Sheet Metal Forming - Introduction

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Sheet Forming as a System

The system variables affect the process and product quality

1. Workpiece / Blank
2. Tooling / Die Set
3. Tool/Mat’l Interface
4. Deformation Zone
5. Equipment / Press
6. Part / Product
7. Environment
Process Variables

Blank Variables:
1. Dimensions
2. Location in die
3. Edge condition

Lubrication Variables:
4. Lube type
5. Lube thickness/distribution

Press Variables:
6. Punch guidance
7. Punch speed
8. Binder force
   (time/location variation)
9. Counter balance pressure
10. Rigidity

Work Material Variables:
11. Thickness (nominal/variation)
12. Mechanical properties
13. Surface topography
14. Surface coatings/chemistry

Die Variables:
15. Guidance
16. Alignment
17. Surface finish
18. Material
19. Drawbeads (wear)
20. Hardness
21. Punch radii (wear)
22. Surface coatings/chemistry
23. Profile radii (wear)
24. Rigidity

Miscellaneous Variables:
25. Dirt on die/blank
26. Blank pre-bend position

Interactive Variables
27. Material temperature
28. Die temperature
29. Ambient temperature/humidity
30. Shims on stop blocks
Characteristics Of Sheet Forming Processes

- Incoming material is sheet blank of partially formed workpiece (thin section)
- Deformation causes significant changes in shape, but little change in thickness (although variations in thickness are very important)
- Elastic recovery is important to maintain shape and tolerances
Blanking / Piercing

Phases of the Blanking/Piercing Process
Courtesy: Schuler Inc.
Fine Blanking

punch
annular serrated blank holder
serrated ring
die
counterpunch

Fine Blanking
Courtesy: Schuler Inc.
Trimming: to shear from a workpiece a particular portion which is not required on the final product.

Trimming (Kalpakjian, 1997)
Air Bending

Sheet Bending: Forming of some finite curvature on (usually) flat sheet metal along a straight edge.
Die Bending

Courtesy: Schuler Inc.
Flanging: a process of bending the sheet metal about a straight or curved edge.
Flanging

- Straight Flange
- Stretch Flange
- Shrink Flange
- Reverse Flange
- Jogged Flange
- Hole Flange
Roll Forming

Process:
- Shaped rolls form long, constant cross-section parts

Application:
- Siding, channel, cable trays, welded tubes

Key Process Variables:
- Forming sequence
- Friction
- Tool geometry

Courtesy: Schuler Inc.
Spinning a Hollow Body

Courtesy: Schuler Inc.
Expanding by Stretching

Courtesy: Schuler Inc.
Stretch Forming

Courtesy: Schuler Inc.
Single-draw Deep Drawing with Blank Holder

Courtesy: Schuler Inc.
Deep Drawn Part Samples

Deep Drawn Rectangular Part

Deep Drawn Cup Part

Deep Drawn Fender
Deep Drawing with Draw bead

Binder holder

Punch

Die

Draw bead

Deep drawing with drawbead

Courtesy: Schuler Inc.
Deep Drawing and Redrawing

Multiple-draw Deep Drawing with Telescopic Punch

Courtesy: Schuler Inc.
Progressive Deep Drawing

Forming sequence: from left to right/ forming stages are indicated with an arrow;
[Courtesy: PAX Machine Works Inc.]

[Courtesy: Schuler Inc.]
What is Tube Hydroforming?

(1) Place the blank tube into tooling

(2) Seal the ends and fill with fluid

(3) Increase pressure, move punches

(4) Open the tooling, remove the part
Hydromechanical Deep Drawing

Hydromechanical Deep Drawing
Courtesy: Schuler Inc.
The Principle of Flexforming

Courtesy: ABB
Ironing

Process:
- Die reduces workpiece thickness around punch

Applications:
- Tubular products
- Beverage cans

Key Process Variables:
- Friction
- Thickness reduction
- Punch velocity
- Tooling geometry
- Process sequence

Courtesy: Schuler Inc.
Can Manufacturing

Deep Drawn Cups Ironed in Several Dies

Courtesy: Schuler Inc.
Summary of Variables in Sheet Forming

1. Workpiece / Blank (Sheet)
   (Mechanical, Thermal and Physical Properties, Flow Stress, Formability, Surface Conditions, Relations between Process Variables and Properties)

2. Tooling / Die Set
   (Geometry, Surface Finish, Material and Hardness, Temperature)

3. Tool-Material Interface
   (Friction/Lubrication, Heat Transfer)

4. Deformation (Work) Zone
   (Deformation Mechanics, Material Flow, Stresses, Temperatures)

5. Equipment / Press
   (Speed and Production Rate, Rigidity and Accuracy, Force/Energy)

6. Part / Product
   (Geometry, Tolerances, Surface Finish, Properties)

7. Environment
   (Manpower, Pollution, Plant and Production, Facilities)
Questions & Contacts

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