HP- RTM – Process Advancements

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ICT
High Pressure Resin Transfer Molding – Process Advancements

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10th ACCE, 15-16. Sept 2010, Troy (MI)
Content

- RTM Material Advantages
- RTM Technology and Applications
- Cooperation Dieffenbacher – Krauss Maffei
- RTM Preforming
- RTM Dosing Systems
- RTM Tool Design
- RTM Press Concept
- RTM Machining
- **RTM Material Advantages**
  - RTM Technology and Applications
  - Cooperation Dieffenbacher – Krauss Maffei
  - RTM Preforming
  - RTM Dosing Systems
  - RTM Tool Design
  - RTM Press Concept
  - RTM Machining
Unbeatable combination of properties
RTM (Resin Transfer Molding) – Basic advantages

1. Excellent Part properties
   - distinguished mechanical properties – bidirectional
   - high surface quality
   - paintable on both part sides

2. Stable Process
   - High repeatability
   - Self cleaning Mixing head
   - Stable temperature control inside the metering machine up to 120°C

3. High Productivity
   - relatively short cycle times compared to LP process
   - IMP Possible
   - high degree of automating possible
Unbeatable combination of properties

RTM (Resin Transfer Molding) – Basic advantages

Fiber contents up to 70 weight percentage with RTM

- Material:
  - EP Epoxy or Polyurethane resin
  - Glass, Carbon fibers

- Fiber length:
  - Start length 50 mm - ∞
  - Length in part 50 mm - ∞

- Benefit:
  - Defined fiber orientation
  - Unsolvable binder
  - High mechanical properties (directional)
  - Low specific weight
  - High fiber contents

Typical application
- Utility vehicles and trucks
- Aircraft & helicopter (Carbon)
- Optical (visual) parts
RTM Material Advantages

RTM Technology and Applications

Cooperation Dieffenbacher – Krauss Maffei

RTM Preforming

RTM Dosing Systems

RTM Tool Design

RTM Press Concept

RTM Machining
RTM – Process Technology
Various Liquid composite molding processes

1. Vacuum infusion process - VIP

- Semi finished cuts
- Preform placement on mold
- Cover preform with vacuum film
- Apply vacuum; inject resin; impregnation and curing
- Cured component

2. Resin transfer molding - RTM

- Semi finished cuts
- Preform placement in matched rigid mold
- Inject resin; impregnation and curing
- Cured component

3. Vacuum assisted resin transfer molding - VARTM

- Semi finished cuts
- Preform placement in matched rigid mold; apply vacuum
- Inject resin; impregnation and curing
- Cured component
**RTM – Process Technology**

**HP- RTM Process**

### High pressure injection RTM – HP-RTM

1. Semi finished cuts → Preform
2. Preform placement in matched rigid mold; apply vacuum
3. Inject resin at high pressure (60-100 bar); impregnation
4. Apply high compression force; Complete impregnation and curing
5. Vacuum
6. Cured component

### Advantages of High Pressure RTM:

- Rapid mold filling
- Improved impregnation quality
- Accelerated resin reactivity system can be applied – short cycle time
- Significant reduction of air entrapments and voids
- Excellent surface properties
- Low tolerance in thickness and 3D shape
- High process stability and repeatability
- Use of internal release agent – self cleaning system
Potential for lightweight design

RTM – Industries

- Automobile
- Trucks
- Train
- Boat/ Shipbuilding
- Aerospace
- Agricultural equipment
Target Light weight design
Structural Body parts

Underbody structure

Side Frame

Bumper

Roof

Audi R8 Spyder

BMW M6

BMW Project I CityCar

Bild Quelle Internet
- RTM Material Advantages
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Cooperation KraussMaffei - Dieffenbacher

Turn Key supplier for RTM application
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Turn Key supplier for RTM application

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Tank /Storage System

Pre-forming

Metering technology

Press process

Mixing head

Line Automating

Post Treatment

Line Control

Tooling

Tool Cleaning

Bild Quelle Internet
RTM Material Advantages
RTM Technology and Applications
Cooperation Dieffenbacher – Krauss Maffei

**RTM Preforming**
- RTM Dosing Systems
- RTM Tool Design
- RTM Press Concept
- RTM Machining
RTM – Process
Process Chain

- Handling of Fabrics
- Layup and Fixing
- Contur Cutting
- Unrolling of Fabrics
- Draping and Preforming
- Net-Shaping of Preform
- Handling into Press Mold
- Closure of Press Mold
- Resin Injection
- Unloading and Finishing
- Mold Cleaning
- Finished RTM Part

Fiber Fabrics

Preform

Finished RTM Part
RTM – Process

Process Chain

- Fiber Fabrics
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**RTM – Preforming**

Definition of product requirements

- **Materials:**
  - Woven fabrics
  - Fiber material
  - Binder material

- **Size:**
  - Dimension: 1,400 x 1,600 mm
  - Height: 100 mm
  - Thickness: 2.5 mm

- **Layup:**
  - Number of layers
  - Type of fabrics
  - Local reinforcement
  - Inserts
RTM – Process
Line Layout

1 Cutting
2 Lamination
3 Stock in/ out
4 Preforming
5 Net Shaving
6 Transfer Container
RTM – Preforming
Cutting Possibilities - Overview

Cutting

Mechanical
- CNC stamping (cutting blade)
- Roll cutting (circular blade)
- Ultrasonic

Other / Energy
- Laser
- Plasma

Cutting device and cutting knife depends on used material
RTM – Preforming
Cutting Unit – Cutting Bridge

Mechanical

- CNC stamping cutting blade
- Roll cutting circular blade
- Ultrasonic
RTM – Preforming
Gripper – Overview

Gripper

- non-positive-locking
  - vacuum
    - vacuum gripper
  - electrostatic
    - electr. adhesion
  - molecular
    - adhesion film
    - freeze gripper

- adhesive-locking

- positive-locking
  - mechanical
    - needle gripper
    - grate gripper
RTM – Preforming
Fixing of Fabrics - Possibilities

Fixing of Fabrics

- chemical
  - bonding
    - powder binder
    - fleece binder
    - hot glue
    - liquid binder
  - welding
  - thermoplastic fiber
  - thermoplastic resin

- thermal
  - welding
  - needling
  - knitting

- mechanical
  - stitching
    - classical stitching
    - one-sided stitching
  - needling
  - knitting
RTM – Preforming
Handling

2D Shape

3D Shape

Robot Gripper
CF
Cutting table / lamination table

Preforming tool

Single fabrics
Fixed Multi layer fabrics

n lay-up
1 lay-up
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**RTM Dosing Systems**
- RTM Tool Design
- RTM Press Concept
- RTM Machining
RTM Dosing Systems
Pump Dosing Maschine
RTM Dosing Systems
New Metering concept from 20g/sec to 200g/sec

Special Working Tanksystem
- Vacuum system
- Refilling by Vacuum

Special Working Tanksystem
- Free selectable part counter
- Variable shift classification
- Trend diagram
- Profile data recording
- Maintenance plan
- Failure protocol
- Administration of up to 512 different foaming programs

Release agent Dosing
- Direct feeding to mixing head
- Increase de-molding properties

Heating chamber
- Preheating of 200l Barrel
- Constant temperature control up to 120°C

Hydraulic System
- Strong system to realize multi-point injection
**RTM Mixinghead**
High Pressure Mixingsystem

**Outstanding Lifetime**
- due to intelligent composition of special materials and surface treatments

**Impingement Mixing**
- Self cleaning system
- No static mixer necessary
- up to 120°C working range
- suitable for high speed system

**Release agent dosing direct at Mixing head**
- amount adjustable
- Controlled by PUC 07
- no contamination of material at working container
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RTM Dosing Systems
**RTM Tool Design**
RTM Press Concept
RTM Machining
Sealing Concept
→ Special sealing concepts for low viscose RTM systems

Vacuum System
→ Patented Vacuum system to ensure 100% resin filling

Multi Mixing head injection
→ Tool can be prepared for x numbers of mixing heads (pressure reduce filling process)

Integrated Pressure measurement
→ to ensure 100% filling of cavity
→ minimize rejection

RTM Tool Design
Tool design by KraussMaffei
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- **RTM Press Concept**
- RTM Machining
Fully automated press concept for large production volume.

Key features:

- High Pressure process for fast reacting resins and high surface quality
- High precision and high speed leveling system
- Full automation and process control
**RTM – Press Concept**

Compress Plus

Hydraulic Press System: COMPRESS PLUS

- Energy efficient ram closing
- Short stroke cylinders with mechanical locking system
High speed
High precision leveling system

- flow control and process control
- high accuracy in part thickness
RTM – Press Concept
Press Automation

Fully automated system including:

- Preform handling into the mold
- Mold transfer into the press
- Resin injection
- Unloading of finished part
- Transfer into rack
- Mold cleaning
- Complete process control
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RTM – Machining
Solution using Robots

3D-Simulation

Offline-Programming

Machining Center Interior

Knife Cutting

Handling
RTM – Machining
Machine concept CF-structure parts

Machine with horizontal turning wall and 2 robots

- Technic-Rack on back frame
- Mobile Robot-cell
- Tool changing system
- Modern waste management
- Horizontal-turning wall
  → Working range BxH 3000x1600 mm
- Complete open operators area
Thank you for your attention.