Abstract

Deep drawing is one of the most important sheet metal forming processes, which produce cups, cones, boxes, and shells. Many variables affect deep drawing process, and to produce successful cups, these variables should be evaluated. In addition, design of deep drawing dies is complicated, time consuming process and requires special experience.

In this work, and for the aforementioned reasons, deep drawing dies are designed using a "computer - aided designed system" to save time and facilitate the design process. Also finite elements method (FEM) is used to simulate the drawing process to select the best die design.

Computer – Aided Design and simulation of Deep Drawing Operation system (CADS-DDO), is the result of designing the drawing process using the computer – aide system and simulating it using FEM.

A programming language (VISUAL BASIC 6.0) was used to build the computer – aided design system, which was linked to drafting package (AutoCAD 2002) to plot the deep drawing dies.

A commercially available finite elements program code (ANSYS 5.4) was used to perform the numerical simulation. Finite elements results is compared with experimental results using a blank of mild steel type (SAE 1006), with thickness (t) and diameter (D) equal to (0.42, 180) mm respectively. In order to select the best die design the effect of die profile radius on punch loads, cup walls thickness, stresses and strains distributed over the drawn cup walls was investigated using five types of punches with diameter (d) equal to (120) mm and punch profile radius (r_p) equal to (2, 5, 10, 15, 20) mm , and five types of dies with diameter equal to (121.1)and die profile radius (r_d) equal to (2, 4, 6, 10, 15) mm. The clearance between punch and die were studied on the same previous variables using one punch with diameter equal to (120) mm and punch
profile radius of (15) mm, and four dies with diameter of (120.9, 120.98, 121.1, 121.14) with die profile radius of (6) mm.

Though the compression between the experimental and FEM, it has concluded that finite elements method is more accurate than the experimental method in predicting the best die design the experimental method, and a good match between the two methods was found. Generally, the experimental maximum punch load is higher than that obtained using finite elements method. In addition, it was concluded, using FEM, that it is possible to produce successful cups with tool set of die profile radius (r_d) more than or equal to 4 mm (10 t), and punch profile radius (r_p) more than or equal to 5 mm (12 t), while successful cups were produce using the experimental method with tool set of (r_p > 5 mm) and (r_d > 2 mm). Best die design, using FEM, was concluded to have tool set with r_p equal to (10 or 15) mm, and r_d equal to (6 or 10) mm, while using the experimental method, best die design was found to have tool set of r_p equal to (15 mm) and r_d equal to (6 mm).

Finally radial clearance was found to have very small effect on the drawing process, where its best value is equal to 0.55 mm (1.309 t), using both methods.