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Not only can powder metallurgy hold extremely tight tolerances but it can do so with absolute repeatability.

Powder metallurgy (PM) parts can be produced at rates of from several hundred to thousands of parts per hour. The key elements of dimensional change include orientation, component size and complexity, run-out, powder formulation, tool wear, sintering and heat treatment, and secondary operations, such as coining and sizing.[1]

Radial dimensions (perpendicular to pressing action) are generally controlled by the dimensions of the tool. Tooling dimensions are consistent relative to what each part experiences during the compaction cycle. Modern computer numerically controlled (CNC) compaction presses provide excellent part-to-part precision and control for complex shapes by continuously monitoring and adjusting positions and speeds through a feedback loop. Highly repeatable positioned accuracies are obtained using state-of-the-art controls.[2] Automated weight correction is possible by validating part weights with a scale that sends feedback to the CNC controller; the program then automatically adjusts the filling positions for all levels as required, further enhancing the quality level.

Tooling-development engineers are highly experienced in accessing size-change expectations based on differing powder formulations, density requirements, and the impact of temperature change on tools with use. The PM tooling engineer is knowledgeable about the complexities of tooling and press operation, accessing the relative movement of multiple tool members and the press members that control them to consistent component tolerances.

PM materials differ in the extent to which they are affected by variation in sintering time, sintering temperature, compact density, and chemical composition. Usually these variables are accounted for by having statistical data on how standard test bars of similar material and density behave in their furnace. This creates a controllable condition.[3]

Component manufacturers understand the impact of powder formulation, component density, tool materials, and production volume on tool dimensional change, and take these factors into consideration for part-to-part repeatability.

PM parts fabricators are also careful to establish heat-treating procedures that are repeatable and differ little in impact when compared with fabricated wrought products. In many cases, sinter-hardened materials do not require secondary heat-treat operations, yet exhibit heat-treated properties.

A final consideration available to parts fabricators when closely repeatable tolerances are required is to size sintered components in a calibration operation. The sizing operation in specifically designed dies will enhance and control part tolerances.

Nearly all MPIF-member parts producers are ISO-9002 registered or QS 9000 approved so they are familiar with statistical quality-control techniques and use them as part of a formal manufacturing control-plan system.

References

1. *Powder Metallurgy Design Manual—3rd edition,* Metal Powder Industries Federation, Princeton, NJ, 1998, pp. 23–24.
2. *Powder Metallurgy, the Preferred Metal-Forming Solution,* Metal Powder Industries Federation, Princeton, NJ, 2008, p. 5.
3. L.F. Pease, III, and W.G. West, *Fundamentals of Powder Metallurgy,* Metal Powder Industries Federation, Princeton, NJ, 2002, p. 100

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