TECHNICAL NOTE 4.0 (Rev.B)

Composition & Thermal Tempering of MadHatter™ 2-Piece Iron Rotors

Like most aspects of rotor technology, there are trade-offs to be weighed in the quest for maximum mechanical strength, maximum thermal stability under extreme stress and superior wear characteristics, while at the same timer, minimizing weight and production costs.

As noted in Table 1, Performance Brake Systems (PBS) uses a low-C, low-Si, high-Mn grade alloy of grey iron for the iron rotor rings, known internationally as HT250 (ISO 185-250) combined with a proprietary 3-step thermal tempering process.

This is different than the common use of HT150 & HT200 grey iron with little or no tempering, used in rotor manufacturing. HT150/200 have a higher coefficient of friction, but are also less durable in terms of wear and deformation. PBS believes that a tempered HT250 offers the best balance of good performance with superior longevity under harsh conditions.

The carbon content of our HT250 is at or below 3.0%. The resultant Pearlite distribution (graphite flakes) is a >98% uniform medium thin flake distribution, resulting in superior strength characteristics as noted in Table 2.

Table 1: Chemical Composition

Gray Iron Comparison				Casting Wall Thicknes s/mm	Chemical Composition (%)					Microstructure (Volume Fractions) (%)
China (GB/T 9439)	ISO 185	ASTM A48/A48M	EN 1561		C	Si	Mn	P ≤	S ≤	Matrix Structure
HT100 (HT10-26)	100	No.20 F11401	EN-GJL-100	-	3.4-3.9	2.1-2.6	0.5-0.8	0.3	0.15	Pearlite: 30-70%, coarse flakes; Ferrite: 30-70%; Binary Phosphorus Eutectic: < 7%
HT150 (HT15-33)	150	No.25A F11701	EN-GJL-150	< 30 30-50 > 50	3.3-3.5 3.2-3.5 3.2-3.5	2.0-2.4 1.9-2.3 1.8-2.2	0.5-0.8 0.5-0.8 0.6-0.9	0.2	0.12	Pearlite: 40-90%, medium coarse flakes; Ferrite: 10-60%; Binary Phosphorus Eutectic: < 7%
HT200 (HT20-40)	200	No.30A F12101	EN-GJL-200	< 30 30-50 > 51	3.2-3.5 3.1-3.4 3.0-3.3	1.6-2.0 1.5-1.8 1.4-1.6	0.7-0.9 0.8-1.0 0.8-1.0	0.15	0.12	Pearlite: > 95%, medium flakes; Ferrite < 5%; Binary Phosphorus Eutectic < 4%
HT250 (HT25-47)	250	No.35A F12401 No.40A F12801	EN-GJL-250	< 30 30-50 > 52	3.0-3.3 2.9-3.2 2.8-3.1	1.4-1.7 1.3-1.6 1.2-1.5	0.8-1.0 0.9-1.1 1.0-1.2	0.15	0.12	Pearlite: > 98% medium thin flakes; Binary Phosphorus Eutectic: < 2%
HT300 (HT30-54)	300	No.45A F13301	EN-GJL-300	< 30 30-50 > 53	2.9-3.2 2.9-3.2 2.8-3.1	1.4-1.7 1.2-1.5 1.1-1.4	0.8-1.0 0.9-1.1 1.0-1.2	0.15	0.12	Pearlite: > 98% medium thin flakes; Binary Phosphorus Eutectic: < 2%
HT350 (HT35-61)	350	No.50A F13501	EN-GJL-350	< 30 30-50 > 54	2.8-3.1 2.8-3.1 2.7-3.0	1.3-1.6 1.2-1.5 1.1-1.4	1.0-1.3 1.0-1.3 1.1-1.4	0.1	0.1	Pearlite: > 98% medium thin flakes; Binary Phosphorus Eutectic: < 1%

Superior Strength Characteristics

As can be seen in Table 2 below, every aspect of the mechanical properties of HT250 is improved by up to 1.5x over HT200.

Table 2: Mechanical Properties

Grade	Compressive Strength σbc/MPa	Shearing Strength τb/Mpa	Impact Testing αKV/(J/cm2)	Safe Range of stress σ-1/MPa	Modulus of Elasticity E/GPa
HT150	500~700	150~250	-	60~90	70~90
HT200	600~800	200~300	2~5	80~90	80~110
HT250	800~1000	250~350	4~8	100~140	100~130
HT300	1000~1200	300~450	7~10	120~160	120~140
HT350	1100~1300	350~500	9~11	140~180	130~160

3-Step Thermal Tempering

The use of HT250 grey iron however, *requires* the careful use of thermal tempering (a 2-day process) to ensure the reduction of brittleness commonly associated with HT250.

Post casting, the rotors are thoroughly cleaned of all contaminants and chemically treated with an annealing agent. The rotors are then heated very gradually under strict gradient control to 800C and kept there for several hours. The rotors are then cooled in a carefully controlled reverse gradient. This process is repeated three (3) more times and under different, proprietary gradients of heating and cooling.

This lengthy tempering process results in a highly stabilized metallic grain structure, ensuring maximum thermal stability and greatly improved metal fatigue under repeated high-heat cycles.