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MICROALLOYED BAR FOR MACHINE STRUCTURAL USE

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The effects of Nb and V and hot rolling on mechanical properties were studied in laboratory melted carbon steels (0.25-0.45%C). Adequately controlled rolled Nb bearing steel showed a good combination of strength and toughness, whereas in the condition of conventional rolling or hot forging V bearing steel was more favorable resulting in moderately good toughness. Further improvement of toughness was attempted in V bearing steel by addition of Ti as an austenitic grain refining element. Utilizing these results, successful mill trials were made for the production of high strength controlled rolled Nb bearing rod and of V bearing rod for hot forging. In these products, final or intermediate heat treatment (QT) could be completely eliminated.

RECENT technical trend in rod products for machine structural use is the introduction of energy or process saving type rod where heat treatment can be eliminated (1,2). Many automotive components such as steering shaft, knuckle arm and others typically require adequate carbon content and heat treatment such as quenching and tempering to obtain the necessary properties. On the other hand, by microalloying in medium carbon steel and/or controlled rolling in bar mill, this heat treatment can be eliminated since the desired properties are obtained as rolled or as hot forged. For the development of energy saving type rod, the following technical consideration is required: establishing controlled rolling technique in bar mill (optimization of rolling temperature, speed, cooling condition, etc.) and/or optimized utilization of microalloying elements (Nb, V and Ti). There are some reports on the controlled rolling of bar products (3-5) and on the influence of microalloying elements in medium carbon steels (6-9). However, the carbon range of most of them is limited to

below 0.30% and information on the optimized use of microalloying elements is not necessarily sufficient.

This paper concerns the development of microalloyed bar products in which quenching and tempering can be eliminated. In the first part, the result of laboratory experiment on the influence of Nb and V on mechanical properties in medium carbon steels (0.25 - 0.45%C) is reported from standpoint of optimization of chemistry and processing. The effect of Ti as austenitic grain refiner in V-(N) steel is also presented for the case of conventional rolling or hot forging in which addition of V is beneficial. In the second part, the results of manufacturing trials are reported for two cases of application. The first case is the as rolled rod from which a machined shaft can be manufactured without quenching and tempering. The second case is V bearing bar which can be used as hot forged without further heat treatment.

EXPERIMENTAL PROCEDURES

The steel ingots were prepared by 50kg air induction melting or 150kg vacuum induction

Table 1. Chemical composition of steels (wt%).

Series	C	Si	Mn	P	S	Nb	V	Ti	Sol.Al	T.N
I (C,Nb)	0.25 0.44	0.25	1.0	0.020	0.003	tr.	tr.	tr.	0.020	0.0060
	0.24 0.45	0.25	1.0	0.020	0.003	0.035	tr.	tr.	0.020	0.0060
	0.35	0.30	1.0	0.020	0.003	0.015 0.025	tr.	tr.	0.020	0.0060
II (V)	0.45	0.30	0.70	0.015	0.015	tr.	tr. 0.140	tr.	0.020	0.0060
III (Nb,V)	0.33	0.25	1.10 1.87	0.007	0.020	tr.	0.05	tr.	0.020	0.0060
	0.33	0.25	1.08 1.84	0.007	0.020	0.025	tr.	tr.	0.020	0.0060
IV (Ti,V,N)	0.45	0.30	0.80	0.015	0.020	tr.	0.10	tr.	0.020	0.0030 0.0097
	0.45	0.30	0.80	0.015	0.020	tr.	0.10	0.006 0.025	0.020	0.0031 0.0122