



IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

e-ISSN: 2319-8753 | p-ISSN: 2320-6710



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 7, July 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.569



9940 572 462



6381 907 438



ijirset@gmail.com



www.ijirset.com

Optimizing the Total Run-out Error by Standardizing the Shrinkage and Repositioning: A Case Study

Mohan Kumar T S¹

Assistant Professor, Department of Industrial Engineering and Management, Siddaganga Institute of Technology,
Tumakuru, Karnataka, India¹

ABSTRACT: During solidification in casting, shrinkage is a volumetric difference between the solid and liquid phases. When metal cools and solidifies, shrinkage reduces the volume of the casting material. As a result, create the line, holes in the casting, which is known as a shrinkage defect. The main objective of the paper is to reduce the total run out defect by studying the processes of the product and to understand the variation in height and shrinkage and its effect on final dimension and apply standard shrinkage. The main problem was observed in the sintering process, that the product removed from the sintering process, the drilled hole size of some of the products were not as per the specifications, increase or decrease in the hole diameter than predetermined and shifting of holes from the reference point. Due to which the product with defect had to be produced again from the starting which a huge loss with respect to time and cost for the case company. The hole shift was measured after the sintering process and absorbed that the products placed at the extreme ends showed much variation. By brainstorming session some of solutions were identified and by using multi-voting tool solution was prioritized and concluded that standardizing the shrinkage and repositioning the product middle position inside the sintering chamber led to reduction in the shift of the holes.

KEYWORDS: Repositioning, Run-out, Shrinkage.

I. INTRODUCTION

Hard metal tools made of tungsten carbide are primarily utilised in metal cutting, mining, forming, and different applications. Powder metallurgy process is used to produce these tools, the powder is produced of by crushing the metals and then the powder is crushed and machined into the desired shapes and sizes using various types of presses. Compacts normally have a density of 55 to 60 % of their theoretical density after pressing. Pressed compacts are sintered at a temperature above the eutectic metal temperature to get 100% density. The metallurgical characteristics of sintered products are evaluated. Eventually, the dimensions are checked and parts are inspected for accuracy and they are sent to various customers. One of the barriers to understanding end dimensions after sintering is uniform density distribution of compacts. The shrink factor at various locations of the pressed compacts can be used to investigate the density distribution. Furthermore, Components OD, ID and height varies depending on shrink factor. Actual linear shrinkage differs from the volumetric shrinkage factor. As a result, achieving dimensional precision is never simple. Shrinkage is caused by closure porosity during sintering, which is measured as a percentage difference in size between a sintered product and the identical component in its pre-shaped or green form. The % shrinkage calculated based on size of the sintered part, therefore 25% shrinkage means the green component. Sintering and its influence on pressed materials such as tungsten carbide are discussed in a research [1]. Results displays how material composition, such as carbide grain size, binder percent, carbon content, and the inclusion of cubic carbides, affects sintering behaviour. It focuses on the densification and microstructural development of tungsten carbide. This article investigated the impact of carbon content and grain size distribution on shrinkage. The presence of high carbon content increases shrinkage rate, but has a less effect on grain size distribution. For a very broad range, the mean carbide particle size is insufficient to represent densification. Another research displayed how computer simulation helps sintering process by setting up sintering and pressing processes with very less quantity of data and also for setup it uses FEM technique. This work investigated the major components that cause dimension or quality fluctuation, such as particle size, carbon content, composition, and tool wear [2]. Compaction of metal particles, compaction pressure, axial density distribution, ejection force, and spring back action are discussed in a research paper. The result shows the densification of metal powder in a hard die cavity is the first step in the production of sintered components. On the powder, a high compacting pressure of

around 650N/mm² is applied. Due to the application of tremendous pressure, this powder particle gets squeezed. The shear stress on particles reduces after densification. Axial pressure is applied in a 1:1 ratio to radial pressure on the die's cylindrical wall [3]. A study focuses on the grain size growth of tungsten carbide during the sintering process and estimates grain growth with and without cobalt in the powder. With electron back scatter diffraction and a SEM, the evolution of grain size for various sintering conditions is examined and measured. There are three phases of grain growth. Grain growth is rapid in the I phase. Grain growth is slower in the II phase, and grain growth is blocked or aberrant in the third phase. The addition of cobalt slows down the sintering process. The addition of 7 to 13% cobalt has a negligible influence on grain size growth [4]. The impact of varying binder usage and sintering temperature on the mechanical properties of tungsten carbide are highlighted in a study. The features of tungsten carbide powder include high hardness, toughness, and melting temperature. Binders like cobalt and vanadium are used to improve these qualities even more. To achieve full densification during the sintering process, an increase in sintering temperature is required in addition to the addition of a large amount of binder. The characteristics of tungsten carbide can also be improved by sintering the pressed component at 1300°C and utilising nano composites, which leads in reduced grain sizes. [5]. In a study the procedures employed in the Kennametal industry in Bangalore for powder manufacture was discussed. Tungsten carbide powder is used in the manufacturing process. The basic material is tungsten tri-oxide, which is heated in a furnace and treated with hydrogen gas to remove oxygen. Pure tungsten is then mixed with either cobalt or carbon, which is done in a mixing machine for uniform distribution and heated in a smaller furnace for particle binding. In ball milling process for binding particles acetone is used because at low temperature it can be removed easily and powder will be sprayed at high pressure to obtain fine grain, wax is applied then it is filled and labelled bottle before dispatch [6]. A study highlights recent advances in powder metallurgy. It can be seen in this paper how powder compressibility can be increased while dust and hazards are reduced and the die filling and lubricating processes [7].

II. A CASE STUDY

A case company deals with tungsten carbide being pressed to the required shape and then sintered with cobalt as a binder. The unit manufactures earth works, metal works and energy products. The following steps describe the process followed for flats to achieve their targets: Purchase Order & Technical Evaluation, Order Booking, Master Data, Release of Route Cards, Manufacturing Process- Pressing, Sintering, Metallurgical Inspection and dispatch. Company is expecting huge orders from KOSO cages but facing issue in maintain hole position and tolerance in sintering process. The issue observed was that, after the product was removed from the sintering process, the drilled hole size of some of the products were not as per the specifications provided i.e. ovalities in the drilled holes, increase or decrease in the hole diameter than predetermined and shifting of holes from the reference point. Due to which the product with defect had to be produced again from the starting which is costing its time and money.

Data Collection

PU1 (Production Unit-1) powder is selected and is pressed in PU2 (Production Unit-2). In PU2 there are many types of press such as hydraulic, mechanical, cold Isostatic and Mon static press. Selected powder should have 0.5 to 3 percent wax which acts as a lubricant. Cold Isostatic Press will be used to press powders with low (0.4-0.6%) wax content, if wax content is more then they will go for hydraulic or mechanical press. Mechanical presses are classified according on their tonnage capacity and ranges to 6, 12, 20, and 50 Tons. The powder from the hopper is sent into the die cavity in a mechanical press. The bottom punch will remain stationary during the pressing operation, while the die and upper punch will move in a relative motion, compacting the powder. If machining is required, these pressed compacts are delivered straight to the sintering process.

Data were collected from company manual, using the past record for initial investigation, then the data are collected in the following steps:

- Initially, the components are pressed according to the design specifications using the closest dies available.
- Using a Vernier calliper, measure the outer and inner diameters of the pressed component on the top and bottom sides.
- Measure the hole sizes using the gauges. Measure the distance of the holes from the face using gauges and vernier-caliper.
- Using the gauges, determine the hole sizes and using vernier calliper, determine the distance between the holes and the face.

- Pressed component actual weight is recorded.
- Hole size, Planned and Actual shrinkages after sintering are calculated.
- Hole distance from face is calculated after sintering using vernier caliper and different gauges.
- Go for GOM test if needed all the components.

The dimensions are measured for the test sample with some conditions are considered while measuring that are 1-8mm holes are measured using PIN gauges and above 8mm holes are measured using vernier caliper and found to be outer diameter of 100mm, Inner diameter 65mm, height 140.16mm, weight 6.92Kg and grade THM. Data are collected for present process by changing the drill bit diameter for both PCD and HSS drill bit diameter (mm). Test sample is as shown in figure 1. The data collected is used for future reference in selecting the right drill bit size by considering the holes size shrinkage after sintering process.



Fig 1: Test sample

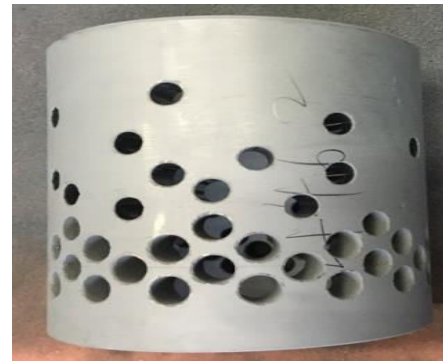


Fig. 2: Mainlot Production piece

Figure 2 shows the sample of mainlot production piece and the data are collected for the sample for hole size and face and hole edge dimensions. After the finishing operations on the green section, the data obtained indicates the product dimensions, hole size, and distance between the hole edge and the face. Five samples parts are taken for the study (Part A1, A2, A3, A4 and A5) and to check for hole size, actual shrinkage percentage.

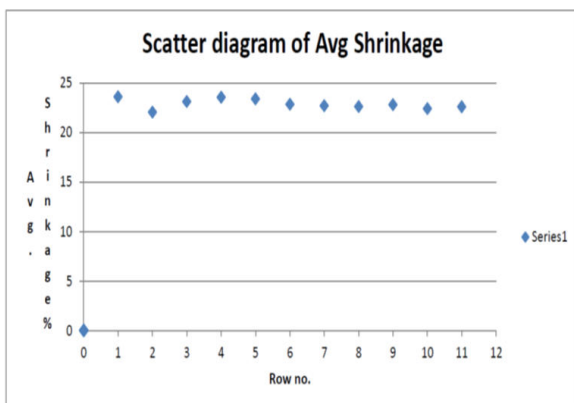


Fig. 3: Plot of Shrinkage % vs rows in part A1

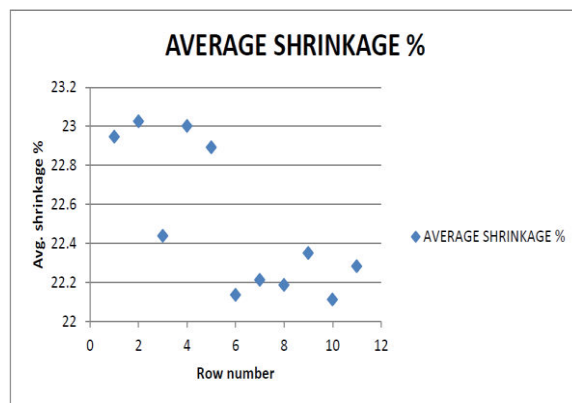


Fig. 4: Plot of Shrinkage % vs rows in part A2

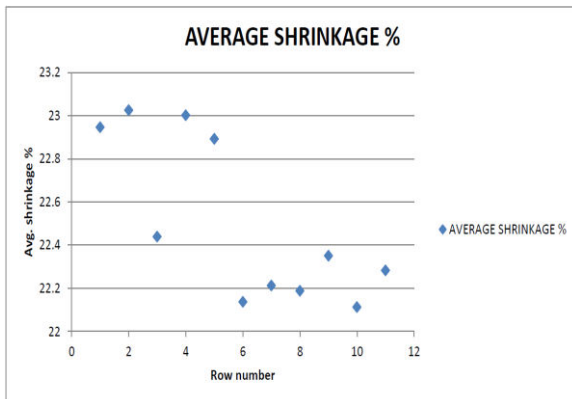


Fig. 5: Plot of Shrinkage % vs rows in part A3

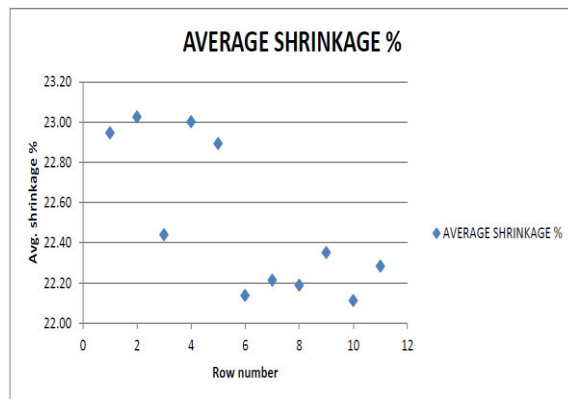


Fig. 6: Plot of Shrinkage % vs rows in part A4

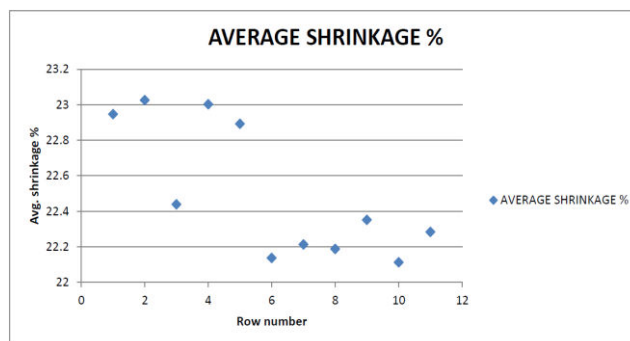


Fig. 3: Plot of Shrinkage % vs rows in part A5

Figure 3 shows sample part A1, where sample is placed in the furnace 34/PF5-back zone, right side top with 1490 degrees. The data gathered after the sintering process represents the hole size and position. The variation in hole positions may be noticed clearly. It has been observed which holes have shifted outside of the tolerance limit. The discrepancy between the calculated and real shrinkage percentages can also be seen. The calculated shrinkage percentage was 21.52 percent, while it was between 22-23 percent. Figure 4 shows sample part A2 that is placed in the furnace back zone, right side bottom row (slightly towards the centre) with 1490 degrees. After sintering, the data reveals the required and actual dimensions of the hole size and position. The holes with out-of-tolerance placements have been highlighted. We can also see how the actual shrinkage % differs from the one computed earlier in part A1. Figure 5 shows sample part A3, where sample is placed back zone, right side middle row with 1490 degrees in the furnace. After sintering, the data reveals the required and actual dimensions of the hole size and position. The holes with out-of-tolerance placements have been highlighted. We can also see how the actual shrinkage % differs from the one computed earlier. Figure 6 shows sample part A4 that gives the same results of previous samples. Figure 7 shows sample part A5, after sintering the data reveals the required and actual dimensions of the hole size and position. The holes with out-of-tolerance placements have been highlighted. We can also see how the actual shrinkage % differs from the one computed earlier.

After this plan to do the no-contact GOM test after noticing that the variations were greater. For each hole, the distance between the hole and the face was measured after the GOM test. The difference between the gauge test and the GOM test was found to be within the tolerance level, therefore the data acquired using the gauge test is acceptable.

After data collection brainstorming session was conducted to find out solution for the variation considering the above data some of the solutions were identified like reposition of sample in sintering chamber, drill bits, speed and feed, standardizing the shrinkage percentage. Then the solution was put to vote for prioritizing the solution

using multi-voting tool, where all the team members are voted for different solutions. Solutions were rated from 1 to 5 where 1 is less effective and 5 is highly effective. Based on the results of multi-voting the solution identified as standardizing the shrinkage and repositioning the product in the middle position inside the sintering chamber. Solutions were implemented and found to be a huge reduction in the shift of the holes.

III. CONCLUSION

Producing a defect-free casting is a demanding task that necessitates consistent effort. The main objectives of the project are to study the existing process of 200 Ton pressing machine, finishing operations, sintering process and analyse the variation in the hole shift, shrinkage of the pressed components and apply standard shrinkage and evaluate the risk. The process was carried out in three stages. In the first stage existing process was studied. A route card will be issued to the 200 Ton pressing machine operator which contains the information about powder batch, powder grade, specific gravity, planned height and final dimensions of the component. Based on the planned height the operator was calculating the weight of the powder that has to be pressed. A planned amount of powder was pressed and parameters like outer diameter, inner diameter were measured both at bottom and top using vernier calliper. The drill bits used and its size along with the machining parameters like speed and feed were observed. The dimensions of the product after the finishing operations were measured and tabulated in the second stage. The same product was measured after the sintering process by considering the shrinkage percentage which was earlier calculated. It was observed the hole positions were shifted more than the shrinkage percentage which showed that a revision in the shrinkage percentage is needed. In the third stage products were placed in different positions inside the sintering chamber. The hole shift was measured after the sintering process and we found that the products placed at the extreme ends showed much variation. It was concluded that standardizing the shrinkage and position of the product inside the sintering chamber led to reduction in the shift of the holes. It was concluded that the products which were placed in the middle position inside the sintering furnace showed least variation in the holes positions and hence the position of the product inside the furnace is affecting the holes position. Also, standardization of the shrinkage percentage is necessary.

REFERENCES

- [1] Anders Petersson, "Cemented Carbide Sintering – Constitutive Relations and Microstructural Evolution", Thèse: Royal Institute of Technology, Stockholm 2005. [Pie96].
- [2] Randall. M. German, "Modeling and Simulation of press and sintering of powder metallurgy", 2010.
- [3] Eugene. A. Olevsky, "Compacting of metal powder", San Diego State University, California, 2011.
- [4] Oscar Bjareborn, "WC grain size distribution during sintering of WC-CO cemented carbide", Master's Thesis Division of Materials Engineering January 2016.
- [5] Al-Aqeeli and K.Mohamad, "The effect of variable binder content, sintering temperature on mechanical properties of tungsten carbide", Materials and Manufacturing Processes Volume 30, 2015 - Issue 32014
- [6] Panirajshanbhog, "Documentation of powder manufacturing", Kennametal industry, Bangalore, 2016.
- [7] RIOrban, "New research directions in powder metallurgy", Technical university of CLUJNAPOCA, Romania, 2016.



**Impact Factor:
7.569**



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details