1. Introduction

In recent years, increasingly high requirements have been set for energy saving in response to environmental and energy problems, and moves to achieve higher efficiency in motors have also accelerated.

With the non-oriented electrical steel sheets which are used as core materials in these motors, motor efficiency improves as iron loss decreases, while torque increases with magnetic flux density. Therefore, non-oriented electrical steel sheets with a combination of low iron loss and high magnetic flux density have been demanded.

JFE Steel produces the JNE™ series of low iron loss, high magnetic flux density electrical steel sheets and has also developed the new non-oriented electrical steel sheet for high efficiency motors, "JNP™ Series" with higher magnetic flux density. The following introduces the "JNP Series."

2. Features of "JNP™ Series"

2.1 Required Properties

The performance required in traction motors for hybrid electric vehicles (HEV) and electric vehicles (EV) and motor core materials are shown in **Fig. 1**[1]. In the traction motors of HEV/EV, high torque is required when starting, climbing hills and accelerating. Therefore, high magnetic flux density in the high magnetizing force area is demanded in non-oriented electrical steel sheets used in the iron cores of traction motors.

On the other hand, because the percentage of iron loss in motor loss becomes large when the motor reaches a high rotational speed, a material with low iron loss at high frequencies is required. Accordingly, while the optimum non-oriented electrical steel sheets will differ depending on which drive condition is given priority, high magnetic flux density and low iron loss in the material contributes to improvement of overall motor performance.

2.2 Properties of "JNP™ Series" and Techniques for Achieving High Magnetic Flux Density

The JNP™ series is a series of non-oriented electrical steel sheets with the distinctive feature of high magnetic flux density and low iron loss and is available in two sheet thicknesses, 0.35 mm and 0.50 mm. To make it possible to supply materials corresponding to the motor application, JFE Steel succeeded in developing two grades with different iron loss levels and further improving magnetic flux density at the same iron loss from the JNE™ Series, which is JFE Steel's conventional high flux density and low iron loss material.

Table 1 shows an example of the magnetic properties of the JNP Series; **Fig. 2** shows the relationship between iron loss ($W_{15/50}$) at 1.5 T, 50 Hz and magnetic flux density (B_{50}) in a 5 000 A/m magnetic field, in comparison with conventional non-oriented electrical steel sheets (JN, JNE Series) . It can be understood that the magnetic flux density of the JNP series at the same iron loss level is approximately 0.02 T higher in comparison with the JNE series.

Figure 3 shows the magnetization curves of 35JNP7 and 35JNE230. The magnetic flux density of 35JNP7 in the high field region is improved in comparison with 035JNE230. s of   E   f a 5)JF

In this JNP Series, improvement of magnetic flux