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DESIGN OF GATING SYSTEM FOR CONNECTING HINGE BY TRADITIONAL AND SOFTWARE METHOD

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Abstract: ***There is various metal casting parameters which are now know through various experiment which are quantified. These parameters should be controlled to improve quality of casted products. Metal casting involves design, gating and risering system design, mold design, pouring of molten metal each process has its own effects on quality of the casting. The flow of molten metal in mold accounts for almost 60% of the casting defects and due to this fact it is quite obvious that it is important to pay more and adequate attention on preparation of molds in such a way that molten metal will flow easily and fill the mould cavity properly. The molten metal is elastically deformable during short interval of time when deformation causes stresses remain in the molten metal and hence in the cast parts. After solidification these internal stresses remain in the metal. The change in temperature is the common cause of volumetric changes in the molten metal. The paper will focus more on study of gating system design since flow of the molten metal has significant effect due to this system. Design of this gating system reduces number of defects produced in casting. This system results compare in between traditional and software. On the commercial front if we look at prices trend charts of important foundry raw material we observe that there is consistent rise in prices and it is quite obvious that these will go on increasing since we have no control over market circumstances and forces. In this situation only alternative to remain competent and all foundries people to keep max control over all manufacturing processes and hence related parameters so as to ensure the quality in the process itself.***

Keywords—Casting, mold, gating system, inspection, defects.

I. Introduction

Casting is one of the many forming processes and it is one of the cheapest methods of giving finished shape. The liquid metal is directly poured into a shaped mould t get the finished product. All other methods of shaping finished product involved several steps. Thus for getting finished product by mechanical working, we must have first a cast ingot which is given final shape by hot working or cold working. Machining involves chipping away from cast or worked material to get the product shape. The element of a basic and very common gating system are the down spur through which metal enters the runner and from which it in turn pass through the in gating into the mold cavity. That part of the gating system which most restricts or regulates the rate of pouring is the primary chock. Gates and riser are often designed to take advantage of the principle of controlled directional solidification which requires that freezing start fastest from the riser. There are different types of Gates Parting gate, Bottom gate, Branch gate, Horn gate, etc**.**

II. Parameters system design of gating

Mold material, Fluid flow ,Sand, slag dross or other impurities, Rough surface, Entrapped gases ,Excessive oxidized metal ,Localized shrinkage(pipe or macro shrinkage),Dispersed porosity or micro porosity, Incomplete fusion of liquid metal where two streams meet (cold shut), Entrapped globules of pre solidified metal Metal penetration into sand mold and/or core.

III. Methods and illustration of numerical calculation for gating and system

These numerical calculation methods are based on fluid mechanics and thermodynamics principles following examples will give us clear idea about mathematical relations and calculations methods for the connect hinge.

A. Casting Data

Casting weight – 5.5 kg, Thickness – 6 mm , Height of casting – 180 mm ,Gross Weight – (5.5 × 4) + (R.R.Wt) = 28.6

B. Metal Data

Pouring temp – 14300C, Liquids temp – 13500C, Chemical Composition (SG Iron 600/10) - as below

C – (3.4 to 3.8) Si – (2.10 to 2.60) Mn – (0.3 max) S – (0.02 to 0.04) P – (0.03 to 0.06) Mg – (0.028 min)
Cu – (0.6 to 0.7), Density of liquid metal – (7000 kg/cm3) (C.I.) – (7.00 gm/cm3)

C. Data of mould

Height of metal in pouring basin – N.A**,** Height sprue (sleeve) – 125 mm , Height of casting in cope – 45 mm

D. Data of gating system

Gating system with filler Sprue: Runner: In gate 1.0: 1.1: 1.2
Gating system with filler Sprue: Runner: In gate 1.5: 3.0: 1

Calculations

1. Calculate the carbon fluidity (factor) equivalent.

CFE = C% + %Si/4 + %P/2, CFE = 3.4 + 2.50/4 + 0.013/2, CFE = 3.4 + 0.625 + 6.5×10-3, CFE = 4.0315

2. Calculate fluidity – P.T. = (Pouring temp.)

F = 14.9× (CFE) + 0.09 (P.T.) – 153.4, F = 14.9× (4.0) + (0.09) (1380) – 153.4, F = 30.4

3. Fluidity factor

K = F/40, K = 30.4/40, K = 0.76

4. Calculate pouring time

T = 1.483 (K) (0.95+0.046t) n√W
Where,
K = Fluidity factor
t = Thickness of casting
W = Gross wt.
N = 2 (For wt. up to 450 kg)
T = 1.483 (K) (0.95+0.046t) n√W
=1.483 (0.76) [(0.95 + 0.046 × 6)] 2√28.6
= 7.38 sec
= 8.00 sec =9.00 sec. (Standard pouring time)
If we considered pouring temp 13500C then pouring time would be 12 sec. i.e. for lower temperature of metal pouring time increases.

5. Calculate effective sprue height (H) or Static (Hst):

Schematic sketch
h=a P.L.
Here, a = Height of casting in cope, c = Total height of casting, h = Height of sprue above parting line (P.L.)
Effective sprue height:-

General formula H = 2hc – ca2 / 2c
Here, a = 45mm, c = 180 mm, h = 150 mm
Case 1: For top gating Hst = Hsp
Case 2 : For bottom gating Hst = Hsp – c/2
Case 3 : For P/L gating Hst = Hsp – p2/2c
For this casting we have consider case 1
i.e. Hst = Hsp Hst = 150 mm

6. Choke area calculation:
Choke area Q = A×V
V/t = AC √2gH
A = W/ ℓct √2gH
Where, A = Choke area (m2), W = Gross wt. (kg), C = Friction factor (0.6 – 0.8), ℓ = Density of fluid (kg/m3)
g = Gravitational acceleration (m/s2), t = Pouring time (sec), H = Effective spure height (mtr.)
A = 28.6 / (7000)(0.6)(8) ×√2(9.81)(0.15)
= 4.9617× 10-4m2
= 4.9617 × 10-2 mm2
= 496.17 mm2
= 500 mm2

7. For pressurized gating system
As: Ar: Ag= 1: 2: 1
Where As = Area of spure, Ar = Area of Runner, Ag = Area of in gate
Here, As =
As = 4×A = 4×500 = 2000 mm2
Ar =2.0 As =2.0 ×2000 = 4000 mm2
Ag = 1.0 As = 1.0 × 2000 = 2000 mm2
Now we calculate actual dimensions from above area as –

- **Dimensions of sprue** :160 mm , ɸ 51

Diameter of sprue "D"
Area of sprue= π/4 × Ds2
DS2= 2000×4/ π
Ds = √2000 × 4/ π = 50.46 = 51 mm
Height of sprue = h
Area of sprue = Ds × hs
2000 = 51 × hs
hs = 40 mmhs = 4 × 40 = 160 mm

- **Dimensions of Runner plate 56 , ɸ72**

Diameter of Runner plate
Area of Runner plate = π/4×Dr2
Dr2= 4000×4/π
Dr = √4000 × 4/ π = 71.36 mm = 72 mm
Height of Runner plate = hr
Area of Runner plate = Dr × hr
4000 = 72 × hr
hr= 55.55 mm
hr= 56 mm

- **Dimensions of In gate**

Ag = 2000 mm^2 for one in gate area = Ag/4
Ag = 2000/4, Ag = 500 mm2
Width of in gate
Area of in gate = bg × hg
Suppose hg = 20 mm
Area of in gate = bg × hg
500 = bg × 20

bg= 500/20 = 25 mm

V. Inspection, Testing and Results

Visual inspection provides a means of detecting and examining a variety of surface flaws, such as corrosion, contamination, surface finish, and surface discontinuities on joints. By doing the inspection following defects are occurs-

Shrinkage Defects, Cold Defects, Blow Hole, Mismatch Defect,

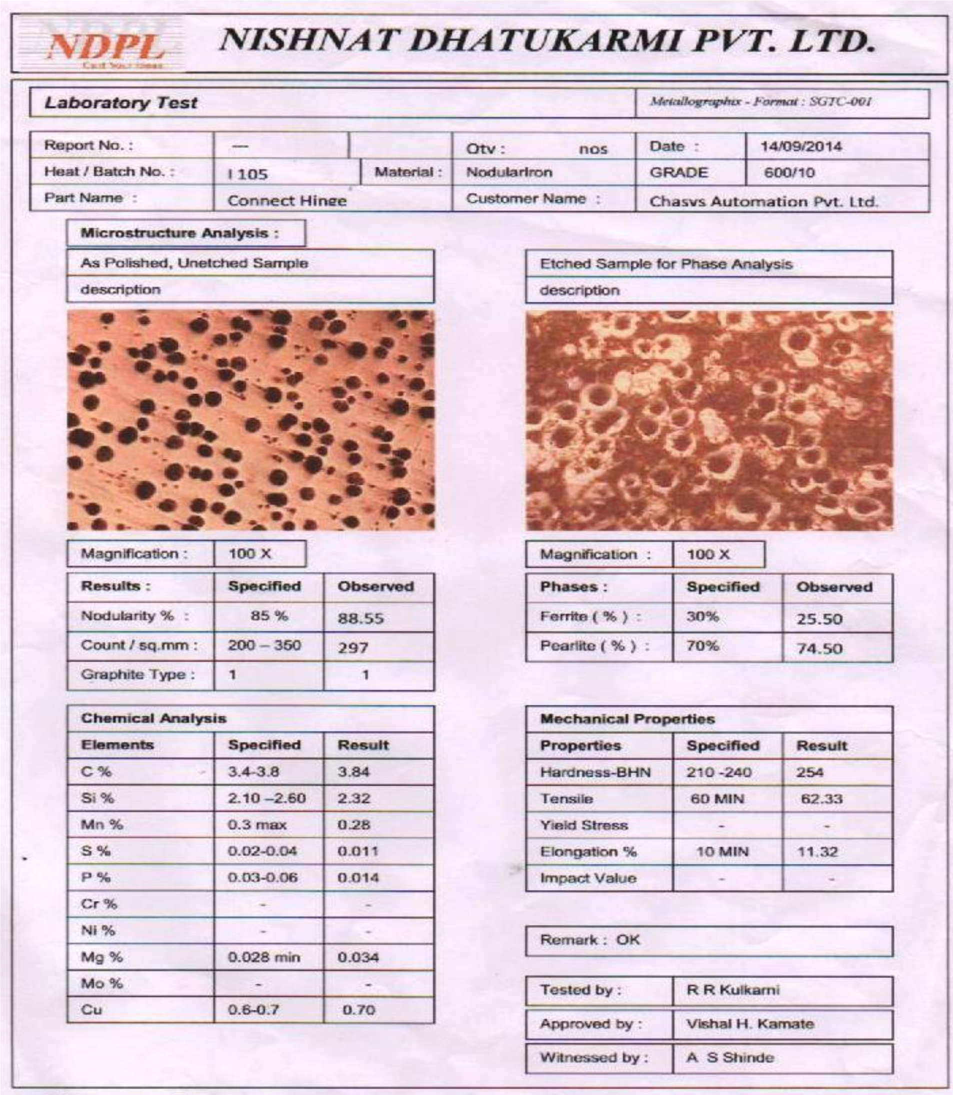
Fig.1 Shrinkage Defects in casting

Fig.2 Blowhole Defect

VI. Casting without defects

Fig.5 casting without defects

VII. Testing Result



NDPL — **NISHNAT DHATUKARMI PVT. LTD.**

Laboratory Test — *Metallographic - Format : SGTC-001*

Report No. :	—	Qty : nos		Date :	14/09/2014
Heat / Batch No. :	I 105	Material :	NodularIron	GRADE	600/10
Part Name :	Connect Hinge	Customer Name :		Chasvs Automation Pvt. Ltd.	

Microstructure Analysis :

As Polished, Unetched Sample — description

Etched Sample for Phase Analysis — description

Magnification :	100 X

Results :	Specified	Observed
Nodularity % :	85 %	88.55
Count / sq.mm :	200 – 350	297
Graphite Type :	1	1

Magnification :	100 X

Phases :	Specified	Observed
Ferrite (%) :	30%	25.50
Pearlite (%) :	70%	74.50

Chemical Analysis

Elements	Specified	Result
C %	3.4-3.8	3.84
Si %	2.10 –2.60	2.32
Mn %	0.3 max	0.28
S %	0.02-0.04	0.011
P %	0.03-0.06	0.014
Cr %	-	-
Ni %	-	-
Mg %	0.028 min	0.034
Mo %	-	-
Cu	0.6-0.7	0.70

Mechanical Properties

Properties	Specified	Result
Hardness-BHN	210 -240	254
Tensile	60 MIN	62.33
Yield Stress	-	-
Elongation %	10 MIN	11.32
Impact Value	-	-

Remark : OK

Tested by :	R R Kulkarni
Approved by :	Vishal H. Kamate
Witnessed by :	A S Shinde

VIII. Casting Simulation for Connect Hinge by use of Auto-cast

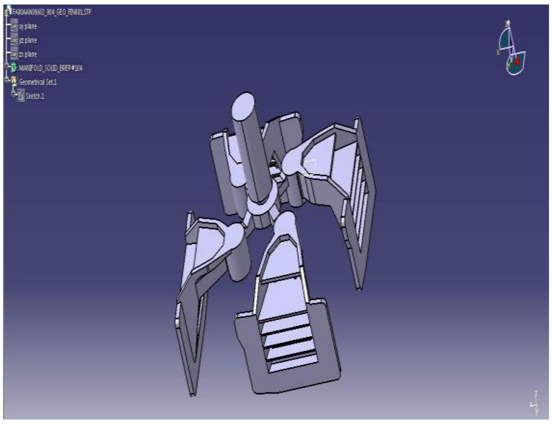


Fig.6 Model of connect hinge

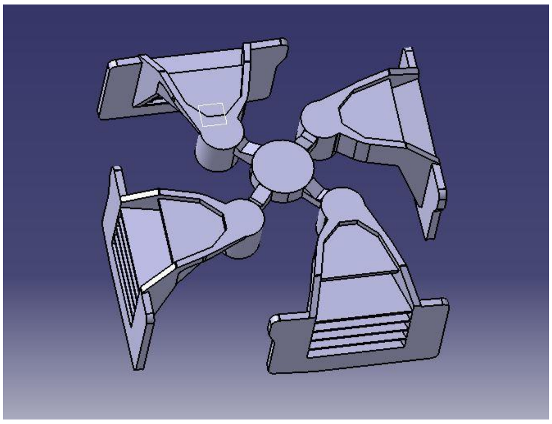


Fig.7 Modified design

IX. Casting Simulation for Connect Hinge

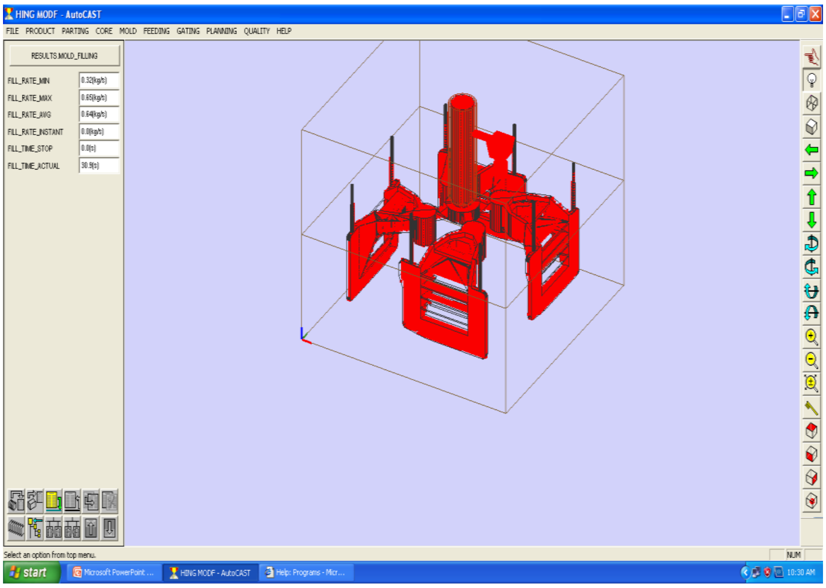


Fig.8 Feeding cooling at top section of thick part

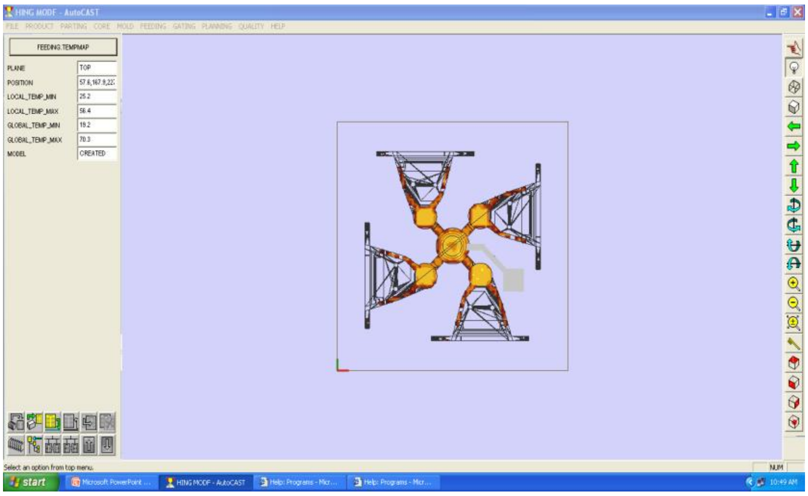


Fig.9 Feeding cooling at a lower section

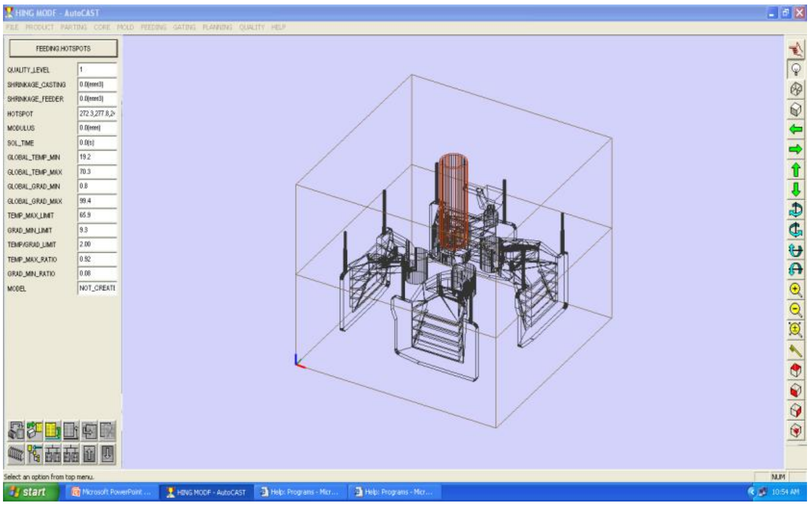


Fig.10 Feeding Cooling does not show any hot spots

X. Comparison between the Traditional and Software method of gating system design

Sr. No	Point	Traditional Method	Software Method
1.	Time Required to design	This method required 15 to 18 days for completed gating system design with required output product.	This method required very less time than the Traditional Method. It required only maximum 4 to 5 days.
2.	Percentage of yield	By the Traditional Method we get the 70% yield.	By the Software Method we get the 70% yield.
3.	Cost of product	In this cost of product increase.	In this cost of product decrease.
4.	Result of product	In this method we get the result after casting done.	In this method we get the result before casting done.
5.	Rejections	In this we have rejected 8 products.	No rejections because we can check the directly hot spot in software. So no any defects in casting.

Conclusion

Gating system plays extremely important role in metal filling of mould. The design and development of this system is therefore part and partial of the good quality of the casting. Every time rules may not lead to good quality of the casting and also can in uneconomic production of casting resulting in to, Lower yield, Higher casting rejection at various stages which mainly includes Hot spots , In gate shrinkage , Porosity ,Sand wash. To avoid such defects it is very much essential that every foundry should have well defined and documented system for design development of gating system. Chock area should be designed by calculation method not by thumb rule which will avoid turbulence and streamlined metal supply to mould will come into existence, it also helps to avoid slag entry in the mold. Use of casting simulation was found to help optimize the gating system dimensions leading to better yield. Further, from simulation it could be revealed that the use of exothermic sleeves could help eliminating the hot spots and hence shrinkage defect.

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