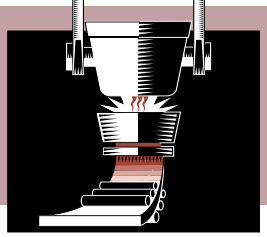
Technology Success Story

STEEL



Enhanced Spheroidized Annealing Cycle For Tube and Pipe Manufacturing

Benefits

- Reduced the spheroidizing heat treating cycle time by 20%
- Potential industry-wide reduction in energy consumption of approximately 34,000 MM British thermal units (Btu) per year
- Increased productivity during spheroidized annealing by 10%
- Maintained the desired carbide size and distribution
- Achieved desired specifications for machining and forming performance

"Experimental findings from the DOE Project spawned new ideas to improve the process of spheroidized annealing for through-hardened steel. The resulting enhanced spheroidized annealing cycle increased the productivity and reduced the energy consumption by approximately 10% in the two facilities conducting this process."

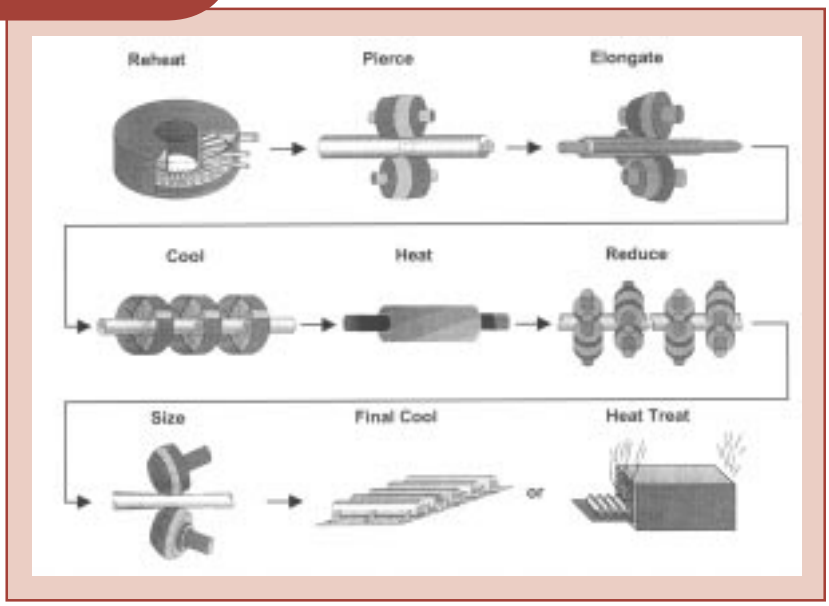
---- Jeffery E. Ives, Process Specialist
The Timken Company

Controlled thermo-mechanical processing (CTMP) technology improves productivity while reducing energy use

Steel tube and pipe production requires the casting of either steel billets or blooms, followed by series of piercing, elongating, and reducing operations to obtain the required pipe and tube dimensions. After the tube making process, the product often receives heat treatment to improve the performance to subsequent manufacturing. These heat treating and cooling cycles for high carbon steels require precise control which results in product quality and carbide microstructural effects. When the heat treating process is controlled properly, product performance, as well as cycle time and energy use in the steel plant can be positively affected. The steel industry is working to improve the manufacturing process of tubes and pipes while maintaining or improving key steel properties and reducing the amount of energy utilized in the process.

Optimization of the process and product quality requires technical processing guidelines and strategies. A coalition of government, industry, and universities partners worked together to generate experimental data to address this need. This group of process and equipment experts developed a system to produce targeted carbide microstructures with maximum process efficiency. Experiments were then conducted to develop the controlled thermo-mechanical processing (CTMP) practices to improve product performance and productivity. Through experimental results of the CTMP project, The Timken Company was able to reduce annealing times and incorporate the improved process into their current operations.

Tube and Pipe Making



Schematic of CTMP of tube and pipe maunfacturing.

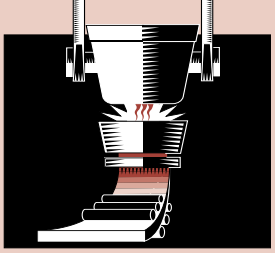
Solution

The Timken Company developed an enhanced spheroidized annealing cycle for through-hardened steel tubes and pipe. The enhanced cycle increases the productivity of the facilities conducting this process while reducing energy consumption. To obtain these benefits, new cycles were developed to shorten the corresponding process times while obtaining the desired metallurgical results. Experiments conducted as a part of the CTMP project were used to select annealing times and temperatures, significantly reducing the full-scale mill trials required to develop the new cycles. The experimentation was conducted to quantify the size and shape of the original carbide particles due to previous hot-working scenarios, and to quantify the effects of various combinations of times and temperatures during the spheroidized annealing cycle.

From a practical sense, the spheroidized annealing process makes high carbon steel easier to machine and form. This is achieved on a microscopic level by changing the hard, elongated carbide particles in the steel to spherical shapes with a preferred diameter and distribution. The size and shape of the original elongated carbides produced by the previous hot-working process have an influence on the ability to spheroidize the carbides. The spheroidized annealing process is conducted by heating to temperatures at which the carbide particles have the tendency to form spherical shapes. This entire heating and holding cycle takes 20-to-50 hours to occur. Various combinations of temperatures and times can be used to achieve the desired shape and distribution of the carbide spheres.

Results

The overall CMTP project, which produced the experimental results, was initiated in September 1999 and is not due for completion until 2004. However the project results involving the shortened annealing cycle were implemented at The Timken Company in May 2000. Using the enhanced annealing cycle, Timken has saved 10% of its natural gas use, approximated at 17,000 MMBtu annually. Their annealing cycle time has been reduced by 20%, resulting in a 10% productivity increase through the annealing facilities. Other steel and specialty metal manufacturers may also find use for the experimental results, which will be published under the Department of Energy's CMTP project upon its completion.



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