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THE RAMM MOLDS

by Horacio Lima

RAMM Metals, Inc.

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THE **GRAY** IRON MOLDS SUPPLIED BY RAMM ARE **NOT** MADE IN BLAST FURNACE IRON

THEY ARE PRODUCED IN HTCI-HIGH THERMAL CONDUCTIVITY GRAY IRON, OBTAINED BY METALLURGICAL REFINING IN THE FOUNDRY LADLE, **USING MOLTEN METAL FROM BLAST FURNACE, AS RAW MATERIAL**.

IT'S THE SAME TECHNOLOGY USED BY THE FORMER RAMM'S SUPPLIER IN BRAZIL (CST) WHICH HAS BEEN DEVELOPED BY THE SAME JAPANESE COMPANY IN THE 70'S (KUBOTA – TOKAI PLANT)

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THE **DUCTILE** IRON MOLDS SUPPLIED BY RAMM ARE **NOT** MADE IN BLAST FURNACE IRON

THEY ARE PRODUCED BY METALLURGICAL REFINING IN THE ELECTRIC INDUCTION FURNACE FOLLOWED BY NODULIZATION AND INOCULATION IN THE FOUNDRY LADLE USING THE MODERN CORED WIRE PROCESS. **MOLTEN METAL FROM BLAST FURNACE AND STEEL SCRAP ARE THE RAW MATERIALS**

IT'S BASED ON THE TECHNOLOGIES USED BY THE FORMER RAMM'S SUPPLIER IN BRAZIL (CST) AND KUBOTA (JAPAN), BUT IT HAS BEEN IMPROVED BY RAMM IN TERMS OF THE FINAL CHEMISTRY AND FINAL PROPERTIES OF THE DUCTILE IRON FOR EACH APPLICATION OF THE MOLDS

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MAIN STRENGTHS AND BENEFITS OF THIS WORLD CLASS TECHNOLOGY:

HIGH CARBON ➔ *HIGH THERMAL CONDUCTIVITY*
(LONGER AND THICKER GRAPHITE FLAKES)
(BETTER NUMBER AND SIZE OF GRAPHITE NODULES)

DESULFURIZED ➔ *CONSISTENT MICRO-STRUCTURE*
(LOW SULFUR CONTENT AND HIGH Mn / S RATIO)

MONOBLOCK PATTERN ➔ *LOW VARIATION OF WALLS THICKNESS*

RIGID CONTROL OF THE MANUFACTURING PROCESS ➔ *CONSISTENT PROPERTIES*
(CONSISTENT METALLIC MATRIX)

. CASTING TEMPERATURE
. CHEMICAL COMPOSITION
. SHAKE-OUT TEMPERATURE

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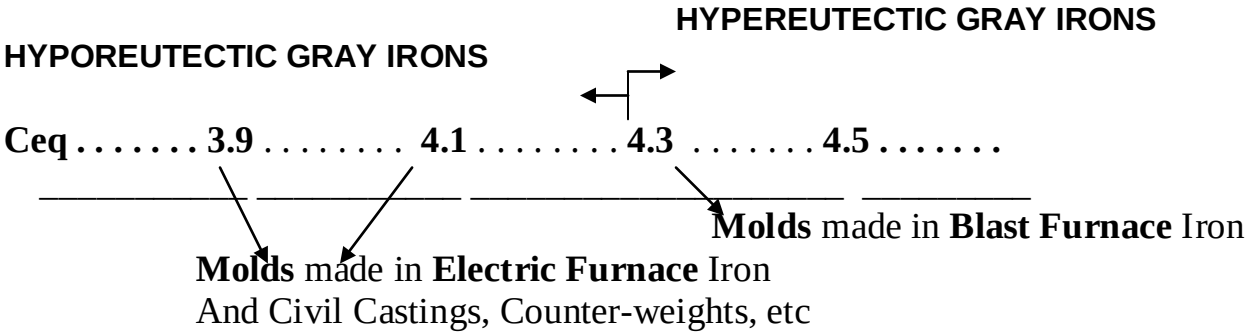
THERMAL CONDUCTIVITY OF GRAY IRONS

The thermal conductivity of Gray and Ductile Irons are influenced strongly by graphite morphology. The conductivity is higher in Gray Iron because of the semi-continuous nature of graphite flake. Because of the influence of the flake graphite on the conductivity, the volume fraction of graphite plays an important role in Gray Iron, but not in Ductile Iron.
A simple way to determine volume fraction of graphite in Gray Irons is using the Carbon Equivalent number, as follows: $Ceq = \%C + \%Si/3$

The range of Carbon Equivalent of Gray Irons for the most of applications is shown below:



The Table 1 shows the thermal conductivities of the main micro-constituents in cast irons:

MICRO-CONSTITUENT		Btu / sq. ft / h / in / F
Ferrite		485 – 555
Pearlite		350
Graphite	Along C-axis	555 – 590
	Along basal plane	1980 - 2950

The Table 2 shows the thermal conductivities of different materials:

	Btu / sq. ft / h / in / F		
18% Cr – 8% Ni steel	112		
Steel	435 495		
Ferritic Ductile iron	250		
	EF Iron(1)		BF Iron(2)
GRAY Iron	313 (1)		380 (2)

(1) Hypoeutectic irons-Molds made in Electric Furnace Iron
(2) Hypereutectic irons -**Molds** made in **Blast Furnace** Iron (same of **HTCI** made by RAMM)

NOTE: Total difference between 313 and 380 Btu/sq.ft/h/in/F is ~ 21.4%.

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Typical Gray Iron Microstructure of Molds

Figure 1 shows more regularly-shaped graphite flakes (250-500µm length range) in an alloy of hypoeutectic gray iron.

(Typical for molds in Electric Furnace Iron)

Figure 1

Figure 2 shows a hypereutectic gray iron where very coarse flakes form before the eutectic which is very fine. This is similar to C-type graphite.

(Typical for molds in Blast Furnace Iron – HTCI made by RAMM)

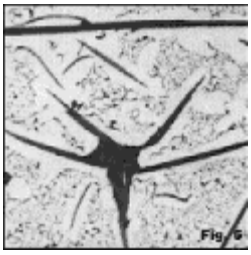

Figure 2

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RESULTS:

➔ THE RAMM MOLDS MADE IN **HTCI-HIGH THERMAL CONDUCTIVITY GRAY IRON** HAVE PERFORMED A HIGHER USEFUL LIFE IN SERVICE, FROM BOTH SUPPLIERS (FORMER CST AND CURRENT SUPPLIER).

EXAMPLES (INFORMED BY TWO CUSTOMERS):

LARGE ROUND MOLDS: **(> 50" DIA.)**	*18.7% OF LIFE INCREASE* ***(AVG. IN 2006 IN ONE CUSTOMER)***
LARGE SLAB MOLDS: **(CROSS SECTIONS OVER 30" X 70")**	29.0% OF LIFE INCREASE ***(AVG. IN 1999, 2000 & 2001 IN ONE CUSTOMER)***

NOTE:
OTHER CUSTOMERS MENTION LIFE INCREASE OF RAMM MOLDS BUT FOR SOME REASON DO NOT INFORM EXACT NUMBERS.
THESE UNEXACT INFORMATION IS BETWEEN 10% AND 50% OF LIFE INCREASE AND WITH A **NARROWER VARIATION OF LIFE**

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RESULTS:

➔ THE RAMM MOLDS MADE IN **DUCTILE IRON** HAVE BEEN TESTED IN SWEDEN AND IN USA.

EXAMPLES (INFORMED BY TWO CUSTOMERS):

25" SQUARE MOLDS: **(SWEDEN)**	*16.7% OF LIFE INCREASE* ***(AVG. IN 2005 IN ONE CUSTOMER)***
28" SQUARE MOLDS: **(USA)**	*SAME AVG. LIFE OF OTHER DUCTILE MOLDS FROM COMPETITORS* ***(ONLY 6 MOLDS HAVE BEEN TESTED AND 2 MOLDS ARE STILL IN SERVICE WITH LIFE OF 310 HEATS)***

NOTES:
DUCTILE MOLDS FOR THE SWEDISH CUSTOMER HAVE DIFFERENT CHEMISTRY, ADJUSTED FOR ITS SPECIFIC MOLD COOLING CONDITIONS

DUCTILE MOLDS FOR THE NORTH-AMERICAN CUSTOMER HAVE THE SAME CHEMISTRY THAN THOUSANDS OF DUCTILE MOLDS MADE BY THE FORMER RAMM'S SUPPLIER (CST-BRAZIL) THAT USED TO PERFORM AVERAGE LIFE OVER 300 HEATS.

IN OTHER WORDS, THE PROCESS IS REPEATABLE IF WE COMMIT TO THE ORIGINAL JAPANESE TECHNOLOGY AND IF WE KEEP CONTINUOUS ADJUSTMENT AND IMPROVEMENT FOR EACH APPLICATION OF THE MOLDS.
