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Design and Analysis of Coke Oven Flash Plate Casting Using CAD

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ABSTRACT: *The flash plate system design plays an important role in the quality and cost of a metal casting. Due to the lack of fixed theoretical procedures to follow, the design process is carried out on a trial-and-error basis. In this study, a flash plate was modelled and analysed by using computational techniques to overcome such (mention warpage) complexities. The proposed optimization framework applied to the gating and riser system of a sand casting gave good results and provided more flexibility in decision making (this statement can be used if result with different ribs can be obtained). The objective of the research presented in this thesis is to optimize gating/riser systems based on CAD and simulation technology with the goal of improving casting quality such as reducing incomplete filling area, decreasing large porosity and increasing yield. Therefore in the thesis, an optimization framework is presented based on CAD and simulation technology. Given a CAD model of part design and after converted to a casting model, it is the first step to evaluate castability of the casting design. Then the runner and risers are represented parametrically, and CAD models generated by varying parameters can be used in the simulation. After analyzing simulation results, the gating/riser system design is optimized to improve casting quality. In the thesis, one engine block is used to verify the effectiveness of the optimization method. Compared with the initial design, it is found that the optimized casting design can decrease porosity around 18% while the yield increases 16%.*

I. INTRODUCTION

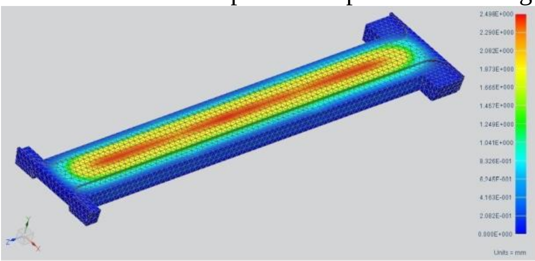
Flash plate is designed for brickwork reinforcement and for coke oven batteries head part protection from mechanical damages. It is a foundation for coke oven frames installation. In casting process determination of casting mechanical properties, thermal stresses and distortion is essential. Modelling and analysis accurately describes a cast component's quality before production starts. Thermal behaviour should be known before casting process to prevent the breakdown. So there is a need to prevent warpage of the casting by improving the existing casting design

In conventional casting process, bending of flash plate occurs due to induced thermal stresses. This may cause the breakdown during the operation of coke oven. Thus it is require to study the thermal behaviour of flash plate. The proper casting method can be done that will prevent the bending of flash plate casting and quality improvement using available CAD software tequniques. Jean et al. (2011) developed Multi-Objective Evolutionary Algorithm (MOEA) design evaluation. The design process is carried out on a trial-and-error basis. A population size of 20 was found to be most efficient for finding the optimal solutions. Regardless of the infeasible initial population, optimal gating and riser system designs were successfully obtained even with the absence of analytical information.

Kuldeepak (2012) simulated gating system parameters for cast iron metal casting by using taguchi's design technique Mould filling and solidification processes of the cast iron casting were simulated with the PROCAST 2009.1. The simulation results indicated that gating system parameters significantly affect the quality of the cast iron casting. S. Guleyupoglu () presented rigging system design rules for light alloy, steel and cast iron castings. it was observed that the geometric features of the casting, such as casting boundaries, location of cores, thick regions and flow paths, are of primary importance for the design of the appropriate gating system. It was concluded that major emphasis to the task of geometric feature extraction to develop a computer program for design of rigging systems.

Yoo et al. (2007) applied numerical simulation technology for optimizing the casting design and conditions in large cast iron castings for marine engine. The amount and positions of chills were optimized to increase the mechanical properties and to minimize the shrinkage and micro porosity in the castings. Non-Destructive testing such as Ultrasonic testing, penetration testing and mechanical property testing were carried out for the parts with the modified casting conditions. It was shown that no defects in the castings were found and the productivity could be distinctly increased. It was also observed that less chill blocks especially without indirect chill blocks in the core the cooling effect was effectively improved through the optimization. CARLOS et al. (2001) carried out a survey to summarize and organize the information on new evolutionary-based current approaches, emphasizing the importance of analyzing the operations research techniques. Advantages and disadvantages, and possible range of applicability of various optimization methods are studied. Future trends and possible paths for further research are also described.

Modelling (Diagram and discription)
The length of flash plate is 4959 mm and the width of the plate is 693 mm. Between the lengths there are two ribs are provided one is at a distance of 1675.43mm and other at 3274.30mm from the left hand side the distance between the two ribs is 1598.87 mm. The thickness of the ribs Is 25.34 mm which is shown in bottom view. Basically flash plate is I section plate which have two flanges of 1132 mm long and the distance between the two flanges is 4434mm. In bottom view there are 12 pallets are provided the length of each pallet is 362.56mm.



Analysis
The tetrahedral element stability was found to be excellent. Tetrahedral elements have rarely been used despite the fact that they are easy to create automatically
While the generation of high quality hexahedral elements is very difficult for complex shapes the tetrahedral elements appeared to be slightly stiffer than the hexahedral elements but the stiffness difference was limited to less than 14%. The tetrahedral elements were also more stable than the bricks when subjected to very high impact energies.

Above image shows the displacement of the various section of the plate. The maximum warpage take place between the ribs which are present in the structural diagram. In the above image warpage at three different sections are observed. Maximum displacement occurs at the central longitudinal axis of the plate it was observed that displacement at the position of the ribs is low as compared to the longitudinal axis of the flash plate where warpage is found to be more
Explanation
Solidification synthesis of cast metal by dispersing hard or soft ceramic particles. During the computational calculation of the model (Nastran) under below boundary conditions it is found that the warpage is occurring at the places where insufficient ribs are provided. It is found that the max. deformation is 2.489 mm & min. 0.0 mm.

Boundary conditions-
Material : Cast Iron

Mesh	Element Family	Elements	Nodes
Solid(2) : PSOLID2 , Cast iron_6061			
3d_mesh(1)	Tetra4	12968	4463

Temperature applied: 1300°C
Convection: Heat transfer coefficient 25w/m²-C
Cooling under atmospheric temperature inside die for 48 Hrs.
Under gravity i.e 9.81 m/sec².

II. CONCLUSION

During the computational process as mentioned above it is concluded that the warpage of 2.489 mm is occurring which is not permissible, it is also found that the warpage is occurring only at those places where insufficient ribs are provided. To avoid the warpage extra ribs must be provided at the affected area. On other hand we can also design fixtures for the model but it will not work as the cooling process of the casting is done inside the die itself.

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