MECHANICAL PROPERTIES AND COMPOSITION OF STEEL. 147

It is unnecessary to enter into the details of other processes for steel production, as none of them have ever been used for the manufacture of boiler plate to which this paper specially refers.

INFLUENCE OF IMPURITIES.—It may be remarked that pure iron or steel has never been produced, and my remarks only apply to the effects on additions made to average qualities.

CARBON.—Increases tensile strength and tempering qualities, but reduces ductility, weldability and melting temperature.

PHOSPHORUS.—Has ascribed to it the chief blame for cold-shortness and all the general bad qualities of steel, but this seems only to be true if much carbon or sulphur is present. It also increases its liability to be burnt and reduces melting temperature.

SULPHUR.—Accentuates the bad effects of phosphorus, produces red-shortness and greasiness as regards welding.

SILICON.—Reduces elongation and melting temperatures, prevents blow holes, increases tenacity in presence of carbon, but does not accentuate the effects of phosphorus.

MANGANESE.—Intensifies the influence of carbon except as regards tempering properties and neutralizes red and cold-shortness of phosphorus, sulphur, etc.

NICKEL.—Reduces tensile strength, but increases ductility, particularly as regards impact. It neutralizes the influence of carbon and perhaps phosphorus and reduces corrosion.

More detailed information as to the effects which these and other impurities have on the good qualities of steel can, unfortunately, only be obtained from conflicting authorities whose experimental results are often impracticable and exceedingly vague. This is due to the difficulty of obtaining pure metals, as the various impurities often accentuate or neutralize one another, to neglect and difficulty experienced in analysis, and of universal ignorance as to the effects of various mechanical treatments.

INTRODUCTION TO METHODS.—In this paper I propose giving a summary of the results of tests made on the mechanical properties, with special reference to tensile strength and the effect of each addition of some impurity, and from this attempt to measure the effect of each element singly and combined with other impurities.

As a specific basis for the determination of these various effects an accurate chemical analysis forms an essential part. The mechanical properties are altered more or less by the various percentages of

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