Productivity improvement in gravity die casting flywheel housings through implementation of regenerative circuited hydraulic powerpack

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***Abstract*— The aim of the project is to improve the productivity of ISX flywheel housings in Gravity die casting in TVS Sundaram Clayton, Padi. Study of pressure die-casting and gravity die-casting processes was done in the first few weeks. The different types of flywheel housings produced by gravity die-casting were thoroughly studied. The flow process of ISX flywheel housing was noted and charts were made based on the data collected for clear understanding. Analysis of cycle time and current production processes through various tools was done. Improving the flow rate was the key operation to be carried out. The capacity of the existing hydraulic powerpack was increased after performing various calculations. Hoses were replaced. Regeneration circuits have been used instead of the existing normal setup for the purpose of opening and closing the dies which is the bottleneck in the sequential processes carried out. Payback calculations was done and comparison of productivity before and after the implementation of the various crucial steps was depicted and it is clear that the productivity rate is significantly increased.**

Keywords—gravitydie casting, productivity improvement, regeneration circuits, flywheel housings, hydraulic powerpack.

I. INTRODUCTION

There are four steps in traditional die casting, also known as high-pressure die casting, these are also the basis for any of the die casting variations: die preparation, filling, ejection, and shakeout. The dies are prepared by spraying the mold cavity with lubricant. The lubricant both helps control the temperature of the die and it also assists in the removal of the casting. The dies are then closed and molten metal is injected into the dies under high pressure. Once the mold cavity is filled, the pressure is maintained until the casting solidifies. The dies are then opened and the shot (shots are different from castings because there can be multiple cavities in a die, yielding multiple castings per shot) is ejected by the ejector pins. Finally, the shakeout involves separating the scrap, which includes the gate, runners, sprues and flash, from the shot. This is often done using a special trim die in a power press or hydraulic press. Other methods of shaking out include sawing and grinding. A less labor-intensive method is to tumble shots if gates are thin and easily broken; separation of gates from finished parts must follow. This scrap is recycled by remeltingit.The high-pressure injection leads to a quick fill of the die, which is required so the entire cavity fills before any part of the casting solidifies. In this way, discontinuities are avoided, even if the shape requires difficult-to-fill thin sections. This creates the problem of air entrapment, because when the mold is filled quickly there is little time for the air to escape. This problem is minimized by including vents along the parting lines, however, even in a highly refined process there will still be some porosity in the center of the casting.

Most die casters perform other secondary operations to produce features not readily castable, such as tapping a hole, polishing, plating, buffing, or painting. Srinivas R et al., [1] -A hydraulic system is a group of hydraulic elements arranged in an order and using these hydraulic element power is transmitted using a confined liquid i.e. Oil. Hydraulic power units are drive system for hydraulic machines

Sridharakeshava K. B. et. al., [2] has discussed about the General Requirements of a Fixture which includes constraints ofDeterministic location, contained deflection, geometric constraint in order to maintain the work piece stability during amachining process. They also discussed three broad stages of fixture design, Stage one deals with information gathering andanalysis, Stage two involves product analysis, and Stage three involves design of fixture elements.Vektec, hydraulic clamping information [3] describes Hydraulic Systems & Circuits which includes Power Supplies,Valves, System Types, Accumulators, Orifices, Filtration, Flow Requirements, Line Sizing, Circuit Design; General Description,information& Application

Recommendations of Work Supports, Swing Clamps, Cylinders & Position Sensing.

Wen Wang et al., [4] -In these study oil pump models with different gear tooth shapes were established and the internalflow field simulation were conducted by utilizing pump links. Especially the flow pulsation of dislocation gear pump is muchlower, than straight gear pumps. E.A.P. Egbe [5] Present detailed design procedure of external gear pump, and also, the fabricating methods and theiranalysis and results. The design analysis, fabrication and testing of an external gear pump, which will serve as a spring boardfor technological transfer and development of country. The components of this gear pump were fabricated by machining.

II GDC FLYWHEEL HOUSINGS

Currently, the number of parts produced in a die per hour is 6. The goal is to increase the number of parts being cast in the dies present. The parts are cast using gravity die casting method. Production cycle and operations carried out were analysed thoroughly.

Following are the list of operations carried out:

1. Raw material storage
2. Weighing
3. Ingots loading
4. Melting
5. Sample testing
6. Metal transfer through ladle
7. Degassing
8. Metal transfer to crucible
9. Die casting solidification
10. Visual inspection
11. Cooling
12. Riser cutting
13. Chipping
14. Inner fettling
15. Outer fettling
16. Final inspection
17. M/c shop
18. Inspection

III ISX FLYWHEEL HOUSINGS

ISX flywheel housing is employed in three out of the four dies present, die 9,8 and 7.

A. PROCESS PARAMETERS

- The crucible temperature is maintained around 770 °C with a tolerance of 10 °C.
- The capacity of the crucible is 1000kg.
- Alloy used: 50016
- Preheating is done for about half an hour at the beginning of every shift to a temperature of 350 °C.
- Preheating is done using LPG gas in the desired ratio mixture.
- Each part approximately consumes 10 mins:

  solidification time: 6 mins

  preparation time : 4 mins
- Part weight: 1) with riser: 38 kg

  2) without riser: 22.5 kg
- Die coating used:

  DIE 34 – WHITE - Heat resistant.

DIE 11 - BLACK - Lubrication and easy removal of the cast part.

- Mixing ratio- 1:3
- Die coating 34 is to be applied first followed by die coating 11.
- Ceramic core is used to prevent formation of blowholes.
- Air vent pins(8) are provided on the top die for quicker solidification.

*B.*PARTS OF ISX DIE

- Big die
- Top die
- Small die
- Starter motor
- Copper pins
- Ceramic core
- Rejectant
- Clamp
- Air vent pins(x8)

Figure1 Flywheel

II. HYDRAULIC POWERPACK

After careful analysis of the sequential operations carried out and time study it is clear that die opening and closing is the bottleneck of operations ignoring the standard solidification time. Out of all the dies, top die opening and closing activity consumes the maximum amount of time nearly 60s i.e 30s for opening and 30s for closing. Our aim is to reduce the 60s to 20s i.e 10s for opening and 10s for closing.

Thus to increase the speed of top die we have to increase the flow rate of the cylinder attached to it which is controlled by directional control valves. So, to increase the flow rate modifications have to be done in the powerpack.

Figure 2 Hydralic power pack

III. CYCLE TIME REDUCTION

- 0.5” hoses used in the existing hoses were replaced by 1” hoses and an M1 manifold was introduced in addition to the existing DC manifold used.
- Motor capacity was increased from 35 lpm to 75 lpm.
- Regeneration circuits were used for top die operations in the place of existing setup.

IV. REGENERATION CIRCUITS

A regeneration circuit can double the extension speed of a single-rod cylinder without using a larger pump. This means that regeneration circuits save money because a smaller pump, motor, and tank can produce the desired cycle time. It also means that the circuit costs less to operate over the life of the machine.

A regeneration circuit can also replace a double rod-end cylinder in some circuits. With equal rod diameters, a double-rod cylinder’s area is the same on both ends. Equal areas mean identical force and speed both ways at a given pressure and flow. Reciprocating tables often use double rod-end cylinders for this reason. When the main function of a double rod-end cylinder is equal speed and power in both directions of travel, replace it with a regeneration circuit.A double rod-end cylinder costs more than a cylinder with a single oversize rod; the extra rod needs space in which to move; and the second rod seal is another potential leakage source. To eliminate these objections, use the full-time regeneration circuit shown in Figures 17-6 and 17-8. Extension and retraction speed (as well as thrust) is the same, without the extra rod and its problems.One disadvantage to using cylinders with a single oversize rod is that speed and thrust are not identical if the rod diameter ratio is not exactly 2:1. Most cataloged 2:1 rod diameters are only close to that ratio. A standard NFPA 3.25-in. bore cylinder comes with a 2.00-in. diameter rod as a 2:1 differential. If using this cylinder in a full-time regeneration circuit, speed is about 21% faster on the extension stroke, with about 21% less force than the retraction stroke.

Figure 3 Hose

Figure 4 Regererative circuit

V. CONCLUSION

Thus the productivity of GDC flywheel housings has been improved by using commonized regeneration circuits in the existing layout.The above step has resulted in significant reduction of cycle time which in-turn has increased productivity.The usage of regenerative circuits was further extended to all the four dies in the layout as a commonised regeneration setup by using a 120 lpm powerpack.Provision for more air vent pins might also reduce the solidification time considerably.Cycle time charts, outline process chart, flow process chart have been used in the analysis of operations carried out for effective understanding.

REFERENCES

1. Shrinivas R, Mrs.Manjula, Saira Das Bharadwaj, “Design modelling and analysis of standardize hydraulic power pack”. In proceeding International journal of research in Engineering and Technology Vol 5.2015.
2. Sridharakeshava K B, Ramesh Babu. K, “An Advanced Treatise on Jigs and Fixture Design” International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181Vol. 2 Issue 8, August – 2013.
3. Vektec, “Fundamental Technical Hydraulic Clamping information” Aug 2009 Rev D.
4. Wel Wang, Yan-Mei Yin, Shang-Hong He and Guang-Ming Liu.Study on flow characteristics of gear pump by gear tooth space. In proceeding of journal of applied science and Engineering 2017.Vol 2.2017.
5. E.A.P. Egbe-Design Analysis and Testing of a Gear Pump in Proceedings of the International Journal of Engineering And Science vol-3 Issue 2 May 2013.
6. Mr.DipenRana and Mr.Nirmal Kumar. “Experimental and Computational Fluid Dynamic Analysis ofExternal Gear Pump”. In proceeding International Journal of Engineering development and research Vol.2 ISSUE2.2014.
7. An E-book on “ HYDRAULICS AND PNEUMATICS”
8. https://www.hydraproducts.co.uk/hydraulic-calculators/pump-flow.aspx for calculations.
9. https://www.eaton.com/Eaton/ProductsServices/Hydraulics/Pumps/VanePumps/PCT_262228#tabs-2 for product specifications.