Abstract

The popularity of composite materials is constantly growing, which can be verified by the rising number of composite parts in our everyday life. Examples of composite parts can be found in the Airbus A 380 or the constantly increasing number of wind turbines which contain composite rotor blades of over 50m length. Because of the main features of composites, which are light weight combined with high strength and the possibility of tailoring the strength and the stiffness of the composite according to the requirements, their application is highly efficient and economic.

In order to manufacture a composite part by employing a Liquid Composite Molding Process (LCM), it is first necessary to select an appropriate manufacturing process such as the Resin Transfer Molding Process (RTM) and to design a mold which corresponds to the requirements of the selected process. Then the stacking sequence of the individual fibrous reinforcements is designed to withstand the loads on the final part. To achieve an efficient composite manufacturing process, pre-shaped, handable, dry reinforcing structures, so called preforms, need to be applied. Such preforms can be assembled either by using conventional binder technologies or by the recently developed "cut and sew approach". A variety of available software simulation tools support the design engineer in this task. These tools are, on the one hand, a fast way of gaining information about the expected loads the mold has to endure during the injection process. On the other hand, they provide the possibility to optimize the injection process and its process parameters and to identify critical points of incomplete saturation. With this information at hand, the design of the mold can be adjusted in order to obtain optimal processing conditions for a slim and efficient production cycle.

A prerequisite for employing these powerful simulation tools is to obtain thorough knowledge of the required input parameters concerning the fibrous reinforcement to be used. The most important input parameters are the compaction behavior and the permeability of the fibrous stacking sequence. Because of the absence of model-based tools to provide this input information experimental determination methods have to be employed.

This work introduces two semi-automated measurement cells which determine the in-plane permeability of fibrous reinforcements in an efficient manner, i.e. the dielectrical permeability work cell and the optical compaction and permeability work cell. The latter of which can determine both the required compaction and the permeability information in one single experiment. The design and manner of operating of the optical compaction and permeability work cell is described and its functionality is validated by a comparison of experimental results.