

**KAWASAKI STEEL TECHNICAL REPORT**

No.11 ( March 1985 )

---

**Properties of Microalloyed Medium Carbon Steel**

Satoru Takahashi, Hideyuki Yuzawa, Naomasa Murai, Yoshihiko Inoue, Tadashi Morii,  
Masanori Minagawa

---

**Synopsis :**

To develop microalloyed carbon steel bars for machine parts, the effects of microalloying elements and the hot working conditions on the strength and toughness of medium carbon steel were investigated. The results obtained are as follows: (1) Because of the effects of V or Nb for precipitation hardening and crystal grain refinement, addition of V and/or Nb is effective for producing microalloyed carbon steel bars. (2) Strength, hardness and toughness are controlled by the heating temperature and the cooling rate from Ar3 to Ar1. (3) The chemical component design should be based on the manufacturing conditions and required properties of each part. (4) This steel is suitable to the connecting rod, crank shaft, pin, shaft and so on.

(c)JFE Steel Corporation, 2003

**The body can be viewed from the next page.**

# Properties of Microalloyed Medium Carbon Steel\*

Nobuyuki KONDO\*\*  
Yoshiji YAMAMOTO\*\*\*

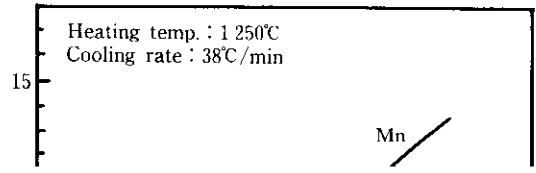
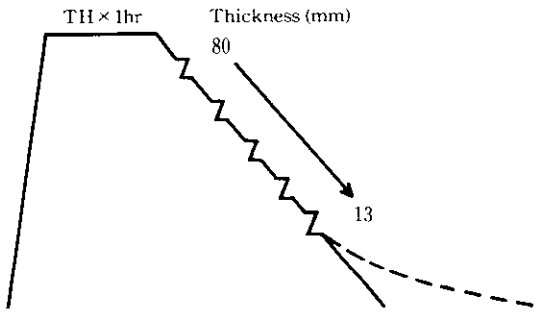
Kimio MINE\*\*  
Toshiro NAKAO\*\*\*\*

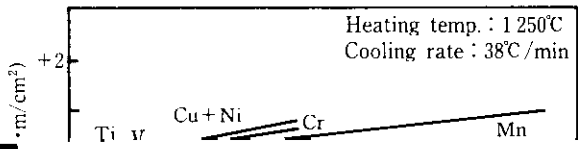
Noriaki KOSHIZUKA\*\*

*To develop microalloyed carbon steel bars for machine parts, the effects of microalloying elements and the hot working conditions on the strength and toughness of medium carbon steel were investigated.*

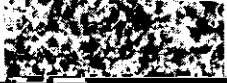

*The results obtained are as follows:*

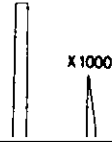
- (1) Because of the effects of V or Nb for precipitation hardening and crystal grain refinement, addition of V and/or Nb is effective for producing microalloyed carbon steel bars.*

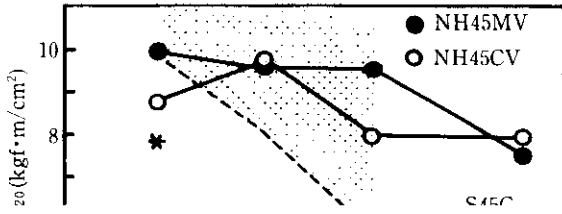




of the microalloyed carbon steel in this figure are compared with those of quenched and tempered S45C steel, the *YS* and *TS* values for the former are sufficiently high, and  $\sigma_{E20}$  in the former is slightly lower than that of the latter when the cooling rate is faster, but is almost equal

	25 mm $\phi$	110 mm $\phi$
MV		

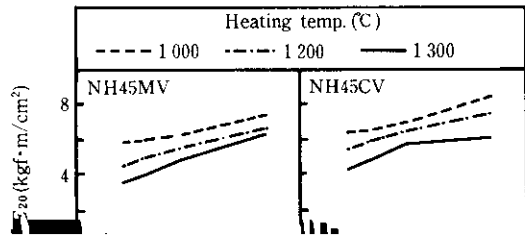




### 3.1.3 Sectional hardness

Figure 8 shows the hardness distribution in sector, indicating that as the diameter increases, hardness tends to decrease. It is also found that for all sizes, the surface of the bar is harder than its center part, but this differ-

	<i>TS</i> (kgf/mm <sup>2</sup> )
● NH45MV (As rolled)	80
○ NH45CV ( " )	79
□ S45C (Q-T)	79



Heating temperature 1300°C

in the ferrite-pearlite structure become coarser and the fractional factor of pearlite becomes greater.



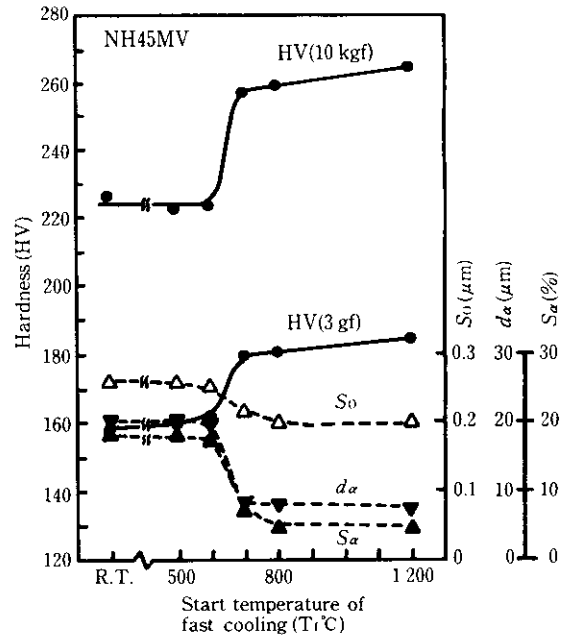
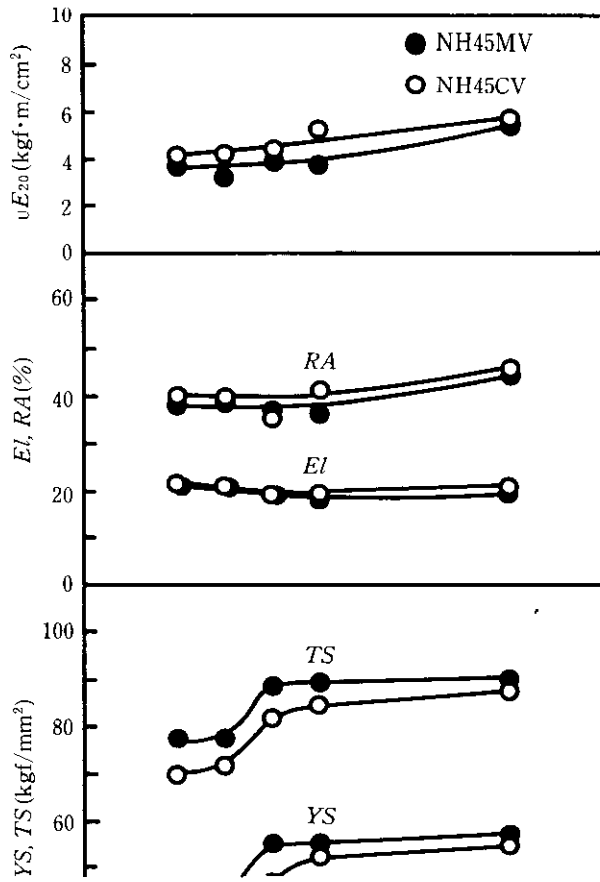
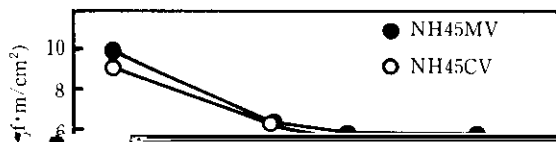


Fig. 16 Influence of start temperature of fast cooling on hardness and structure factor

toid ferrite. When cooling started at a rate of about 50°C/





strength and toughness of medium carbon steel bars.

The main results of the investigation are given below.

- (1) It is effective to add minute amounts of V, Nb, or V + Nb to microalloyed steel bars to bring about