CLAIMS

1. A production method of high-grade non-oriented silicon steel, comprising the following steps:

1) smelting steel by molten iron desulfurization, converter smelting and RH refining in sequence, the finally obtained molten steel comprising the following chemical components in percent by mass: 0.002-0.004% of C, not greater than 0.003% of S, 1.4-1.7% of Si, 0.7-0.95% of Mn, not greater than 0.03% of P, 0.015-0.035% of Sn, not greater than 0.004% of Nb, not greater than 0.004% of V, not greater than 0.005% of Ti, not greater than 0.004% of Mo, not greater than 0.03% of Cr, not greater than 0.03% of Ni, not greater than 0.03% of Cu, not greater than 0.003% of N, and the balance Fe and inevitable impurities, and $1.0 \leq 11 \times ([Si]-1.4\%)/14 \times ([Mn]-0.7\%) \leq 1.3$;

2) continuously casting the molten steel obtained in step 1 into a continuous casting billet with the thickness of more than 200 mm;

3) heating the continuous casting billet obtained in step 2 to reach 1,120-1,150°C, and maintaining the temperature for more than 200 min; then carrying out multi-pass rough rolling to obtain an intermediate billet with the thickness of 40-45 mm; and then carrying out multi-pass finish rolling, cooling and coiling to obtain a hot-rolled coil with the thickness of 2.50±0.1 mm, the finishing temperature in finish rolling being 890±15°C, the rolling reduction of the last pass of finish rolling being not less than 30%, the total rolling reduction of the last two passes of finish rolling being not less than 50%, and the coiling temperature being 650±20°C;

4) carrying out uncoiling, acid pickling, rinsing, drying, cold rolling and coiling on the hot-rolled coil obtained in step 3, rather than carrying out normalizing treatment, thereby obtaining a cold hard coil with the thickness of 0.500±0.005 mm or 0.350±0.004 mm; and

5) carrying out finished product annealing on the cold hard coil obtained in step 4 in a mixed atmosphere of H_2+N_2 through a continuous annealing furnace, the finished product annealing temperature being 920-980°C, and

the annealing time being 60±5 s; and carrying out cooling, coating and finishing on the annealed steel strip to obtain a finished product of non-oriented silicon steel;

in a case that the thickness of the finished product of the non-oriented silicon steel is 0.500±0.005 mm, the iron loss is shown as $P_{1.5/50}$≤3.8 W/kg, and the magnetic induction intensity is shown as B_{5000}≥1.71;

or, in a case that the thickness of the finished product of the non-oriented silicon steel is 0.350±0.004 mm, the iron loss is shown as $P_{1.5/50}$≤3.3 W/kg, and the magnetic induction intensity is shown as B_{5000}≥1.70.

2. The production method of the high-grade non-oriented silicon steel according to claim 1, wherein in a case that the thickness of the finished product of the non-oriented silicon steel is 0.500±0.005 mm, the iron loss is shown as $P_{1.5/50}$≤3.8 W/kg, and the magnetic induction intensity is shown as B_{5000}≥1.71;

or, in a case that the thickness of the finished product of the non-oriented silicon steel is 0.350±0.004 mm, the iron loss is shown as $P_{1.5/50}$≤3.3 W/kg, and the magnetic induction intensity is shown as B_{5000}≥1.70.

3. The production method of the high-grade non-oriented silicon steel according to claim 1, wherein in step 3, the continuous casting billet obtained in step 2 is heated to reach 1,130-1,150°C, and the temperature is maintained for more than 200 min.

4. The production method of the high-grade non-oriented silicon steel according to claim 1, wherein in step 3, in the cooling process, two-stage cooling is carried out on the steel plate obtained by finishing in finish rolling, the previous-stage cooling is natural slow cooling without water cooling and lasts for 3-8 s, and the later-stage cooling is water-cooling rapid cooling.

5. The production method of the high-grade non-oriented silicon steel

according to claim 1, wherein in the molten iron desulphurization process, the temperature of desulphurized molten iron is controlled to be not less than 1,320°C, the content of S is not greater than 0.0015% by mass, and the slagging-off rate is not less than 98%;

in the converter smelting process, the desulphurized molten iron is mixed with scrap steel to be smelted in a converter, and the scrap steel accounts for 20-25% of the total mass of the molten steel; in the tapping process, a sufficient quantity of tin ingots are added into the molten steel according to the ratio of 0.015-0.035% of Sn in the finished product; and after tapping is finished, a slag top deoxidizing agent is added into the molten steel;

in the RH refining process, the molten steel is subjected to decarburization treatment in a pre-vacuumized RH refining furnace; then ultra-low titanium ferrosilicon and metal manganese are added into the molten steel according to an alloying solution that the finished product contains 1.4-1.7% of Si, and 0.7-0.95% of Mn, and $1.0 \leq 11 \times ([Si]-1.4\%)/14 \times ([Mn]-0.7\%) \leq 1.3$; tapping is carried out more than 7 min after net circulation; and a desulfurizing agent is added into the molten steel for deep desulfurization treatment during net circulation.

6. The production method of the high-grade non-oriented silicon steel according to claim 1, wherein in the acid pickling process, the hot-rolled coil obtained in step 3 is uncoiled and then subjected to three-stage acid pickling through HCl; wherein the concentration of first-stage acid liquor is 50-80 g/L, and the concentration of Fe^{2+} in the acid liquor is not greater than 130 g/L; the concentration of second-stage acid liquor is 90-120 g/L, and the concentration of Fe^{2+} in the acid liquor is not greater than 90 g/L; the concentration of third-stage acid liquor is 140-160 g/L, and the concentration of Fe^{2+} in the acid liquor is not greater than 50 g/L;

during each-stage acid pickling, the temperature of the acid liquor is 75-85°C, the acid liquor contains a silicon steel acid pickling accelerant, and the silicon steel acid pickling accelerant accounts for 0.05-0.10% of the acid

liquor by weight; and

the temperature of rinsing water is 45-55°C, and the acid pickling and rinsing speed is controlled to be 100-180 mpm.

7. The production method of the high-grade non-oriented silicon steel according to claim 1, wherein in step 5, the steel strip obtained after finished product annealing is subjected to three-stage cooling; the first-stage cooling is high-temperature-stage slow cooling, and the steel strip is cooled from annealing temperature to 850°C at a cooling speed of not greater than 5 °C/s; the second-stage cooling is circulating gas jet controlled cooling, and the steel strip is continuously cooled from 850°C to 350°C or below at a cooling speed of not greater than 15 °C/s; and the third-stage cooling is circulating water jet cooling, and the steel strip is continuously cooled from 350°C to 100°C or below.

8. A production method of high-grade non-oriented silicon steel, comprising the following steps:

1) smelting steel by molten iron desulfurization, converter smelting and RH refining in sequence, the finally obtained molten steel comprising the following chemical components in percent by mass: 0.002-0.004% of C, not greater than 0.003% of S, 1.4-1.7% of Si, 0.7-0.95% of Mn, not greater than 0.03% of P, 0.015-0.035% of Sn, not greater than 0.004% of Nb, not greater than 0.004% of V, not greater than 0.005% of Ti, not greater than 0.004% of Mo, not greater than 0.03% of Cr, not greater than 0.03% of Ni, not greater than 0.03% of Cu, not greater than 0.003% of N, and the balance Fe and inevitable impurities, and $1.0 \leq 11 \times ([Si]-1.4\%)/14 \times ([Mn]-0.7\%) \leq 1.3$;

2) continuously casting the molten steel obtained in step 1 into a continuous casting billet with the thickness of more than 200 mm;

3) heating the continuous casting billet obtained in step 2 to reach 1,120-1,150°C, and maintaining the temperature for more than 200 min; then carrying out multi-pass rough rolling to obtain an intermediate billet with

the thickness of 40-45 mm; then carrying out multi-pass finish rolling, and coiling to obtain a hot-rolled coil with the thickness of 2.50±0.1 mm, the finishing temperature in finish rolling being (Ar1-40)±15°C, Ar1 representing the temperature for transformation from austenite to ferrite, the rolling reduction of the last pass of finish rolling being not less than 30%, the total rolling reduction of the last two passes of finish rolling being not less than 50%, and the coiling temperature being 650±20°C; and carrying out two-stage cooling on the steel plate obtained by finishing in finish rolling before coiling, the previous-stage cooling being natural slow cooling without water cooling and lasting for 3-8 s, and the later-stage cooling being water-cooling rapid cooling;

4) carrying out uncoiling, acid pickling, rinsing, drying, cold rolling and coiling on the hot-rolled coil obtained in step 3, rather than carrying out normalizing treatment, thereby obtaining a cold hard coil with the thickness of 0.500±0.005 mm or 0.350±0.004 mm; and

5) carrying out finished product annealing on the cold hard coil obtained in step 4 in a mixed atmosphere of H_2+N_2 through a continuous annealing furnace, the finished product annealing temperature being 920-980°C, and the annealing time being 60±5 s; and carrying out cooling, coating and finishing on the annealed steel strip to obtain a finished product of non-oriented silicon steel;

in a case that the thickness of the finished product of the non-oriented silicon steel is 0.500±0.005 mm, the iron loss is shown as $P_{1.5/50}$≤3.8 W/kg, and the magnetic induction intensity is shown as B_{5000}≥1.71;

or, in a case that the thickness of the finished product of the non-oriented silicon steel is 0.350±0.004 mm, the iron loss is shown as $P_{1.5/50}$≤3.3 W/kg, and the magnetic induction intensity is shown as B_{5000}≥1.70.

9. High-grade non-oriented silicon steel, prepared through the production method according to claim 1;

in a case that the thickness of the finished product of the non-oriented silicon

steel is 0.500±0.005 mm, the iron loss is shown as $P_{1.5/50}$≤3.8 W/kg, and the magnetic induction intensity is shown as B_{5000}≥1.71;

or, in a case that the thickness of the finished product of the non-oriented silicon steel is 0.350±0.004 mm, the iron loss is shown as $P_{1.5/50}$≤3.3 W/kg, and the magnetic induction intensity is shown as B_{5000}≥1.70.