HIGH ENERGY RATE FORMING (HERF) PROCESSES

Introduction:

The forming processes are affected by the rates of strain used.

Effects of strain rates during forming:

1. The flow stress increases with strain rates
2. The temperature of work is increases due to adiabatic heating.
3. Improved lubrication if lubricating film is maintained.
4. Many difficult to form materials like Titanium and Tungsten alloys, can be deformed under high strain rates.

Principle / important features of HERF processes:

- The energy of deformation is delivered at a much higher rate than in conventional practice.
- Larger energy is applied for a very short interval of time.
- High particle velocities are produced in contrast with conventional forming process.
- The velocity of deformation is also very large and hence these are also called High Velocity Forming (HVF) processes.
- Many metals tend to deform more readily under extra fast application of force.
- Large parts can be easily formed by this technique.
- For many metals, the elongation to fracture increases with strain rate beyond the usual metal working range, until a critical strain rate is achieved, where the ductility drops sharply.
- The strain rate dependence of strength increases with increasing temperature.
- The yield stress and flow stress at lower plastic strains are more dependent on strain rate than the tensile strength.
- High rates of strain cause the yield point to appear in tests on low carbon steel that do not show a yield point under ordinary rates of strain.

Advantages of HERF Processes

i) Production rates are higher, as parts are made at a rapid rate.
ii) Die costs are relatively lower.
iii) Tolerances can be easily maintained.
iv) Versatility of the process – it is possible to form most metals including difficult to form metals.
v) No or minimum spring back effect on the material after the process.
vi) Production cost is low as power hammer (or press) is eliminated in the process. Hence it is economically justifiable.
vii) Complex shapes / profiles can be made much easily, as compared to conventional forming.
viii) The required final shape/ dimensions are obtained in one stroke (or step), thus eliminating intermediate forming steps and pre forming dies.
ix) Suitable for a range of production volume such as small numbers, batches or mass production.

Limitations:

i) Highly skilled personnel are required from design to execution.
ii) Transient stresses of high magnitude are applied on the work.
iii) Not suitable to highly brittle materials
iv) Source of energy (chemical explosive or electrical) must be handled carefully.
v) Governmental regulations/ procedures / safety norms must be followed.
vi) Dies need to be much bigger to withstand high energy rates and shocks and to prevent cracking.
vii) Controlling the application of energy is critical as it may crack the die or work.
viii) It is very essential to know the behavior or established performance of the work metal initially.

Applications:

i) In ship building – to form large plates / parts (up to 25 mm thick).
ii) Bending thick tubes/ pipes (up to 25 mm thick).
iii) Crimping of metal strips.
iv) Radar dishes
v) Elliptical domes used in space applications.
vi) Cladding of two large plates of dissimilar metals.

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