International Journal on Emerging Technologies **3**(2): 84-89(2012)
ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

Automated Determination of Gating System Parameters for a Die-Casting Die

Chandan Deep Singh
Department of Mechanical Engineering,
University College of Engineering, Punjabi University, Patiala, (PB) India

(Received 15 October, 2012 Accepted 01December, 2012)

ABSTRACT: The term *automated determination of Gating System Parameters* from CAD file of the part means that various dimensions of the gating system are determined with the aid of computer and very less interaction with the user. Design of gating system takes a great deal of time of the die-casting expert since it requires lot of manual input and a number of iterations to finalize the design. This requires a good knowledge of die-casting process, making this activity completely dependent on the user. For the automatic determination; we require some inputs to achieve the required output. Proposed system takes CAD file of the die-casting part as input and uses die-casting process knowledge to determine different parameters for the gating system.

Keywords: die-casting, die design, CAD file, gating system, gating system parameters.

I. INTRODUCTION

This paper shows the step by step process of determination of gating system parameters from user interface for the calculation of gating system parameters for a die-casting die. In this, various parameters like length, gate land, runner diameter, overflow height, length, width, etc. have been calculated [15] with the help of a Guided user interface prepared in Matlab.

Importing Data

The importing data window prompts the user to input the value of cavity volume (V_c), cavity area (A_c) and mass. User selects the file and the file is stored by the system. The stored files having data for V_c, A_c, and mass are read by the system. Fig. 1 system GUI for importing data.

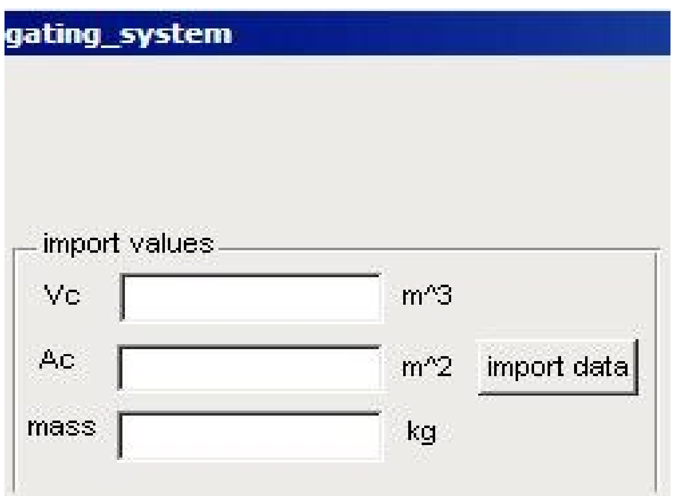

Fig. 1. System GUI for import data.

II. MATERIAL AND METHODS

Machine selection

Based on the values of the part CAD file imported in earlier step, machine selection takes place and along with the machine its maximum pressure [16, 24, 25] is selected. Fig. 2 shows the system for GUI for machine selection.

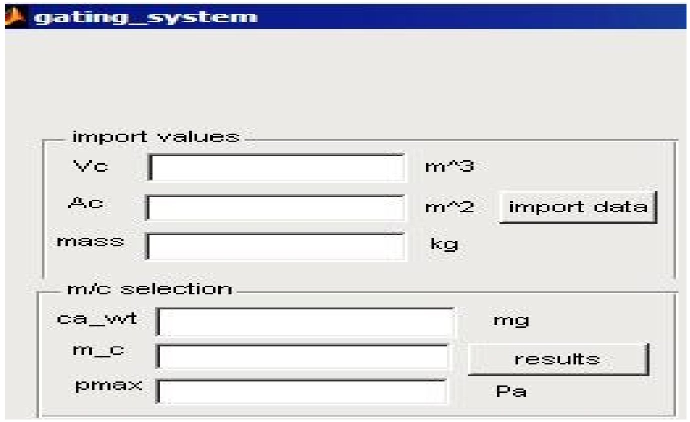

Fig. 2. System GUI for machine selection.

Material selection, values and inputs

Material is selected by the user based on the application and use as for clutch (in bikes and scooters) the material is aluminium while it is zinc in case of taps. Fig. 3 shows system GUI for material selection. After the material has been selected, user has to input some values like the length, wall thickness, gate velocity and gate thickness. The length is of the CAD part which is the longest section of it [15], since gate length will be equal to this as gate will be attached along CAD part's length. Gate velocity and gate thickness are to be entered because there's a range for them according to the choice of material [25, 26]. Fig. 4 and 5 shows the dialog boxes for the inputs.

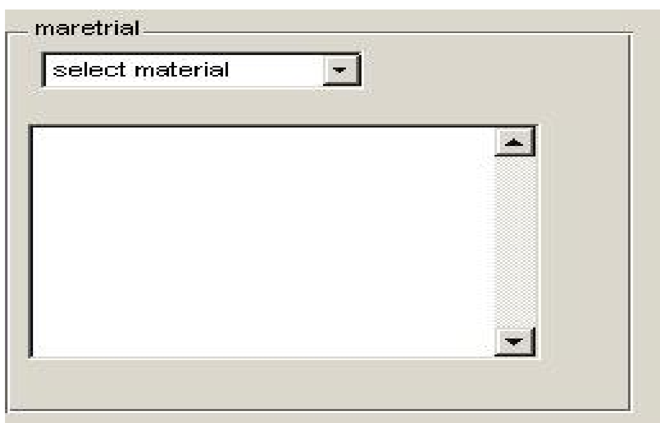

Fig. 3. System GUI for material selection.

Fig. 4. System GUI for inputs.

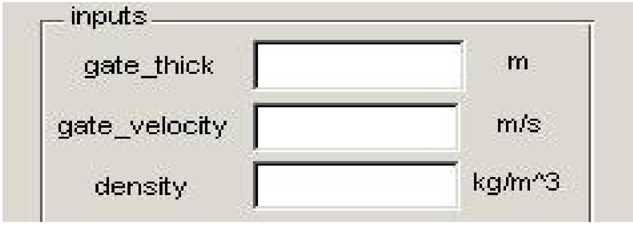

Fig. 5. System GUI for material values.

III. EXPERIMENTAL

Process Parameters

Gate area is calculated by the values of gate width and gate depth entered in earlier steps and from gate area, flow rate is determined. Based on flow rate, gate area, density and discharge coefficient, working pressure is calculated [2, 3, 15]. This pressure is then compared with the maximum machine pressure. If p1 <= to pmax then the process is on right track else re-enter gate velocity and gate depth. Fig. 6 shows system GUI for process parameters. Fig. 7 shows the system GUI for error which appears when check shows 0 *i.e.* when p1>pmax.

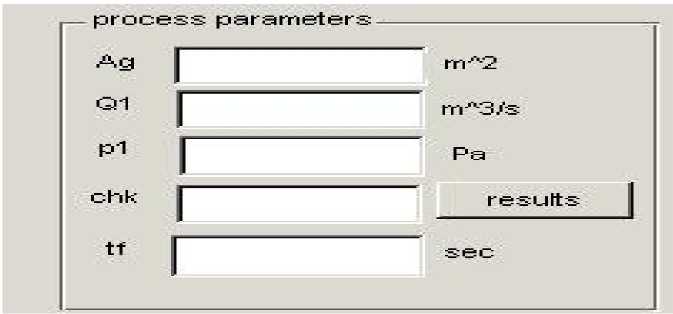

Fig. 6. System GUI for process parameters.

Fig. 7. System GUI for error.

Gate parameters

Once the process parameters are finalized, calculation of gating system parameters takes place. For calculation of gate parameters ratio, r_1 is required, which is nothing but ratio of width on cavity side to depth on cavity side. Fig. 8 shows its system GUI. The Fig. 9 shows the dialog box for length of gate, also called Gate land, which is entered through a file since its maximum value is limited to 0.00254m [15].

After entering the required values, gate parameters on cavity side are to be calculated which are dependent on the ratio of width to depth on cavity side and gate area on runner side [3, 4, 15]. Since, here gate of constant cross sectional area is considered. Fig. 10 shows the dialog box for remaining gate parameters.

Fig. 8. System GUI for r_1 input.

Fig. 9. System GUI for gate land.

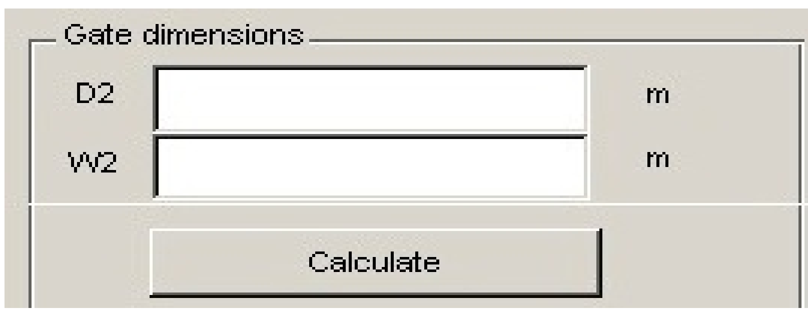

Fig. 10. System GUI for gate parameters.

Runner Parameters

Runner length is another parameter. The value of which is stored in the file. Fig. 11 shows the runner length dialog box. Runner parameters like runner area, runner diameter are calculated. Area of runner is calculated based on the empirical relation between gate area and runner area. Then, based on the calculated runner area, runner diameter is calculated [15]. Fig. 12 shows system GUI.

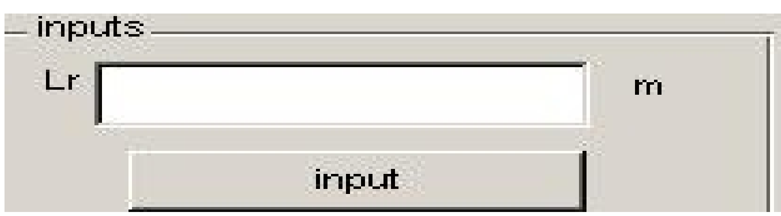

Fig. 11. System GUI for runner length.

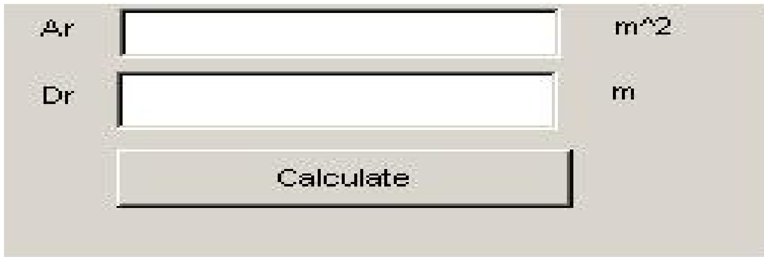

Fig. 12. System GUI for runner calculations.

Overflow Parameters

This section shows the snapshots from user interface for the calculation of gating system parameters for a die-casting die. Thus based on choice of material, the overflow length is selected. Fig. 13 shows the overflow length and 14 overflow height dialog box. [15]. At last, the overflow parameters like area of overflow, volume of overflow, width and height are calculated as shown in a dialog box in Fig. 15.

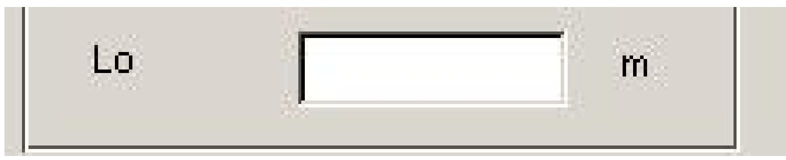

Fig. 13. System GUI for overflow length.

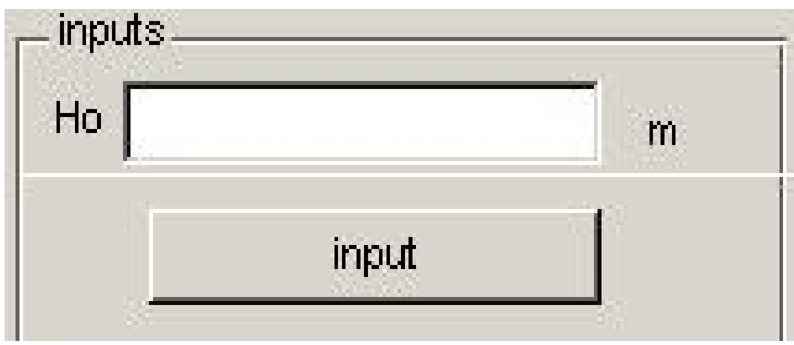

Fig. 14. System GUI for overflow height.

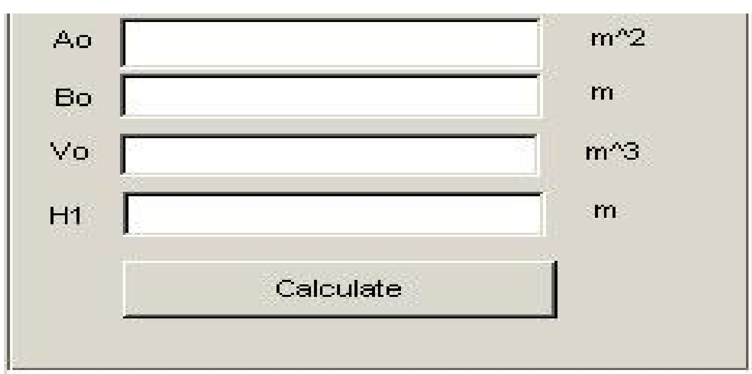

Fig. 15. System GUI for overflow calculations.

IV. CONCLUSION

Proposed system is capable of generating parameters of gating system from CAD model of the part. It also uses die-casting machine database and process knowledge. Proposed system uses die-casting principles to determine gating system parameters The system would go a long way in bridging the gap between designing and manufacturing of die-casting. The future scope for this work is appended below.

- Gate location and placement is another area that could be explored
- System could be modified to incorporate parts with complex geometrical features
- Data base for machine, material and process could be enhanced.

REFERENCES

[1]. Choi, J.C., Kwon, T.H., Park, J.H., Kim, J.H., and Kim, C.H., (2002), "A study on development of a die design system for die-casting", *Int. J Adv.Manuf.Technol* **20**: 1-8.

[2]. Lee, K.S., Fuh, J.Y.H., and Wu, S.H., (2002), "Development of semi-automated die-casting die design system", *Proc. Instn. Mech. Engrs* Vol. **216**, Part B: *J Engineering Manufacture*, 1557-1588.

[3]. Lee, K.S., and Lin, J.C., (2006), "Design of runner and gating system parameters for a multi-cavity injection mold using FEM and neural network", *Int. J Adv.Manuf.Technol* **27**: 1089-1096.

[4]. Lee K.S., Wu, S.H., Fuh, and J.Y.H., (2007), "Semi-automated parametric design of gating systems for die-casting die", *Computers and Industrial Engineering* **53**(2): 222-232.

[5]. Lee, K.S., and Woon, Y.K., (2004), "Development of a die design for die-casting", *Int. J Adv.Manuf.Technol* **23**: 399-411.

[6]. Lee K.S., Wu, S.H., Fuh, and J.Y.H., (2002),"Feature based parametric design of gating system for die casting die", *Journal of Advanced Manufacturing technology* (2002), **19**: 821-829.

[7]. Lin, J.C., (2002), "Selection of the optimal gate location for a die-casting die witha freeform surface", *Int. J Adv.Manuf.Technol* **19**: 278-284.

[8]. Lin., and Tai., (1996) , "A runner optimization study of a Die Casting Die", Jo*urnal of Materials Processing Technology* **84** (1998) 1–12.

[9]. Madan, J., Rao, P.V.M., and Kundra, T.K., (2007), "Die-casting feature recognition for automated parting direction and parting line determination", *J. Comput. Inf.Sci. Eng.* Volume **7**(3): 236-248.

[10]. Rad, M.T., (2006) "An approach towards fully integration of CAD and CAM technologies", *Journal of achievements in materials and manufacturing engineering*, Volume **18**(1-2): 31-36.

[11]. Reddy, A.P., Pande S.S., and Ravi B.,(1994), "Computer aided Design of Die Casting Dies", *IIF transactions* (94-19)239-245.

[12]. Sulaiman, S., and Keen T.C., (1997),"Flow analysis along the runner and gating system of a casting process", *Journal of material processing technology* **63**: 690-695.

[13]. Wong Yoon Khai (2003),"Development of Windows based computer die design system for die casting dies".

[14]. Zahi, M., Lam, Y.C., and Au, C.K., (2009), "Runner sizing in multiple cavity injection mold by non-dominated sorting genetic algorithm", *Engineering with Computers* **25**: 237-245.

[15]. Bill Anderson, "Die Casting Engineering: a hydraulic, thermal and mechanical process", Marcel Dekker (2005).

[16]. Geoffrey Boothroyd, Peter Dewhurst, Winston Knight, "Product Design for Manufacture and Assembly" ,CRC Press (2004).

[17]. Frank E.Goodwin, "Handbook of Metallurgical Process Design",CRC Press (2004).

[18]. Jay Shoemaker, "Moldflow Design Guide", Hanser Publishers, Munich (2006).

[19]. John P. Beaumont, "Runner and Gating Design Handbook", Hanser Publishers, Munich (2007).

[20]. Pye, R.G.W., "Injection Mould Design", Affiliated East-West press Pvt Ltd, New Delhi (2000).

[21]. Richard A. Flinn, "Fundamentals of Metal Casting", Addison-Wesley Publishing Company, Inc. (1962).

[22]. "Automatic Computerised optimization in die casting", Casting Plant & Technology 4/2008.

[23].http://www.brockmetal.co.uk/papers/14_runner_design_guide_lines_issue_5.php(Accessed on September 20, 2010).

[24]. http://www.chinyen-engineering.com/english/product-hot-standard.html (Accessed on September 25, 2010).

[25]. http://www.die-casting.org/faq/ (Accessed on October 7, 2010).

[26]. http://www.themetalcasting.com/casting-parting-line.html (Accessed on October 25, 2010).