanced Quench-and-Temper Facility (AQTF) allows us to produce more value-added steel for your most demanding applications. Additional continuous heat treat capabilities provide flexibility to create more customized steels.

The AQTF, the largest of our thermal treatment facilities, can handle 50,000 process tons annually of up to 13-inch (330.2mm) bars and tubes. This added quench-and-temper capacity especially benefits intensive horizontal and offshore drilling and completion activities.



Benefits of the AQTF include:

- Demanding material property specifications;
- Tight temperature tolerance;
- Uniform product heating and cooling;
- Uniform quenching (no “slack” quench);
- Strong quench (high-percent martensitic structure);
- Long soak times (L80)—adds capacity; and
- Quick order changeover (furnace cooling).

The AQTF accommodates size ranges up to 13.000 inches (330.20mm) in diameter:

- Bars and tube OD: 4.000 inches – 13.000 inches (101.60 – 330.20mm);
- Tube wall thickness: 0.400 inches – 3.000 inches (10.16 – 76.20mm)
- Maximum length: 45 feet (13.72m)

ITTF: MAXIMUM CONTROL EQUALS EASIER CUSTOMIZATION

Our heat-treated steel bars and tubes suit jobs of any size. The ITTF supports customization with highly precise, consistent temperature controls. Such control and efficiency help ensure that all jobs—even those for small quantities—meet exacting specifications. We manage the entire process, from melt through thermal treatment, so you get the quality you expect using clean steel with exceptional uniformity, straightness and hardness.

Our ability to rotate the steel during the treatment process enables exceptional uniformity and straightness. Our heat-treated steel fulfills stringent mechanical and hardness requirements due to the ITTF’s combination of consistent temperatures, faster rotational speeds, controlled quenching and uniform tempering.

The ITTF completely finishes the steel, including normalization, quenching-and-tempering, and process stress relieving or tempering.

The ITTF induction-heating process means:

- Ideal processing for small and large jobs;
- Shorter turnaround times; and
- Elimination of cold straightening and stress relieving.

Our second ITTF operation is an all-induction line capable of processing a wider range of OD bars and tubes. The facility employs a unique V-shaped roll design that allows product to remain exceptionally straight. The piece-tracking system gathers key parameters at all points of processing.

The ITTF accommodates size ranges up to 8.000 inches (203.20mm) in diameter. Operations we perform in the second ITTF operation include normalize, stress relieve and temper.

- Bars: 1.000 – 8.000 inches (25.40 – 203.20mm) diameter
- Tubes: 2.000 – 8.000 inches (50.80 – 203.20mm) OD <= 3.000 inches (50.80mm) wall
- Lengths: 12 – 40 feet (3.66 – 12.19m)

QTF: COMBINING STRENGTH WITH EFFICIENCY

A deep technical knowledge of manufacturing processes led us to build a specialized QTF operation, where we efficiently process both bar and tubular orders. Our streamlined quench-and-temper operation produces customized product quickly and reliably.

With precise temperature control, we can adjust our processes to meet customized product requirements. This helps us achieve the best possible results.

The QTF process provides:

- Induction preheating results in quick processing times;
- Continuous piece-tracking to gather data throughout all stages of processing; and
- Modified quench-and-roll design—along with a specially designed cooling table—so product remains exceptionally straight without the need for post-straightening operation.



The QTF accommodates size ranges up to 9.000 inches (228.60mm) in diameter.

- Bars: 4.000 – 9.000 inches (101.60 – 228.60mm) diameter
- Tubes: 4.000 – 9.000 inches (101.60 – 228.60mm) OD <= 3.000 inches (76.20mm) wall
- Lengths: 12 – 40 feet (3.66 – 12.19m)

GTTF: SPECIALLY FORMULATING HEATING, COOLING CYCLES

Our GTTF thermal treatment assets include 10 car-bottom-type furnaces, five roller-hearth-type furnaces and one tunnel-hearth furnace. We perform all seven treatment processes at the GTTF.

Car furnaces

- Bars: 1.000 – 13.000 inches (25.40 – 330.20mm) diameter
- Tubes: 2.000 – 13.000 inches (50.80 – 330.20mm) OD <= 3.000 inches (76.20mm) wall
- Lengths: 9 – 50 feet (2.74 – 15.24m)

Roller furnaces

- Bars: 1.000 – 12.000 inches (25.40 – 304.80mm) diameter
- Tubes: 2.000 – 13.000 inches (50.80 – 330.20mm) OD <= 3.000 inches (76.20mm) wall
- Lengths: 9 – 40 feet (2.74 – 12.19 m)

Tunnel furnaces

- Bars: 2.000 – 12.000 inches (50.80 – 304.80mm) diameter
- Tubes: 2.000 – 13.000 inches (50.80 – 330.20mm) OD <= 3.000 inches (76.20mm) wall
- Lengths: 9 – 40 feet (2.74 – 12.19m)

**CONSISTENT INNOVATION
MAKES US AN INTEGRAL
PART OF OUR CUSTOMERS’
SUCCESS.**



OUR ENGINEERS ARE EXPERTS IN MATERIALS, PROCESSING AND APPLICATIONS, ALLOWING US TO WORK WITH OUR CUSTOMERS TO DELIVER HIGH-QUALITY, FLEXIBLE SOLUTIONS.

ANSWERING CUSTOMERS' TOUGHEST CHALLENGES

We customize every product and service we deliver to meet customers' specific needs. Our focus is on improving performance by addressing the toughest challenges, whether that requires a special bar quality (SBQ) steel bar or a seamless mechanical tube, a value-added component, honing, drilling or thermal treatment services or a supply chain solution.

Our engineers are experts in materials, processing and applications, so we can work closely with each customer to deliver flexible solutions related to our products as well as their applications and supply chains. We believe few others in our industry can consistently deliver this kind of breadth, customization and responsiveness.

METALLUS

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