भारत डायनामिक्स लिमिटेड
BHARAT DYNAMICS LIMITED

# "Study of Reverse Flow Process

Engineering Intern | Duration: Jan 2021 – Feb 2020

Leifeld Flow Forming Machine

- **System Overview**

Production of Seamless Rocket Motor Tubes Using Flow Forming.

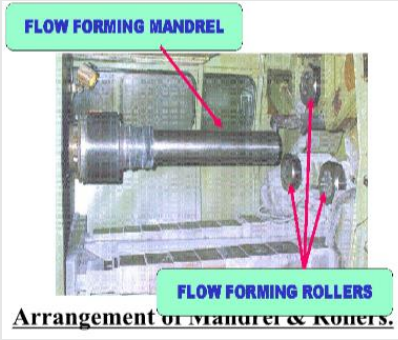
- **Key Learnings:**

✓ **Process Optimization**: Studied and optimized parameters such as feed rate, roller geometry, and hardness variations to improve tube quality.

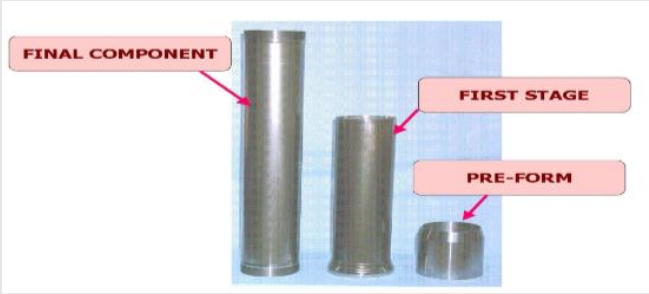
✓ **Experimental Analysis**: Conducted tests using CNC flow forming machines to evaluate effects on thickness, ovality, and diameter.

✓ **Material Evaluation**: Assessed the mechanical properties and microstructural changes of SAE 4130 Steel after flow forming.

✓ **Quality Improvement**: Implemented stagger adjustments and controlled roller movement to achieve better surface finish and dimensional accuracy.




Arrangement of Mandrel & Rollers.



# Process and Experimentation

**Experimental Setup**

•**Machine Used:** Three-Roller **CNC Flow Forming Machine**
**Material:** SAE 4130 Steel (chosen for high strength and heat resistance)

•**Key Process Parameters:**

- **Feed Rate:** Controls thickness and surface finish.
- **Roller Radius & Stagger:** Determines tube ovality and dimensional accuracy.
- **Lubrication & Cooling:** Ensures smooth material flow and prevents overheating.

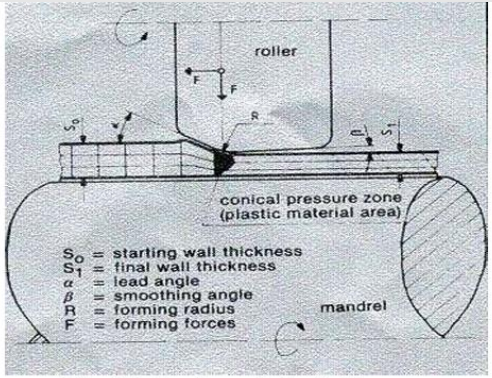
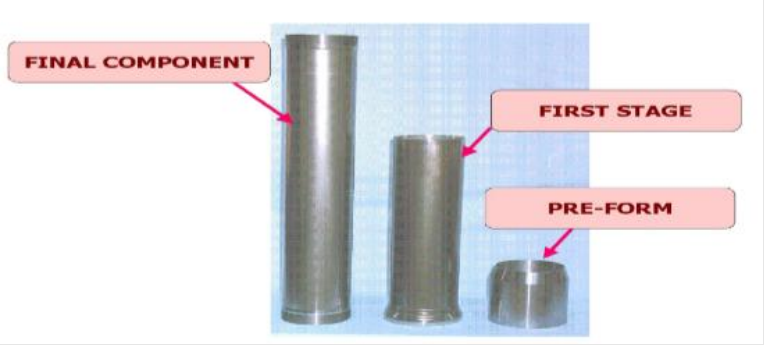


Fig- Mechanism of plastic flow

**Testing and Quality Control**
To ensure precision and quality, the following equipment was used:

•**Ultrasonic Thickness Meter** – Measures wall thickness consistency.
•**Hardness Tester (EQUITIP-D, Frank Tester)** – Ensures uniform hardness.
•**Surface Finish Measurement**– Evaluates texture and roughness.



# Results and Conclusions

✓ The finishing roller radius should be lower than other two rollers to have uniform mean diameter and reduction in ovality.

✓ The hardness variation in the preforms tube should be as less as possible to avoid thickness variation and ovality.

✓ The staggering of the rollers should be kept in such a way that there is a minimum of thickness of preforms tube.

✓ The feed rate is arrived at 50 mm/min on SAE 4130 Steels to obtain better ovality , thickness and mean diameter.

✓ Material Performance Evaluation – Assessed load-bearing capacity, impact resistance, and flexibility across multiple auxetic structures.
✓ Though reduction in feed rate improves surface finish, but its effect is there on ovality and mean diameter, therefore it is optimized at 50 mm/min.