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# METALLURGICAL ASPECTS

## Introduction

With the development of the art and science of steelmaking, there has been a corresponding evolution of terms to describe manufacturing processes and treatments, and of accurate definitions for steel products and their qualities. Science and industry have not always advanced hand in hand; consequently, numerous shop and trade terms have become so thoroughly implanted in the language that they are used instead of more precise and descriptive technical terms.

The chemical composition of steel may vary from almost pure iron to a material of complex constitution. The properties of steel likewise vary from those of almost pure iron through all of the chemical compositions and qualities that have developed to serve the requirements of our complex mechanized civilization. Consequently, comprehensive definitions are needed when dealing with this widely adaptable material.

It is our purpose to describe the various grades and qualities of steel plate to assist consumers in selecting the proper grade and quality for a given use. Moreover, there are distinct limitations inherent in different grades and qualities which should be understood in order to prevent possible misapplication with resulting disappointments in fabrication and service.

In all phases of steel production, various practices are employed which determine the type and quality of finished product. Controls must be exercised over such factors as raw materials and techniques of refining and processing.

Some of the practices employed by steel producers to improve the final product are special melting, ladle refining, vacuum degassing, special pouring practices, hot topping, controlled heating and rolling practices, special discards, controlled cooling, special surface preparation and special inspection procedures. Even with special practices, loss of product or diversion to less stringent requirements is sometimes necessary.

The freedom and scope of applications of materials for several qualities and grades are of necessity progressively limited as the end use requirements become more severe. Obviously, it would be wasteful to make all steel of a given superior quality regardless of end use, and for many applications nothing would be gained in the perfor-

mance of the product. Conversely, there are many instances where the higher quality product is necessary for the intended purpose.

In view of the established economy of the blast furnace and the almost universal necessity for the use of scrap as a raw material in steelmaking, the basic oxygen furnace, electric furnace and open hearth processes seem destined to remain as units for the manufacture of steel. In addition, secondary refining processes such as Ladle Refining, Electro Slag Remelting (ESR) or Vacuum Arc Remelting (VAR) may be used.

The product of any one of the steelmaking processes can be cast into a slab or ingot form and hot rolled or hot forged to convenient size for further working. Further processing is described later in this section.

**Carbon Steel** is steel for which no minimum content is specified or required for chromium, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium or zirconium, or any other element added to obtain a desired alloying effect; when the specified minimum for copper does not exceed 0.40 percent; or when the maximum content specified for any of the following elements does not exceed the percentages noted: manganese 1.65, silicon 0.60 and copper 0.60.

**High Strength Low Alloy (HSLA)** steel comprises a group of steels with chemical composition specially developed to impart higher mechanical property values and, in certain of these steels, greater resistance to atmospheric corrosion than is obtainable from conventional carbon structural steels. It is not considered to be alloy steel, as described in other parts of this section of the Manual, even though an intentionally added alloy would qualify it as such. The minimum yield point and tensile strength requirements most often specified are between:

42 to 80 ksi (290 to 550 MPa) yield point  
60 to 90 ksi (415 to 620 MPa) tensile strength

HSLA steel is generally intended for applications where savings in weight can be effected by reason of its greater strength. These steels will vary in atmospheric corrosion resistance from equal to that of conventional carbon steels to approximately four times that of conventional