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RESTRICTED YIELD STRENGTH VARIATION IN HIGH STRENGTH LOW ALLOY STEELS

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Variability in the yield strength of High Strength Low Alloy sheet steel is a major concern of the automotive industry and other industries involved in forming sheet metal. In order to have a material with a more consistent forming behavior, restrictions have been imposed on the permissible yield strength variation.

Achieving uniform properties requires identifying those components of the processing sequence that may have significant effect on yield strength variability of the product. Alloy design is examined and optimized with regard to steelmaking, hot strip mill processing capabilities, batch and galvanize line annealing capabilities. The use of low carbon steels containing columbium or columbium and vanadium together with silicon for solid solution strengthening achieves a family of steels that minimize yield strength variation. Cold rolled steels utilize that portion of the annealing cycle that achieves a fully recrystallized structure for steels with yield strengths of 50 ksi (345 MPA) and 60 ksi (414 MPA) and a recovered structure for steels with minimum yield strength of 70 ksi (483 MPA) and 80 ksi (552 MPA).

VARIABILITY IN THE YIELD STRENGTH of High Strength Low Alloy sheet steel is a major concern of the automotive industry and other industries involved in forming sheet metal. In order to have a material with a more consistent forming behavior, restrictions have been imposed on the permissible yield strength variation. For the steel supplier, this translates into identifying the area where improved control of composition and processing will result in a product that will meet new and more restrictive specifications.

The present goal of the steel supplier is to be able to ship product on a routine basis that does not vary more than 0 ksi below the minimum yield strength and not more than 15 ksi above the minimum yield strength.

Achieving uniform properties requires identifying those components of the processing sequence that may have an effect on yield strength variability of the product. The first step in this process is the question of optimum alloy design. The goal is to chose an alloy system that exhibits the least amount of sensitivity to processing parameters.

For example, skid marks, acquired during reheating, can result in regions of the slab being 50 to 100°F (28 to 56°C) cooler than the remainder of the slab. Since these regions have a different thermal history than the remainder of the slab, they are a source of variability in strength. Similarly, the coiling temperature on some hot strip mill facilities can vary as much as 150°F (83°C). The sensitivity of yield strength to coiling temperature for certain compositions can be quite large as illustrated in Figure 1. Two compositions containing 0.4% Mn and 1.5% Mn with varying amounts of Ti were subjected to a coiling temperature of 1100°F (593°C) and 1300°F (704°C). For the steel containing 0.4% Mn, the variation in yield