
MAGMA

Optimizing Gating Design For Iron Casting

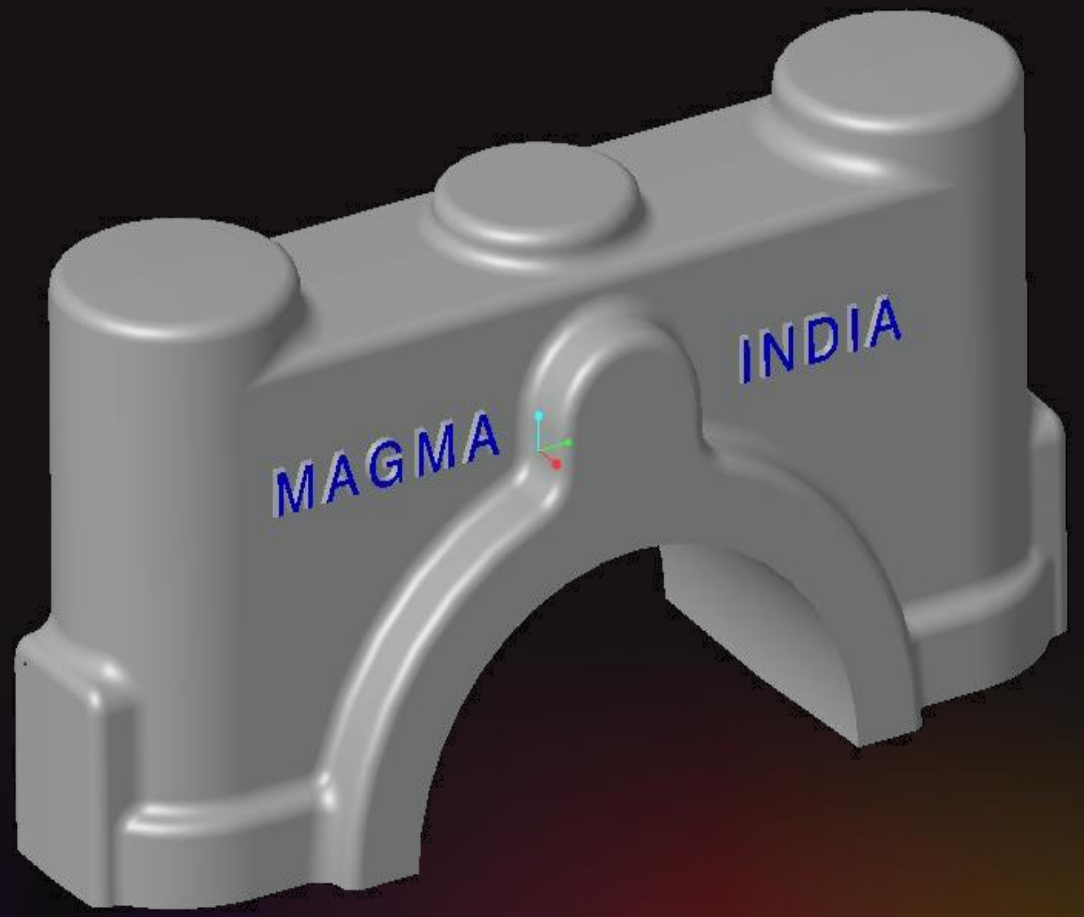
Gating System Design For- IRON

HPML-Vertical Green Sand Molding Process

Description : Bearing CAP-MAGMA

Material Type : Ductile Iron / GJS-400

Casting Weight : 1.60 Kg

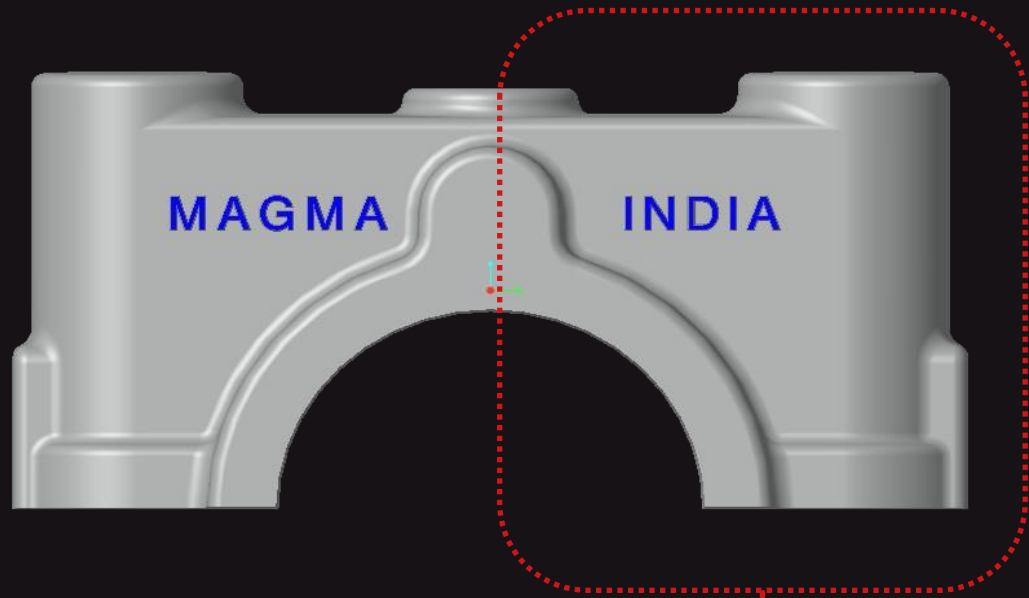


STEP-01 : To find the feedmod from CAD :

Mass Properties :

- Volume of the casting, Vc = 219.3 mm^3
- Surface area of the casting, Ac = 28.96 mm^2
- Formula, Mc = Vc, mm^3 / Ac, mm^2
- Mc = 219.3, mm^3 / 28.96, mm^2 ; 7.58 mm

Mc = 8 mm (or) 0.8 cm, Approx.



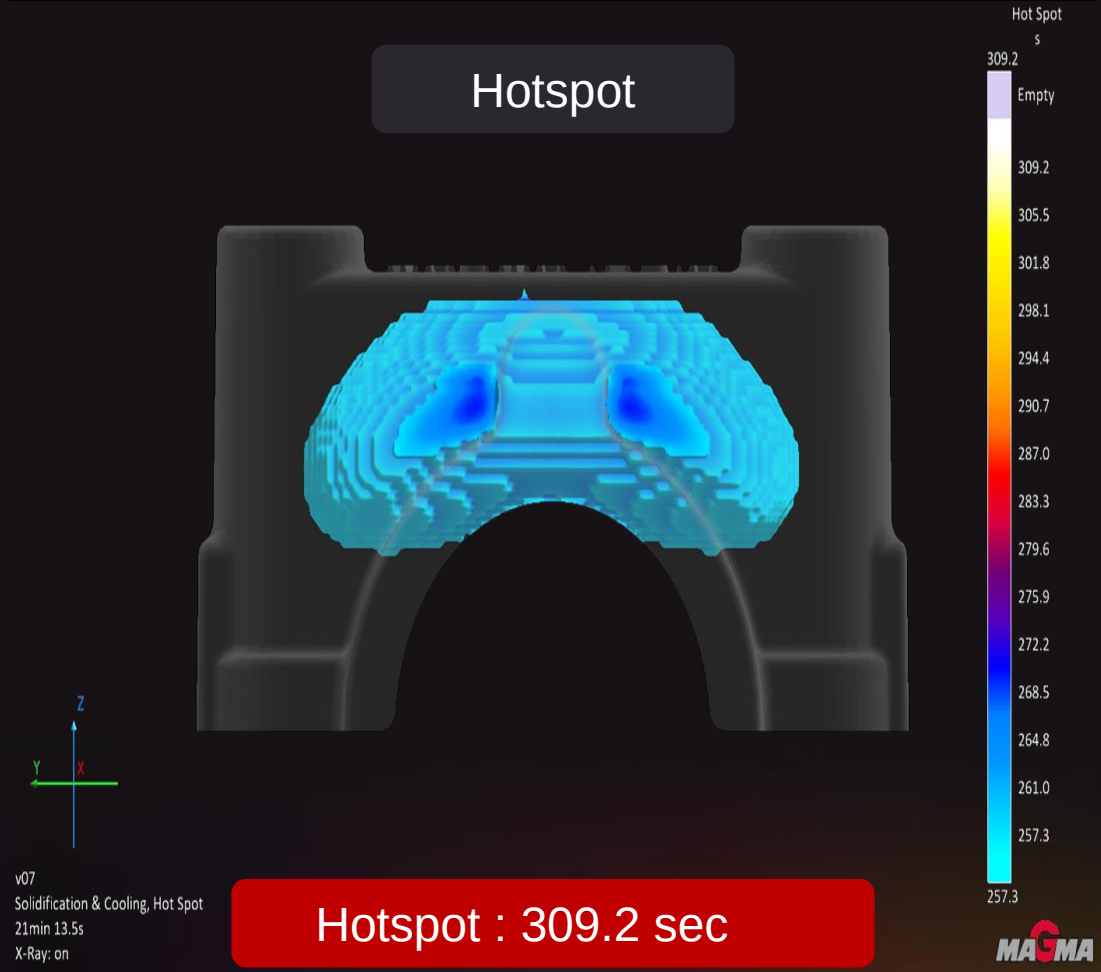
- To find the localized Mc section the portion

STEP-02: To find feedmod from MAGMASOFT® :

Feed Modulus

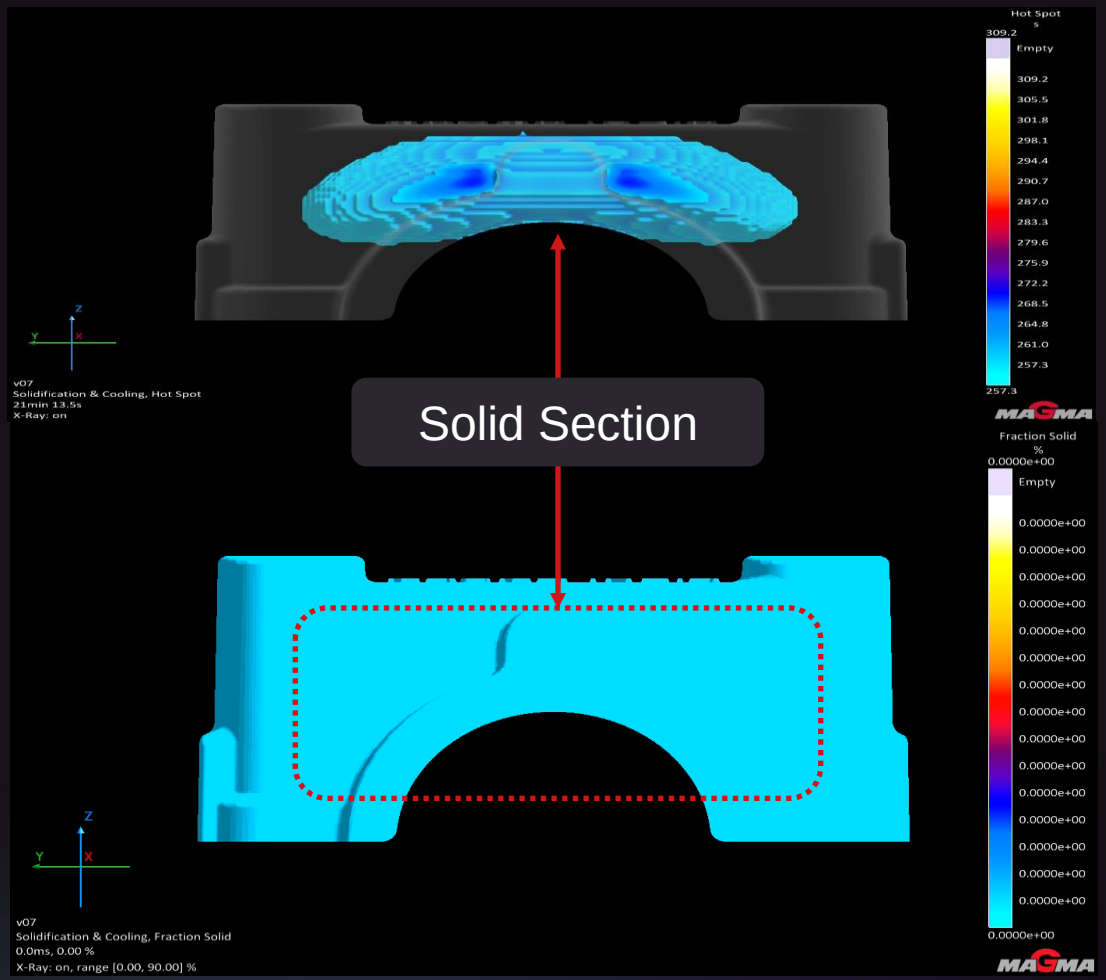
Mc : 0.79 cm, 0.8 Approx.

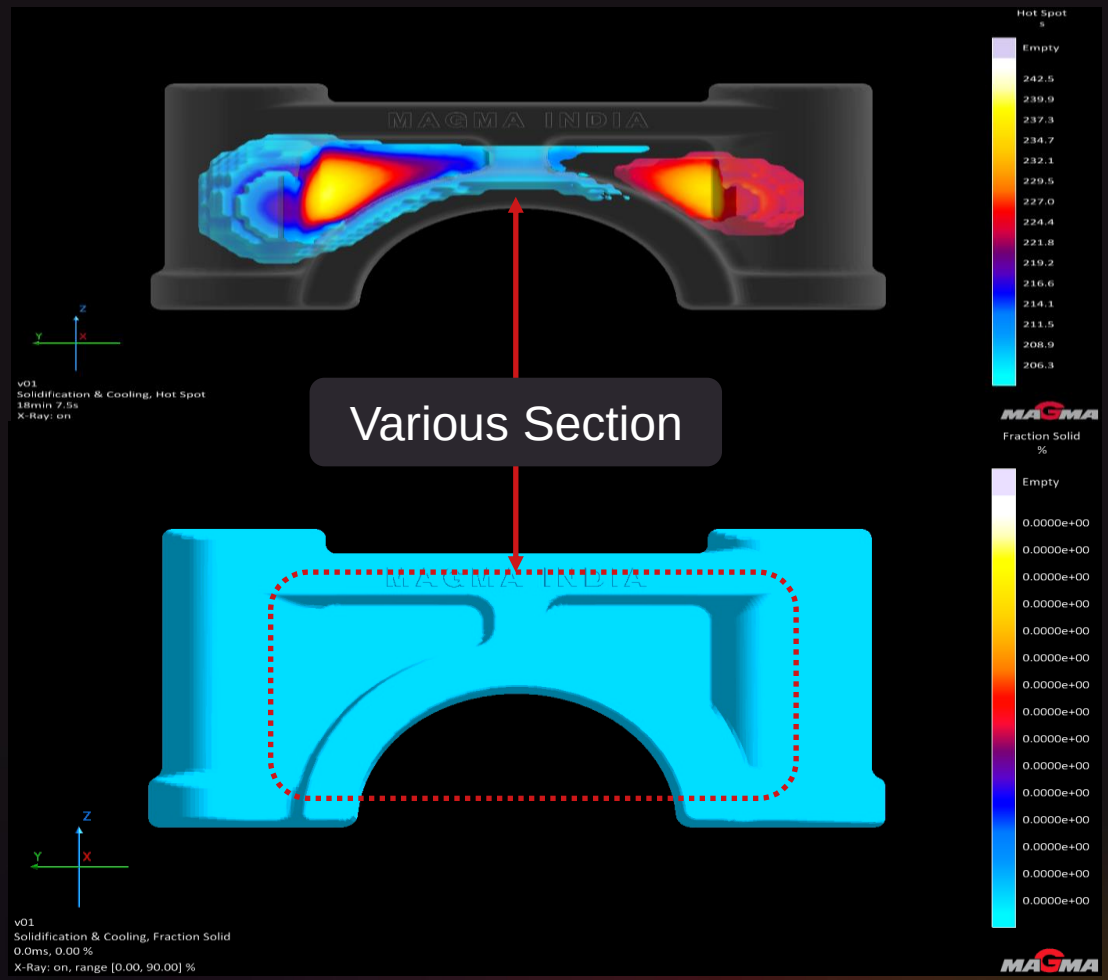
Hotspot



Hotspot : 309.2 sec

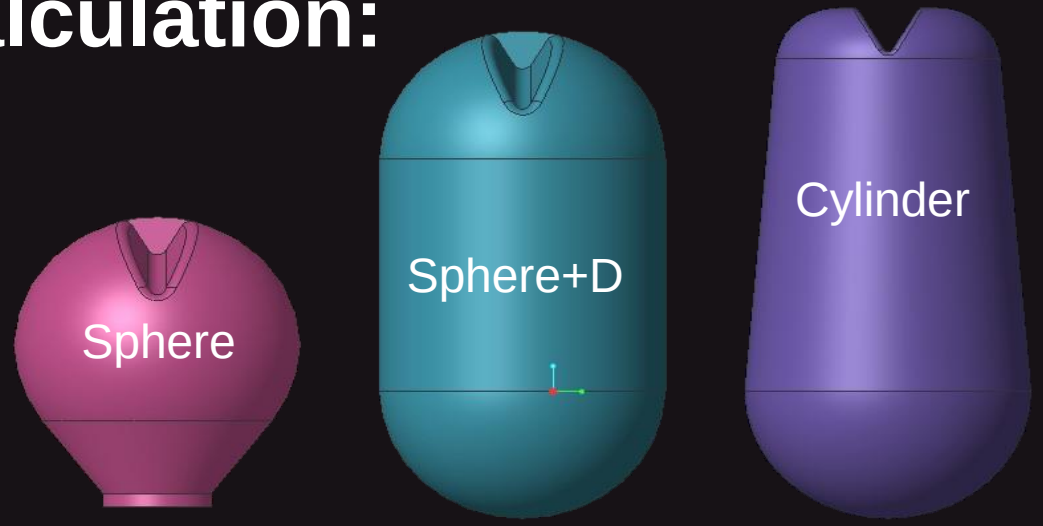
STEP-03: Understanding of Directional Solidification :





STEP-04 : Feeder Design Calculation:

- Measured Mc = 8 mm (or) 0.8 cm, Approx.
- Feedmod, M_F = Mc*1.2 to 1.4 for SG iron
- Feedmod, M_F = Mc*1.2 to 0.8 for Grey Iron
- M_F = Mc*1.2 ; 0.8 *1.2 = 0.96 cm, min
- $M_{F\ (cylinder)} = 3*D_F/16$; $M_{F\ (Sphere)} = D_F/6$, cm
- $V_{F\ (cy)} = 3*\pi*D_F^3/8$; $V_{F\ (Sphere)} = \pi*D_F^3/16$, cm



$D_{F\ (sphere)} = M_F*6$; 5.76 cm (or) Ø 60 Approx.

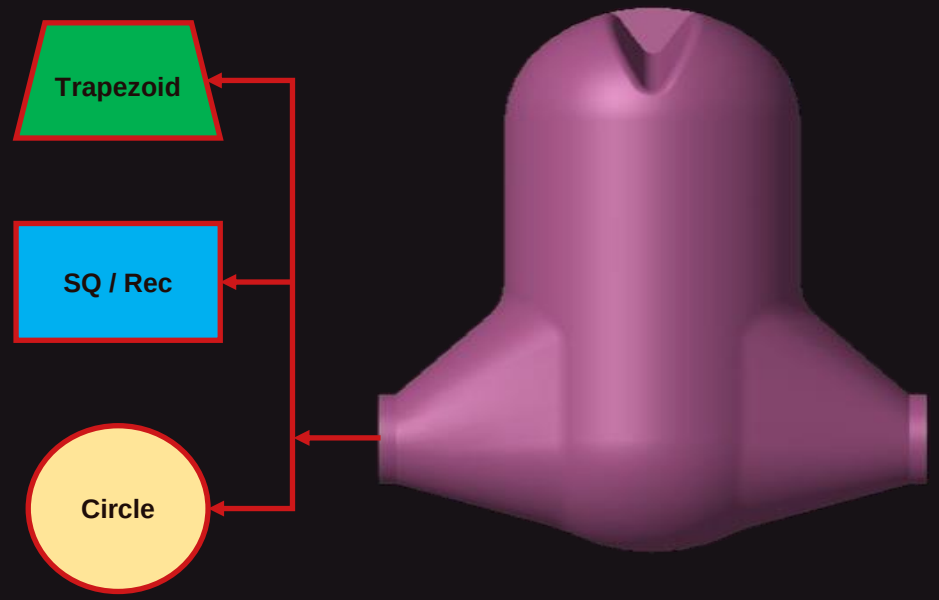
$V_{F\ (Sphere)} = (\pi*D_F^3/6)/1000$, mm^3 ; 113.2 mm^3

$W_{F\ (Sphere)} = (V_F * L\rho)/1000$, Kg ; 0.82 Kg, Min

Note : If any space constrain in mold, we can slightly optimize feeder dia with maintained wt : 0.82 Kg

STEEP-05: Feeder Neck Design Calculation:

- Measured M_F = 0.96 cm (or) 1.0 cm, Approx.
- Feedmod, $M_N = M_F / 2$, min for SG iron,
- Feedmod, $M_N = M_F / 3$, min for Grey Iron
- $M_N = M_F / 2$; 1 / 2 = 0.50 cm, min
- M_N = a / 4 (for SQ) & M_N = D / 4 (for Dia)
- M_N = D / 4, cm ; D = (M_N * 4 * 10), in mm

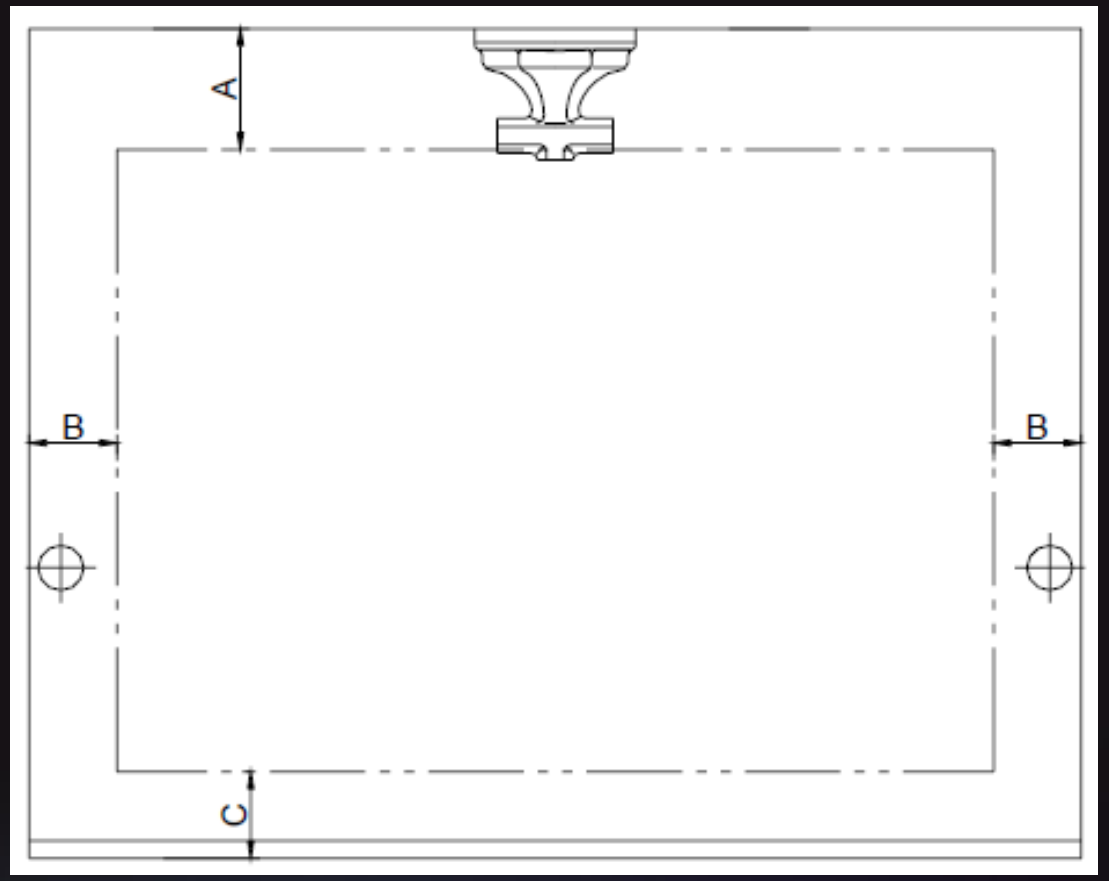


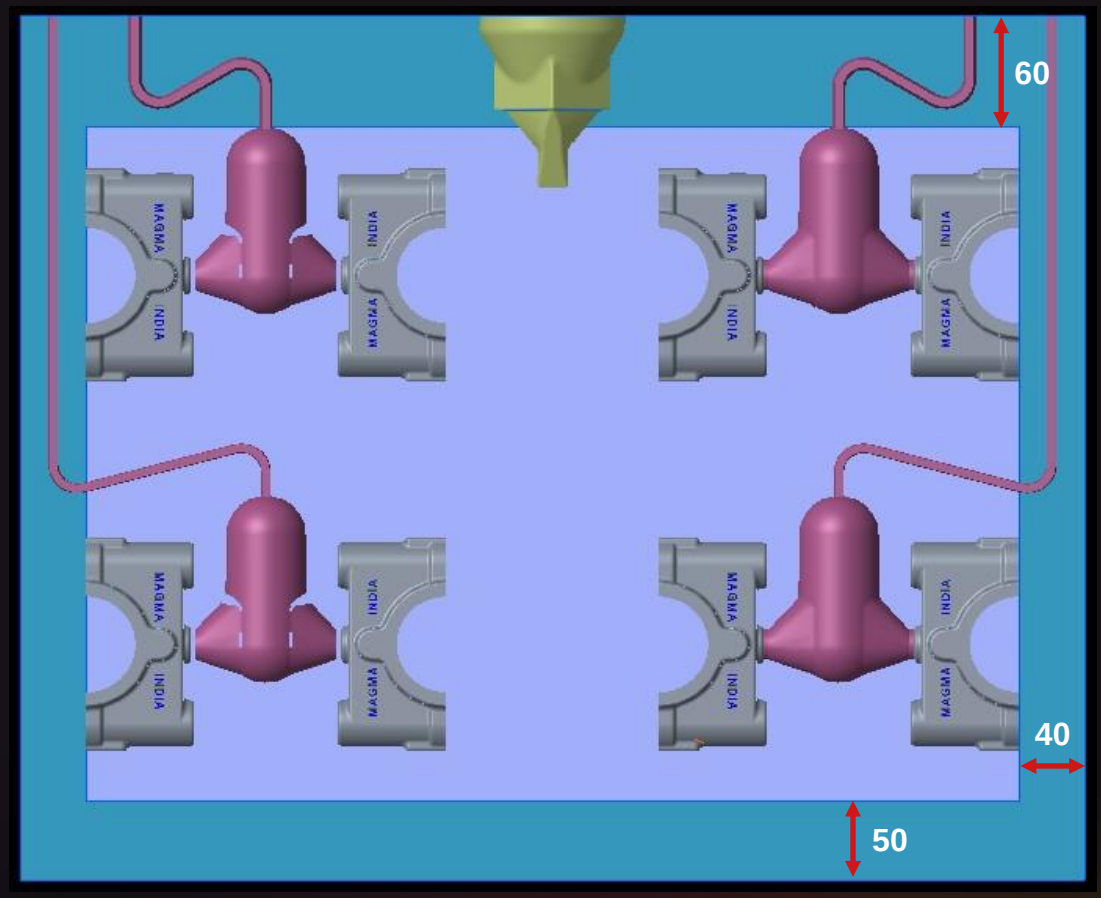
D = (M_N * 4 * 10) ; (0.5*4*10) ; Ø20, in mm

$A_N = (\pi/4 * D^2)$; ($0.7854*20^2$) ; 314 mm^2, min

Note : We can follow any geom for neck design with maintained calculated min neck area 314 mm^2

STEP-06: Pattern Layout & Mold Utilization:





Note : With followed specific m/c safety distances from edges of the molds we should arrive the layout

STEP-07: Gate Area Calculation (Ac):

- For Iron, Gate Area, Ac = (1036 * Wc) / (Fr * t * $\sqrt{H}$), Here A_G bottom : 88mm² / A_G top : 147mm²

- 1036 - Gravity acceleration of liquid metal @1400°C in density 6.9 g/cm³, (Default) / 1036

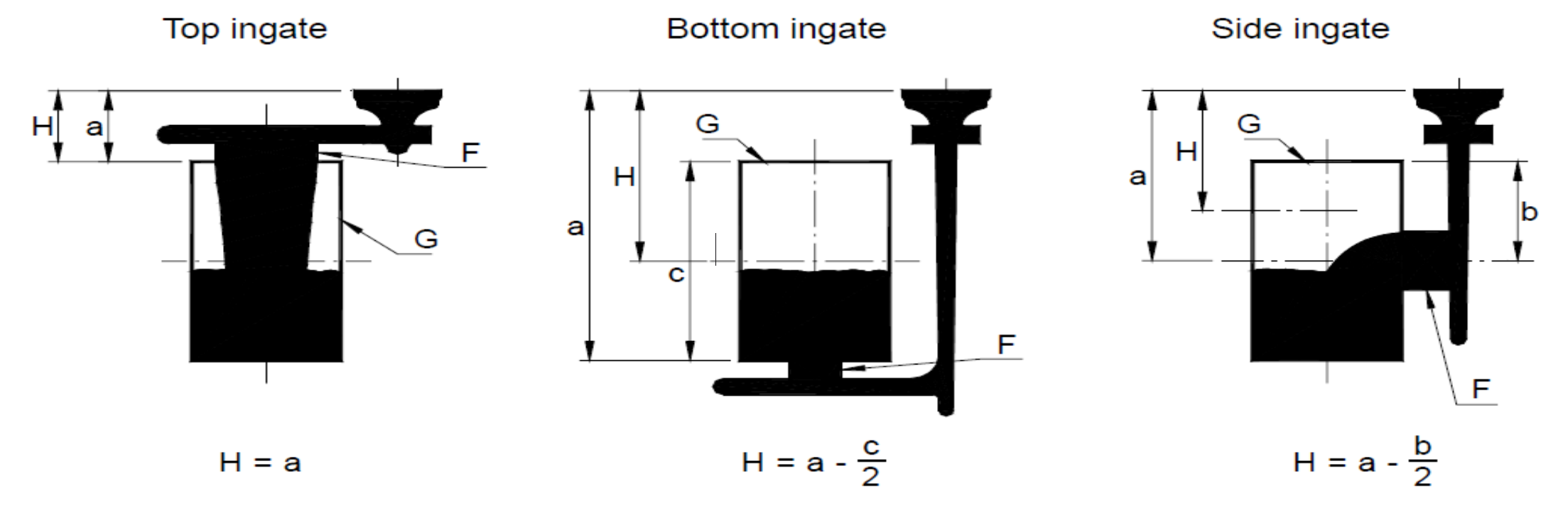
- Wc - Casting weight including feeder, in Kg (≠ Here, Do not apply Bunch wt.,) / 5.20 Kg

- Fr - Friction factor ; Fr = Fluidity (k) / 40 (for Iron) ; k = (14.91*CEL)+(0.05*T°F)-155 / 0.9

- t - Time to take fill cavity alone, in sec ; t = √ (2.2 * Wc) ; t = √ (2.2 * 5.2) / 3.3 sec

- $\sqrt{H}$ - Ferro static height with respective feeding type (≠ Top / Side / Bot) / H1-19.13 & H2-11.44

Ferro static Calculation ($\sqrt{H}$):



- $\sqrt{H}$ indicates - Ferro static height with respective feeding type (≠ Top / Bottom / Side Ingate)
- Reference from DISAmatic

STEP-08: Non-Pressurized Gating Design:

Ref Gating Ratio : $A_G > A_{R\ Horizontal} > A_{R\ Vertical}$

$A_G = 1 > A_{R\ Hor} = A_G * 0.8 > A_{R\ Vertical} = A_{R\ Hor} * 0.8$

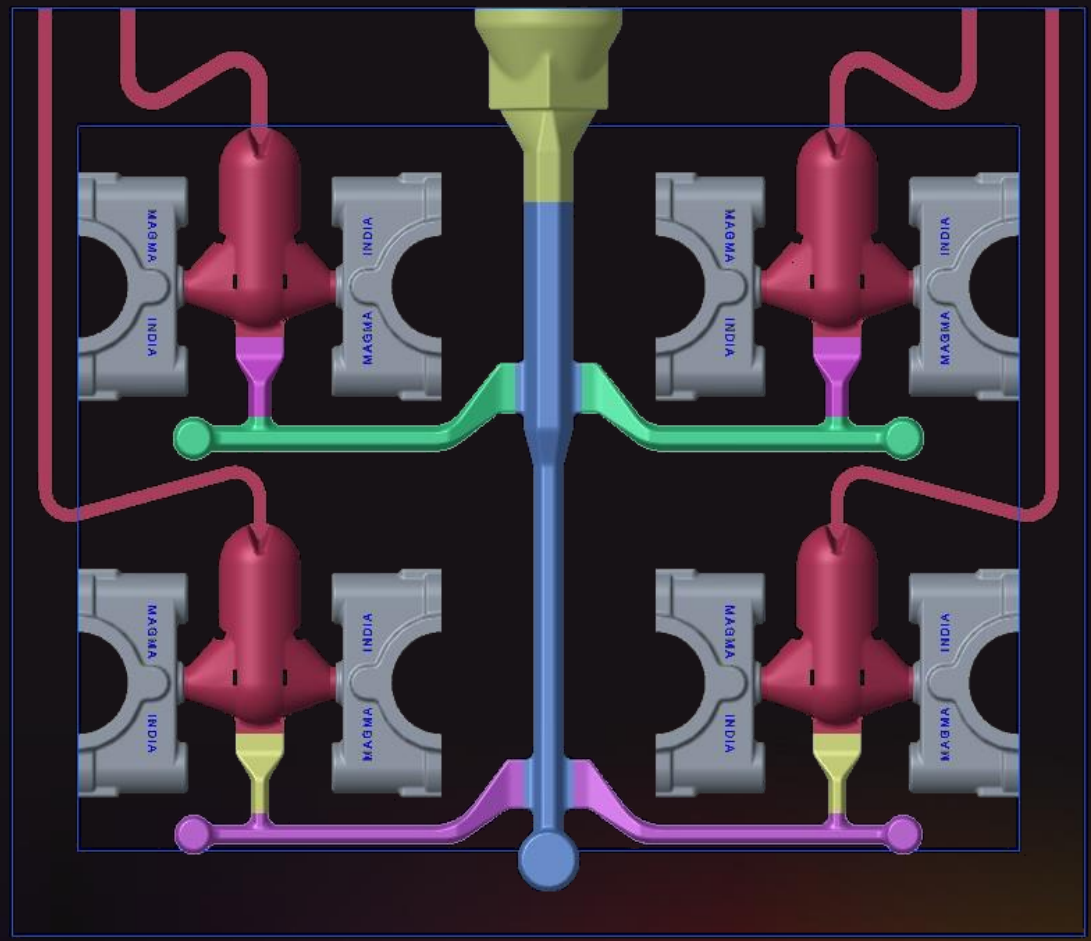
$A_{G1} = 88\ mm^2$; $A_{R1\ Hor} = 70\ mm^2$; $A_{R1\ Ver} = 112\ mm^2$

Note : $A_{R1\ Ver} = (A_{R1\ Hor} * 2) * 0.8 = 112\ mm^2$

$A_{G2} = 147 mm^2$; $A_{R2\ Hor} = 118\ mm^2$; $A_{R2\ Ver} = 300\ mm^2$

Note : $A_{R2\ Ver} = (A_{R2\ Hor} * 2) * 0.8 + A_{R1\ Ver} = 300\ mm^2$

Est, Bunch wt : 23.5 Kg ; Filling time = 7.2 sec



STEP-09: Pressurized Gating Design:

Ref Gating Ratio : $A_G < A_{R\ Horizontal} < A_{R\ Vertical}$

$A_G=1 < A_{R\ Hor} = A_G * 1.2 < A_{R\ Vertical} = A_{R\ Hor} * 1.2$

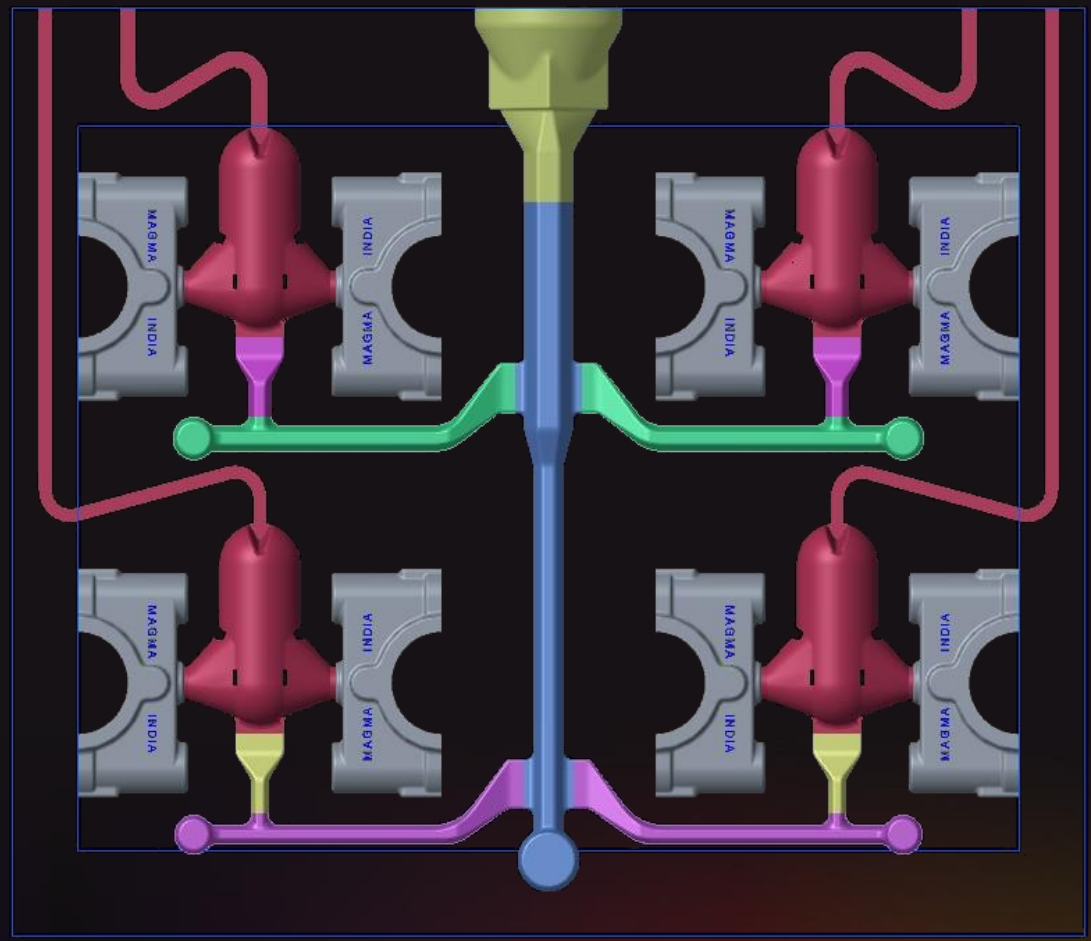
$A_{G1} = 88\ mm^2$; $A_{R1\ Hor} = 106\ mm^2$; $A_{R1\ Ver} = ?$

Note : $A_{R1\ Ver} = (A_{R1\ Hor} * 2) * 1.2 = 255\ mm^2$

$A_{G2} = 147 mm^2$; $A_{R2\ Hor} = 176\ mm^2$; $A_{R2\ Ver} = ?$

Note : $A_{R2\ Ver} = (A_{R2\ Hor}*2)*1.2+A_{R1\ Ver} = 677\ mm^2$

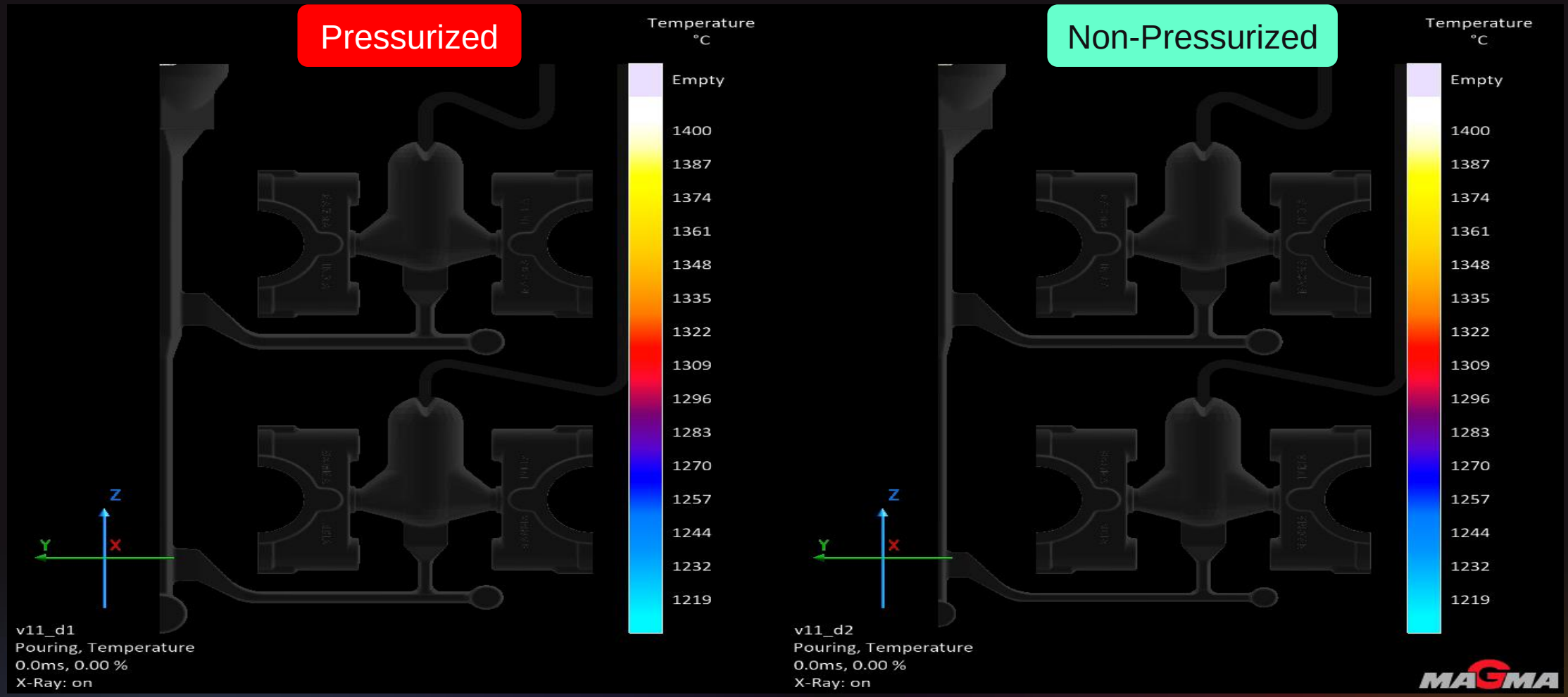
Est, Bunch wt : 24.80 Kg ; Filling time = 7.4 sec



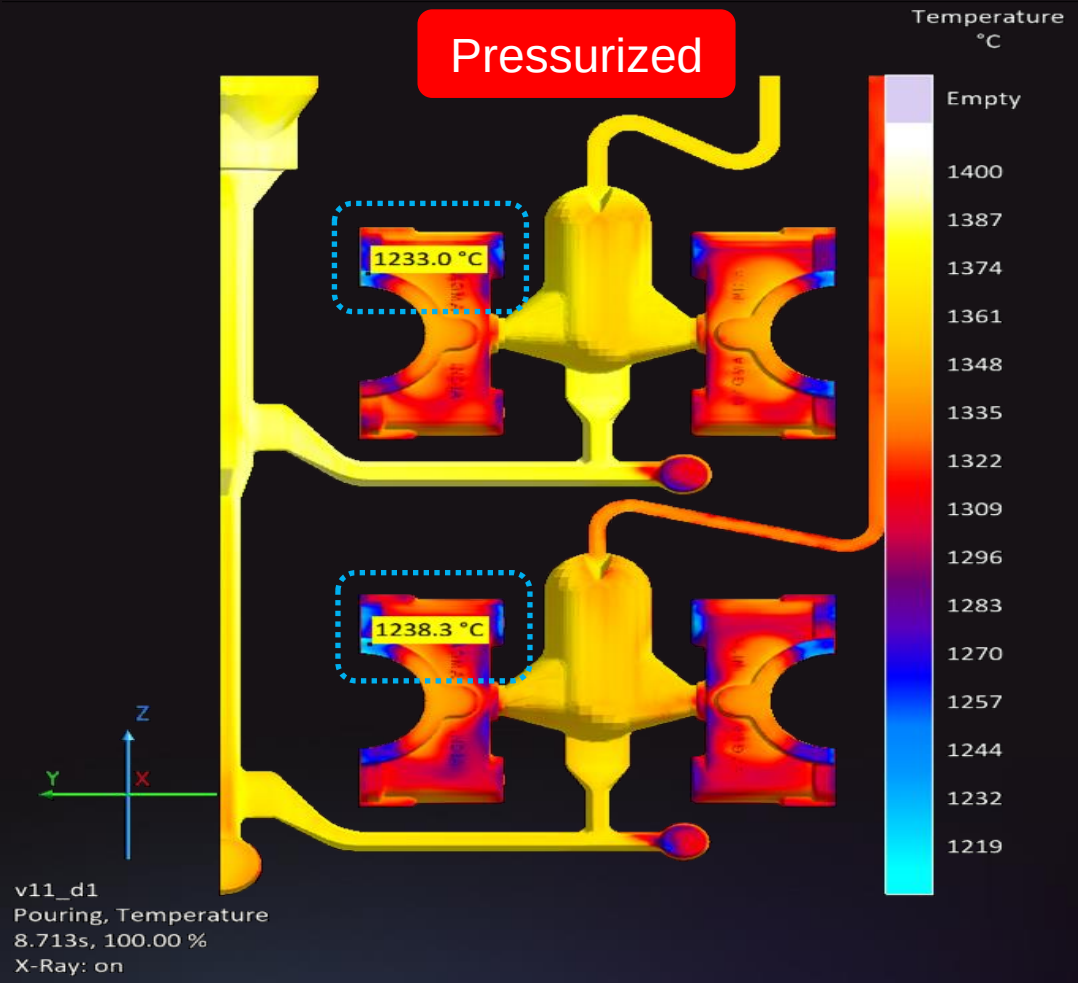
Gating Validation

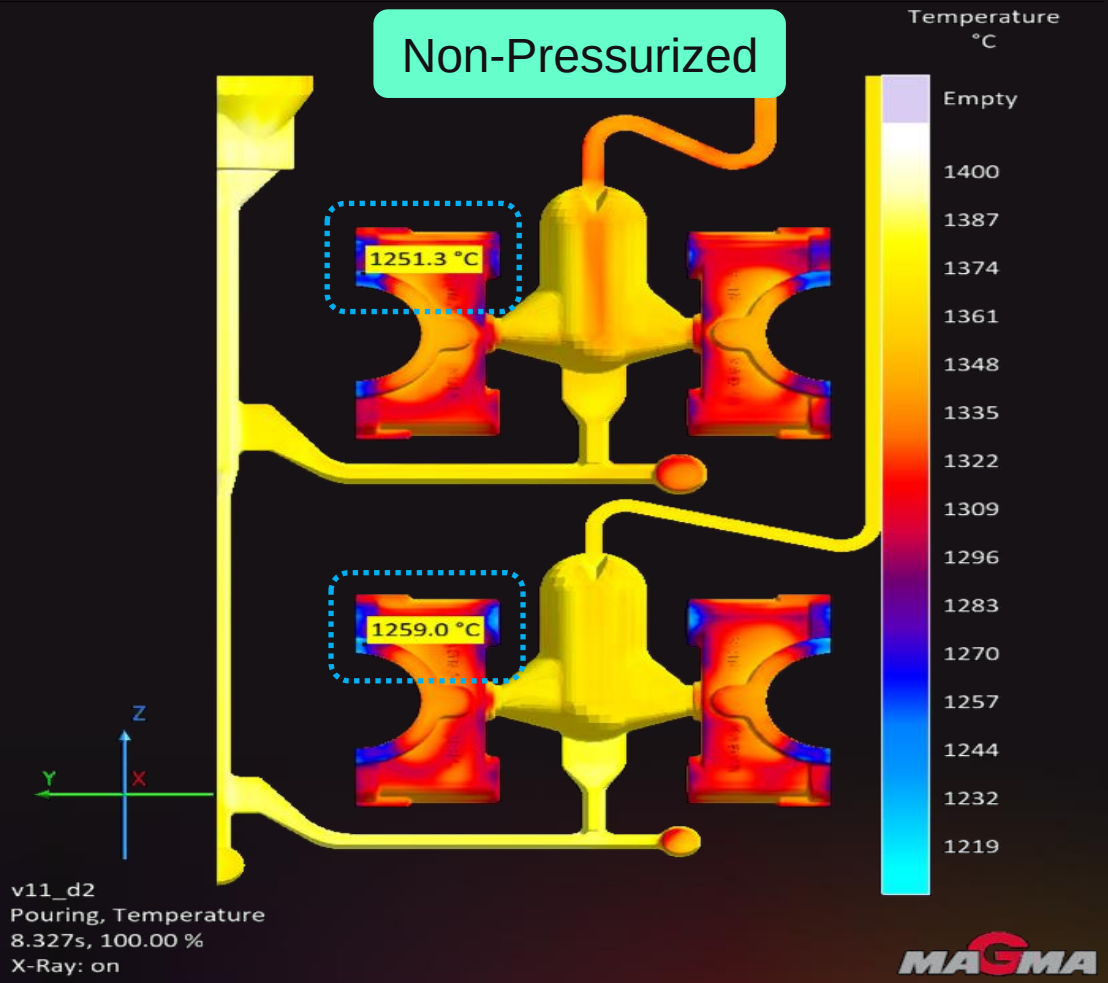
Pressurized vs Non-Pressurized

Filling Comparison:



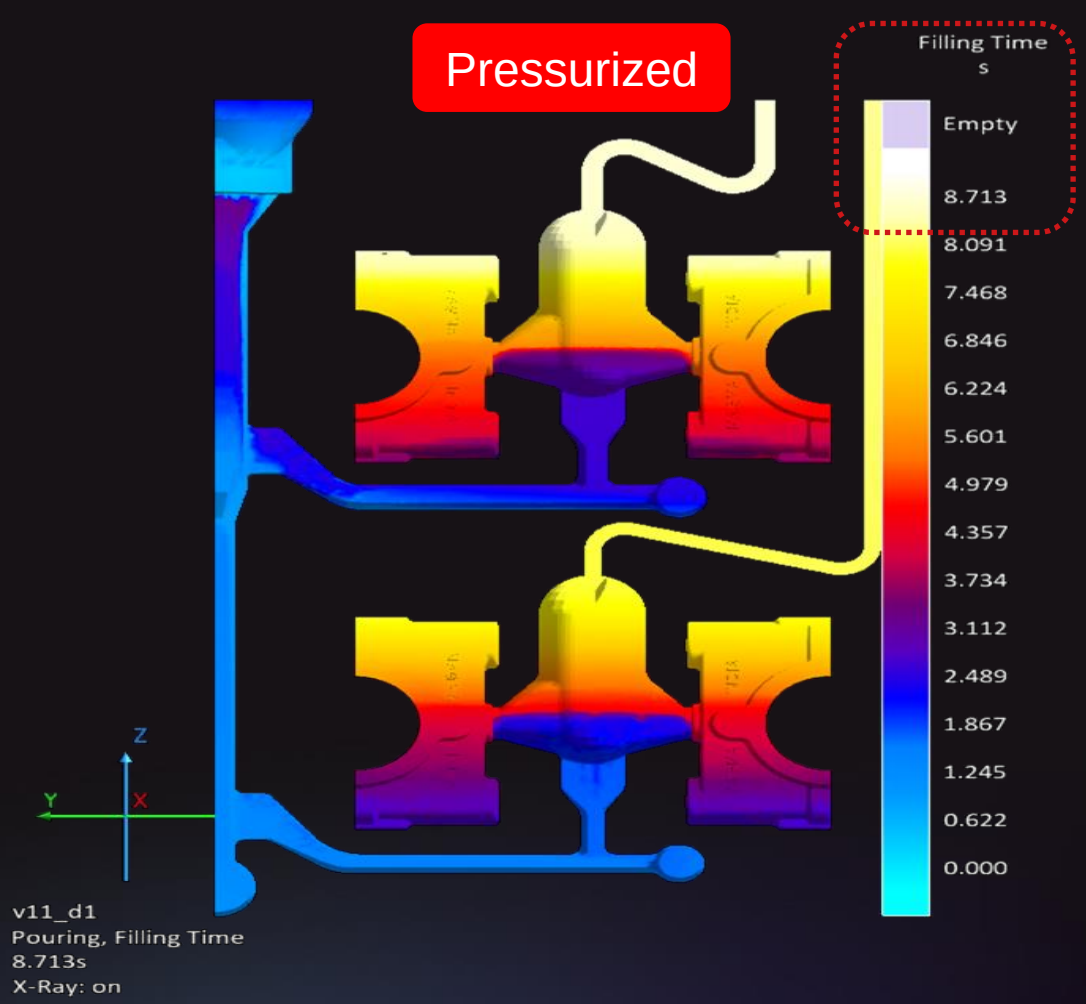
How MAGMASOFT® Leading NPD KRA:



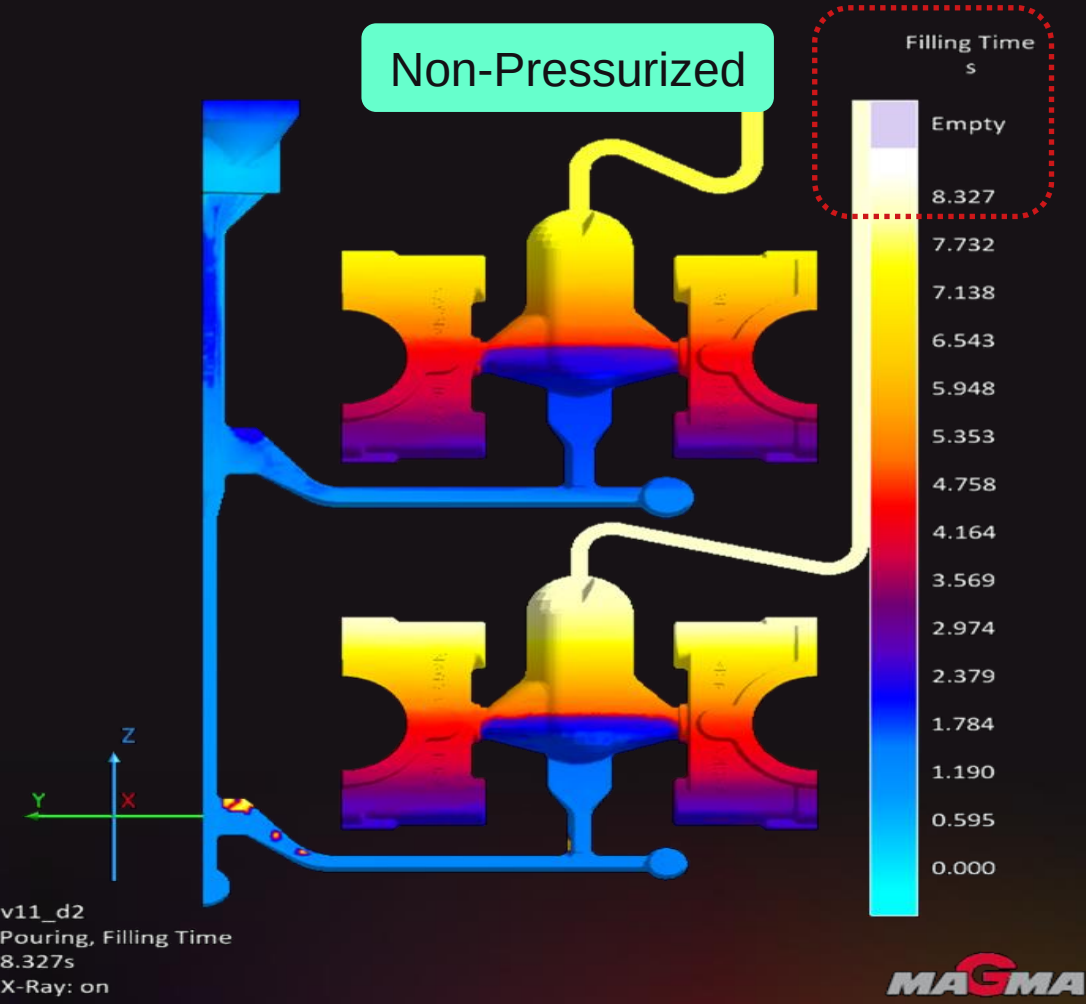


Filling Time Comparison:

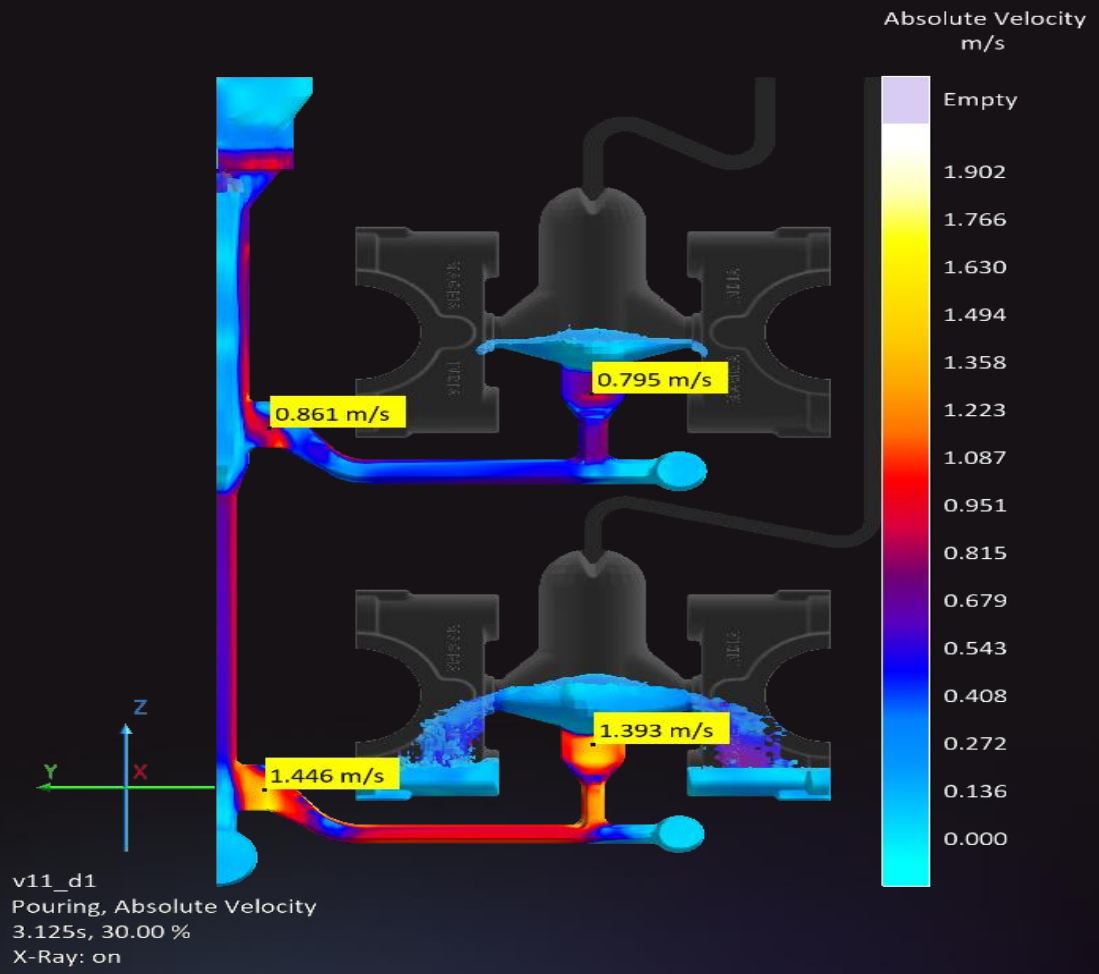
Pressurized

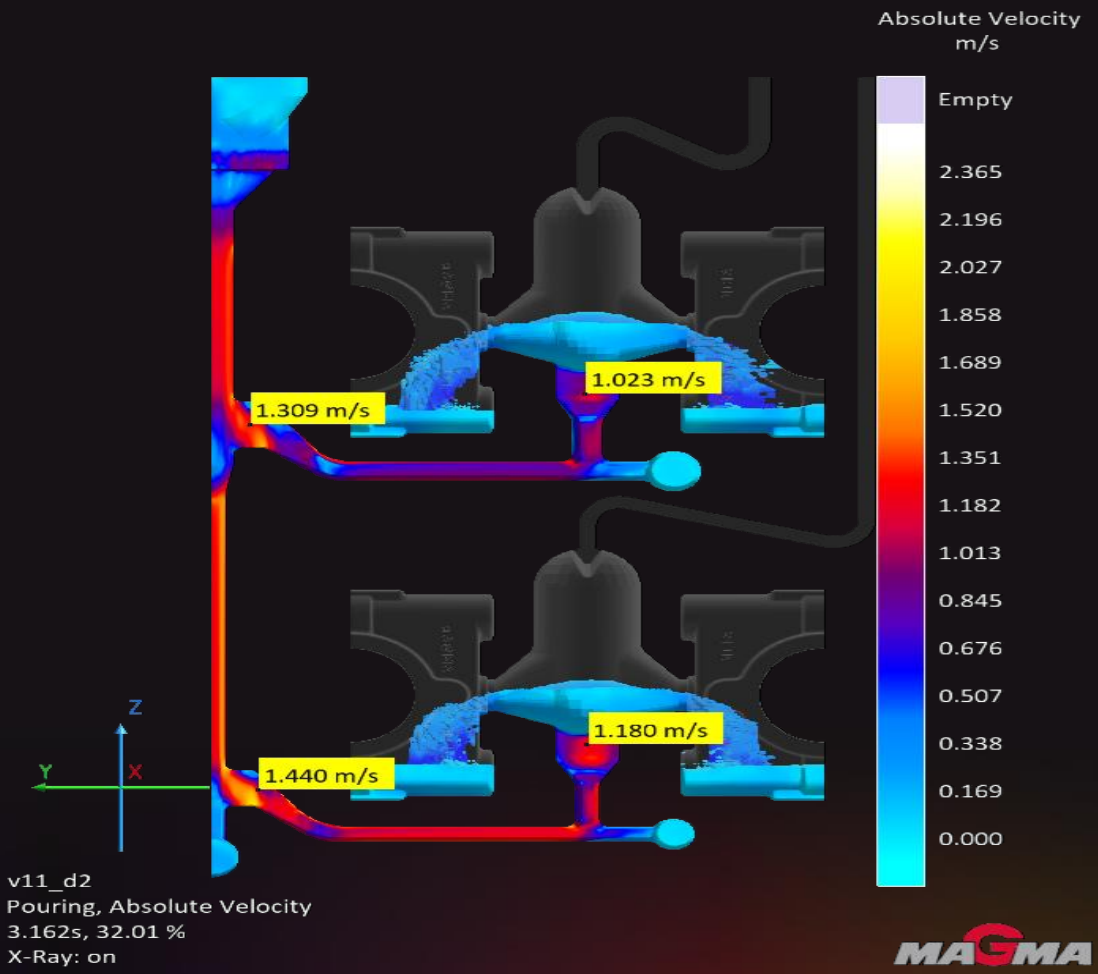


Non-Pressurized

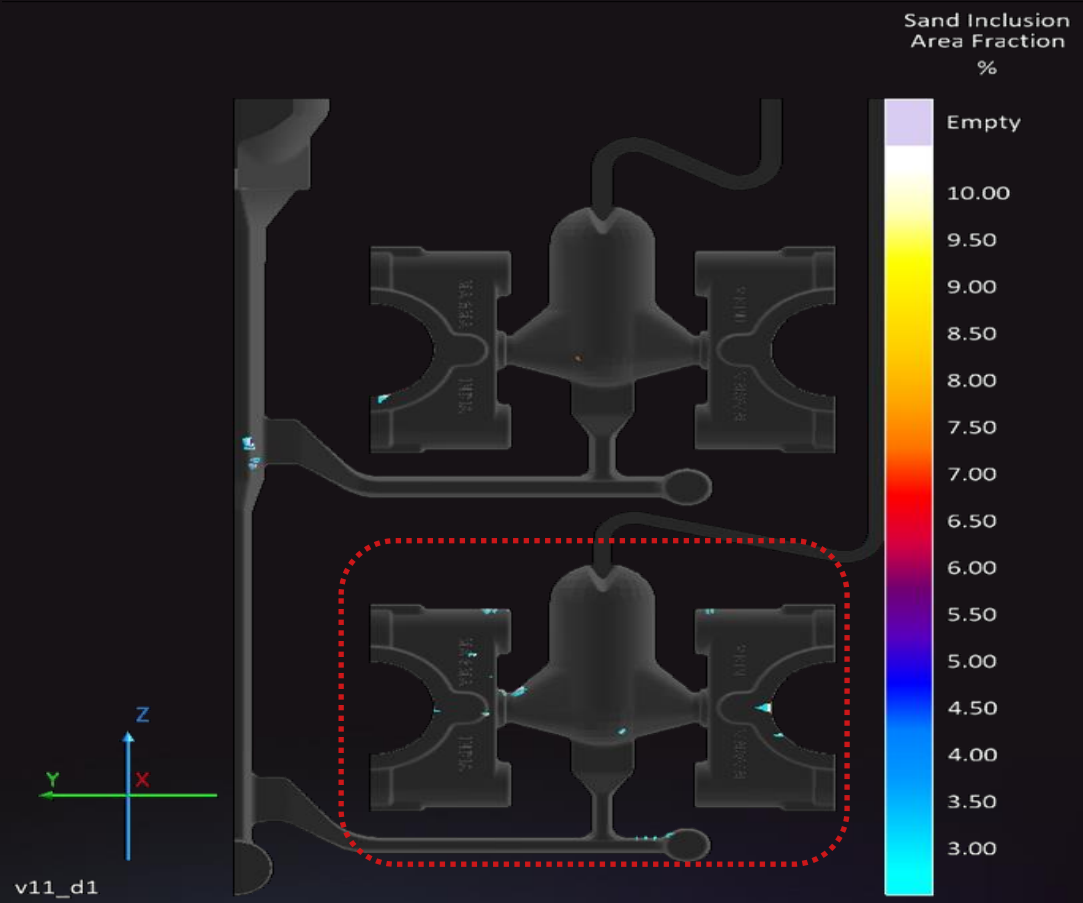


Gate Velocity Comparison:

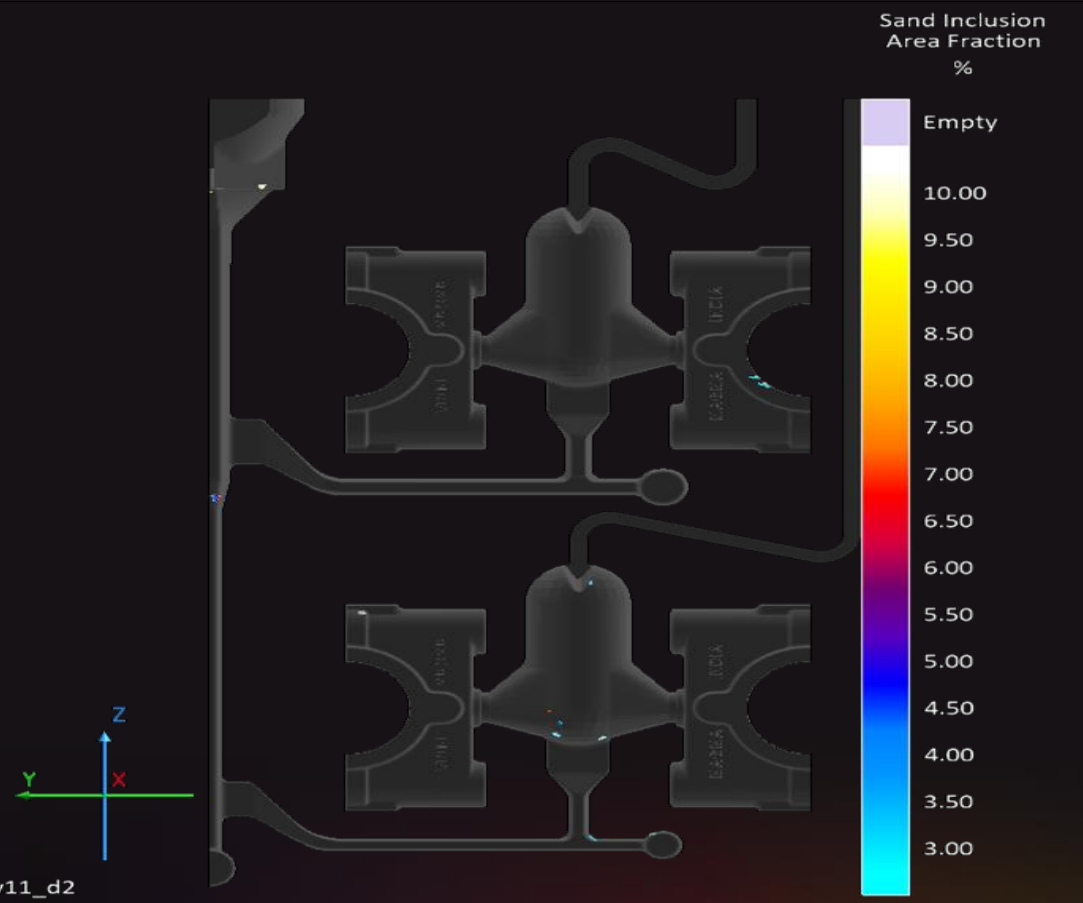




Gate Velocity Comparison:

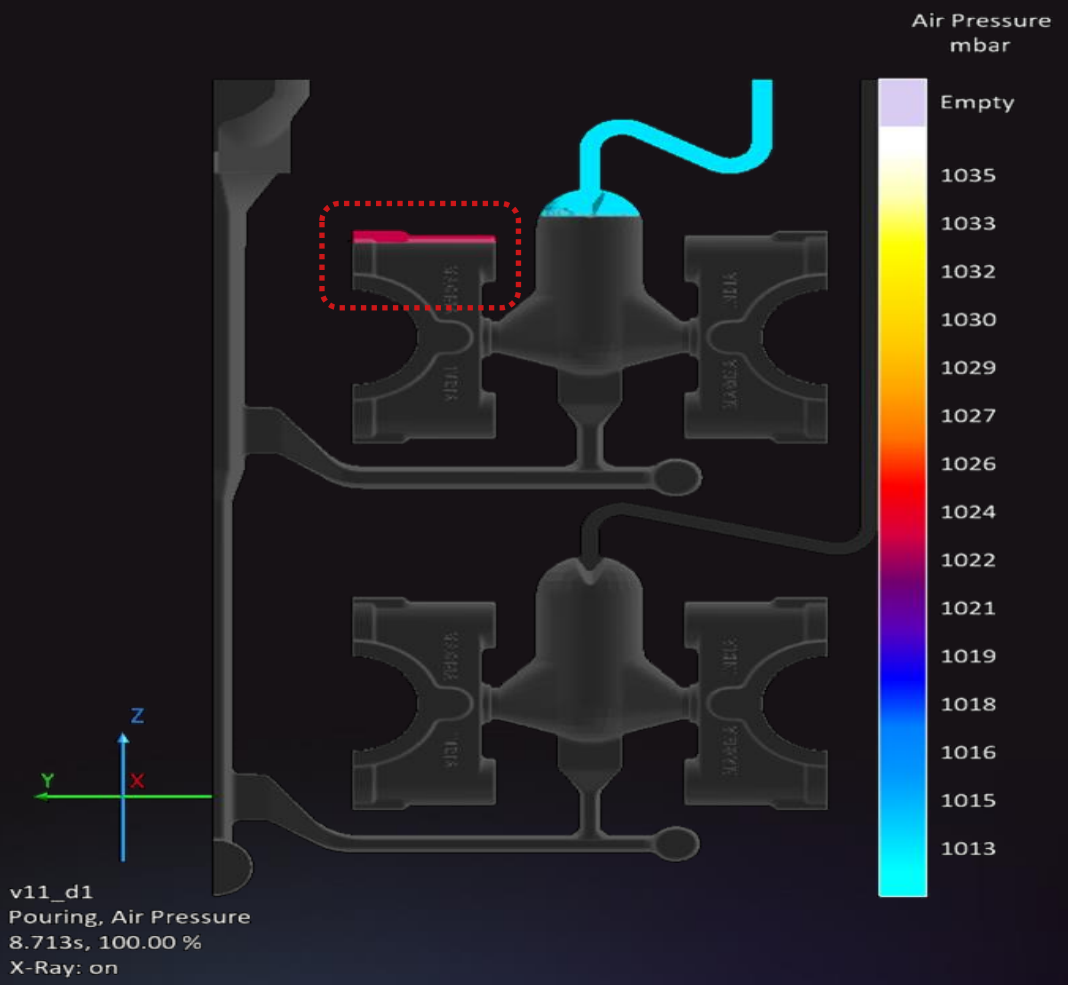


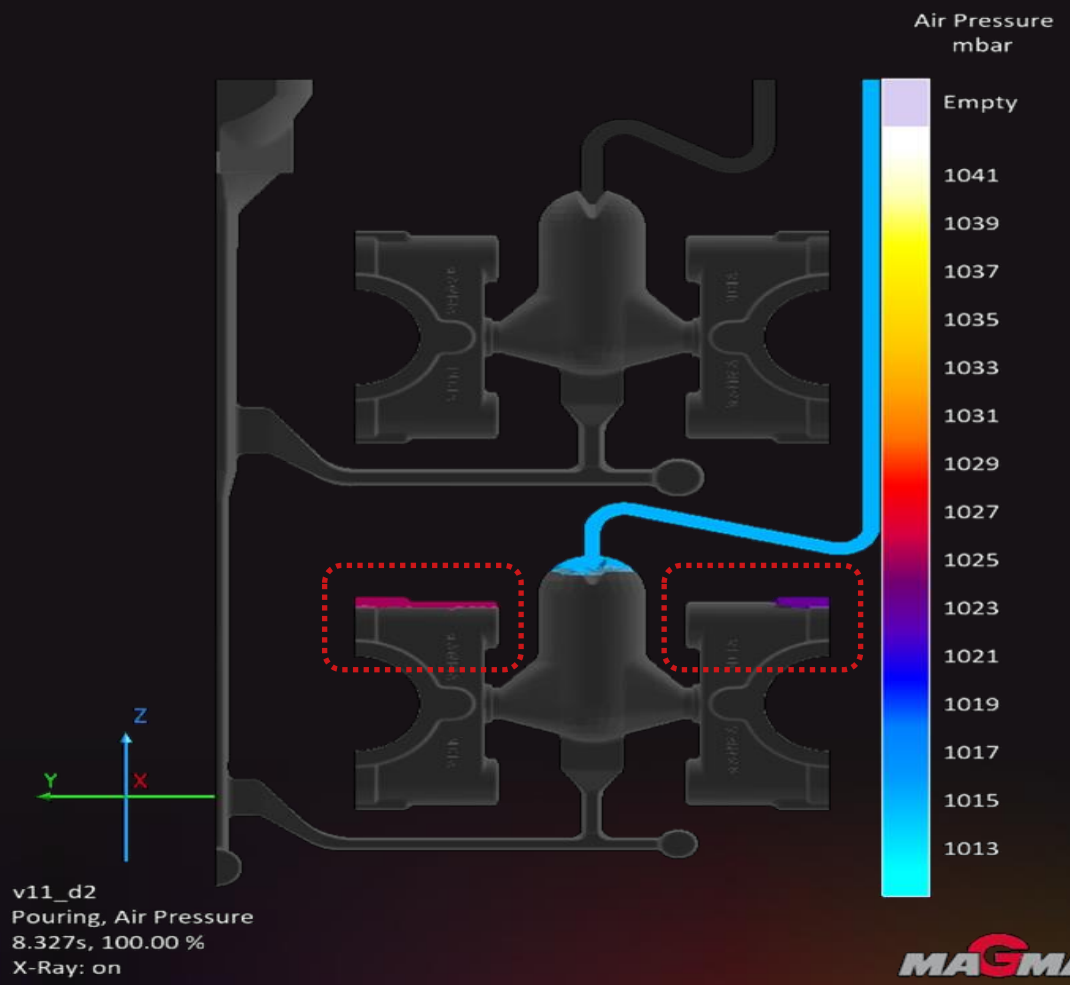
v11_d1
Pouring, Sand Inclusion Area Fraction
8.713s
X-Ray: on, range [3.00, 10.00] %



v11_d2
Pouring, Sand Inclusion Area Fraction
8.327s
X-Ray: on, range [3.00, 10.00] %

Air Pressure Comparison:





Conc:

- Compared with Pressurized gating design.
- Filling seems smooth & balance in non-pressurized gating design.
- Temp drop less in non-pressurized gating design.
- Filling time less in non-pressurized gating design.
- Sand inclusion intensity less in non-pressurized gating design.
- The possible air-entrapment noticed in both design and need to improve venting system in both design.
- Finally, we choose Non-Pressurized Gating Design for further optimization and improvements.

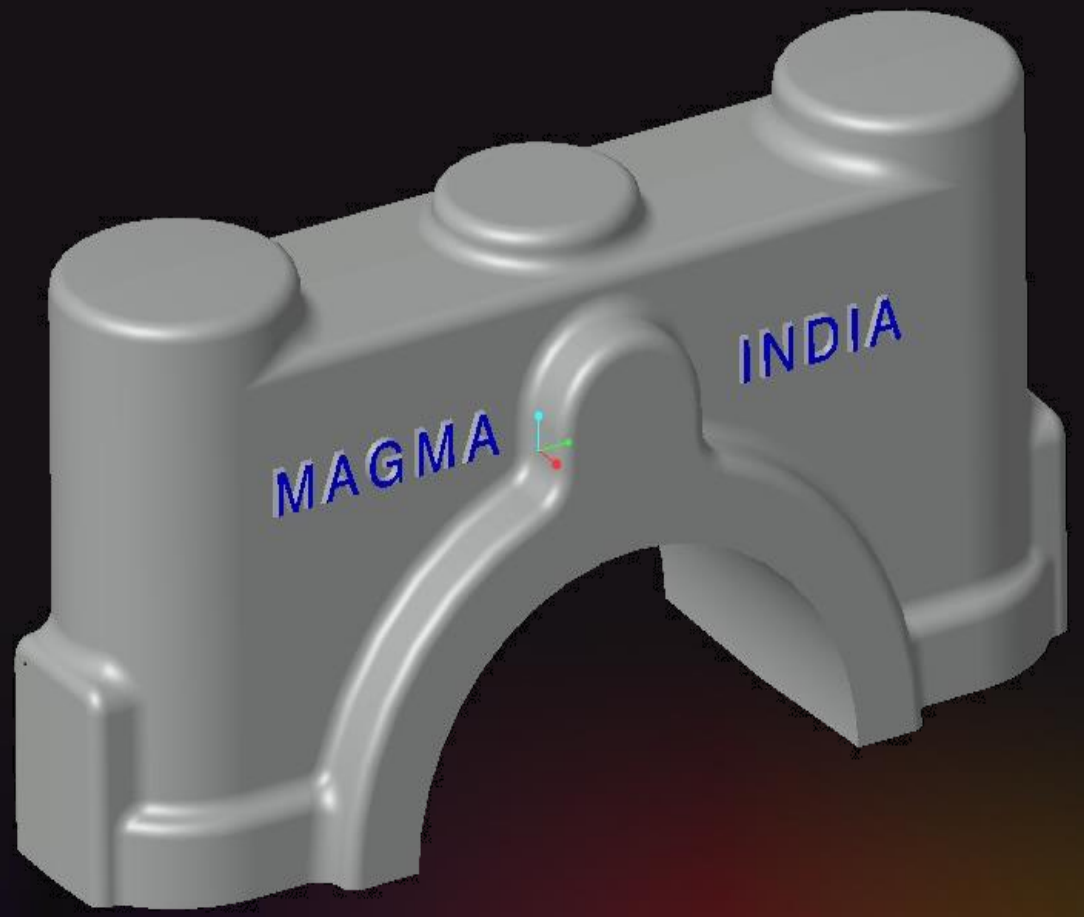
Gating System Design For- IRON

HPML-Horizontal Green Sand Molding Process

Description : Bearing CAP-MEI

Material Type : Ductile Iron / GJS-400

Casting Weight : 1.60 Kg

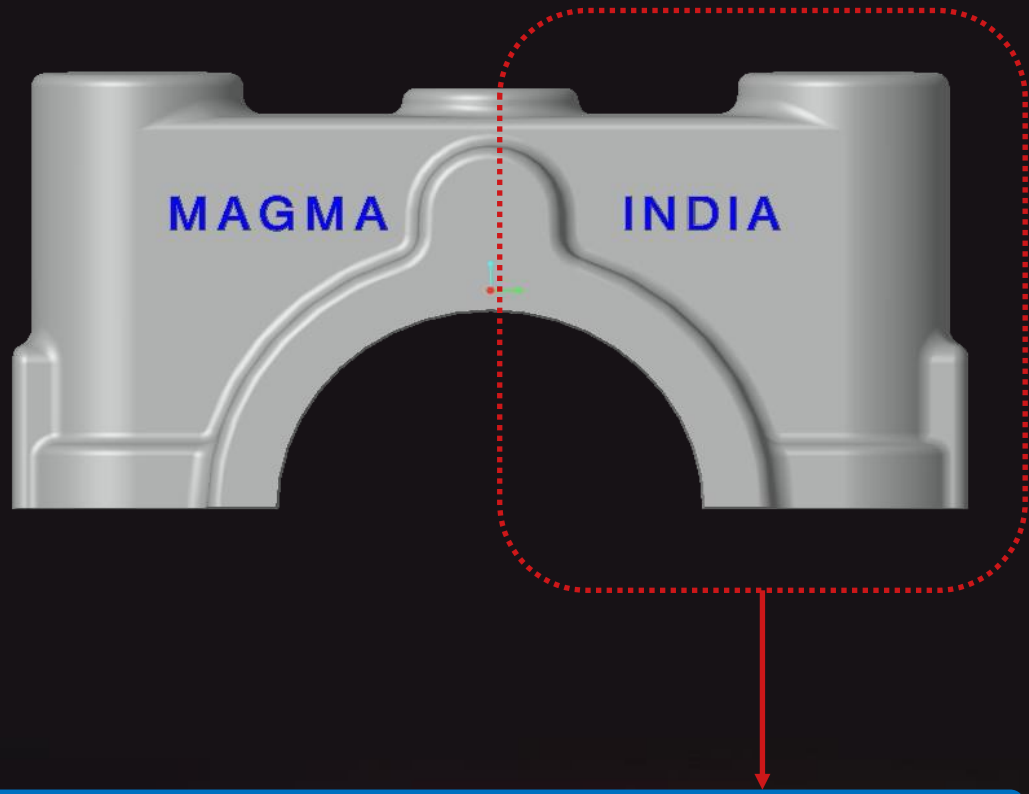


STEP-01 : To find the feedmod from CAD :

Mass Properties :

- Volume of the casting, Vc = 219.3 mm^3
- Surface area of the casting, Ac = 28.96 mm^2
- Mc = Vc, mm^3 / Ac, mm^2
- Mc = 219.3, mm^3 / 28.96, mm^2 ; 7.58 mm

Mc = 8 mm (or) 0.8 cm, Approx.



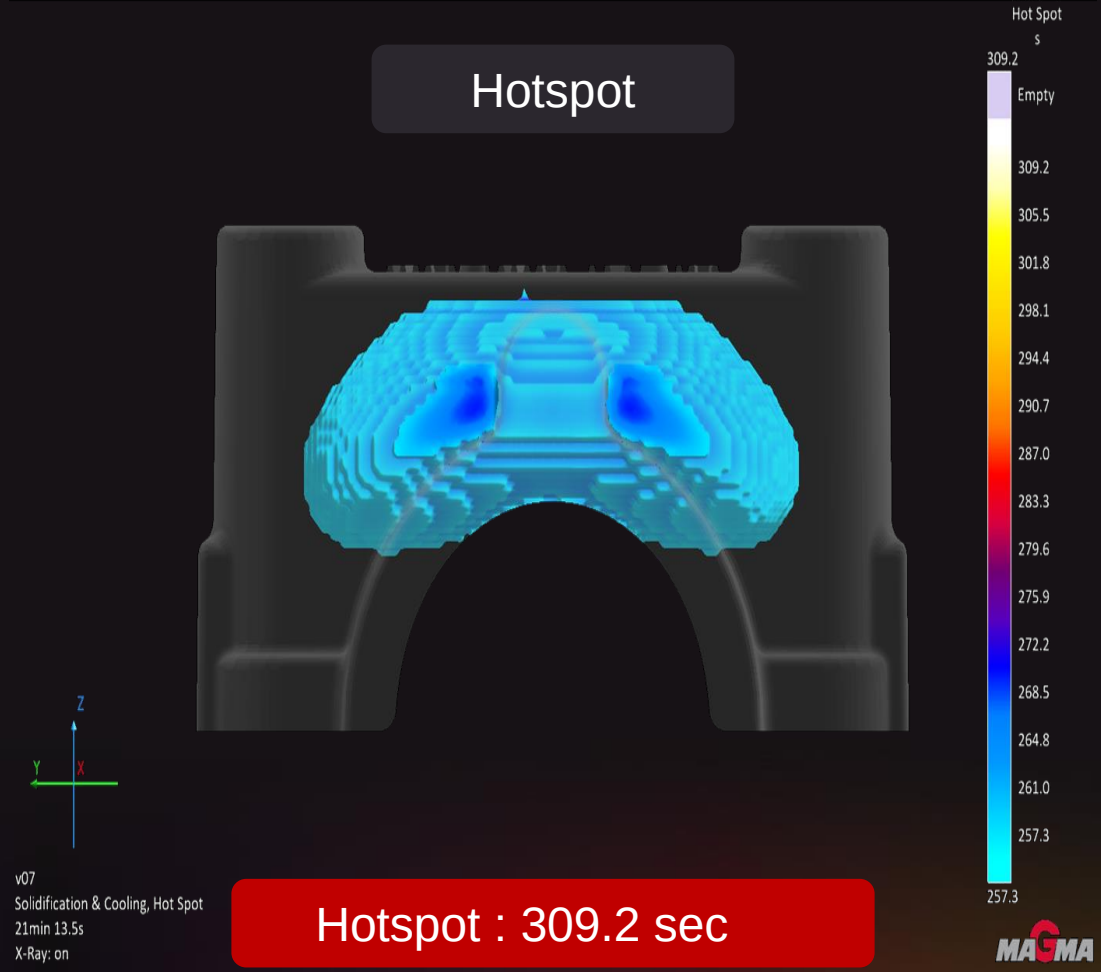
- To find the localized Mc section the portion

STEP-02: To find feedmod from MAGMASOFT® :

Feed Modulus

Mc : 0.79 cm, 0.8 Approx.

Hotspot



Hotspot : 309.2 sec

STEP-03 : Feeder Design Calculation:

- Measured Mc = 8 mm (or) 0.8 cm, Approx.
- Feedmod, M_F = Mc*1.2 to 1.4 for SG iron
- Feedmod, M_F = Mc*1.2 to 0.8 for Grey Iron
- M_F = Mc*1.2 ; 0.8 *1.2 = 0.96 cm, min
- $M_{F\ (cylinder)} = 3*D_F/16$; $M_{F\ (Sphere)} = D_F / 6$, cm
- $V_{F\ (cy)} = 3*\pi*D_F^3/8$; $V_{F\ (Sphere)} = \pi*D_F^3/16$, cm

$D_{F\ (cy)} = M_F*16/3$; 5.2 cm (or) Ø 55 Approx.

$V_{F\ (cy)} = (3*\pi*D_F^3 / 8) / 1000$, mm^3 ; 196 mm^3

$W_{F\ (cy)} = (V_F * L\rho) / 1000$, Kg ; 1.40 Kg, Min

Note : We can use any feeder material (Sand / Exo / HD sleeve) with maintained M_F = 0.96cm, min

STEP-04: Gate Area Calculation (Ac):

- For Iron, Gate Area, Ac = (1036 * Wc) / (Fr * t * $\sqrt{H}$), Here A_G : 170 mm²

- 1036 - Gravity acceleration of liquid metal @1400°C in density 6.9 g/cm³, (Default) / 1036

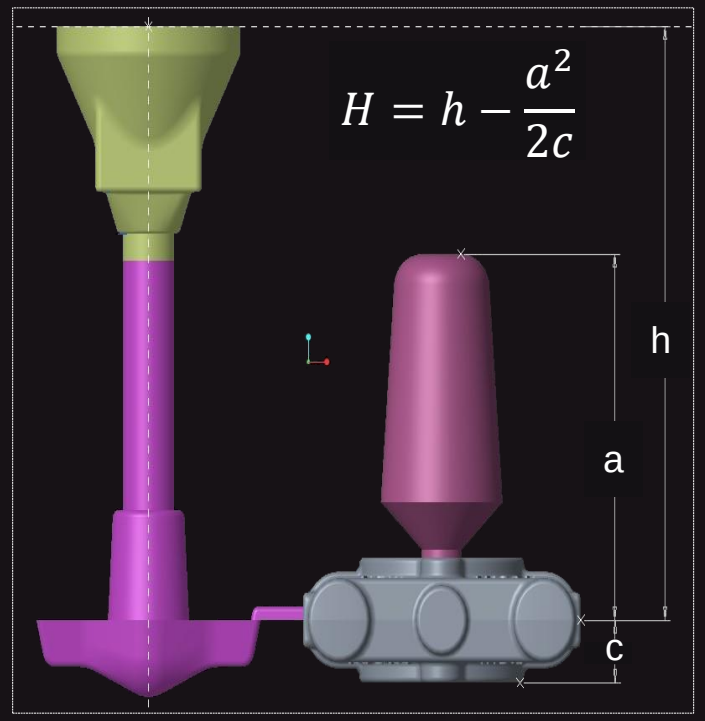
- Wc - Casting weight including feeder, in Kg (≠ Here, Do not apply Bunch wt.,) / 5.20 Kg

- Fr - Friction factor ; Fr = Fluidity (k) / 40 (for Iron) ; k = (14.91*CEL)+(0.05*T°F)-155 / 0.9

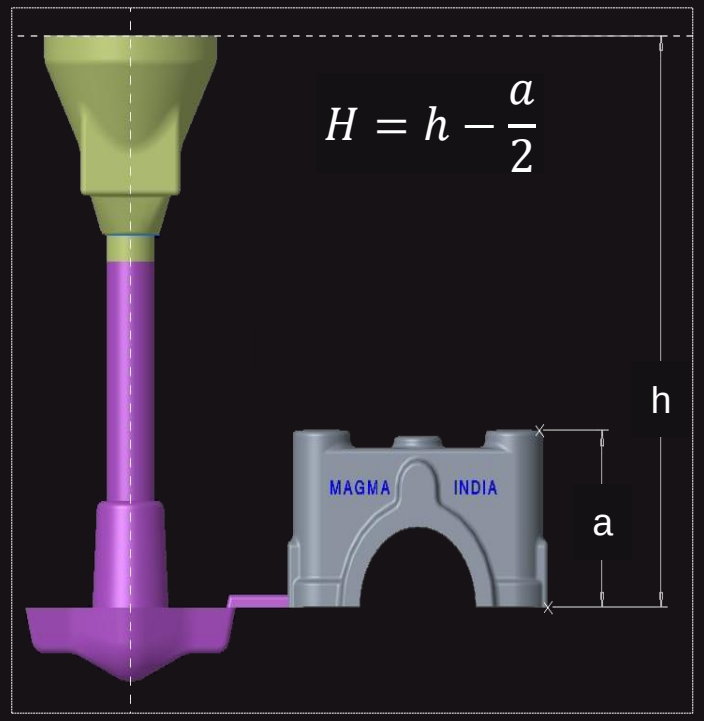
- t - Time to take fill cavity alone, in sec ; t = √ (2.2 * Wc) ; t = √ (2.2 * 5.2) / 3.3 sec

- $\sqrt{H}$ - Ferro static height with respective cavity position into the mold (Cope / Drag / Both)

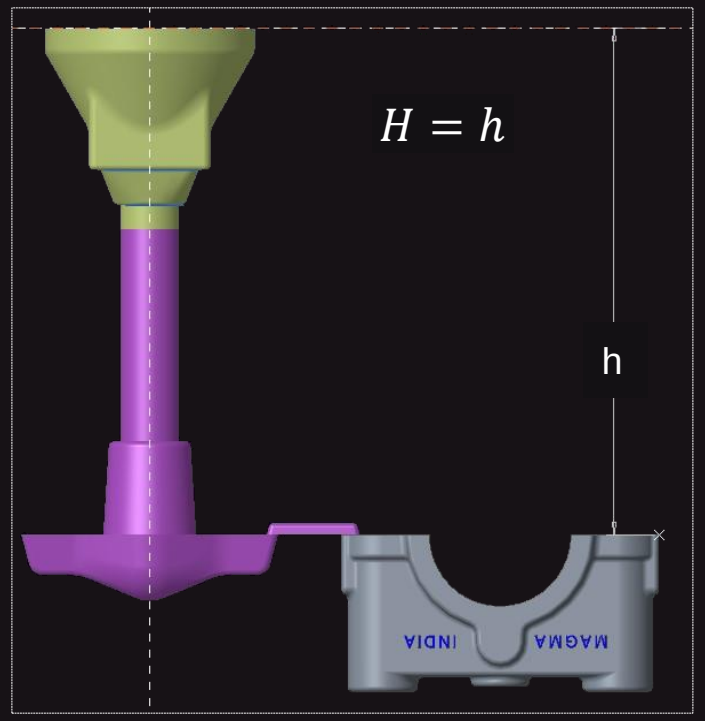
Ferro static Calculation (√H):



Condition : 1



Condition : 2



Condition : 3

¬ $\sqrt{H}$ indicates - Ferro static height with respective feeding type (≠ Top / Bottom / Side Ingate)

STEP-05: Non-Pressurized Gating Design:

Ratio : $A_G = 1 > A_R = A_G * 0.8 > A_s = A_R * 0.8$

Gate area, A_{G1} =170 mm^2 ; ($A_G = A_{G1}*4$) = 340 mm^2

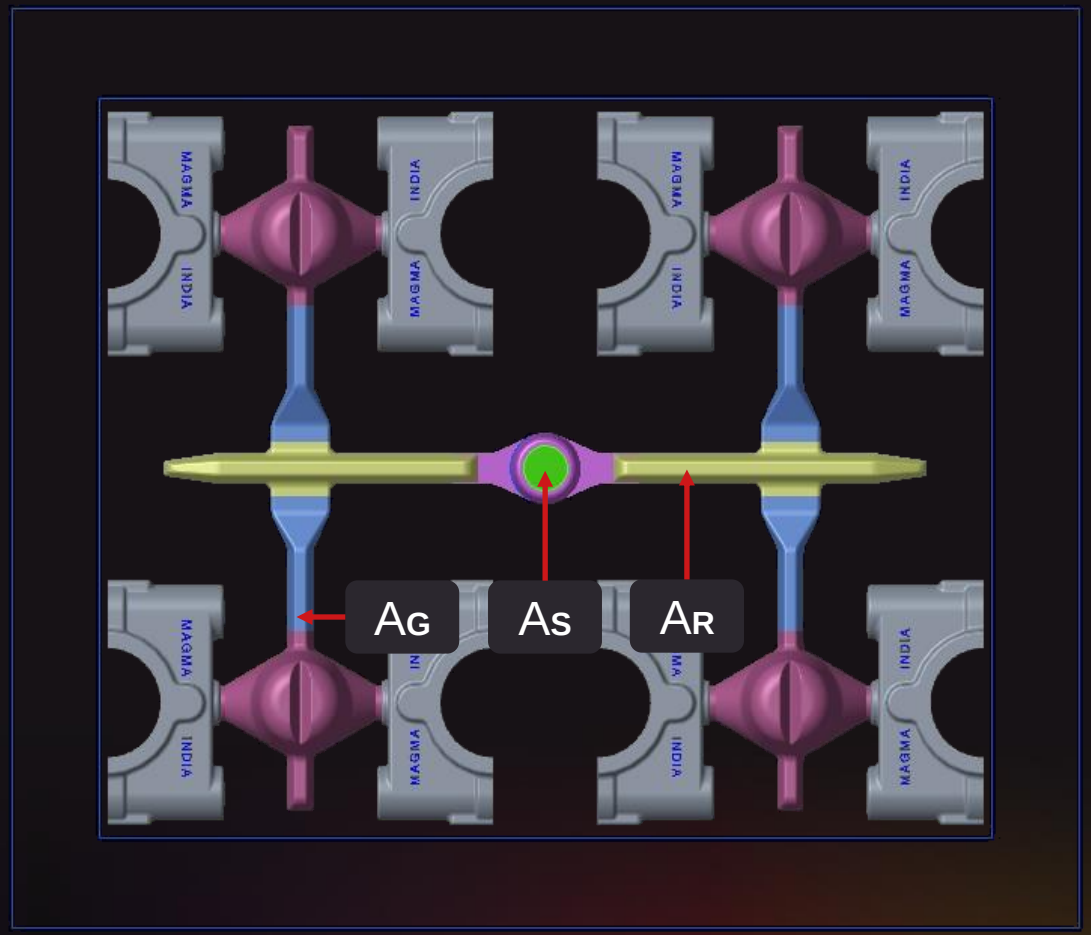
Runner area, $A_{R1} = A_{G1}*0.8$=136 mm^2 ($A_R = A_{R1}*2$)

Down sprue, $A_s = A_R * 0.8$ = 218 mm^2

As = 218 mm^2 ; D = √ 218 / 0.7854 ; Ø 16.7 mm

Est, Bunch wt : 23.8 Kg ; Filling time = 7.2 sec

Standard → Ø20 Ø25 Ø30 Ø40



STEP-06: Pressurized Gating Design:

Ratio : $A_G = 1 < A_R = A_G * 1.2 < A_s = A_R * 1.2$

Gate area, A_{G1} =170 mm^2 ; ($A_G = A_{G1}*4$) = 340 mm^2

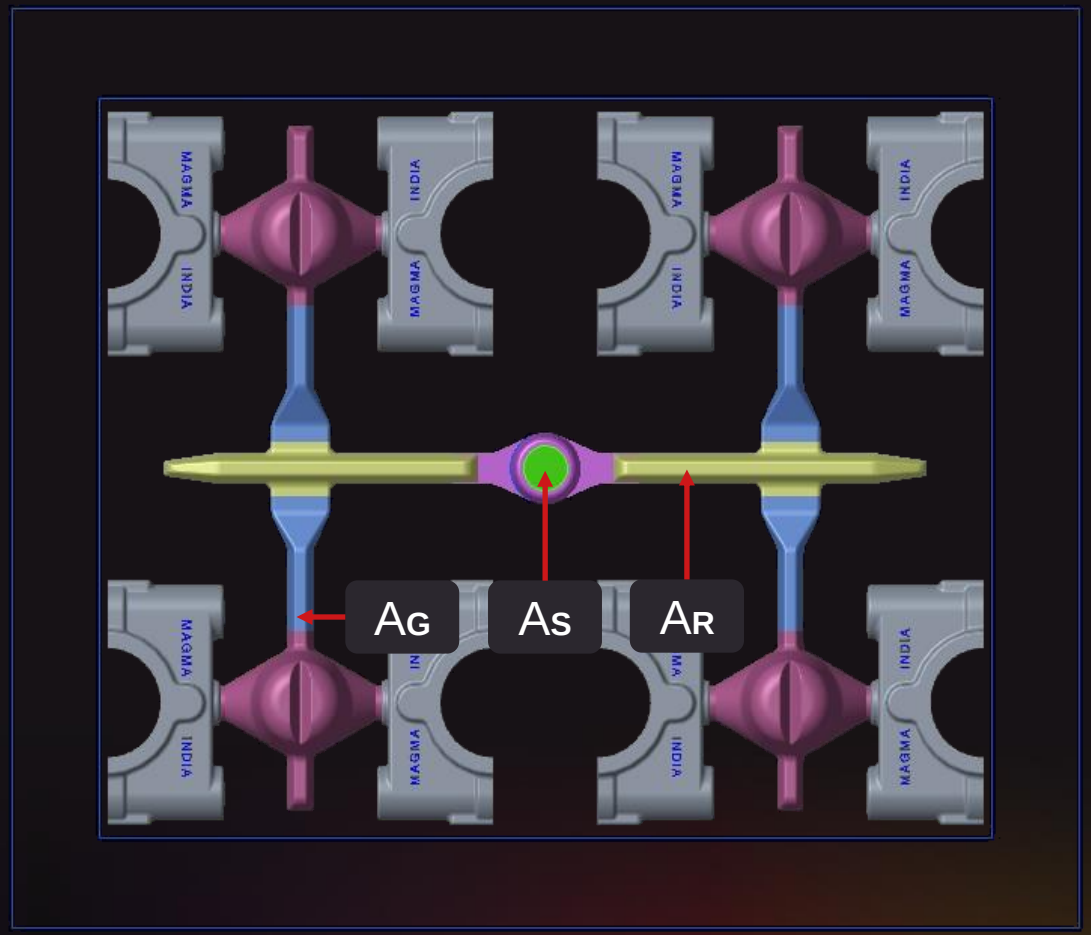
Runner area, $A_{R1} = A_{G1}*1.2$=204 mm^2 ($A_R = A_{R1}*2$)

Down sprue, $A_s = A_R * 1.2$ = 490 mm^2

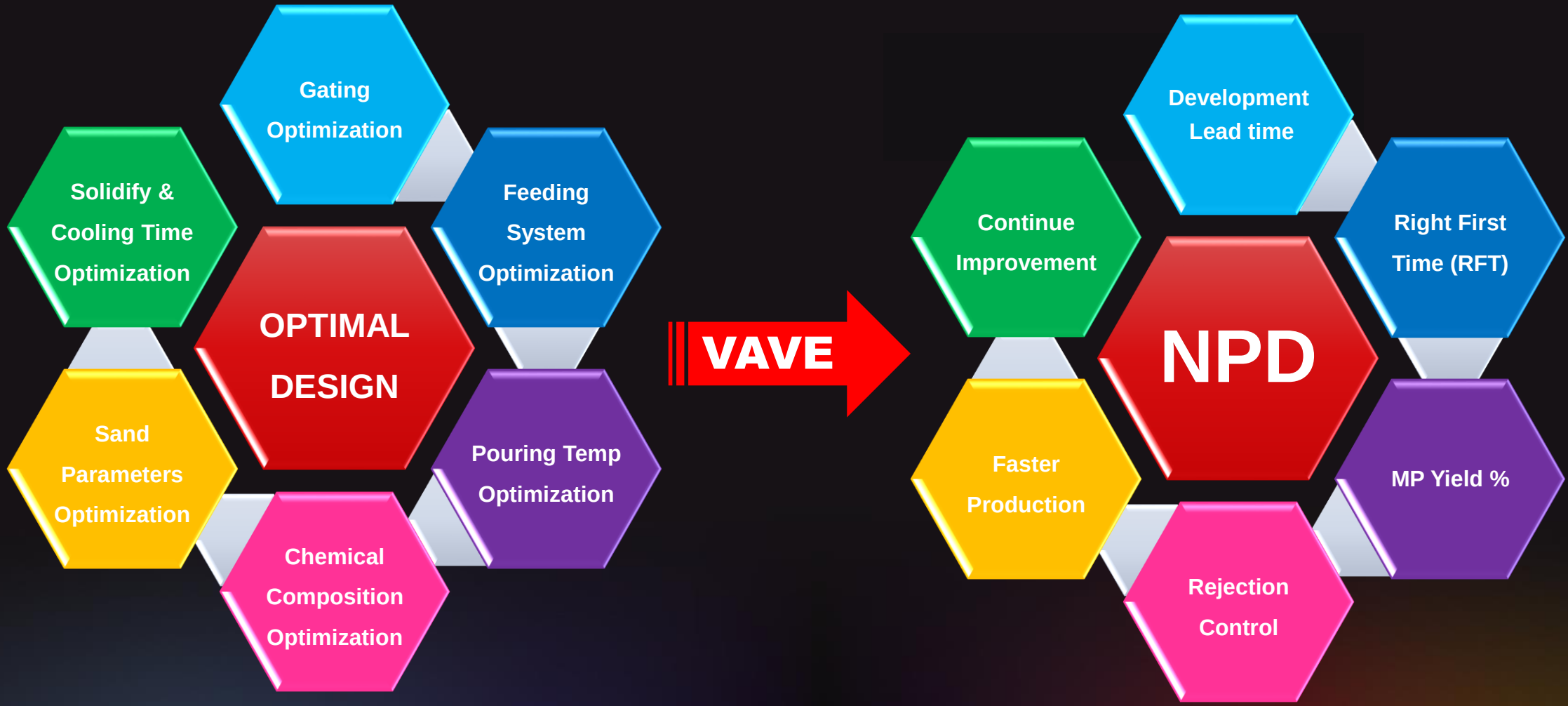
As = 490 mm^2 ; D = √ 490 / 0.7854 ; Ø 24.9 mm

Est, Bunch wt : 23.8 Kg ; Filling time = 7.2 sec

Standard → Ø25 Ø30 Ø35 Ø40



How MAGMASOFT® Leading NPD KRA:



Advantages of MAGMASOFT®

- **MAGMASOFT®** is the comprehensive and effective simulation tool for Improving metal casting quality, optimizing process conditions and Substantially reducing costs in production.
- It software enables the establishment of robust process conditions and optimized casting layouts for all cast materials and process.
- It software is designed to predict total metal casting quality by Simulating mold filling, solidification and cooling.
- It optimizes given iterations & ranks the best ideas based on our object priorities, Like Balance filling b/w cavity / Low gate velocity / Less Temp Drop / Shrinkage / Sand Inclusion / Mold erosion…etc.,
- It shows porosity in specified evaluated area for better understanding of defect intensity.

Thank you

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