HyperNO

NON-ORIENTED ELECTRICAL STEEL FOR EV TRACTION MOTOR

posco

Electrical steels have excellent electro-magnetic properties. There are two types of electrical steel: grain-oriented and non grain-oriented electrical steel. Today, as the needs to reduce energy loss are increasing sharply, demands for high quality electrical steel are also growing. POSCO produces 1 million tons of high quality electrical steel each year.

Contents

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FOR EV TRACTION MOTOR

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Pohang & Gwangyang steelworks

Pohang Steelworks

Upon completion of its first-phase manufacturing facility in 1973, Pohang Steelworks, Korea's first integrated steel mill, was finally completed after 4 stages of construction at Young-il Bay in February 1981.
POSCO is capable of producing and processing a variety of carbon steels and stainless steels. The company's global competitiveness was further enhanced when we opened the world's first FINEX commercialization facility in May 2007.

Main products _ Hot-rolled steel, Plate, Cold-rolled steel, Wire rod, Electrical steel, Stainless steel, API steel, etc.
Crude steel production _ 16,852 million tons (as of 2021)

Gwangyang Steelworks

Gwangyang Steelworks is the world's largest integrated steel mill which features an optimal layout for processing carbon steel.
Products from Gwangyang works include automotive steel, high-strength hot rolled steel, high-quality API steel, and thick plates among other products.
With the goal of specializing in the manufacturing of the world's best automotive steels, Gwangyang Steelworks focuses on enhancing its competitive edge.
The new Electrical Steel plant is completed in October 2023.

Main products _ Hot-rolled steel, Plate, Cold-rolled steel, Car steel, API steel, Electrical Steel etc.
Crude steel production _ 21,412 million tons (as of 2021)

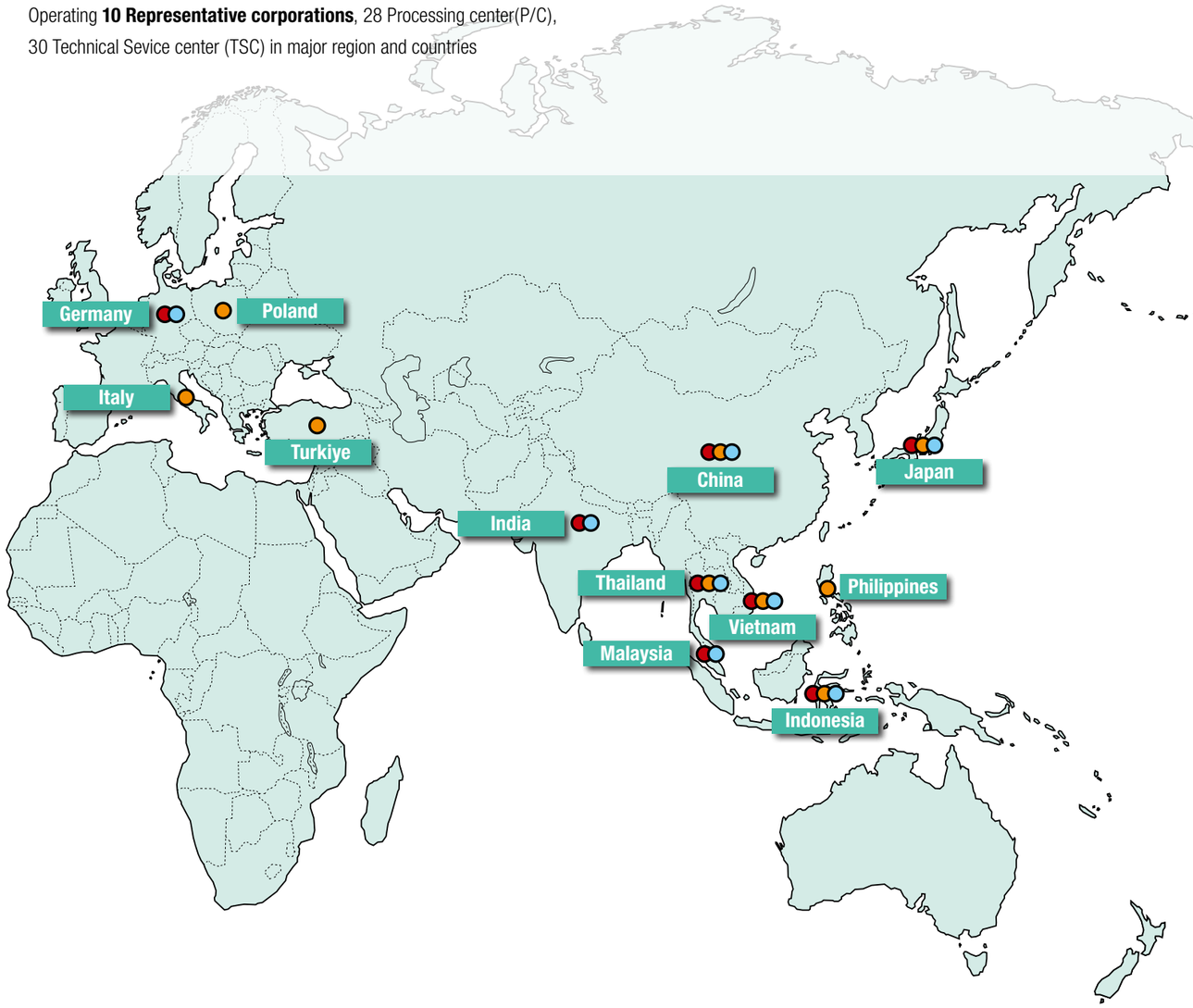
Creation of customer value by securing product quality and cost competitiveness

Realization of symbiotic values through the establishment of a robust industrial ecosystem with suppliers, partners, and customers

- Development of quality and top-notch products that can impress our customers
- Creating customer value by securing cost competitiveness with suppliers and partners
- Robust facility implementation and smart facility management that can be called the cornerstone of production and quality

Worldwide network of supply chain for electrical steel

Operating **10 Representative corporations**, 28 Processing center(P/C),
30 Technical Sevice center (TSC) in major region and countries



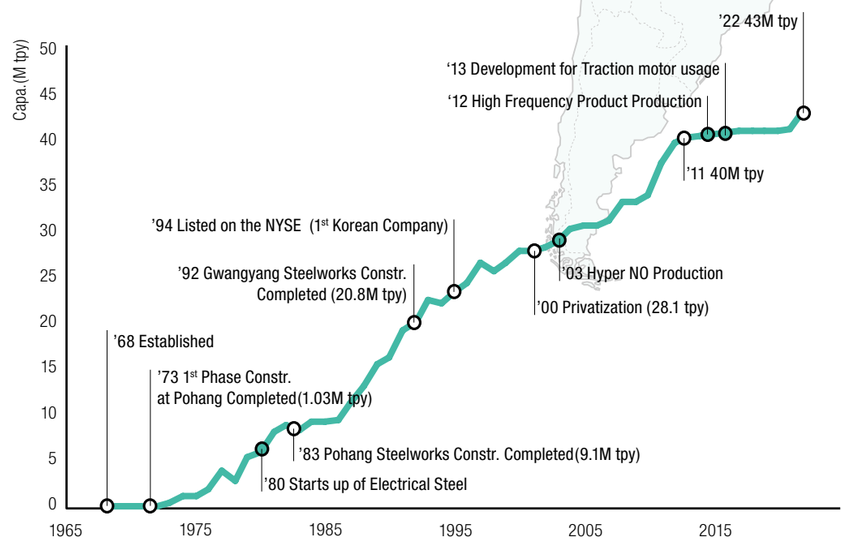
- **Rep. Corp 10 countries** : China, Japan, Indonesia, Vietnam, Thailand, Malaysia, India, US, Mexico, Germany
- **P/C 11 countries** : China, Japan, Indonesia, Vietnam, Thailand, Philippines, US, Poland, Italy, Mexico, Turkiye
- **TSC 10 countries** : China, Japan, Germany, India, Indonesia, Vietnam, Malaysia ,Thailand, US, Mexico

Europe/MiddleEast	Southwest Asia	Northeast Asia	Southeast Asia	America
Rep Corp 1ea	Rep Corp 1ea	Rep Corp 2ea	Rep Corp 4ea	Rep Corp 2ea
P/C 4ea	P/C 3ea	P/C 13ea	P/C 5ea	P/C 3ea
TSC 2ea	ES Mill in India	TSC 9ea	TSC 4ea	TSC 3ea
ES P/C in Poland		ES P/C in China, Japan	ES P/C in Thailand, Vietnam	P/C in US, Mexico

History of POSCO and Electrical steel

Established in **'68**, completed in **'92**, privatized in **'00**, → 50th anniversary of its founding in **'18**

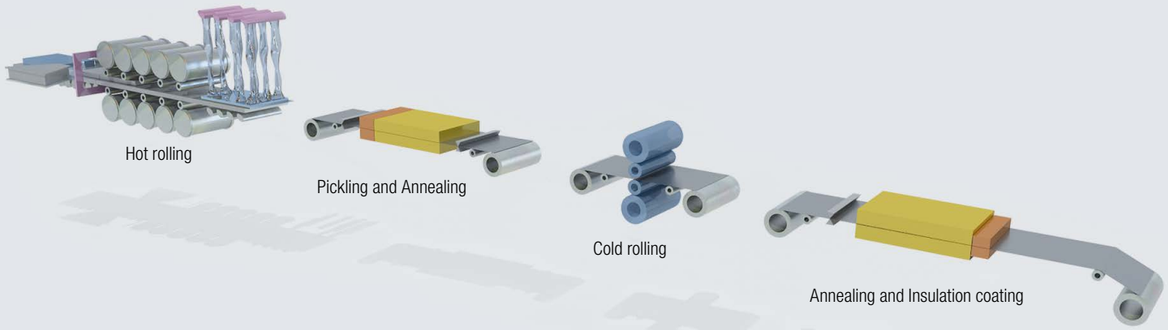
Crude Steel Capacity



Manufacturing processes & equipment

Cutting-edge facilities and state-of-art technologies enable us to meet customer's request for high quality products.
Every process is controlled automatically to keep the best quality of products.

Non-oriented electrical steel



Preliminary Annealing
In this process, scales on the surface of hot rolled coil are removed by scale breaker and hydrochloric acid cleaning. This process improves cold rolling properties of steel as well as it's magnetic properties.

Cold Rolling
In order to obtain specific thickness and material properties, cold rolling process should be conducted. For uniform thickness and width of strip, this process is controlled automatically.

Annealing
Annealing is a recrystallizing process of hardened cold rolled structures by heat treatment. There are two annealing processes for grain-oriented electrical steel : decarbonization and high temperature annealing. During decarbonization annealing, excess carbon in the steel is removed and MgO coating is applied on the surface of the steel. High temperature annealing produces secondary recrystallized structures having superior magnetic properties. Non grain-oriented electrical steel is recrystallized and insulation coating is applied during annealing process.

Insulation Coating
In this process, insulation coating is applied continuously to minimize eddy current losses, which are proportional to the sheet thickness. Grain-oriented electrical steel has two layers of coating; one is base coating with dark brown color which consists of Forsterite(Mg_2SiO_4), and the other is transparent insulation coating containing phosphates. For non grain-oriented electrical steel, there are various types of coating according to final usage and customer's requests.

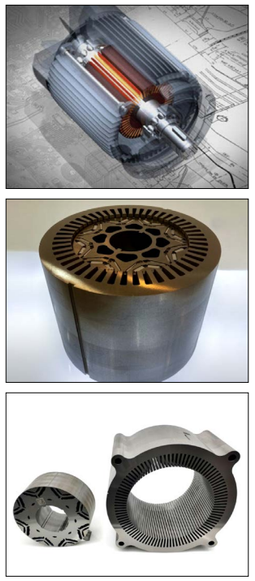
Material properties for Better EV motor

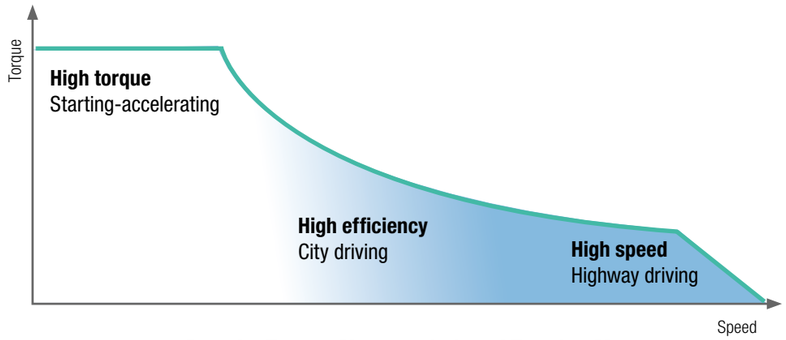
EV driving requires advanced properties of electrical steel

Motor Properties
- High Efficiency
- High Speed
- High Torque

EV driving

Electrical Steel Properties
- Low Core Loss(at high frequencies)
- High Yield Strength
- High Flux Density

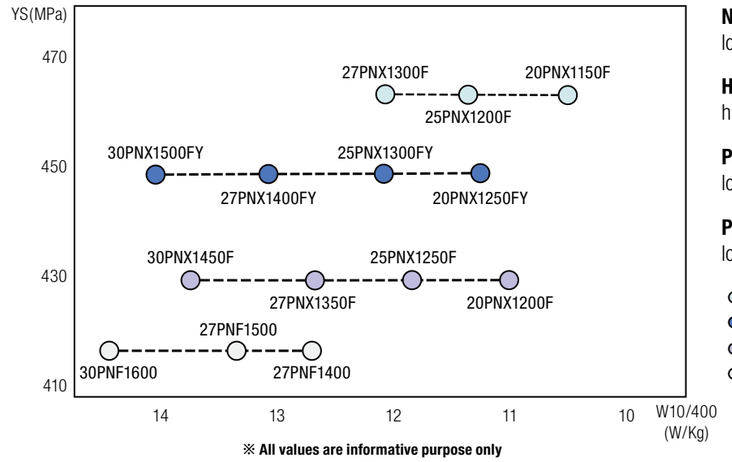




Speed – Torque Characteristics of Traction Motor

Hyper NO was developed based on properties for EV motor

Line up
POSCO Hyper NO for EV Traction motors are represented by these series: New PNX, PNX-FY, PNX, PNF series.



※ All values are informative purpose only

New PNX series :
lower core loss and higher strength

High strength PNX-FY series :
high strength

PNX series :
low core loss and high strength

PNF Series :
low core loss at high frequency

- New PNX series
- High strength PNX series
- PNX series
- PNF Series

Note) Pilot development and commercial production grades are included.

New PNX Core

PNX-Core is optimized core for traction motor in electrical vehicle(EV). It has lower core loss at high frequencies, and has higher mechanical strength compared PNX core.

■Standard Size

Product	Grade	Thickness mm. (in)	Width mm. (in)	Inner diameter mm. (in)
PNX-Core	20PNX1150F	0.20(0.0079)	950~1250 (37.4~49.2)	508 (20)
	25PNX1200F	0.25(0.0098)		
	27PNX1300F	0.27(0.0106)		

Note) For non-standard sizes, please contact us.

■Specification

Magnetic properties and lamination factors

Grade	Density (kg/dm³)	Max Core Loss, W/kg	Magnetic Flux Density Min. T (B50)	Lamination Factor, Min. (%)
		1.0T/400Hz		
20PNX1150F	7.60	11.5	1.60	93.0
25PNX1200F	7.60	12.0	1.60	93.5
27PNX1300F	7.60	13.0	1.61	94.0

Note) 1. Above test is conducted in accordance with IEC60404-2 (or JIS C 2550-1), using as-sheared specimens taken one half parallel and one half transverse to the rolling direction.
2. W10/400 indicates the core loss at the frequency of 400 Hz and magnetic flux density of 1.0T.
3. B50 indicates the magnetic flux density at 5000A/m

■Dimension & Shape Tolerance

Thickness mm. (in)	Thickness Tolerance mm. (in)	Thickness deviation in Width mm. (in)	Width Tolerance mm. (in)	Camber (Length: 2m) mm. (in)
0.20 (0.0079)	±0.020 (0.00079)	0.02 (0.0008) and under	+1.5 (0.0591)	1.0 (0.0394) and under
0.25 (0.0098)	±0.025 (0.00098)			
0.27 (0.0106)	±0.027 (0.00106)			

Note) Thickness deviation in width means the gap between the thickness of center and the one section 15mm away from the edge part.

■Typical Electrical and Magnetic Properties

Magnetic properties and lamination factors

Grade	Resistivity Ω·m (×10-8)	Core Loss, W/Kg				Magnetic Flux Density,		
		1.5T/50Hz	1.0T/400Hz	1.0T/800Hz	1.0T/1000Hz	B25	B50	B100
20PNX1150F	65	2.01	10.6	27.6	38.1	1.52	1.62	1.76
25PNX1200F	65	1.97	11.7	32.5	45.6	1.54	1.63	1.75
27PNX1300F	65	1.94	12.0	33.6	47.5	1.55	1.64	1.75

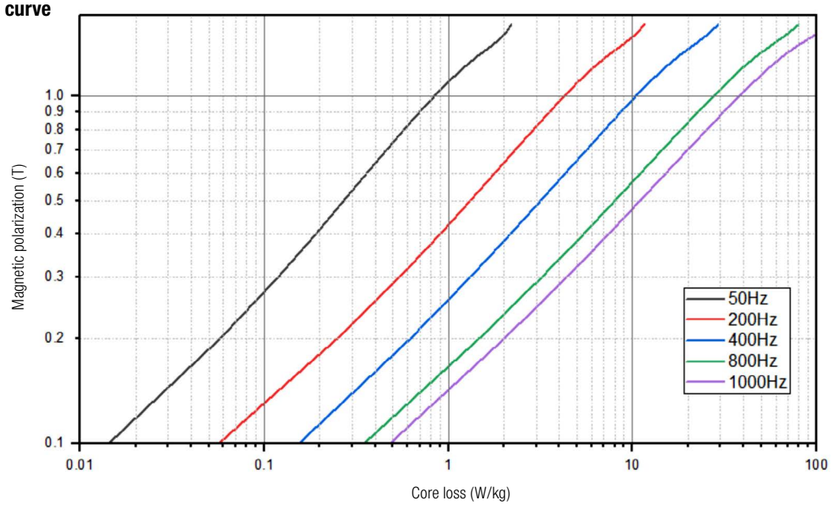
Note) Above values are not guaranteed. Tests are conducted in accordance with IEC 60404-2 (or JIS C 2550-1) method, using as-sheared specimens taken one half parallel and one half transverse to the rolling direction.

■Typical Mechanical Property and Lamination Factor

Grade	Tensile Strength (MPa)		Yield Point (MPa)		Elongation (%)		Hardness Hv1	Lamination Factor (%)
	L	C	L	C	L	C		
20PNX1150F	562	577	457	458	16	17	237	96.5
25PNX1200F	575	582	468	472	17	18	232	97.0
27PNX1300F	579	586	458	467	18	19	238	97.0

Note) 1. Tests are conducted in accordance with JIS Z 2241 and 2244.
2. L : Specimen is parallel to the rolling direction / C : Specimen is transverse to the rolling direction
3. Specimens with C-6H or NS coating are used for lamination factor test.

■20PNX1150F Iron loss curve



PNX-FY Core

PNX-FY Core has higer mechanical strength optimized core for traction motor in electrical vehicle(EV) compare to PNX core.

■Standard Size

Product	Grade	Thickness mm. (in)	Width mm. (in)	Inner diameter mm. (in)
PNX-FY Core	20PNX1250FY	0.20 (0.0079)	950~1250 (37.4~49.2)	508 (20)
	25PNX1300FY	0.25 (0.0098)		
	27PNX1400FY	0.27 (0.0106)		
	30PNX1500FY	0.30 (0.0118)		

Note) For non-standard sizes, please contact us.

■Specification

Magnetic properties and lamination factors

Grade	Density (kg/dm^3)	Max Core Loss, W/kg	Magnetic Flux Density Min. T (B50)	Lamination Factor, Min. (%)	Yield Point Min (MPa)
		1.0T/400Hz			
20PNX1250FY	7.60	12.5	1.59	93.0	420
25PNX1300FY	7.60	13.0	1.60	94.0	420
27PNX1400FY	7.60	14.0	1.61	94.0	420
30PNX1500FY	7.60	15.0	1.61	95.0	420

Note) 1. Above test is conducted in accordance with IEC60404-2 (or JIS C 2550-1),
using as-sheared specimens taken one half parallel and one half transverse to the rolling direction.
2. W10/400 indicates the core loss at the frequency of 400 Hz and magnetic flux density of 1.0T.
3. B50 indicates the magnetic flux density at 5000A/m

■Dimension & Shape Tolerance

Thickness mm. (in)	Thickness Tolerance mm. (in)	Thickness deviation in Width mm. (in)	Width Tolerance mm. (in)	Camber (Length: 2m) mm. (in)
0.20 (0.0079)	±0.020 (0.00079)	0.02 (0.0008) and under	+1.5 (0.0591)	1.0 (0.0394) and under
0.25 (0.0098)	±0.025 (0.00098)			
0.27 (0.0106)	±0.027 (0.00106)			
0.30 (0.0118)	±0.030 (0.0012)			

Note) Thickness deviation in width means the gap between the thickness of center and the one section 15mm away from the edge part.

■Typical Electrical and Magnetic Properties

Magnetic properties and lamination factors

Grade	Resistivity Ω·m (×10-8)	Core Loss, W/Kg				Magnetic Flux Density,		
		1.5T/50Hz	1.0T/400Hz	1.0T/800Hz	1.0T/1000Hz	B25	B50	B100
20PNX1250FY	59	2.03	11.1	29.3	40.5	1.55	1.65	1.76
25PNX1300FY	59	2.08	12.1	33.5	47.1	1.56	1.65	1.76
27PNX1400FY	59	2.23	13.3	38.5	51.1	1.57	1.66	1.77
30PNX1500FY	59	2.26	14.1	40.5	58.1	1.57	1.66	1.77

Note) Above values are not guaranteed. Tests are conducted in accordance with IEC 60404-2 (or JIS C 2550-1) method,
using as-sheared specimens taken one half parallel and one half transverse to the rolling direction.

■Typical Mechanical Property and Lamination Factor

Grade	Tensile Strength (MPa)		Yield Point (MPa)		Elongation (%)		Hardness Hv1	Lamination Factor (%)
	L	C	L	C	L	C		
20PNX1250FY	565	571	445	452	16	15	232	96.5
25PNX1300FY	570	577	448	456	18	17	231	97.0
27PNX1400FY	572	578	450	459	19	18	232	97.0
30PNX1500FY	573	579	450	457	20	19	230	97.5

Note) 1. Tests are conducted in accordance with JIS Z 2241 and 2244.
2. L : Specimen is parallel to the rolling direction / C : Specimen is transverse to the rolling direction
3. Specimens with C-6H or NS coating are used for lamination factor test.

PNX Core

PNX-Core is optimized core for traction motor in electrical vehicle(EV). It has low core loss at high frequencies, and has high mechanical strength for excellent endurance.

■Standard Size

Product	Grade	Thickness mm. (in)	Width mm. (in)	Inner diameter mm. (in)
PNX-Core	20PNX1200F	0.20 (0.0079)	950~1250 (37.4~49.2)	508 (20)
	25PNX1250F	0.25 (0.0098)		
	27PNX1350F	0.27 (0.0106)		
	30PNX1450F	0.30 (0.0118)		

Note) For non-standard sizes, please contact us.

■Specification

Magnetic properties and lamination factors

Grade	Density (kg/dm^3)	Max Core Loss, W/kg	Magnetic Flux Density Min. T (B50)	Lamination Factor, Min. (%)
		1.0T/400Hz		
20PNX1200F	7.60	12.0	1.60	93.0
25PNX1250F	7.60	12.5	1.63	93.5
27PNX1350F	7.60	13.5	1.63	94.0
30PNX1450F	7.60	14.5	1.64	94.5

Note) 1. Above test is conducted in accordance with IEC60404-2 (or JIS C 2550-1), using as-sheared specimens taken one half parallel and one half transverse to the rolling direction.
2. W10/400 indicates the core loss at the frequency of 400 Hz and magnetic flux density of 1.0T.
3. B50 indicates the magnetic flux density at 5000A/m

■Dimension & Shape Tolerance

Thickness mm. (in)	Thickness Tolerance mm. (in)	Thickness deviation in Width mm. (in)	Width Tolerance mm. (in)	Camber (Length: 2m) mm. (in)
0.20 (0.0079)	±0.020 (0.00079)	0.02 (0.0008) and under	+1.5 (0.0591)	1.0 (0.0394) and under
0.25 (0.0098)	±0.025 (0.00098)			
0.27 (0.0106)	±0.027 (0.00106)			
0.30 (0.0118)	±0.030 (0.0012)			

Note) Thickness deviation in width means the gap between the thickness of center and the one section 15mm away from the edge part.

■Typical Electrical and Magnetic Properties

Magnetic properties and lamination factors

Grade	Resistivity Ω·m (×10-8)	Core Loss, W/Kg				Magnetic Flux Density,		
		1.5T/50Hz	1.0T/400Hz	1.0T/800Hz	1.0T/1000Hz	B25	B50	B100
20PNX1200F	59	2.06	10.9	29.0	40.2	1.54	1.64	1.77
25PNX1250F	59	1.97	12.1	33.9	47.7	1.56	1.65	1.78
27PNX1350F	59	1.98	12.7	35.9	50.9	1.57	1.66	1.78
30PNX1450F	59	2.00	13.8	39.8	57.1	1.57	1.66	1.78

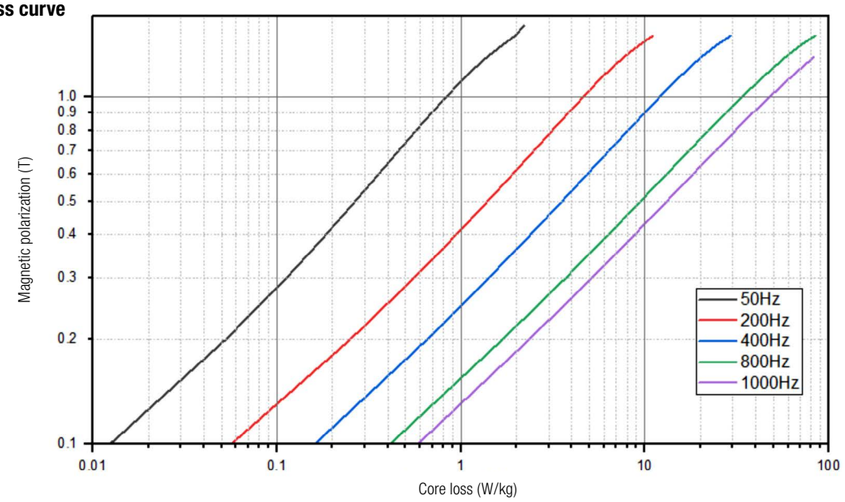
Note) Above values are not guaranteed. Tests are conducted in accordance with IEC 60404-2 (or JIS C 2550-1) method, using as-sheared specimens taken one half parallel and one half transverse to the rolling direction.

■Typical Mechanical Property and Lamination Factor

Grade	Tensile Strength (MPa)		Yield Point (MPa)		Elongation (%)		Hardness Hv1	Lamination Factor (%)
	L	C	L	C	L	C		
20PNX1200F	557	563	429	436	15	14	225	96.5
25PNX1250F	565	569	438	447	18	17	230	97.0
27PNX1350F	559	565	430	437	19	18	225	97.0
30PNX1450F	561	566	431	438	19	18	228	97.5

Note) 1. Tests are conducted in accordance with JIS Z 2241 and 2244.
2. L : Specimen is parallel to the rolling direction / C : Specimen is transverse to the rolling direction
3. Specimens with C-6H or NS coating are used for lamination factor test.

■25PNX1250F Iron loss curve



PNF Core

PNF-Core has excellent magnetic properties at high frequencies. It is suitable for motors which needs low core loss at high frequencies.

■Standard Size

Product	Grade	Thickness mm. (in)	Width mm. (in)	Inner diameter mm. (in)
PNF Core	20PNF1200	0.20 (0.0080)	950~1250 (37.4~49.2)	508 (20)
	20PNF1500			
	25PNF1400	0.25 (0.0098)		
	27PNF1500	0.27 (0.0106)		
	30PNF1600	0.30 (0.0118)		
	35PNF1800	0.35 (0.0138)		

Note) For non-standard sizes, please contact us.

■Specification

Magnetic properties and lamination factors

Grade	Density (kg/dm³)	Max Core Loss, W/kg	Magnetic Flux Density Min. T (B50)	Lamination Factor, Min. (%)
		1.0T/400Hz		
20PNF1200	7.60	12.0	1.61	93.0
20PNF1500	7.65	15.0	1.62	93.0
25PNF1400	7.60	14.0	1.62	93.5
27PNF1500	7.60	15.0	1.63	94.0
30PNF1600	7.60	16.0	1.64	94.5
35PNF1800	7.60	18.0	1.65	95.0

Note) 1. Above test is conducted in accordance with IEC60404-2 (or JIS C 2550-1), using as-sheared specimens taken one half parallel and one half transverse to the rolling direction.
2. W10/400 indicates the core loss at the frequency of 400 Hz and magnetic flux density of 1.0T.
3. B50 indicates the magnetic flux density at 5000A/m

■Dimension & Shape Tolerance

Thickness mm. (in)	Thickness Tolerance mm. (in)	Thickness deviation in Width mm. (in)	Width Tolerance mm. (in)	Camber (Length: 2m) mm. (in)
0.20 (0.0080)	±0.020 (0.0008)	Max 0.02 (0.0008)	+1.5 (0.0591)	1.0 (0.0394) and under
0.25 (0.0098)	±0.025 (0.00098)			
0.27 (0.0106)	±0.027 (0.00106)			
0.30 (0.0118)	±0.030 (0.0012)			
0.35 (0.0138)	±0.035 (0.0014)			

Note) Thickness deviation in width means the gap between the thickness of center and the one section 15mm away from the edge part.

■Typical Electrical and Magnetic Properties

Magnetic properties and lamination factors

Grade	Resistivity Ω·m (×10-8)	Core Loss, W/Kg				Magnetic Flux Density,		
		1.5T/50Hz	1.0T/400Hz	1.0T/800Hz	1.0T/1000Hz	B25	B50	B100
20PNF1200	59	1.98	10.9	29.2	40.7	1.54	1.63	1.78
20PNF1500	50	2.56	13.3	34.2	47.0	1.57	1.66	1.78
25PNF1400	58	2.13	12.8	35.3	49.8	1.57	1.66	1.76
27PNF1500	58	2.14	13.2	36.8	51.3	1.57	1.65	1.76
30PNF1600	59	2.16	14.4	41.5	59.3	1.57	1.66	1.77
35PNF1800	59	2.19	16.5	50.1	72.4	1.57	1.66	1.77

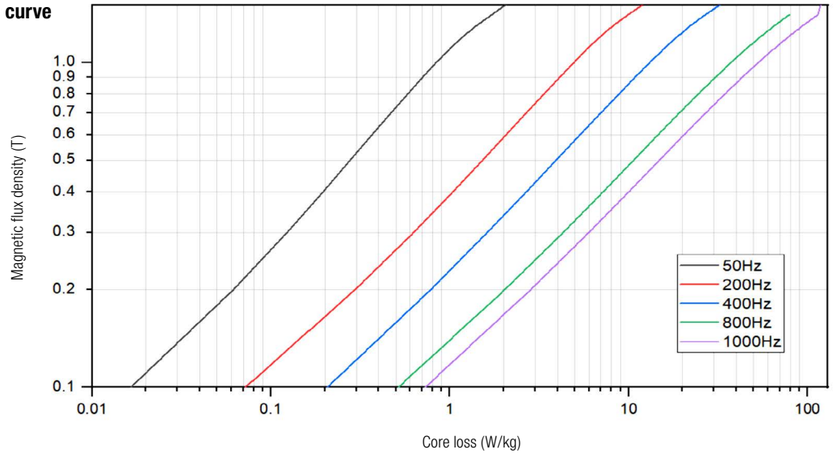
Note) Above values are not guaranteed. Tests are conducted in accordance with IEC 60404-2 (or JIS C 2550-1) method, using as-sheared specimens taken one half parallel and one half transverse to the rolling direction.

■Typical Mechanical Property and Lamination Factor

Grade	Tensile Strength (MPa)		Yield Point (MPa)		Elongation (%)		Hardness Hv1	Lamination Factor (%)
	L	C	L	C	L	C		
20PNF1200	490	500	380	390	15	16	215	96.5
20PNF1500	471	490	363	381	17	19	195	97.0
25PNF1400	530	541	405	411	17	18	224	97.0
27PNF1500	535	543	405	412	17	18	225	97.0
30PNF1600	535	545	416	426	18	19	224	97.5
35PNF1800	536	546	418	428	19	20	224	97.5

Note) 1. Tests are conducted in accordance with JIS Z 2241 and 2244.
2. L : Specimen is parallel to the rolling direction / C : Specimen is transverse to the rolling direction
3. Specimens with C-6H or NS coating are used for lamination factor test.

■27PNF1500 Iron loss curve



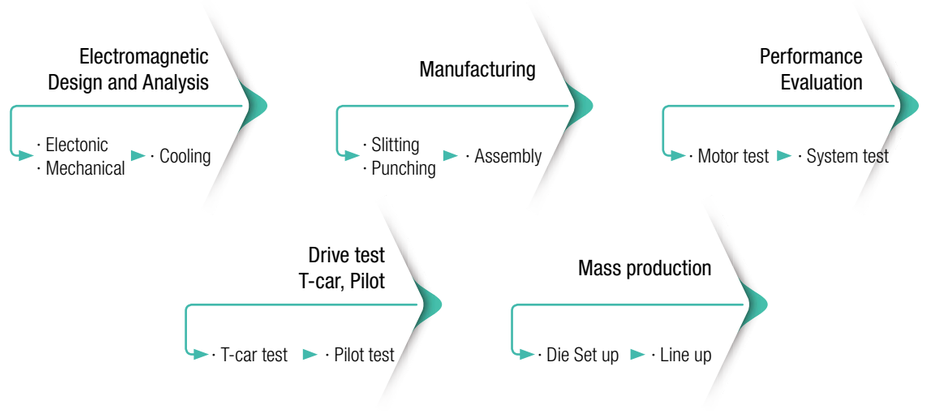
Insulation Coating

POSCO insulation coating

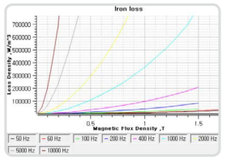
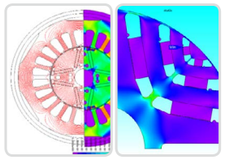
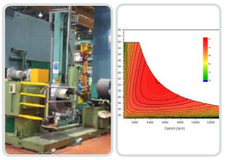
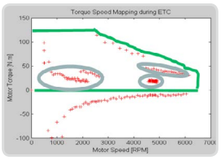
POSCO Coating Type		General (Chromate base)		Eco-friendly (Phosphate base)			Self bonding	Remark
		C6-H	C9-H	NS	NM	NT	SP	
Composition		Organic + Inorganic	Organic + Inorganic	Organic + Inorganic	Organic + Inorganic	Organic + Inorganic filler	Organic + Inorganic	
Thickness (μm/side) (typical)		0.5~1.0	1.2~1.8	0.5~1.0	1.2~1.8	5.0~7.0	1.0~2.0	
Coating side		Both side	Both side	Both side	Both side	Both side	Both side	
Resistivity (Ω-cm^2/lam.) (typical)	Before SRA	0.5	5.0	0.5	5.0	50	2.0	ASTM A 717 SRA Condition : 750°Cx2hr in DX rich gas
	After SRA	0.1	0.5	0.1	0.5	SRA not Accepted	SRA not Accepted	
Heat Resistance	Continuous	Not recognized	Not recognized	Not recognized	Not recognized	SRA not Accepted	SRA not Accepted	155°C×24hr in Air
	Short	Not recognized	Not recognized	Not recognized	Not recognized	SRA not Accepted	SRA not Accepted	750°C×2hr in DX rich gas
Weathering (powdering)		Not recognized	Not recognized	Not recognized	Not recognized	Not recognized	Not recognized	65°C, 95% humidity, 72hr
Adhesion	Before SRA	10 mmø	10 mmø	10 mmø	10 mmø	20 mmø	10 mmø	ISO 1519 Mandrel Pipe bending
	After SRA	5B	5B	5B	5B	5B	5B	ASTM D3359B Cross Cut Test [0B(bad)~5B(good)]
Resistance to refrigerants	Change of surface	Not recognized	Not recognized	Not recognized	Not recognized	-	-	R-134a/ Freol@ 15C=65g/100g (130°C,21days, 0.45um filter paper)
	change of weight	Not recognized	Not recognized	Not recognized	Not recognized	-	-	
Weldability		Good	Normal	Good	Normal	Not allowed	Not allowed	Current : 100-150A Ar 99% flow : 10~20L/min Speed : 0.25~0.50mpm

Solution support for EV traction motor development

■ **Motor development process**



■ **POSCO solution for EV**

Material DB	Design/Analysis	Manufacturing	Evaluation
			
· Mangetic property · High H-field property · MP under stress · Core building factor · Ring MP · Mechanical property · Fatigue · Physical property	· Electronic design · Mechanical design · Noise/vibration · Motor performance optimization (Efficiency, Stability, NVH) · Drive system analysis · EV electric efficiency prediction	· Punchability · Core building (Welding/Interlocking/bonding) · Core stacking force · SRA (BA, BAB) · Motor core magnetic property measurement · FC* shrink fit *FC: Frame-Core	**Core/Motor test** · Peformance and efficiency · Heat shock · Condensation · Resonance test · Noise/vibration test · Durability/fatigue test · Drop test

Solution support for EV traction motor development

Equipment for material Data Base

Magnetic property measurement

Magnetic induction and iron loss measurement

(IEC, ASTM, JIS, KS, customized test)

Mechanical property measurement

Yield strength, tensile strength, hardness, fatigue limit

(ISO, ASTM, JIS, KS, customized test)

Motor core property and quality evaluation

Welding, SRA, Environment, Stacking force, etc (customized test)

■ Motor development process

Category	Equipments	Standards
Magnetic property	Epstein test	IEC60404-02
	Single sheet test	IEC60404-03
	Ring test	IEC60404-06
Stacking factor	Stacking factor measurement	IEC60404-13
Specialized Magnetic property	Motor core test	-
	High H-field test	-
	Magnetic property under stress	-
	Magnetostriction	-
	High and low-T MP test	-
Mechanical property	Tensile test and hardness	ISO 6892-1
Durability	Fatigue test	ISO 12106
Manufacturing quality	Welding simulator	-
	SRA simulator	-
	Heat shock tester	-
	Stacking force tester	-

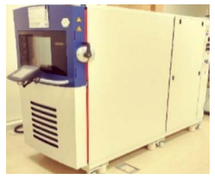
Magnetic property

Stacking factor

Tensile test

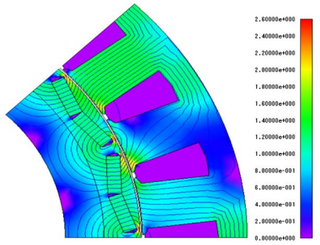
SRA simulator

Heat shock tester

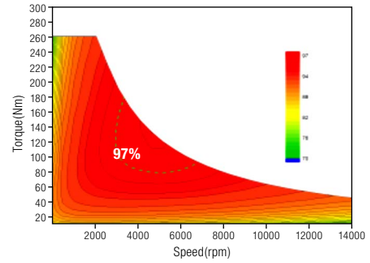


Motor design and analysis examples

Motor performance evaluation



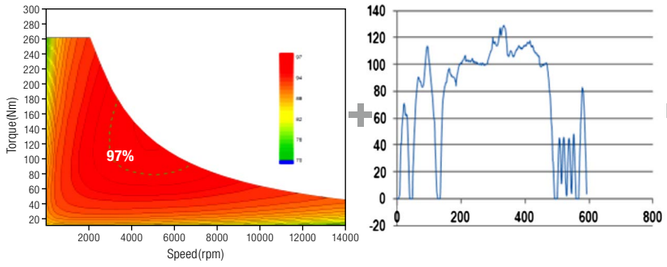
FEM analysis



Efficiency map

EV driving efficiency prediction

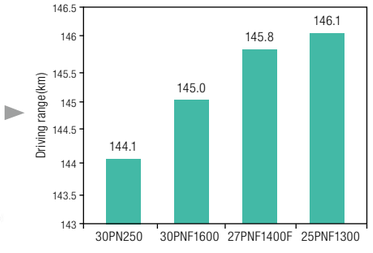
Applying driving cycle to motor system



Efficiency map

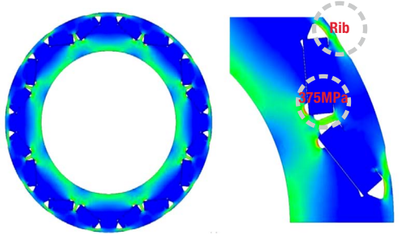
Driving history

Efficiency calculation

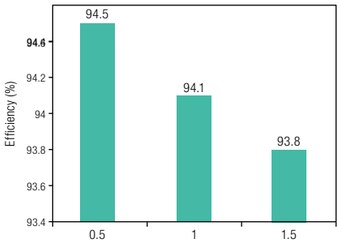


EV driving range, city mode

Rotor mechanical- design evaluation



Stiffness analysis



Efficiency evaluation

Self-Bonding Technology

■ Introduction to Self-Bonding Technology

· Self-bonding technology allows cores to be assembled by the coating itself to minimize core efficiency degradation due to the adhesion method in motor core manufacturing.

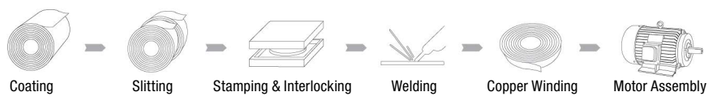
■ Structure and feature comparison

· SP : Self-bonding coating with high adhesion to the coating itself for high motor efficiency

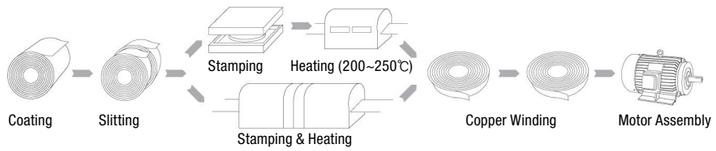
Conventional Fixation (Interlocking / Welding)	Self Bonding (SP)
 · Damage to the motor core - Negatively affects its magnetic properties (Core loss, Flux density)	 · Skip welding or Interlocking - Improve electrical properties - Opimize motor design
 Embo · No Adhesion in Teeth - Teeth vibration in use (vibration, noise)	 Self Bonding · Strong adhesion of whole surface - Reduce vibration and noise - Remove compression plates (in large size)

■ Manufacturing process comparison

Conventional Fixation
(Interlocking/Welding)



Self Bonding
(SP)



HyperNO

NON-ORIENTED ELECTRICAL STEEL
FOR EV TRACTION MOTOR

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