This research work investigates the barrelling behaviour of non-ferrous metals during cold upsetting. The barrelling study on upsetting has been carried out, because of its technical potential in metal forming processes. The existence of friction between the dies and work piece directly affect the plastic deformation of the later. When a solid cylinder is compressed axially between the punch and bottom platen, the work piece material in contact with the surfaces undergoes heterogeneous deformation that results in the “barreling” of the cylinder. Friction at the faces of contact retards plastic flow of metal on the surface and in its vicinity. A conical wedge of a relatively un-deformed metal is formed immediately below it while the rest of the cylinder suffers high strains and bulges out in the form of a barrel. Metal namely commercially available pure annealed Aluminium and Copper have been studied with die constraints and also under different frictional conditions. The curvatures of the barreled cylinders are physically measured and found to match with the calculated one. The relation between the different parameters like new hoop strain, radius of curvature of the barrel, new geometrical shape factor, stress ratio parameter, and hydrostatic stress and axial strain were established.
INVESTIGATIONS

1. When a conical die constraint is introduced at one end of the work-piece, two barrels were observed irrespective of the aspect ratio used and the lubricating condition.

2. For both metals under the experiment conditions, the curvatures of the barreled part of the work piece, physically measured, followed the geometry of circular arc.

3. Having the conical die constraint at both the ends of the work piece resulted with two barrels and a boldered part almost at the center of the work piece irrespective of the aspect ratios and the lubricant used.

4. The axially compressed aluminium specimen with an extrusion die at one end resulted with three geometries namely; a barreled part, truncated cone part and an extruded part irrespective of the lubricating condition and aspect ratio.

5. Also, applying lubricant at one end of the specimen, when compressed axially between flat die surfaces found to form a barreled portion and a truncated cone.

6. The ring compression tests established that Molybdenum disulphide to have maximum lubrication effect and thereby reducing the amount of barrel produced, while the SAE 40 oil showed the lowest lubrication effect.
7. By varying the surface finish of the flat dies, under axial compression, it is observed that the dies with grinding finish showed a lesser amount of barrel compared with other surface finished die surfaces.

8. For both metals, under the stipulated conditions of experiments, the ln-ln graph between the axial and new hoop strain is a straight line. For arriving at the new hoop strain, physically measured values of the deformed samples were used.

9. Using simple theory of plasticity, stresses namely hoop stress (\( \sigma_h \)), the effective stress (\( \sigma \)) and the hydrostatic stress (\( \sigma_m \)) are calculated and plotted against the axial strain. These stresses have been found to increase with increased level of deformation. The hydrostatic stress is found to be compressive in nature.

10. For all the experimental conditions, the calculated values of curvature of barrels formed are in close proximity with measured values and fitted a circular arc.

11. The ln-ln plots between the barrel radius and the new geometrical factors are all straight lines and suggested power law relation between them.

12. The rate of change of barrel radius with respect to the new geometrical shape factor does not exhibit major differences under different lubricating conditions, irrespective of the die used.
13. From the ring compression test, it is observed that the friction factor value for any combination of lubrication lie in between the values of the respective two parent lubricants.

14. The semi log graph between the geometrical shape factor and the friction factor suggested a straight line relationship between them.

15. The stress ratio parameter and the hydrostatic stress have a direct effect on barrelling under the experiment conditions. The radius of curvature of the barrel decreased exponentially with increasing values of stress ratio parameter. The straight-line behaviour between the barrel radius and stress ratio parameter is the manifestation of a power law relationship.