BAOSTEEL

宝钢取向电工钢

BAOSTEEL GO ELECTRICAL STEEL

Application Technology

应用技术

创享生活 璀璨城市

LIVELY INNOVATION, BRIGHTER CITIES

宝钢电工钢
Baosteel Electrical Steel

CERTIFIED
Intertek

宝钢应用技术理念 | Baosteel application technology concept

成为用户真诚可靠的材料供应商及其解决方案的合作者，实现可持续、共赢发展。

To be customer's sincere and reliable partner in providing electrical steels and their solutions to achieve win-win collaboration.

宝钢应用技术文化 | Baosteel application technology culture

用户思维——源于用户、服务用户、成就用户

Customer thinking ——From customer, Serve customer, Achieve customer

协同思维——同一目标、网式工作、众口同声

Synergy thinking ——Same target, Net-working, One word

进取思维——精于专业、诚于奉献、超越期待

Enterprising thinking ——Professional, Sincere dedication, Beyond expectation

宝钢取向电工钢应用技术 | Baosteel application technology for GO electrical steel

宝钢为变压器厂提供从选材设计到产品制造的技术支持：

- 铁心设计选材支持，以设计控制成本和性能；
- 铁心用材和结构持续优化，实现技术降本；
- 铁心加工制造支持，实现材料与装备最佳匹配；
- 新产品、新技术的推荐应用，提升变压器产品的竞争力。

Baosteel could offer a variety of specialized services and technical support from material selection in design of transformer cores to transformer manufacturing, including:

- Material selecting in core design for property and cost control;
- Optimization of steel and structure in terms of cost and performance purposes;
- Technical support for core manufacturing to ensure the best performance;
- Recommendation of new products and technologies to enhance the competitiveness of transformer products.

完善的取向电工钢产品体系和发展方向 | Perfect product system of GO electrical steel

- 经验：40余年研发、生产及应用技术研究；
- 品种：普通型、高磁感型、磁畴细化高磁感型、低噪声特性、环保涂层取向电工钢产品，全系列全品种；
- 等级：最高牌号铁损$P_{1.7/50}$低于0.55W/kg；
- 能力：国内首家成功开发低温工艺并具备100%高等级取向电工钢制造能力的企业，取向电工钢产量全球第一。
- Experience: Devoted in grain-oriented electrical steel more than 40 years ago, with a complete capability of R&D, manufacturing and application;
- Products: A great variety of products, including convetional, high permeability,domain refined, low magnetostriction and chromate-free coating grain-oriented electrical steel;
- Grades:The most advanced grade with iron loss $P_{1.7/50}$ lower than 0.55W/kg;
- Ability: The ever first steel company in China who developed low-temperature reheating technology with the ability of manufacturing 100% high grade grain-oriented electrical steel. The output of grain-oriented electrical steel ranks first in the world.

普通型 Conventional

B30G120 B30G130 B35G155

30Q120 30Q130 35Q155

高磁感型 High permeability

B18P075 B18P080 B20P075
B20P080 B20P085 B23P085
B23P090 B23P095 B23P100
B27P090 B27P095 B27P100
B30P095 B30P100 B30P105
B30P120 B35P115 B35P135

18QG080
20QG080 20QG085 23QG085
23QG090 23QG095 23QG100
27QG090 27QG095 27QG100
30QG100 30QG105
30QG120 30QG135

磁畴细化型 Domain refined

B18R055 B18R060 B18R065
B18R070 B20R060 B20R065
B20R070 B20R075 B23R070
B23R075 B23R080 B23R085
B23R090 B27R080 B27R085
B27R090 B27R095 B30R090
B30R100

18RK065
18RK070
20RK070 20RK075
23RK075 23RK080 23RK085
23RK090 27RK085
27RK090 27RK095
30RK100

低噪音型 Low magnetostriction

B23R075-LM B23R080-LM
B23R085-LM B27R085-LM
B27R090-LM B27R095-LM
B30P100-LM B30P105-LM
B30P120-LM

27QG100-LN 27QG120-LN
30QG105-LN
30QG120-LN 30RK100-LN

特殊涂层 Special coating

35Q155-Y 35Q155-Z
35Q155-W 30QG120-H

耐热刻痕 Heat-resistant domain refined

B20HS075 B23HS075
B23HS080

注：绿色字体为全球首发产品。
“-W”代表无底层系列产品；“-Y”代表C6涂层系列产品；“-Z”代表自粘接涂层系列产品；“-H”代表无铬涂层系列产品。

Note: The products in green font are the world's premiere products.
"- W" stands for no - glass - film products; "- Y" stands for C6 coating series products; "- Z" stands for self-adhesive coating series products;
"- H" stands for chromate free coating series products.

一级能效配电变压器
Energy efficiency I distribution transformer

一级能效立体卷铁芯配电变压器
Energy efficiency grade 1 distribution transformer with tridimensional wound

±800kV换流变压器
±800kV Converter transformer

1000kV交流变压器
1000kV AC transformer

±1100kV换流变压器
±1100kV Converter transformer

取向电工钢全面技术解决方案 | Comprehensive technical solutions for GO electrical steel

完善的变压器用材数据库支持 Complete material database support for transformer use

不断更新和完善的变压器用材性能数据库，为用户提供从机械性能、基础电磁性能及特殊工况性能等一系列全套的数据支持。根据用户的多样化需求，可提供性能指标与原始曲线数据等各种形式数据。

Baosteel continuously updates and improves properties database of products for transformer use, supporting customers with a range of full set of data from mechanical properties and basic magnetic properties to the properties under special working conditions. According to the diversed requirements, Baosteel can provide customers with performance data, the original curves, and other forms of data.

变压器用材性能数据库
Transformer material database

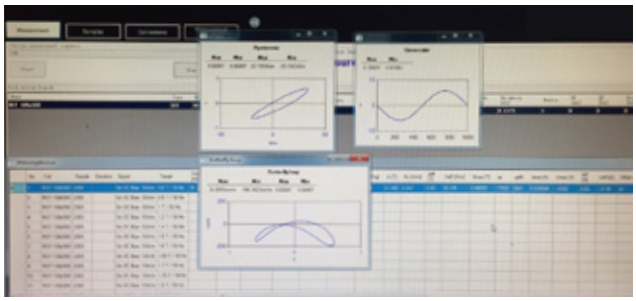
基础电磁性能 Basic magnetic properties	典型机械性能 Typical mechanical properties
铁损曲线 Core loss curves	抗拉强度 Tensile strength
交流激磁功率曲线 A.C. Exciting power curves	弯曲次数 Number of bends
交流激磁曲线 A.C. Exciting curves	屈服强度 Yield strength
直流磁化曲线和直流磁导率曲线 D.C.Magnetization curves/D.C. Permeability curves	延伸率 Elongation
高频铁损曲线 Core loss at high frequency	硬度 Hardness

完备的性能测试支持 Comprehensive performance test support

1） 磁性测试平台 Magnetic properties test platform

完备的材料性能测试平台，可为用户提供各种尺寸的材料在任一频率、场强下的磁性数据，以及B-P、B-H、H－μ等各种电磁性能曲线的测量，最大程度地挖掘材料特性。

With complete material property test platform, Baosteel could provide customers with magnetic property data at any frequency and magnetic flux density of all size of the material, and the measurement of B-P, B-H and H-μ and other forms of magnetic property curves, to fully make use of the material properties at the greatest extent.



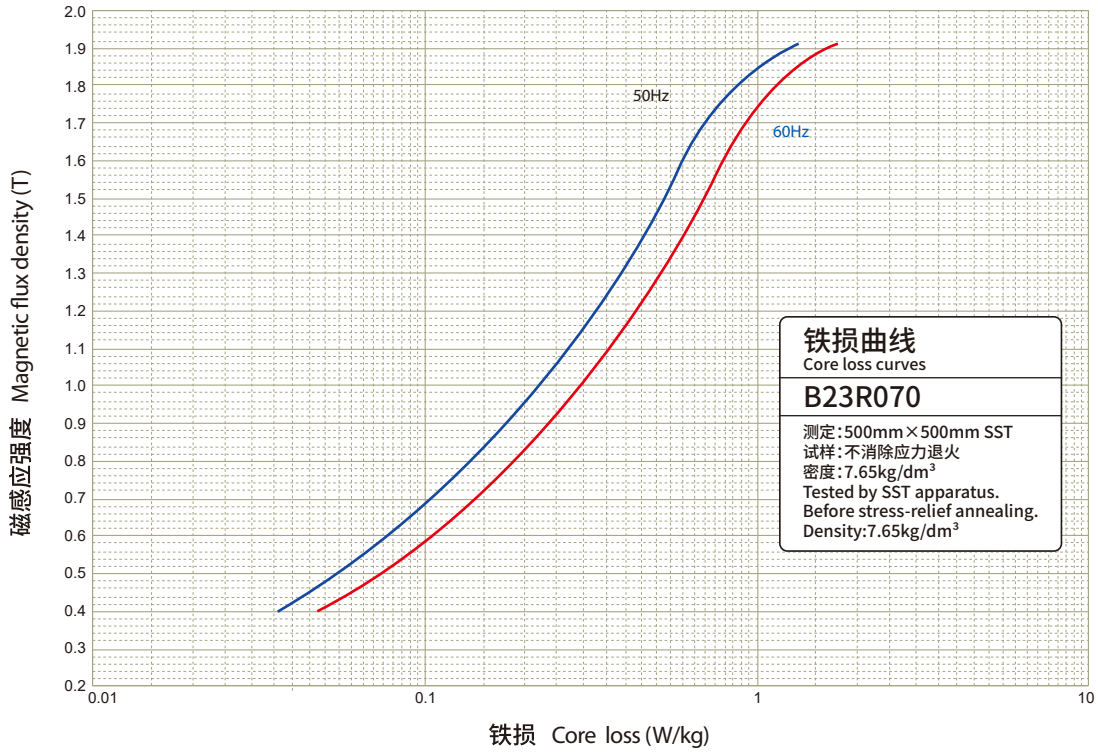
2） 基础性能数据　Typical magnetic properties

取向电工钢主要牌号的典型性能
Typical magnetic properties of major grain-oriented electrical steel grades

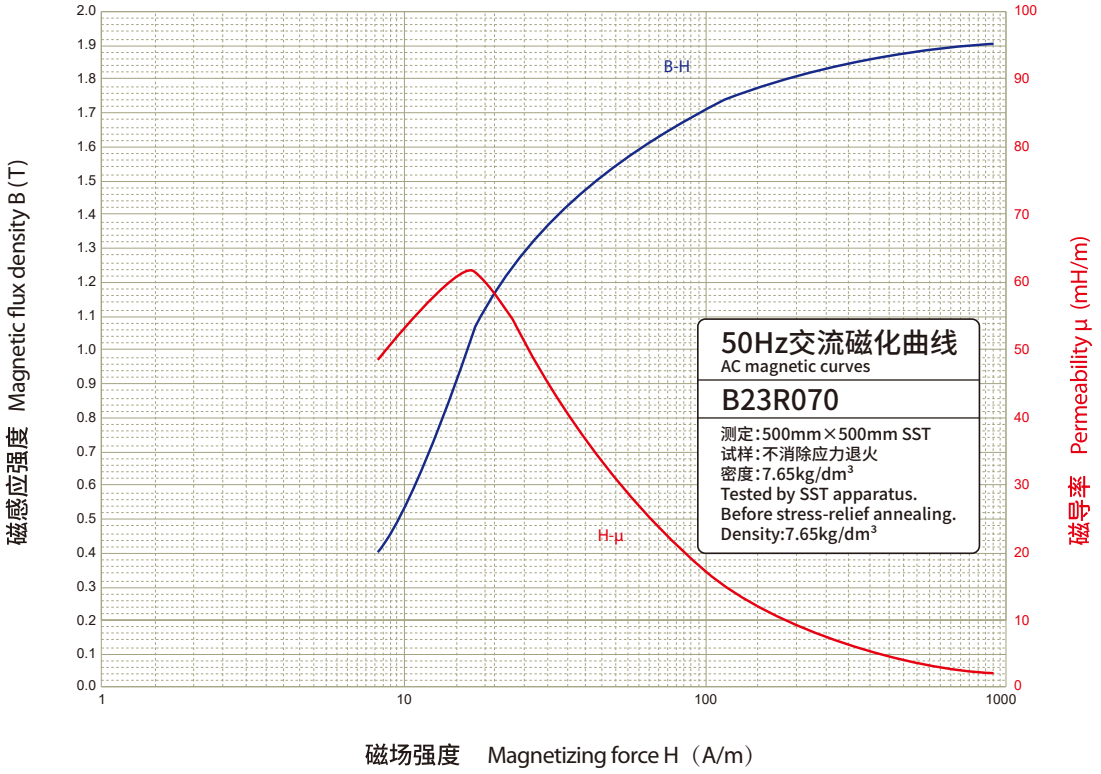
类型 Type	牌号 Grade	比总损耗 Specific total loss (W/kg)	磁极化强度 Magnetic polarization (T)
		$P_{1.7/50}$	B8
高磁极化强度型 High permeability type	B18P075	0.74	1.89
	B18P080	0.79	1.89
	B20P075	0.74	1.91
	B20P080	0.79	1.89
	B23P085	0.83	1.92
	B27P095	0.92	1.91
	B27P100	0.94	1.91
	B30P105	0.99	1.91
磁畴细化型 Domain refined type	B18R055	0.54	1.91
	B18R060	0.59	1.92
	B18R065	0.64	1.91
	B20R060	0.59	1.92
	B20R065	0.63	1.92
	B20R070	0.68	1.91
	B23R070	0.69	1.90
	B23R075	0.74	1.92
	B23R080	0.77	1.91
	B23R085	0.80	1.91
	B27R080	0.78	1.92
	B27R085	0.82	1.91
	B27R090	0.86	1.90
	B30R090	0.88	1.92
	B30R100	0.94	1.91

3） 电磁性能曲线　Typical magnetic curves

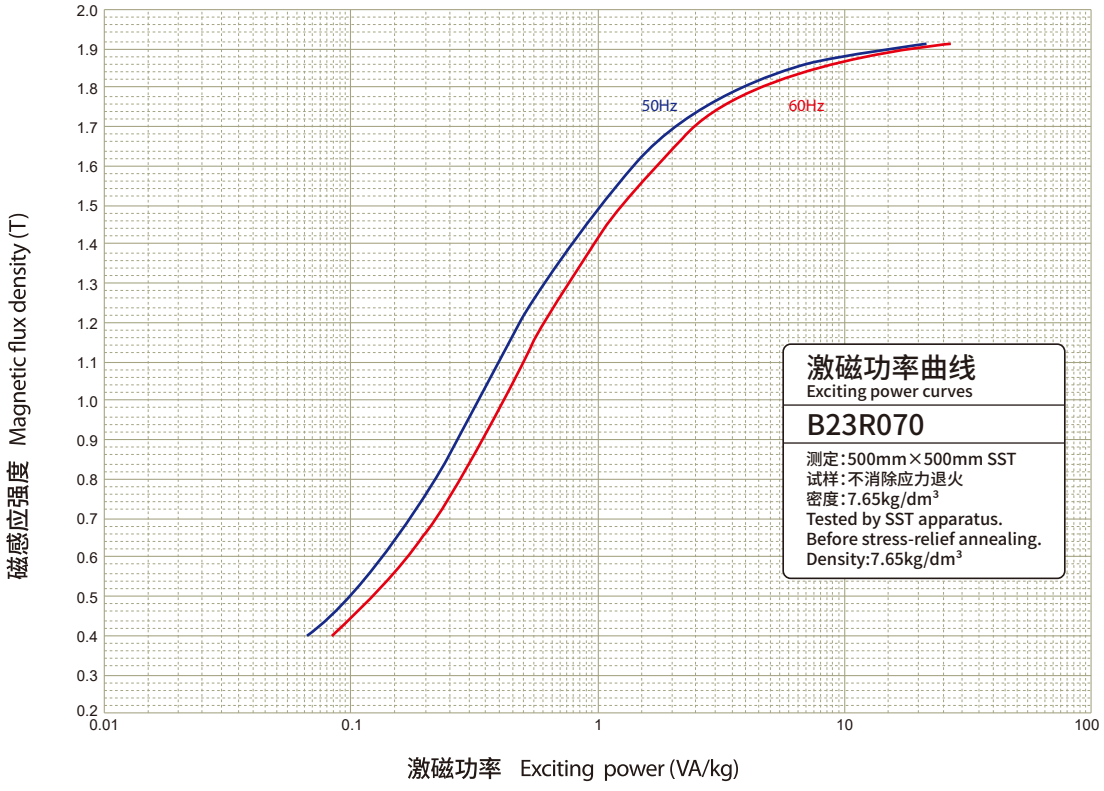
■ 铁损曲线　Iron loss curves



交流磁化曲线 AC magnetic curves

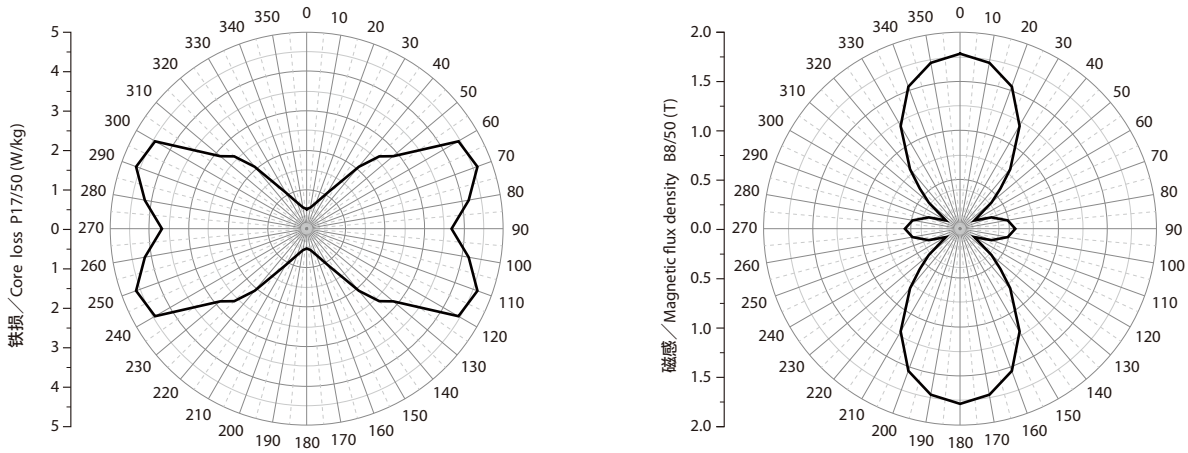


激磁功率曲线 Exiting power curves

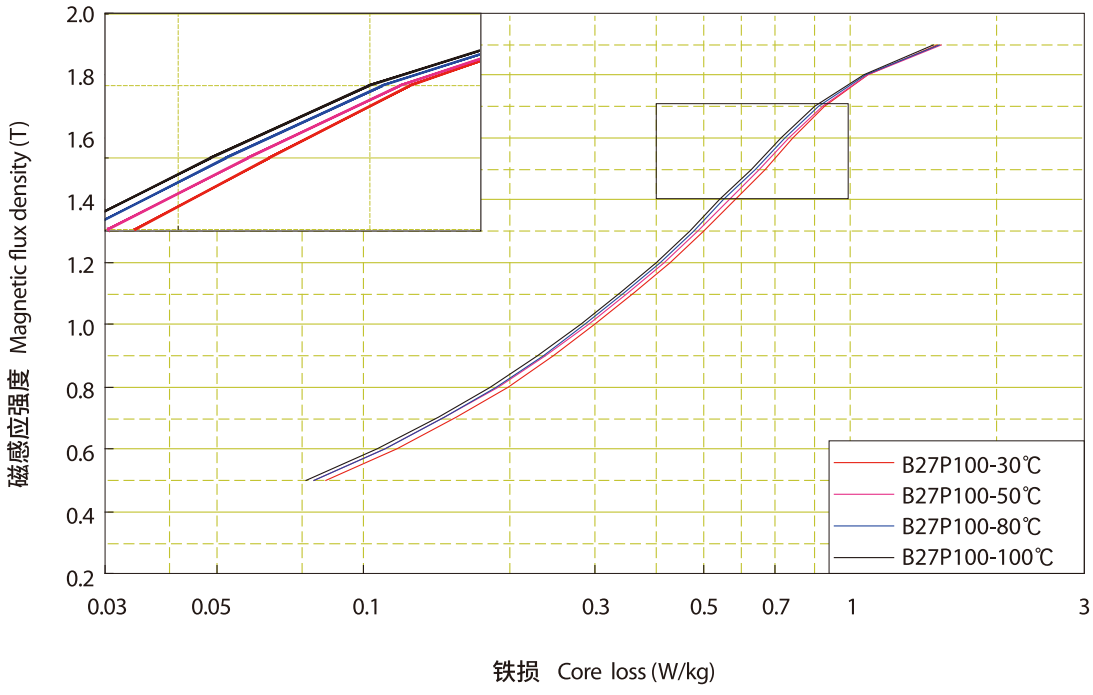


4） 特殊条件下的磁性曲线　Magnetic curves under special conditions

■ 不同方向下的磁性　Magnetic properties along various directions



■ 不同工作温度条件下的铁损曲线　Iron loss curves at various working temperatures



使用技术支持 Application support

1） 选材推荐 Material selection

综合考量材料性能、价格等因素，为变压器铁心设计进行选材支持。根据铁心设计、加工工艺预测性能，对比不同材料的使用效果，以实现性价比最优。

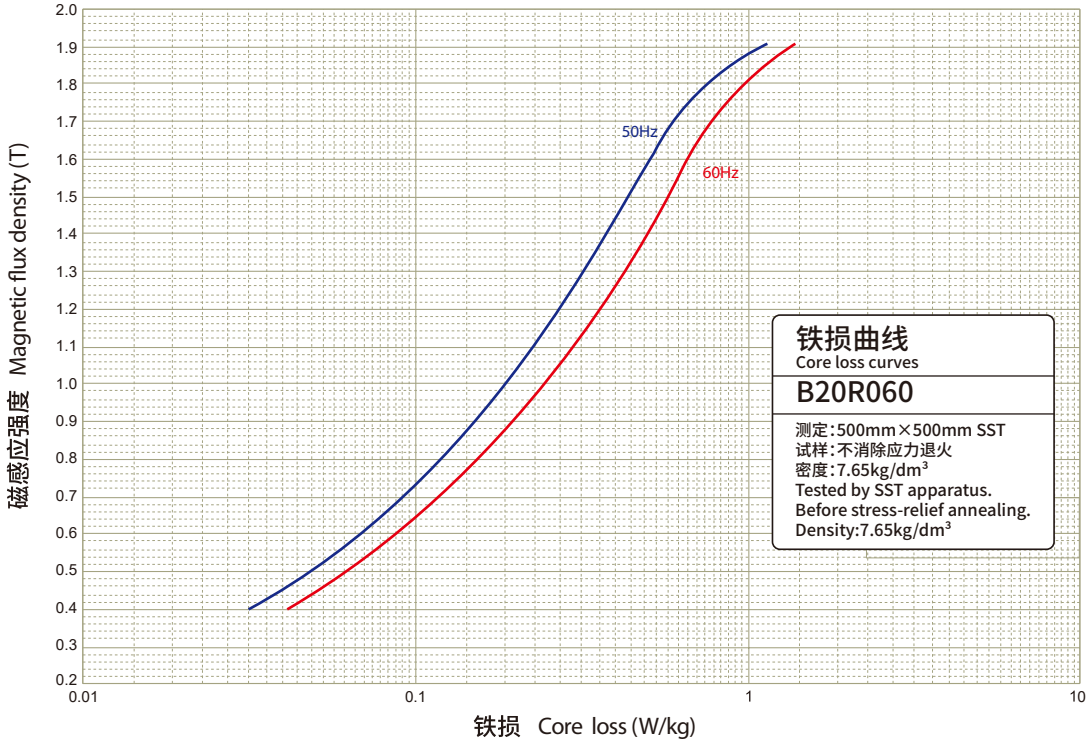
Considering overall the factors such as material properties and prices, Baosteel could supply technical support for material selection for the design of transformer cores. By effective comparison between different materials through predicting core properties according to the design and process, the optimal cost can be achieved.

1.1） 高能效配变领域 High efficiency distribution transformers

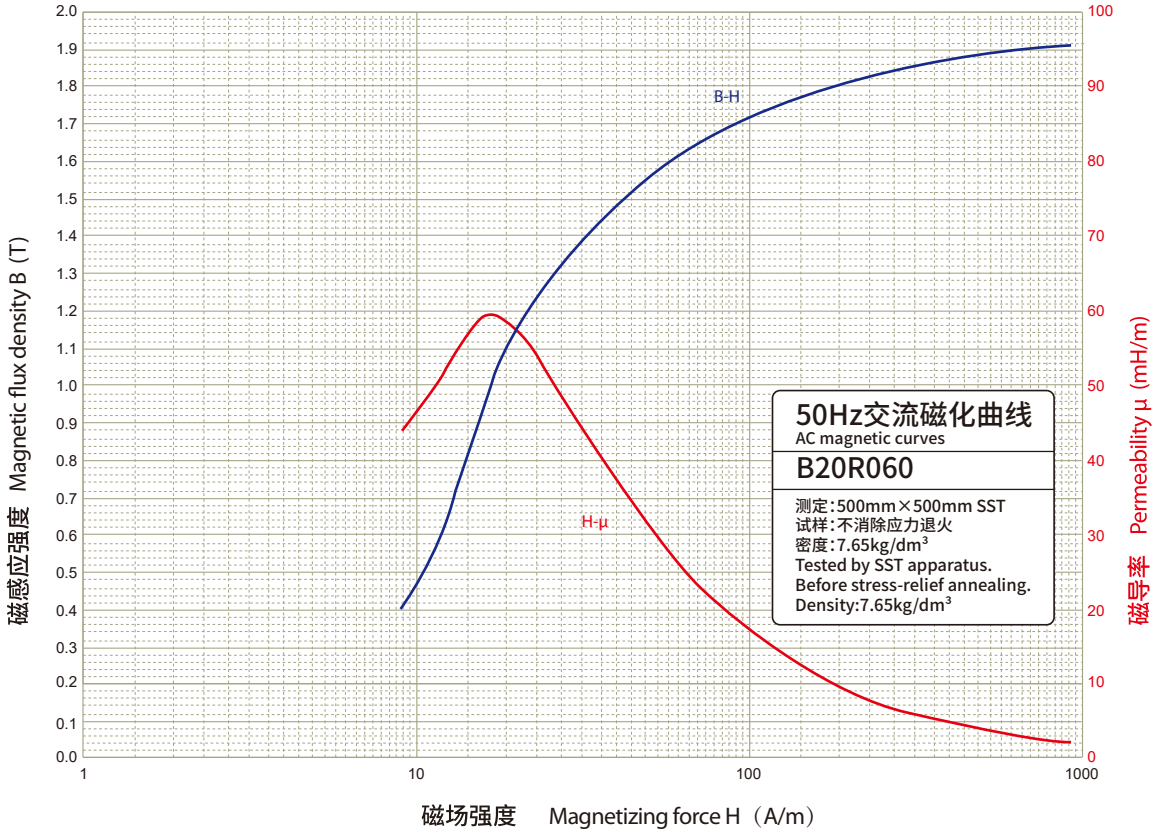
高能效配电变压器用取向电工钢牌号表
Grain-oriented electrical steel grades applied to high efficiency distribution transformers

配电变压器能效等级 GB20052-2020 Energy efficiency grades for distribution transformers	能效2级 Energy efficiency grade 1	能效1级 Energy efficiency grade 2
油浸式配电变压器 Oil-immersed distribution transformer	B20R070	B18R055
	B23R070	B20R060
	B23R075	B20R065
干式配电变压器 Dry type distribution transformer	B23R080	B20R070
	B23R085	B23R070
	B27R085	B23R075

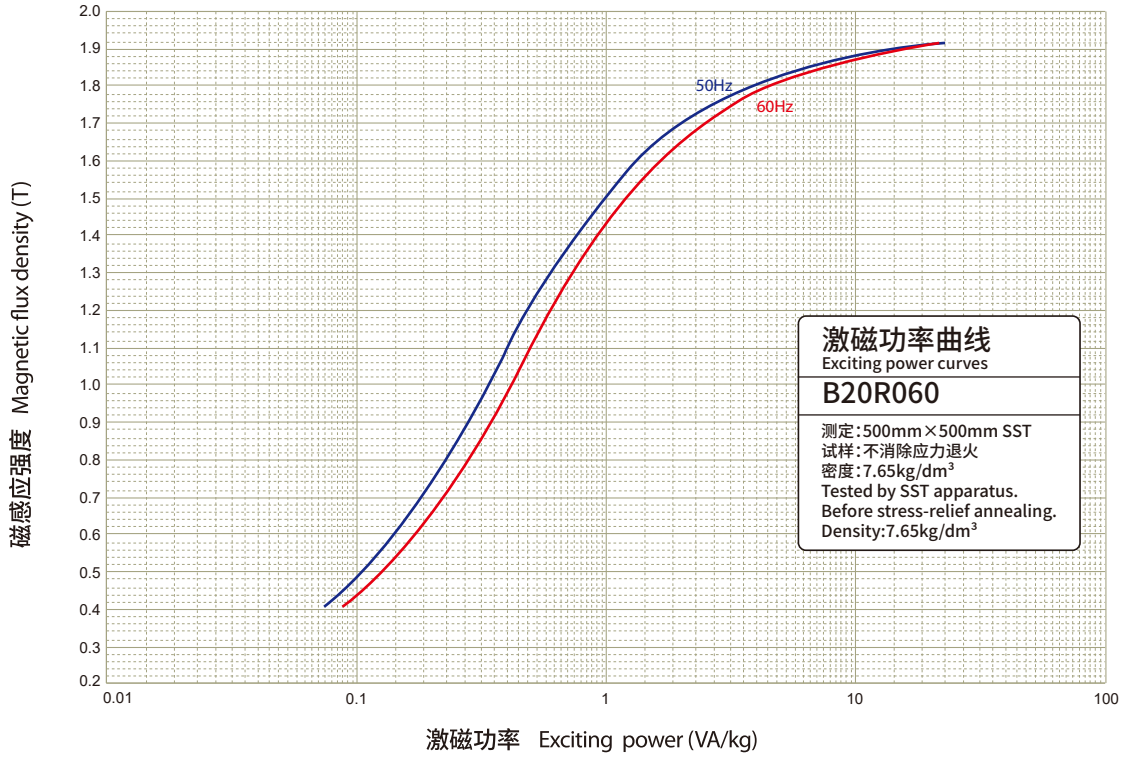
- B20R060：典型值$P_{1.7/50}$=0.59W/kg，B8=1.92T。
  B20R060 : typical values $P_{1.7/50}$=0.59W/kg, B8=1.92T
- 铁损曲线 Iron loss curves



交流磁化曲线 AC magnetic curves



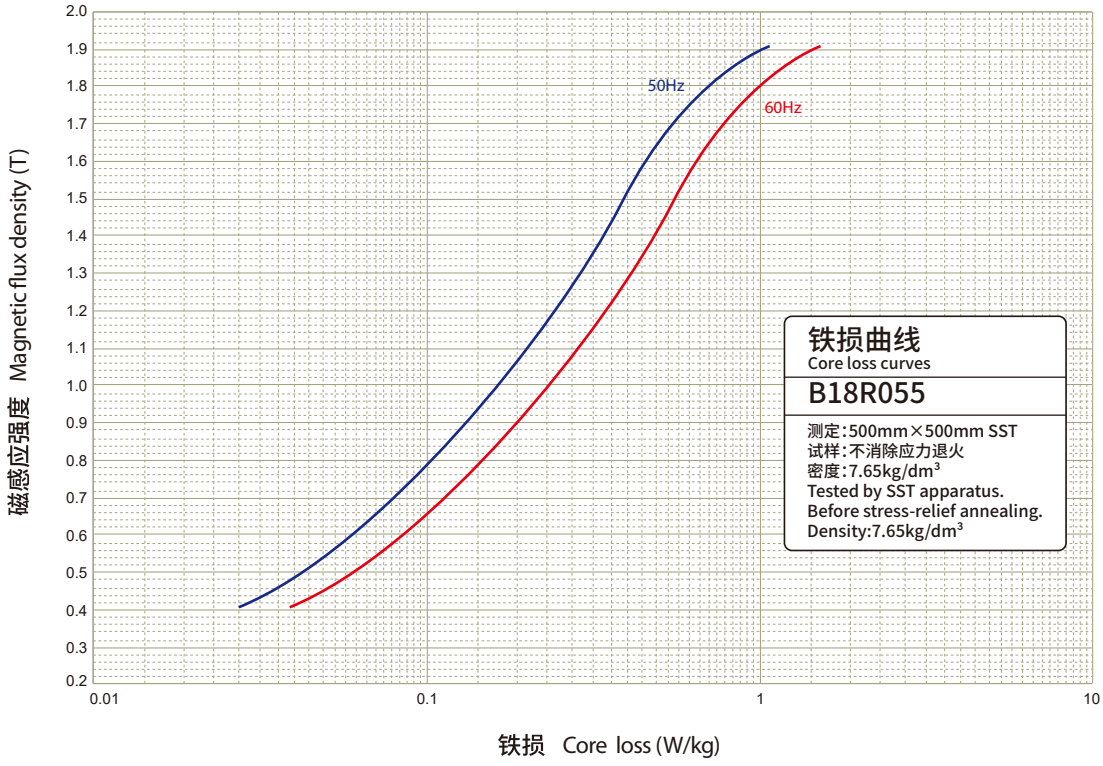
激磁功率曲线 Exiting power curves



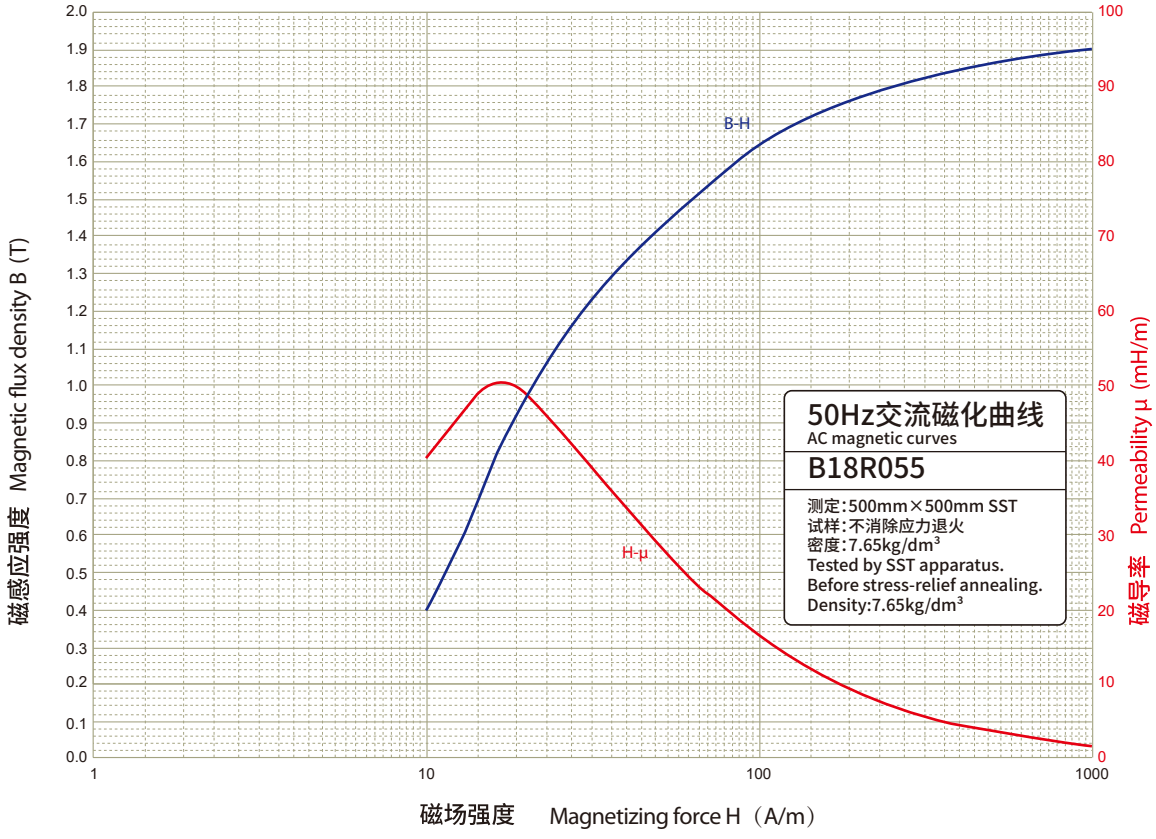
■ B18R055:典型值$P_{1.7/50}$=0.54W/kg，B8=1.91T。

B18R055: typical values $P_{1.7/50}$=0.54W/kg, B8=1.91T

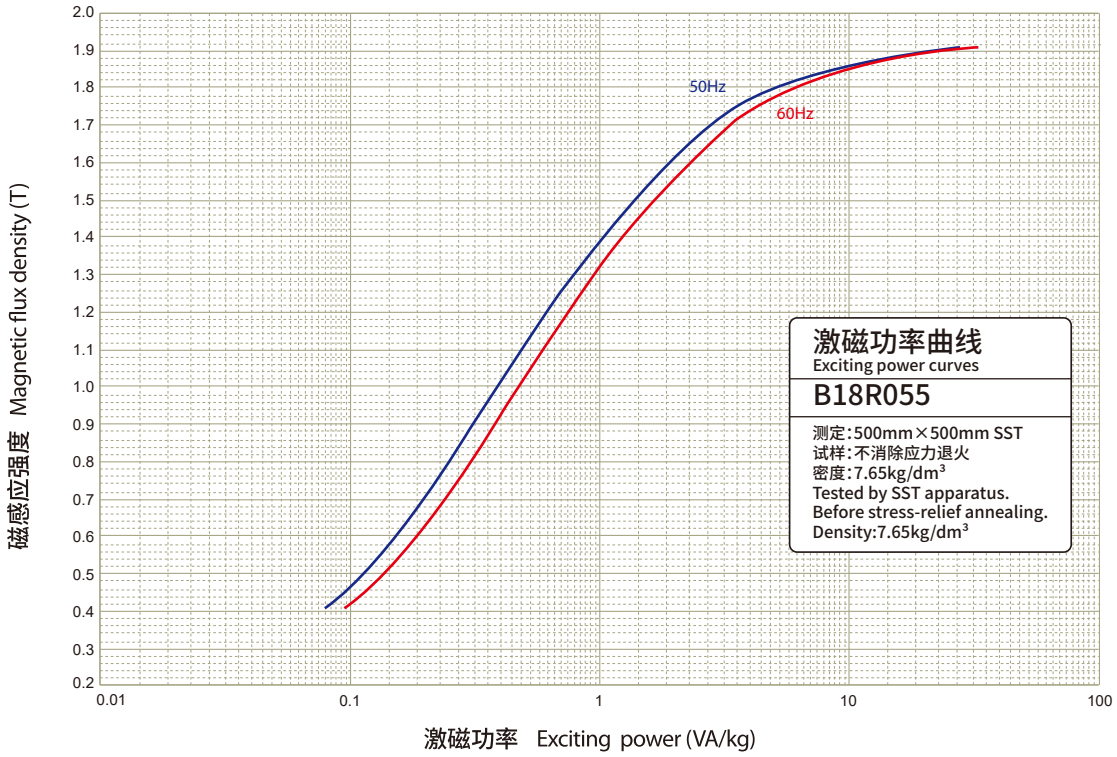
■ 铁损曲线 Iron loss curves



■ 交流磁化曲线 AC magnetic curves



激磁功率曲线 Exiting power curves

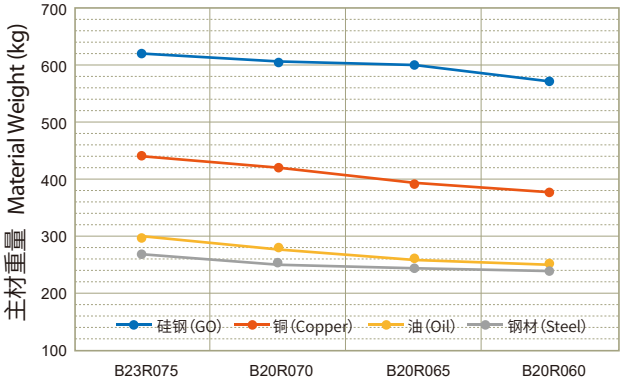


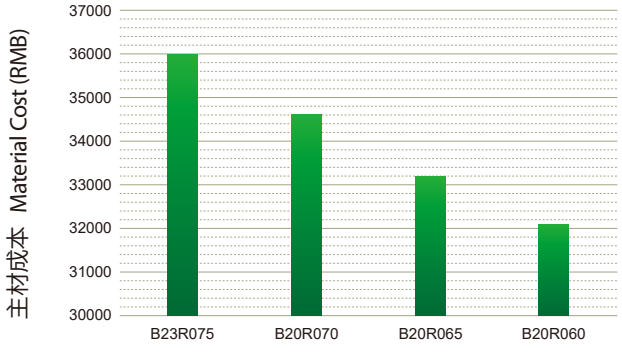
案例——配电变压器性价比优化分析

Case——Cost-performance ratio analysis for the distribution transformer

更高的性价比是采用高性能取向电工钢产品生产变压器的动力之一。下面以GB20052-2020新能效1级叠铁心S15-M-400/10-NX1油浸式配电变压器为例，采用宝钢四种电工钢牌号进行变压器成本分析。

High cost-performance ratio is one motivation to use high-performance grain-oriented electrical steel. Taking the new energy efficiency grade 1 laminated core S15-M-400/10-NX1 oil immersed distribution transformer of GB20052-2020 as an example, four kinds of electrical steel grades of Baosteel are used for transformer cost analysis.





采用高等级取向电工钢B18R055、B20R060已成功制造生产出GB20052-2020新能效标准1级能效产品，S15-M-200/10、S15-M-400/10型变压器，变压器的空载损耗、负载损 耗均达到新一级能效变压器的要求。

GB20052-2020 new energy efficiency grade 1 products S15-M-200/10, S15-M-400/10 transformers have been successfully manufactured with high grade GO electrical steel B18R055, B20R060 , whose no-load loss and load loss all meet the requirements of the new grade 1 transformer.

采用B18R055、B20R060试制的一级能效变压器性能
Properties of energy efficiency gradel 1 transformers made with B18R055 or B20R060

S15-M-200/10 测试项目 Test items	标准要求值 Standard value	实测值 Measured value
空载损耗，W No-load loss, W	190	174 （B18R055）
空载损耗，W No-load loss, W	190	181 （B20R060）
S15-M-400/10 测试项目 Test items	标准要求值 Standard value	实测值 Measured value
空载损耗，W No-load loss, W	330	282 （B18R055）
空载损耗，W No-load loss, W	330	306 （B20R060）

1.2) 节能型电力变领域 Energy saving power transformer

节能型电力变压器主要应用牌号表
Grain-oriented electrical steel grades applied to energy saving power transformer

主要应用电工钢牌号 Grain-oriented electrical steel grades applied	$P_{1.7/50}$(W/kg)	B8 (T)
B18R060	0.59	1.92
B20R070	0.68	1.91
B23R070	0.69	1.92

■ **案例——节能型电力变压器宝钢2030冷轧主变应用**

Case——Application of energy saving power transformer Baosteel 2030 Cold Rolling main transformer.

宝钢股份结合2030冷轧单元主变的更新改造，在产线的2台大型主变中，全部采用B20R070超薄取向电工钢制造大型轧机110kV主变。按照30年寿命测算，节约能耗1495万 kWh，节约成本747.5万元。

Baosteel adopted two large-scale 110kV main transformer manufactured with B20R070 in the production line to upgrade and reform 2030 cold rolling mill. Arcording to the 30 year life expectancy， 14.95 million kWh and 7.475 million RMB cost will be saved.

宝钢2030冷轧主变SFSZ-140000/110kV采用B20R070制造结果
Baosteel 2030 Cold Rolling main transformer SFSZ-140000/110kV made with B20R070 performances

序号 NO	性能指标 Performance indicators	新主变参数 New main transformer	旧主变参数 Old main transformer
1	空载损耗 No-load loss	37.46 kW	74.9 kW
2	空载电流 No-load current	0.06%	0.31%
3	负载损耗 Load loss	483.2kW	522.6 kW
4	30年寿命节能 Energy saving in 30-year life	1495万kWh 14.95 million kWh	——
5	30年寿命节能成本 Cost saving in 30-year life	747.5 万元 7.475 million RMB	——

1.3） 大型电力变领域　Large power transformers

特高压交直流变压器主要应用牌号表
Grain-oriented electrical steel grades applied to large power transformers

主要应用电工钢牌号 Grain-oriented electrical steel grades applied	$P_{1.7/50}$(W/kg)	B8 (T)
B23RT075	0.72	1.91
B23RT080	0.77	1.91
B27RT085	0.82	1.91
B27RT090	0.86	1.91
B27RT095	0.89	1.91
B27PT100	0.94	1.91

案例——特高压交流输电工程项目双百万变压器应用

Case——Dual million transformers used in the ultra high voltage AC transmission project

宝钢高等级取向电工钢B27R090成功用于生产国家电网皖电东送特高压交流输电工程项目双百万变压器ODFPS-1000000/1000，变压器的空载损耗、空载电流、噪音达到要求。

Baosteel high-grade grain-oriented electrical steel B27R090 was successful applied to manufacturing the dual million transformer ODFPS-1000000/1000 for the ultra high voltage AC transmission project. All the transformer properties including no-load loss, no-load current and noise meet the design requirements.

采用B27R090试制的双百万变压器性能

Properties of the dual million transformer made with B27R090

测试项目 Test items	合同要求值 Guaranteed value	实测值 Measured value
空载损耗，kW No-load loss, kW	185, +15%	179.9
空载电流，% No-load current , %	0.1	0.07
噪音，dB(A) Noise, dB(A)	75	72

案例——国网昌吉-古泉±1100kV特高压直流输电工程应用

Case——Application in Changji - Guquan ± 1100kV UHVDC transmission project from of State Grid.

宝钢高等级取向硅钢B23R075成功应用于生产国网昌吉-古泉±1100kV特高压直流输电工程换流变压器，变压器的空载损耗、空载电流、噪声完全满足技术要求。

Baosteel high grade grain oriented silicon steel B23R075 has been successfully applied to the production of converter transformer in Changji - Guquan ± 1100kV UHVDC transmission project of State Grid. The no-load loss, no-load current and noise of the transformer fully meet the technical requirements.

采用B23R075制造的±1100kV特高压换流变压器性能

The performance of the ±1100kV UHV converter transformer made with B23R075

型号 Model	牌号名称 Grades	空载损耗，kW No-load loss	空载电流，% No-load current	噪声，dB(A) Noise
ZZDFPZ-587100/1000-275	B23R075	198.5	0.079	72
ZZDFPZ-587100/1000-550		199.8	0.089	73

1.4） 特殊需求—低噪音变压器　Special demand—low noise transformers

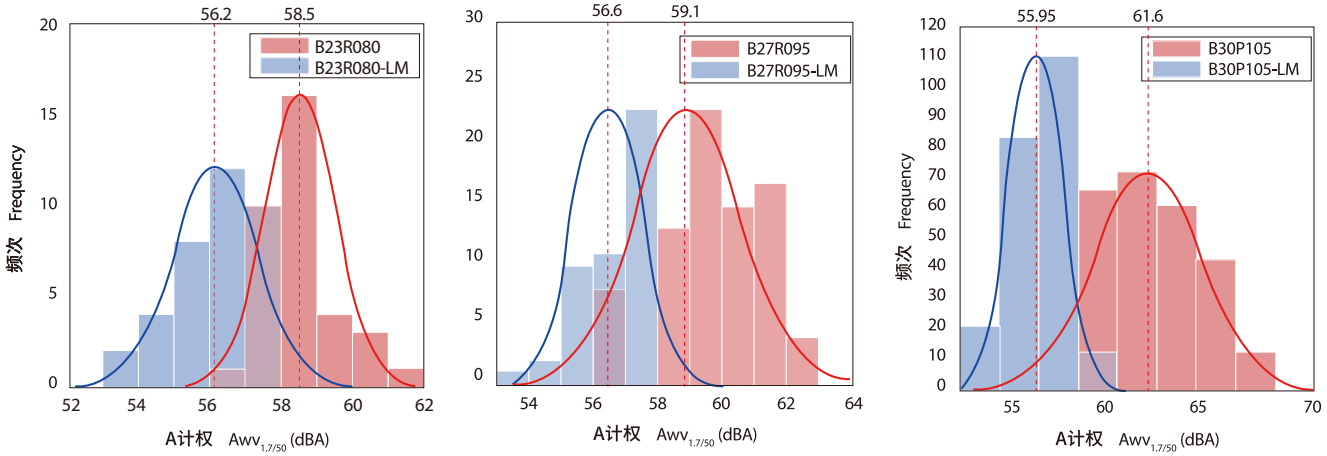
随着国民经济的发展，人口密集化，变电站负荷加重，对城市变压器的噪音要求变得越来越严格。宝钢也已开发出0.23mm、0.27mm、0.30mm所有牌号的低噪音产品。

With the development of national economy, densification of population in cities, substation load is increasing. The noise requirements of transformers becomes stricter. Baosteel has also developed low-noise products of 0.23mm, 0.27mm, and 0.30mm.

低噪音变压器主要应用牌号表

Grain-oriented electrical steel grades applied to low noise transformers

牌号名称 Grades	$Awv_{1.7/50}$, dB(A)		$P_{1.7/50}$, W/kg		B8,T	
	典型值 Typical value	保证值 Guaranteed value	典型值 Typical value	保证值 Guaranteed value	典型值 Typical value	保证值 Guaranteed value
B23R080-LM	57	≤58	0.77	≤0.79	1.91	≥1.88
B23R085-LM	57	≤58	0.80	≤0.82	1.91	≥1.88
B27R095-LM	57	≤58	0.90	≤0.94	1.91	≥1.90
B30P105-LM	57	≤60	1.01	≤1.03	1.91	≥1.90
B30P120-LM	57	≤60	1.04	≤1.06	1.91	≥1.90



注：$Awv_{1.7/50}$表示频率为50Hz、磁感为1.7T时的磁致伸缩速度水平（A计权）

Note: $Awv_{1.7/50}$ is the A-weighted magnetostriction velocity level at the frequency of 50Hz and the magnetic flux density of 1.7T

应用案例 Cases

宝钢低噪声特性材料经多家用户试用，变压器的噪音较标准要求降低2-3dB(A)，材料获得广泛认可。

With transformer noise 2-3dB(A) lower than the requirement, Baosteel low magnetostriction GO electrical steel has been widely accepted by customers.

采用低噪声材料试制的变压器性能

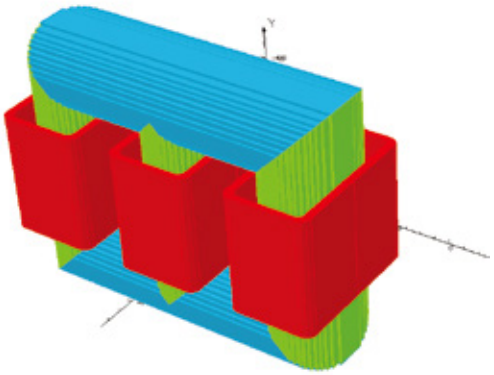
Properties of transformers made with low magnetostriction grain-oriented electrical steel

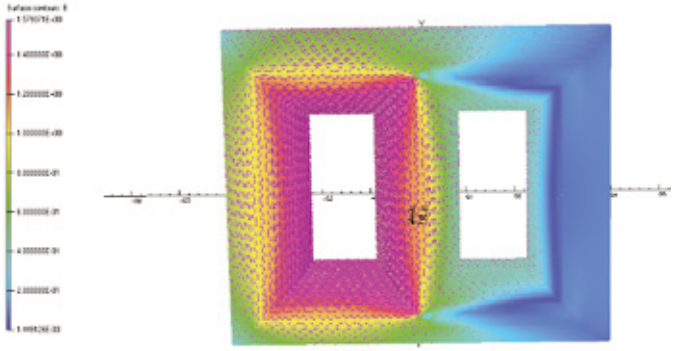
电力产品名称 Power products	噪音要求 Noise requirements	常规材料 Normal material	低噪音材料 Low magnetostriction material B30P105-LM
SSZ11-240000/220型变压器 SSZ11-240000/220 transformer	≤63 dB(A)	--	60 dB(A)
SB11-M-500/10型变压器 SB11-M-500/10 transformer	≤47 dB(A)	44.3 dB(A)	42 dB(A)
SFSZ-180000/220型变压器 SFSZ-180000/220 transformer	≤63 dB(A)	60 dB(A)	58 dB(A)
SZ-50000/110型变压器 SZ-50000/110 transformer	≤60 dB(A)	58 dB(A)	56 dB(A)
SCB11-1000/10型变压器 SCB11-1000/10 transformer	≤50 dB(A)	47.5 dB(A)	44 dB(A)
DF11-120000/750型变压器 DF11-120000/750 transformer	≤65 dB(A)	62 dB(A)	60 dB(A)
S14-M-400/10 型变压器 S14-M-400/10 transformer	≤48 dB(A)	45 dB(A)	42 dB(A)
BKS-90000/230型电抗器 BKS-90000/230 reactor	≤75 dB(A)	70 dB(A)	69 dB(A)
BKS-75000/238型电抗器 BKS-75000/238 reactor	≤75 dB(A)	74 dB(A)	72 dB(A)

2） 仿真能力 Simulation analysis

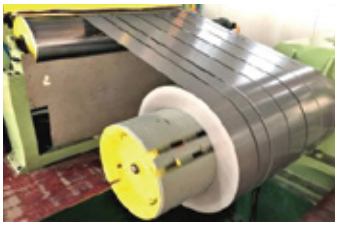
- 具备提供变压器空载特性分析的能力
- 具备仿真磁场分布的能力
- 具备仿真直流偏磁特性的能力
- 具备仿真谐波特性的能力

- Ability to provide no-load characteristic analysis
- Ability to simulate magnetic field distribution
- Ability to simulate DC magnetic bias characteristics
- Ability to simulate harmonic characteristics





3） 材料剪切技术支持　Technical support in material slitting and cross cutting



产线因素
Production line factors

- 产线类型
- 运行速度
- 送料对中
- 稳定性
- Production line
- Production speed
- Feed centering
- Stability

刀具因素
Cutting tool factors

- 刀刃状态
- 刀刃间隙量
- 刀刃重合量
- 刀具修磨精度
- 刀具修磨周期
- Blade condition
- Gap between blades
- Overlap
- Grinding precision
- Grinding cycle

良好的剪切质量是
保证变压器空载特性的重要因素

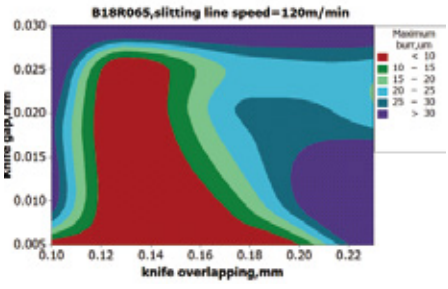
Good cutting quality is important to ensure no-load characteristics of transformers

其他因素
Other factors

- 压板间隙
- 张紧气压
- 导轨位置
- 分离环状态
- Gap between platens
- Tension pressure
- Position of guides
- Separation ring

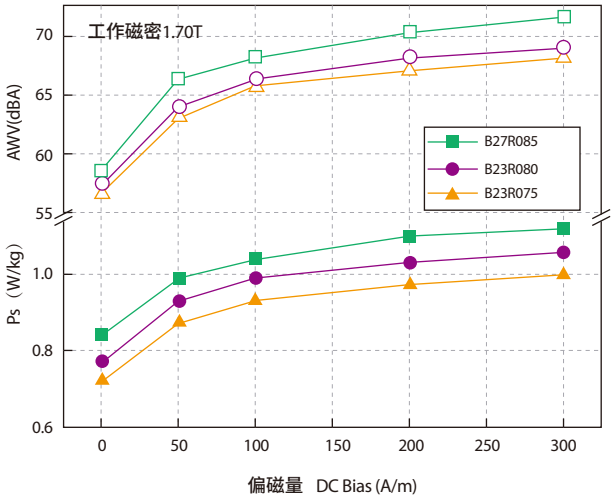
材料因素
Material factors

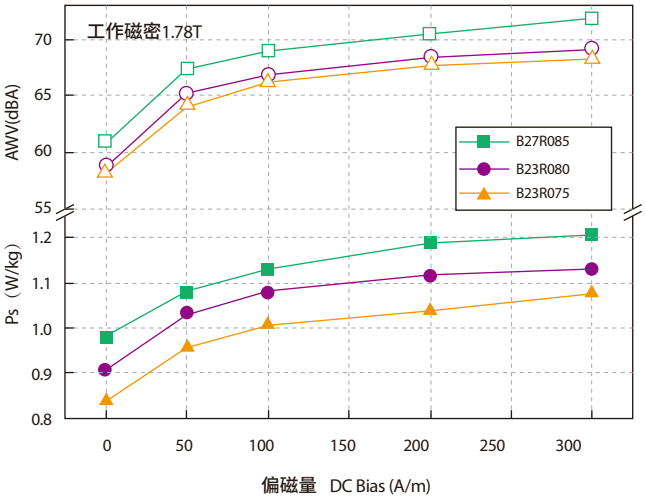
- 来料厚度
- 力学性能
- 来料版型
- 边部质量
- 涂层
- Material thickness
- Mechanical properties
- Coil status
- Edge quality
- Coating



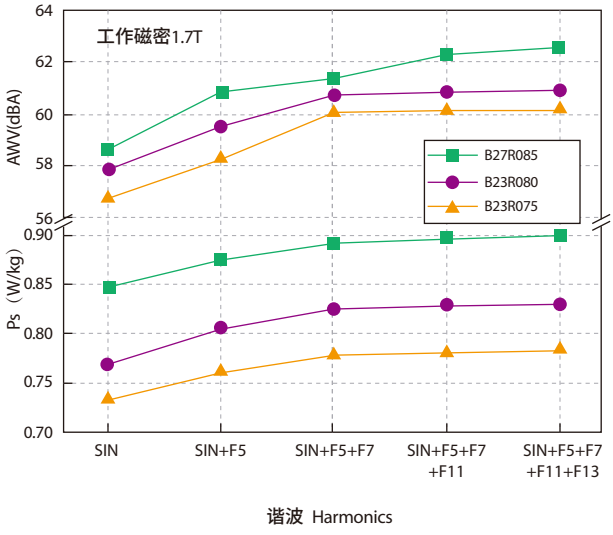
4） 特殊工况技术支持 Technical support in special operating condition

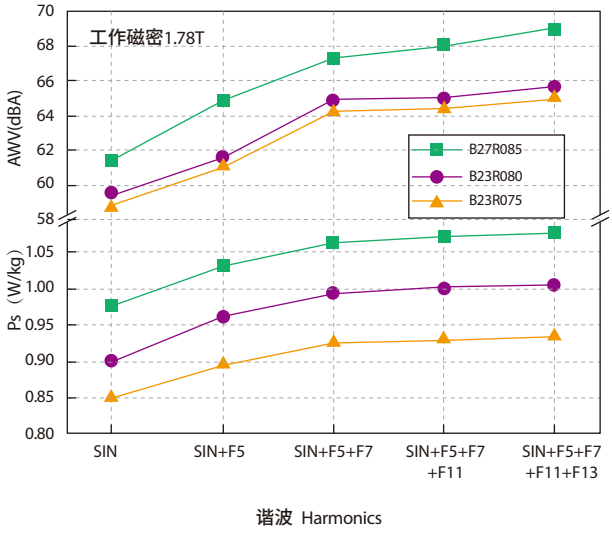
4.1） 直流偏磁 DC magnetic bias





4.2） 高次谐波 High order harmonics





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硅钢销售部
Silicon Steel Sales Department
地址:上海宝山漠河路151号
邮编:201900
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宝钢美洲贸易有限公司
BAOSTEEL AMERICA INC.
TEL: 001-201-3073355
FAX: 001-201-3073358

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LOS ANGELES OFFICE
TEL: 001-949-7526789
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FAX: 905-731-5883

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