ATLAS OF JOMINY CURVES FOR VANADIUM STEELS

The increasing competitiveness of alternative materials together with the increases in cost of fuel and labour used in heat treating steels has, in recent years, caused steel makers and steel users to re-examine the use of alloys in many types of steel particularly those used in the fully heat treated condition with the object of minimising the total cost of alloys and hence keeping steel costs to a minimum.

In some cases it has been possible to replace fully heat treated steels by "as forged" steels but where this is not feasible the total alloy contents have been reduced. A number of companies attempt to select the most economic steel composition to meet specific hardenability requirements and property specifications on the basis of alloy costs and hardenability data in the form of Di values. Some companies have, in fact, developed computer programmes for determining the optimum composition for minimum cost on the basis of this data. While Di values, which are derived from Jominy distance for 50% martensite in the microstructure, can be used for comparing steels of similar composition in which the microstructure consists of martensite and ferrite – pearlite, it is dangerous to use them for comparing steels of different alloy types because these may contain other microstructure constituents which can influence the hardness; the steels may also have different coefficients for thermal diffusivities which can effect the microstructure. The only satisfactory method of comparing the practical hardenabilities of steels of different alloy types is, in fact, to use Jominy hardness curves.

This Atlas has therefore been prepared to assist steel makers and steel users in determining the most effective use of vanadium, alone or in combination with other hardenability elements in alloy steels, particularly those used in the fully heat treated condition.

Some of the curves have been taken from published literature but most of them have not been published previously. They have, in fact, been produced in the course of projects on the possible substitution of vanadium for molybdenum in fully heat treated steels. These have been supplied by The Swedish Institute for Metals Research arising from a project undertaken for VANITEC, The Foote Mineral Company in the U.S.A. and The Sheffield University Materials Advisory Centre working with Highveld Steel and Vanadium Corporation. VANITEC wishes to acknowledge the co-operation of these organisations and companies and to thank them for permission to publish the data.

Particular attention is drawn to the high hardenability which is reported by all three laboratories for steels containing additions of vanadium together with molybdenum and titanium and in vanadium molybdenum steels when melted in vacuum. The mechanism by which these very high hardenabilities are achieved has not been established but it will be seen that the hardenabilities of these steels are of the order of those achieved in Nickel Chromium and Nickel Chromium Molybdenum steels to which the vanadium steels become competitors.

Arthur M. Sage
Chairman