Gating and Feeding System Design for Grate Plate and Simulation for Yield Reclamation

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Abstract

Casting is the type of manufacturing process where component is desired geometry is get acquire by either pouring liquid material into mould where flaws are sourced from insufficient mould characteristics or gating system. Casting defects is mainly root age from the ineffective gating system. Casting defects and their emplacement can be anticipated and extinguished by appropriate design of gating system and simulation. It saves both money and time because simulation gives optimal solidification parameter for specific casting component and eliminates any defect way before doing actual casting. Here a case of grate plate is discussed in detail.

Keywords: *Gating system, feeding system, simulation, NRL*

INTRODUCTION

The rise in the productivity is the key parameter of any industries. To compete with the global challenges productivity rise becomes thrust area. Foundries square measure faced by the requirement to supply high-grade casting, however even so to supply them economically. To do this, experimental casting, particularly for individual casting or little runs before production, square measure uneconomical. Quality of casting are often improves the dependableness of casting and reduces the surplus price of defective casting and different resources price and yield. Simulation of casting is completed with employing a worm that consists of set of mathematical equations.
P.D.Chauhan et al. proposed the method & techniques of feeding and gating system design to increase the yield of casting [14].

ABOUT PRODUCT: GRATE PLATE

Grate plate is mostly used in cement plant in conveyer for transporting heavy material in industry. Grate plate can withstand heavier loads.

Product Description

- Product Weight:- 26 kg
- Material:- HRCS Grade-7
- Yield Strength:- 680 N/mm^2
- Density:-7830 kg/m^3
- Hardness :-250-300 BHN

Chemical Composition

- Carbon: 0.30-0.50%
- Nickel: 12.0-14.0%
- Manganese: 1.75% max
- Silicon: 2.0% max
- Mo: 0.5% max
- Chromium: 25.0-27.0%
- S &P: 0.04% each
- Nb: 0.3-0.5%

Fig. 1: Product Defect

Figure-1 shows the crack defect observed during the casting

METHODOLOGY

To eliminate defects and to achieve better yield Naval Research Laboratory (NRL) Method is used.

Calculation for Riser Design:

- Length = 416 mm
- Thickness = 52 mm
- Width = 307 mm
  - Now, Shape Factor = $\frac{L+W}{T}$ [6]
  - $=\frac{416+307}{52}=13.90$
  - Riser Volume, V_r = 0.38× Casting Volume
  - Casting Volume = 4115724 mm^3
  - Riser Volume = 0.38×4115724 = 1563975.12mm^3
- We divided our total riser volume into 3 parts and we put 2 small riser with equal volume and 1 big riser
- So, Big riser volume = 781869.17 mm^3
  - Diameter = 100 mm
  - Height = 76 mm
- 2 small riser volume = 497734.57 mm^3
  - Diameter = 80 mm
  - Height = 76 mm

Comparing with the Existing System

- 5 riser
- 1 big riser Diameter = 63 mm and Height = 70 mm
- 4 Small riser Diameter = 38 mm and Height = 70 mm

Calculation of Gating System:

- **Pouring Time of Molten metal:**

$$\text{Pouring Time} = (2.4335 - 0.3953 \times \log W) \times \sqrt{W} \quad [6]$$

Where, W = Mass of Casting (Not including Riser) = 26 kg

So, Pouring Time = $(2.4335 - 0.3953 \times \log 26) \times \sqrt{26}$= 9.55 sec

- **Effective Height of Sprue:**

Effective height= $h - \frac{p2}{2c}$ [6]

$= 76 - \frac{38^2}{2\times76}$ =66.5 mm

Where,h= height of sprue,

C =height of casting cavity,

P = height of mold cavity in cope

- **Chock Area:**

Chock Area = $\frac{W}{\delta tc\sqrt{2gh}}$ [6]

$=\frac{26}{7850\times9.55\times0.90\times\sqrt{2\times9.81\times0.076}}$ = 315.55 mm^2

Where, W= Weight of Casting,

δ = Density of Metal,

t = Metal Pouring Time,

g = gravity acceleration = 9.81 m/s,

c = efficiency co-efficient for part gating

- **Pouring Basin:**

  Pouring Basin Height = 76 − 66.5=9.5 mm

- **Velocity Calculation:**
  - **Velocity at Top of Sprue:**

    $v_2^2 - v_1^2 = 2gh_1$, Here, $v_1 = 0$

    So, $v_1 = \sqrt{2 \times 9.81 \times 0.00950}$, $V_1 = 0.431$m/s

  - **Velocity at Chock:**

    Same as above equation, $v_2 = \sqrt{2 \times 9.81 \times 0.076}$ = 1.22m/s

  - **According to Volume Flow Rate,**

    $(\text{Volume})_{input} = (\text{Volume})_{output}$ [6]

    $v_1A_1 = v_2A_2$

    We have the values of v_1, v_2 and A_2

    So, $A_1 = \frac{1.22 \times 315.55}{0.431} = 893.20$ mm^2

    Now, Area $A_1 = \frac{\pi}{4} \times d_1^2$, $d_1 = 33.72$ mm

  - **Chock Area** $A_2 = \frac{\pi}{4} \times d_2^2$, $d_2 = 20.04$mm

- **Sprue well Calculation:**
  - Sprue well area = 5 × chock area, = 5 × 315.55 = 1577.75 mm^2
  - So, Sprue area = πr^2 = 1577.75 mm^2, r = 22.41 mm
  - So, D = 44.82 mm
  - Here Sprue base well height = Sprue base well diameter
  - So, H = 44.82 mm

- **Ingate Calculation:**
  - A = πr^2 = 315.55, r = 10.02 mm
  - So, Gate Diameter = 20.04 mm

- **Yield Calculation:**

  $$\text{Yield} = \frac{V_c}{V_c + V_r} = \frac{4115724}{(4115724 + 1563975.12)} = 79.13\ \%$$

- **Comparing with existing data:**
  - Sprue Diameter = 38 mm
  - Sprue Height = 76 mm
  - Gating Width = 15 mm
  - Gating Height = 15 mm

Riser And Gating System

Figure-2 shows grate plate with riser and feeding system as per new calculated design data.

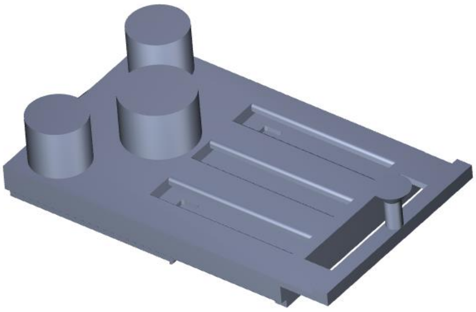

Fig: 2.Product image with new gating and feeding system design

RESULT

- **Temperature Analysis of the Model**

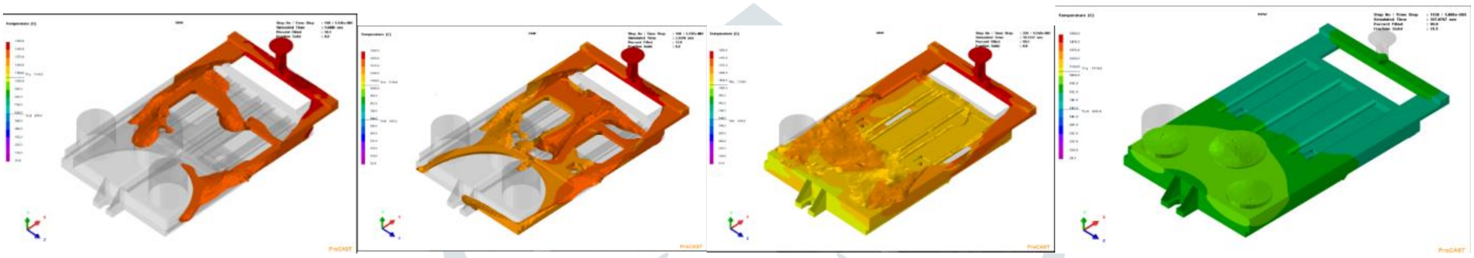

Fig. 3 Temperature Analysis

- **Fraction solid Analysis**

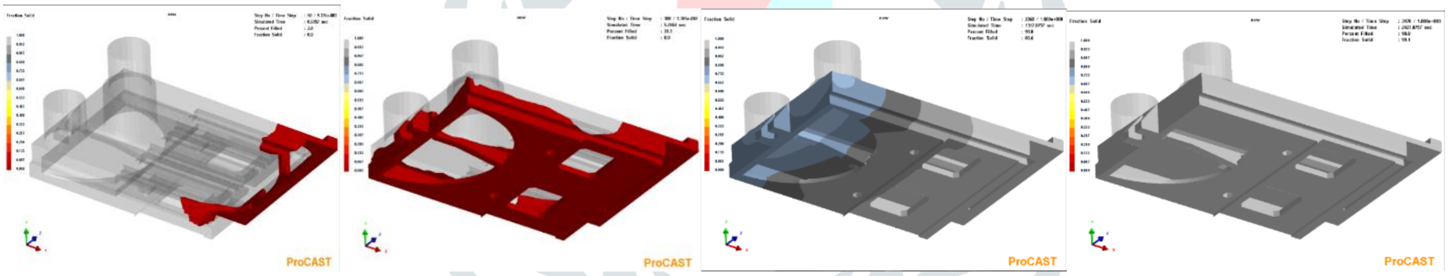

Fig. 4 Fraction Solid Analysis

Figure-3 and Figure-4 shows the Temperature analysis and Fraction solid Analysis of this design. It shows that the new design is defect free and improving the yield by 12 pecentage.

CONCLUSION

Here it is an attempt to make calculation for feeding and gating system design for grate plate. From calculation it is suggested that in this product 3 risers are to be placed, out of which 1 is of large diameter and 2 are of small diameter to achieve following benefits: Comparatively higher Yield, Favorable Temperature Gradient, Suitable for industry's Methodology. Easy removal of Riser can be achieved because of its shape and only 3 risers are used by replacing 5 risers from molding design. In this product we have achieve 79.13% yield, 1470˚C temperature gradient.

COMPARISON TABLE

Existing Data	New Design Data
Gating dimensions: • Sprue = Dia.=38 • Height = 63 mm • Runner= width = 20 mm • Height = 20 mm • Length= 120 mm • Ingate = width = 20 mm • Height = 10 mm	**Gating dimensions:** • Sprue = Dia.= 45 mm • Height = 45 mm • Runner= width = 22 mm • Height = 22 mm • Length= 85 mm • Ingate = width = 22 mm • Height = 22 mm
Riser diameters : • 5 riser • 4 Of equal size • Diameter of Riser = 38 mm Height of riser = 76 mm • 1 Big riser Diameter of Riser = 63 mm Height of riser = 76 mm	**Riser diameters :** • 3 riser • Diameter of Big Riser = 100 mm • Height of the Big Riser = 85 mm • Diameter of 2 small Riser = 80 mm • Height of 2 small Riser = 85 mm

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