METHOD OF MAKING STEEL STRAPPING AND STRIP

**Semi-Annual Report for Period Ending
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Semi-Annual Report #2

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Narrative:

a) Technical Progress-A contract for Phase II of the Bricmont contract has been awarded and work has been initiated. The direction for the heat treating method has been established with input from the work to date on the Northwestern contract for the project entitled "Effects of Steel Composition and Quench Rate on Microstructures and Mechanical Properties of Strapping".

The conclusion has been accepted by ourselves and Northwestern that our direction to heat treat to a Martensitic microstructure will give us optimum physical properties in the final product. The attached comparison from the American Society of Metals "Handbook of Quenchants and Quenching Technology" clearly shows the superiority of this end objective (Quenched and Tempered) as compared to "Normalized and Tempered" structures.

Present industry practice produces a "Normalized" or a close compromise to this structure which is obtained by Quenching in Lead. It is not possible to prevent some lead adherence to products produced in this manner and the industry has been searching for new methods to avoid this environmental hazard which is present not only in the production process but in the product as well.

It is appropriate to review our production methodology at this time in order to reconfirm the steps taken which have been previously designated by those knowledgeable in the field to be proven in former steel conversion practice.

Step 1 - Conduction Heating: This is a very efficient method of heating the workpiece which not only provides considerably lower energy consumption and high operating flexibility but has metallurgical advantages as well. The principle is that the heating is so rapid that residuals or contaminants have insufficient time to reach the steel's grain boundaries (in the Austenitic Phase) where they would have their most weakening effect.

Conduction Heating has been in use in the strapping industry for over 50 years and while the application is comparable but not exactly similar, has been accepted and confirmed by production practice in heat treating larger cross section steel bars. This gets into the area of "Transformation Kinetics" and is hard to qualify and or quantify as we are working with transformation times in the order of 1 second or less (Austenitic to Martensitic transformation).

Step 2 - Hot Rolling round sections to flats: This is an existing practice to which we will be applying modern mechanical and electrical technology to optimize the operation.

Step 3- Heat Treating or Controlled Cooling: Our principal advantage in this respect is that we are working with relatively thin cross sections with large surface area which facilitates very rapid heat transfer.

Present day heat treating practice and methodology are based on larger cross sections where the surface area to volume ratio is much less. For example: the standard "Jominy" test for heat treating evaluation of various chemistry steels, uses a 1" diameter round bar.

The Northwestern test procedure uses a standard laboratory furnace for heating our samples and while this doesn't exactly duplicate a conduction practice it has been deemed acceptable with results no better than what would be achieved with conduction heating. Conduction heating is so rapid that it is very difficult to achieve an exact or reproducible elevated temperature which will vary widely over very small time increments when working with stationary test pieces.

As mentioned in Step 1 above, we are working in a very short time frame for the transformation to Martensite. While very rapid, the practicality of our proposed method of cooling has been confirmed by "Dilatometry" of representative steel compositions. It is also possible to extend this time frame by altering the steel composition i.e. "Taylor" the steelmaking practice to the production scheme which is frequently done for high volume applications. Again, our direction is further supported by the commercial production, although in a different manner, of Martensitic steels in sheet form.

At present, to more closely duplicate our proposed practice, we have recently obtained in the U.K., test specimens of flat, low carbon steel samples which have been conductively heated and hot rolled from round rod. These are being further hot rolled to strapping thickness at the Touchstone Laboratories in Triadelphia, West Virginia. (Incidentally, I was introduced to Touchstone at the DOE "Showcase" recently held in Pittsburgh. Up to this time we were unable to find a test facility who could perform this operation).

These samples will now be forwarded to Northwestern for appropriate heat treating.

This is about as close as we can come to duplicating our new practice, the next step being the construction of a Pilot/Production Line.

b) Technical difficulties: The market reply to our selling efforts to date is that our technology remains "Unproven". Northwestern's metallurgical team are highly respected in the industry as having extensive knowledge and previous experience in this heat treating area. The results of their supporting work, which has broadened in scope from the onset, will answer a lot of the conservative and unfounded challenges coming from the field who resist "Change".

General: The project is currently on the revised schedule for completion by August 31, 2000 and within the allowed Budget.

Respectfully yours,

A handwritten signature in cursive script, reading "Robert Reilly".

Robert Reilly

encl.

DOESEMIB

Measuring Hardenability and Quench Severity

The best combination of properties in carbon and low-alloy steel can be obtained by quenching to a martensitic microstructure, followed by tempering. A considerably higher yield strength can be obtained at a given tensile strength by quenching and tempering than by normalizing and tempering, as illustrated in Fig. 2.1.

Successful hardening depends on the geometry of the part, the hardenability of the steel, and the quenching practices employed. Quenching to develop a martensitic structure without warping or cracking requires good part design, a steel with adequate hardenability, properly maintained heat treating furnaces and quench facilities, the proper quenchant, knowledgeable technicians, and experience.

Fig. 2.1 Tensile and yield strengths of normalized and tempered and of quenched and tempered steels