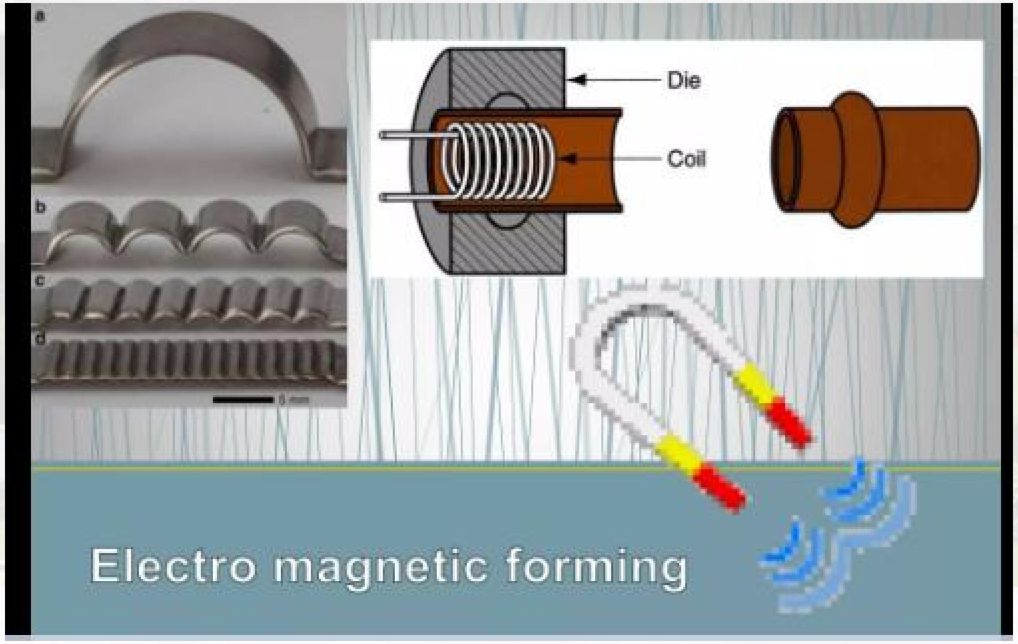
SNS COLLEGE OF TECHNOLOGY

(An autonomous institution)

Department of Mechanical Engineering

Unit – IV

Topic
Electro Magnetic Forming



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Electro Magnetic Forming

Electromagnetic forming (EM forming or magneforming) is a type of high velocity, cold forming process for **electrically conductive metals, most commonly copper and aluminum.**

The work piece is reshaped by **high intensity pulsed magnetic fields** that induce a current in the work piece and a corresponding repulsive magnetic field, rapidly repelling portions of the work piece.

The work piece can be **reshaped without any contact from a tool,** although in some instances the piece may be pressed against a die or former. The technique is sometimes called high velocity forming.

Electro Magnetic Forming

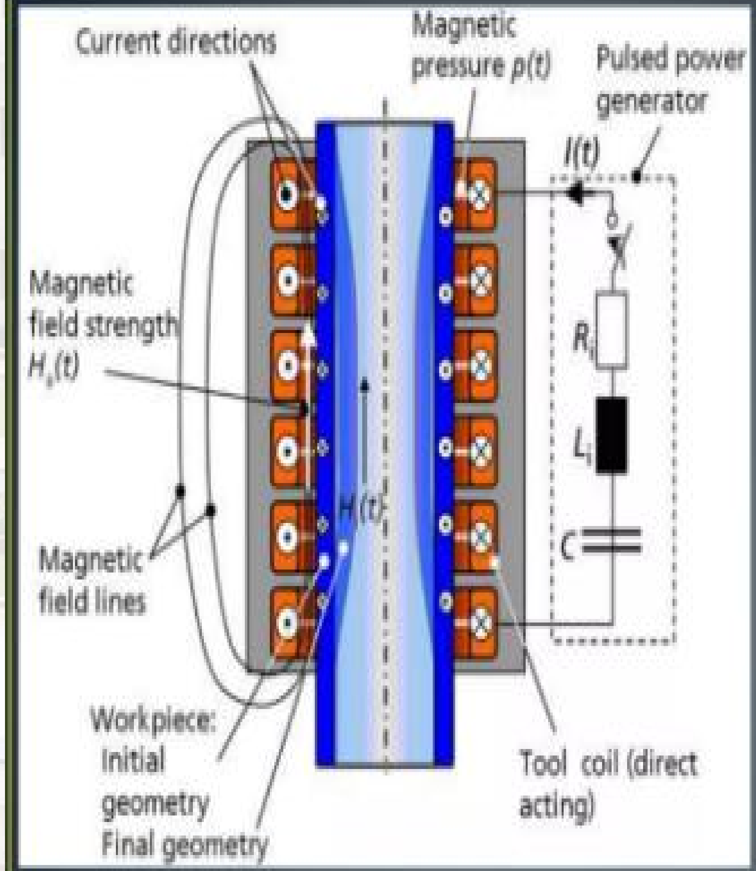
Process description:

in this process the sheet metal is deformed by the **mechanical force of an electromagnetic field** induced in the workpart by an **energized coil.**

The coil, energized by a capacitor, produces a magnetic field. This generates eddy currents in the work that produce their own magnetic field.

The induced field opposes the primary field, producing a mechanical force that deforms the part into the surrounding cavity.

It is typically used to form tubular parts



Electro Magnetic Forming

Electromagnetic formation can usually be applied to three forming methods:

Compression,

Expansion, and

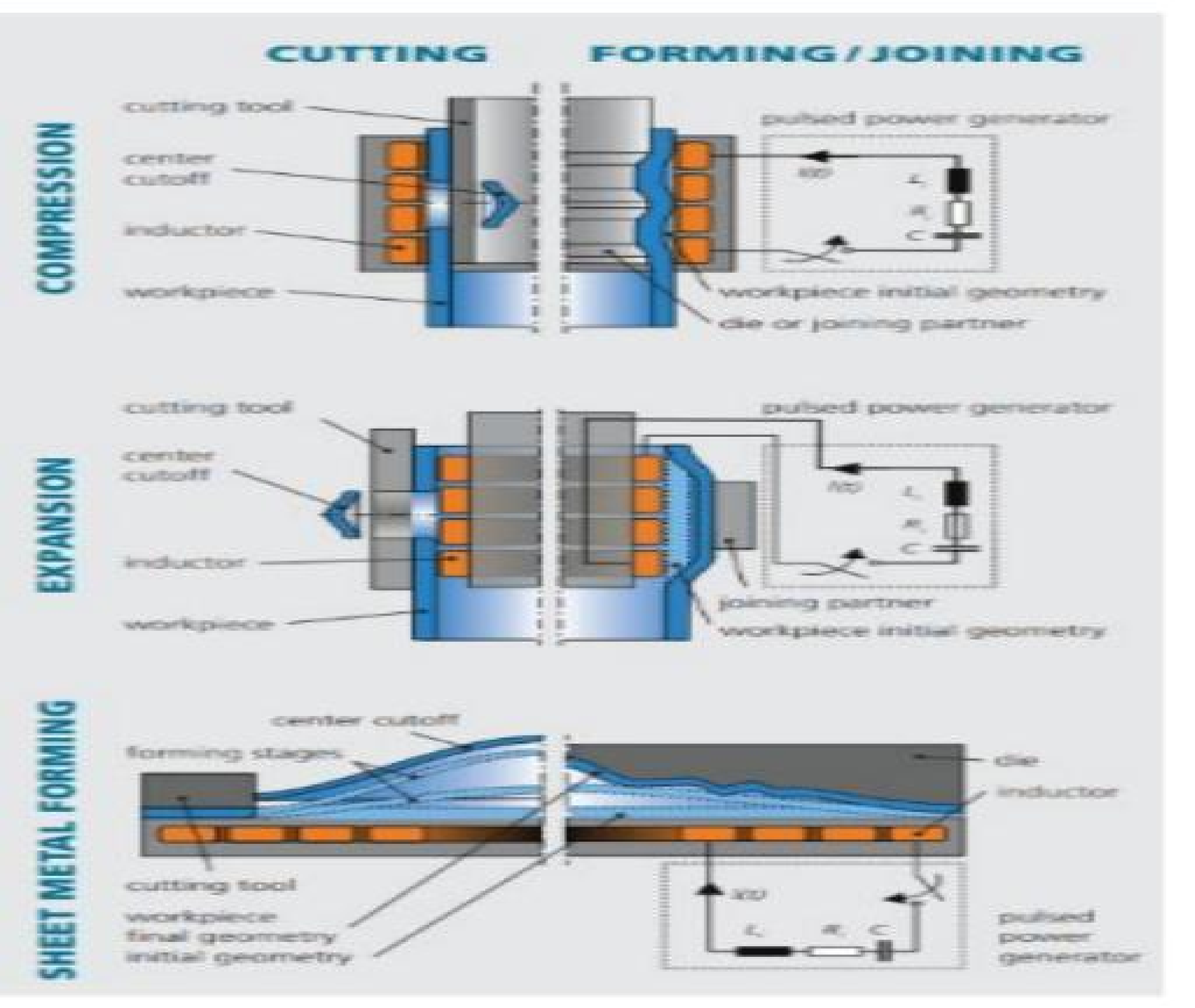
Counter forming

A tubular workpiece is compressed by an external coil, usually against a grooved contoured insert, plug, tube or fitting inside the workpiece.

A tubular workpiece is expanded by an internal coil as shown in figure usually against a collar or other component surrounding the workpiece.

Flat stock is almost always contour-formed against a die as seen in figure

Electro Magnetic Forming



Electro Magnetic Forming

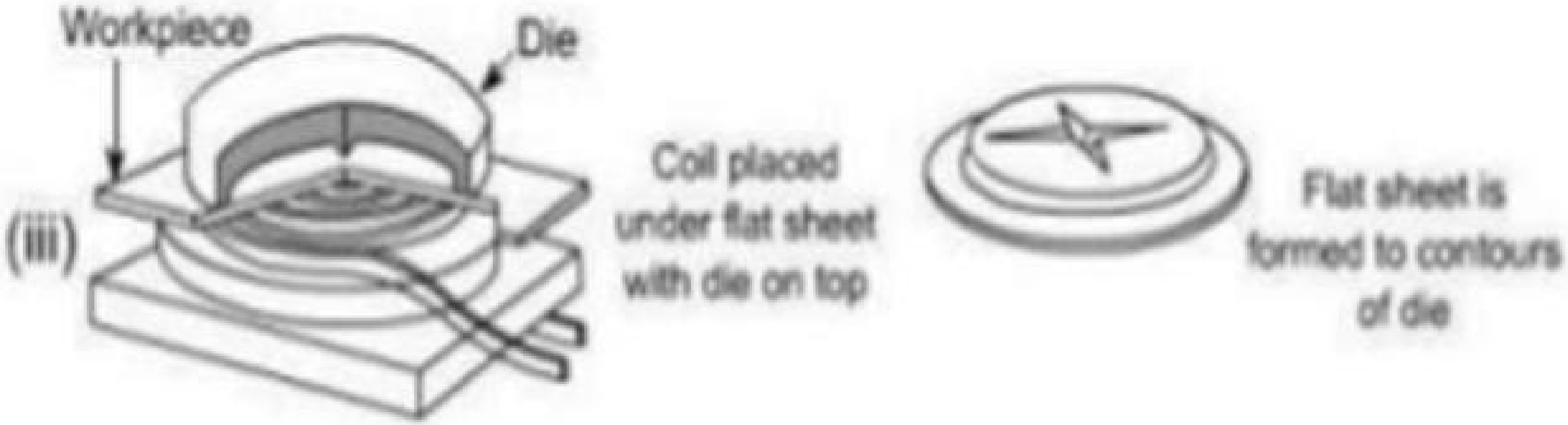
Depending on the geometry and the alignment of tool and workpiece, three process variants can be distinguished. These are :

(i) electromagnetic compression of tubes and hollow profiles by means of an inductor enclosing the workpiece,

(ii) electromagnetic expansion of tubes and hollow profiles by means of an inductor positioned within the workpiece,

Electro Magnetic Forming

(iii) electromagnetic sheet forming, for which an inductor is positioned in close proximity of a flat semi-finished part or a preformed component.



Electro Magnetic Forming

Constructional Details and Working:

- The setup of EMF consists of the pulsed power generator, the inductor including a fieldshaper, if applicable, the workpiece and application-dependent further tool components such as form-defining dies etc.
- The process is started by charging and subsequently discharging the capacitor of the pulsed power generator.
- A sinusoidal current flows through the inductor. This current induces a corresponding magnetic field.
- If there is an electrically conductive workpiece in direct proximity to inductor, a second opposedly directed current is induced.
- The energy density stored in the magnetic field between workpiece and inductor acts as magnetic pressure which can reach several hundreds of megapascal and causes the acceleration and deformation of the workpiece.
- The direction of the movement is always targeted away from the inductor

Electro Magnetic Forming

- In electromagnetic forming, the electrical energy from a capacitor bank is passed through a coil.
- A large magnetic field builds up around the coil, inducing a voltage in the workpiece.
- The resultant high current builds up its own magnetic field.
- These two magnetic fields of force are opposite in direction and repel each other, causing deformation of the workpiece.
- If the coil is placed on the inside of a tubular workpiece, the magnetic force (pressure up to 340 MN-2) moves the workpiece at velocities up to 300 ms-1 and causes the tube to bulge and assume the shape of the die cavity. Actual forming time 50–100 μs.
- If the coil is placed around the outside of the workpiece, then parts may be shrunk onto formed mandrels.
- Field-shaped coils may be used to concentrate the magnetic field of force when irregular shapes are to be formed.

Electro Magnetic Forming

- The strength of the magnetic force can be closely controlled, allowing metal to form over plastic, glass and composites.
- Repetitive machines can be used at up to 40 parts per minute.
- Magneform machines make no physical contact, so no lubrication is required. There is no tool wear or maintenance.
- Process is primarily used for swaging or expanding tubular shapes. It may also be used for embossing, punching, forming and shrinking operations.

Electro Magnetic Forming

Process Parameters:

- Workpiece thickness – A higher thickness means that the magnetic field diffuses slower through the workpiece wall.
- Electrical conductivity – The higher the electrical conductivity of the workpiece, the better the shielding of the magnetic field, the pressure difference in higher.
- Frequency – A higher frequency of the discharged current can balance a low conductivity or a small wall thickness.
- Size of the capacitor bank
- The strength of the current, which decides the strength of the magnetic field and the force applied.
- Gap between workpiece and tool coil – The smaller the air gap, higher is magnetic field and pressure.
- Winding of the tool coil – For each pulse generator and each forming task exists an optimum of number of turns.

Electro Magnetic Forming

This process is primarily applied in the forming of good conducting materials such as: **copper, aluminum, silver and low carbon steel.**

It can also be used to form a poor conductor like stainless steel.

The efficiency of the magnetic pulse forming depends upon the **resistivity of metal being formed.**

For good results the resistivity of the material should be less than 15 microohm-centimeters.

Explosive Forming

Advantages

1. It gives a **high rate of production**

2. **Non-contact:** unlike other mechanical processes in which a tool contacts a workpiece, in EMF the magnetic field that applies the pressure requires no lubrication, leaves no tool marks and therefore requires no cleanup after forming.

3. **No Springback:** the springback often associated with mechanical processes is virtually eliminated, because there is no mechanical contact.

4. The EMF process **allows increased ductility** for certain aluminum alloys because of the lack of mechanical stress and friction normally encountered with mechanical processes.

5. Tooling: the tooling for process is relatively inexpensive. the machine and the work coils can be viewed as general –purpose tooling.

Explosive Forming

General limitations

The speed of joining or formation also represents one of the limitations of the process.

Because forming take place in such a short period, the material does not lend itself to deep drawing of materials.

The process is also limited to those materials that are electrically conductive .materials with an **electrical resistivity of 0.15 micro –ohm- meter** or less are ideal candidates for the process. Included in this group are such materials as copper, aluminum, brass, and mild steels.

Pressure limit:

The **maximum pressure** that can be applied by standard compression coils is approximately **340 Mpa**, thus the process is restricted to relatively thin –wall tube or sheet products.

Thankyou