

**SHORT COURSE
ON
TUBE HYDROFORMING (THF)
FUNDAMENTALS AND APPLICATIONS**

June 2002

COURSE CONTENT

1. General Overview

Manufacturing Process Overview

Example Hydroformed Parts

Hydroforming System Components

- Appendix A – Forming of a Y-Shape
- Automated THF Production Line

2. Material Properties and Formability

Material Properties relevant for Tube Hydroforming

Stress/ Strain Diagrams

Determination of Material Properties

Tube Hydroforming and Quality Control

Effect of Friction in Hydroforming

Parameters Influencing the Friction

Types of Lubricants used for Hydroforming

Evaluation of the Lubricant Performance

- Appendix A – Tube Bulge Test Tooling
- Appendix B – Tube Bulge Test
- Appendix C – Tube Bulge Test

3. Friction in THF

Introduction

Lubrication Test for Guiding Zone

Lubrication Test for Transition Zone

Lubrication Test for Expansion Zone

- Appendix A – LDH Test
- Appendix B – Friction Test for Guided Zone
- Appendix C – Friction Test for Expansion Zone

4. Tooling for Tube Hydroforming

Concepts of Tool Design

Selection of Die Material and Surface Treatments

Sealing Techniques

Pressures and Tool stresses

5. Tube Hydroforming Presses

Die Closure Systems

Various Machine Concepts

Control of Internal Pressure and Axial Feed

Automation and Cycle Times

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6. Tube Bending in THF

Purpose of Pre-forming and Bending

Tube Pre-forming and Crushing

Effects of Bending on Wall Thinning and Hardening

Limits and Variables of Bending

Bending Process and Equipment Selection

Requirements of Hydroforming

- Appendix A – Crushing and Expansion of a Round Tube
- Appendix B – Crushing and Expansion of an Oval Tube
- Appendix C – Wrinkle Formation in Crushing and Expansion of Various Geometries

7. Process Simulations

Metal Deformation in Hydroforming

Stress & Strain

Process Limits and Process Control

Prediction of Process Parameters

Forming Limit Diagrams

Process Simulation using FEA

- Appendix A – Simulation of a Y-Shape
- Appendix B – Simulation of a T-Shape without a Counter Punch
- Appendix C – Simulation of a T-Shape with a Counter Punch
- Appendix D – Simulation of a Bulge with Conventional Loading Paths
- Appendix E – Simulation of a Bulge with Adaptive Loading Paths (the conditions are same as that for the conventional simulation in Appendix D)

8. Product Design in THF

Example Hydroformed Parts

Classification of Parts

Design Considerations

Computer Aided Design Systems

9. Discussion

COURSE FEES

A. When the course is given at a hotel or university, or in cooperation with a conference:

Per person: \$495.00 – includes

- a) A booklet, which contains black & white copies of the slides used and
- b) A CD**.

B. When the course is given at a company location: Per person: \$450.00 – includes a booklet that contains black & white copies of the slides used and one copy of a CD** (that contains the power point slides, animations and other stamping modules). Minimum of 8 people (or \$3600) plus travel expenses for the instructor.

C. The course is provided on a CD only:** It is possible to purchase this course, together with appropriate modules, on CD**. The cost will be \$495 per CD + \$15 shipping and handling.

**** The CD contains a) all the figures (in color), animations and videos used in the course and b) a booklet that consists of all the chapters (text) of the course.**

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PAST EVENTS

New Developments in Tube Hydroforming Technology 2001 and Tube Hydroforming Fundamentals Workshop, organized by SME and ERC/NSM, December 4-6, 2001, Novi, Michigan

Innovations in Tube Hydroforming Technology International Conference and Tube Hydroforming Fundamentals Workshop, Sponsored and Organized by: SME and ERC/NSM June 13-14, 2000, Troy (Detroit), Michigan

Auto Tube Hydroforming Conference, Hydroforming 101 Workshop, Presented by: ERC/NSM in cooperation with PMA May 2, 2000, Southfield (Detroit), Michigan

The 4th Annual Automotive Tube Conference, Hydroforming 101 Workshop, Presented by ERC/NSM in cooperation with TPA April 26, 1999, Dearborn, Michigan

The 2nd International Hydroforming Congress and Fundamentals of Hydroforming Workshop, Sponsored by: ERC/NSM, SME and Schuler Inc. November 17-19, 1998, Nashville, Tennessee

The 2nd International Conference on Innovations in Hydroforming Technology, Sponsored by: ERC/NSM and TPA September 15-17, 1997, Columbus, Ohio

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