



Filament Winding with Increased Efficiency: Ring Winding Head – Multiple Payout Device

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Demands on Advanced Manufacturing Technologies

Increasing Demand for Pressure Vessels in the Automotive Sector:

- The increasing number of natural-gas vehicles
- Prototype cars with hydrogen fuel cells or combustion engines
- Economical high-quantity production of pressure vessels

Developments in the Hydrogen Storage Tank Technologies:

- Operation pressures of up to 700 bar
- Light weight pressure tanks consisting of fully wrapped liners (steel liners: Type III or polymeric liners: Type IV)
- High volume production technology

Objectives

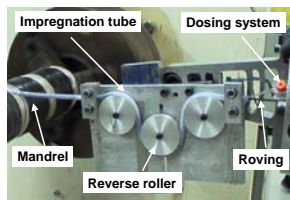
Reduction of Cycle Times for the Winding of Tanks (Wet Winding):

- Development of a high volume production filament winding technique
- Increasing the lay down rate by processing a higher number of rovings at the same time
- Development of an impregnation technique allowing a long processing time without cleaning breaks
- Considerations concerning a continuous and fully automated winding process (double spindle winding machine)

Impregnation Unit

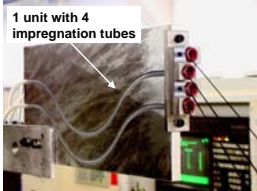
Advantages:

- Compact and modular construction
- Variable filament guide towards the mandrel
- No limitation due to pot life, resin is fed continuously
- Clean impregnation near the winder, minimized resin leakage
- Easy cleaning of the impregnation device
- Reduced amount of hazardous waste



Prototype of the tube siphon impregnation unit (test assembly)

Construction and Prototypes:



Optimized prototype (processing of four 12k CF rovings)



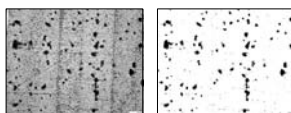
Final construction with resin dosing system during vessel winding (CF/EP, aluminum liner)

Investigation of the Suitability of the New Impregnation Method:

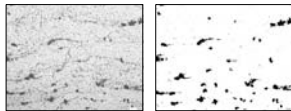
- Required length of the impregnation tube
- Deflection radius (sheaves with different diameters, see test assembly)
- Tube material (PA and PTFE)
- Abrasion resistance of the tube
- Fiber damage (rupture of rovings or single filaments)
- Influence of the fiber tension (creel brake)

Impregnation Quality:

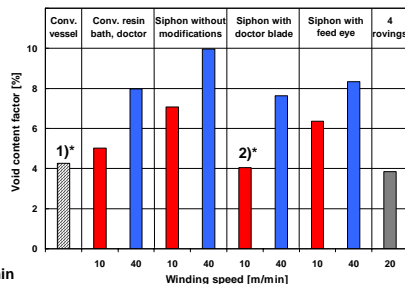
- Low void content of the reference (serial production) is reachable!



1)* Reference, standard pressure tank

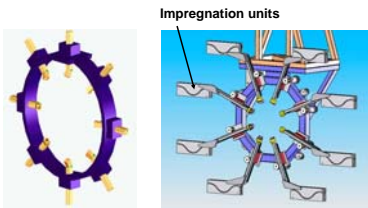


2)* Siphon with doctor blade, v = 10 m/min



Ring Winding Head

Ring Winding Head:



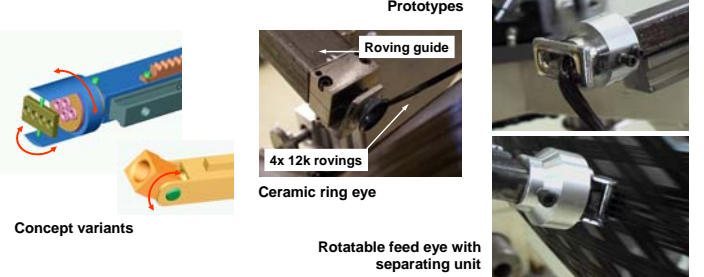
Design concept

3D-CAD construction



Optimized prototype (stiff steel frame)

Movable Payout Eyes:

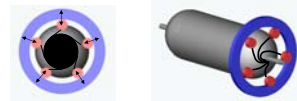


Concept variants

Rotatable feed eye with separating unit

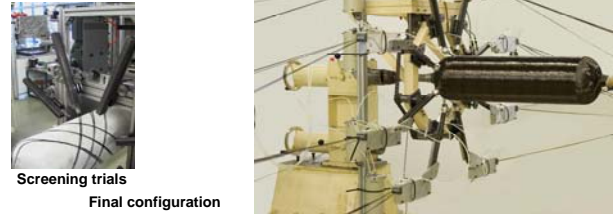
Development from Concept to Solution

Concept:



Ring winding head having radial movable arms

Ring Winding Head:



Screening trials

Final configuration

Pressure Vessels:



Improved wet wound vessels (Type III)

Tested vessel

Results:

- Increased lay down rate (factor 3.2 higher compared to standard wet winding)
- Optimized hoop layers and reduced fiber undulations (optimized light weight structures)
- Encapsulated siphon impregnation unit (reduced resin leakages and avoided hazardous waste)

AVK Innovation Award 2006:

IVW received the AVK Innovation Award for the development of:

- Ring winding head technology including the
- New impregnation techniques



JEC Innovation Award

Automotive 2007:

IVW and MATERIAL received the JEC Innovation Award Automotive for the development of:

- Ring winding head technology
- Path generation tool
- New impregnation techniques



Acknowledgement

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