



MATERIALS & MANUFACTURING PROCESSES

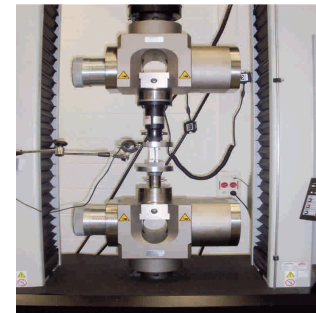


Materials Selection and Characterization

When selecting materials for blades a proper characterization is crucial, and then our experience combined with a modern materials laboratory becomes a key factor for design optimization.



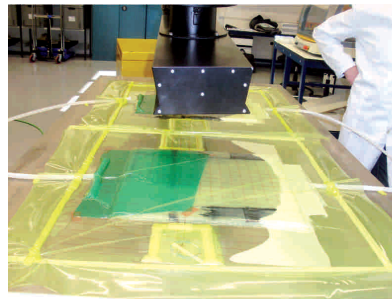
Dynamic Fatigue Test



Static Tensile Test

Blade Manufacturing Processes Optimization

CENER has a manufacturing workshop where different processes can be replicated and analyzed.



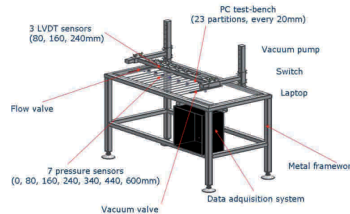
Infusion Porecess



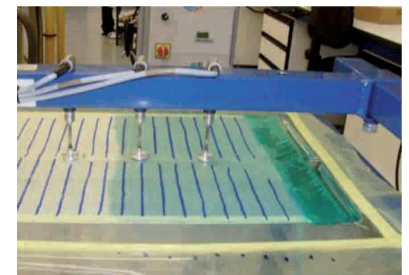
Oil heated table

Blade Manufacturing Process Simulation

Simulation of blade VARI processes – fibre permeability and resin characterization test bench in use.



Permeability Test Bench – schema



Permeability Test Bench– in use

The 3D simulation program for VARI process provides:

- Experimental permeability characterization of reinforcements and adjustment of numerical models.
- Numerical simulation of the mould filling process and adjustment of numerical models. This model takes data from the mentioned experimental characterization processes – In progress -.

Materials Selection and Characterization

Through its modern composite materials laboratory, CENER provides assessment and characterization services of new materials for blades in terms of:

- Chemical properties
- Physical properties (mechanical properties, viscosity, thermal conductivity, etc.)
- Cost and processability requirements
- Resin rheokinetics

Optimization of Blade manufacturing Processes

- Optimization of existing processes (VARI, prepregs, etc.)
- Development of new processes
- Cost and productivity assessment

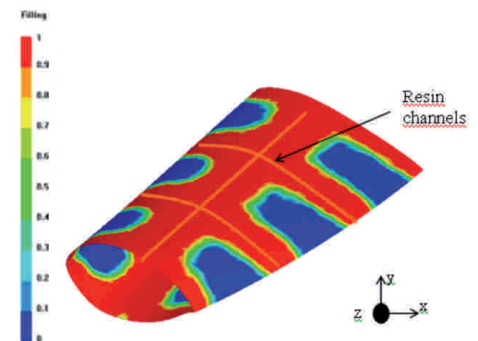
Blade Manufacturing Process Simulation

This project is developing and validating a number of tools which allows to:

- Change the current approach consisting in adjusting the process on a trial and error basis
- Select the most adequate materials for each product and process
- Optimize the manufacturing process in order to reduce manufacturing times and to improve both product quality and reliability.

The tools under developedment make possible the following issues:

- Experimental characterization of resin reo-kinetics and adjustment of numerical models
- Experimental permeability characterization of reinforcements and adjustment of numerical models.
- Numerical simulation of the mould filling process and adjustment of numerical models.
This model will make use of models obtained by means of the above mentioned experimental characterization processes.



Finally, the 3D simulation program and tools will be validated through experimental means of different manufacturing tests perform on a full size blade mould.

Materials Laboratory Equipment:

- Σ **DSC**:cure kinetics, Cp measurements
- Σ **DMA**: Tg measurements, modulus measurements, elastic/viscoelastic behaviour
- Σ **Brookfield**: viscosity and evolution during curing
- Σ **Gel Time**: measurements in thermosetting resins
- Σ **Optical microscope with image software**: porosity measurements, layer thickness, fibre alignment
- Σ **Fatigue test machine 250 KN**:fatigue tests
- Σ **Static test machine 600 KN**: tensile, compressive, 3&4 point bending tests
- Σ **Large work area to test sub-components**; 30 KN load cell to test adhesives, resins or coats
- Σ **Determination of FVF and void content**
- Σ **Density measurements**