New method for producing multidirectional layer fabrics

The advantage of multidirectional layer structures applied for fiber-reinforced plastics is the high exploitation of fiber-specific properties. By using the new method for producing multidirectional layer fabrics defined layer structures are manufactured in a two-stage process. The chemically fixed multidirectional fabric has an +α/0°/-α structure.

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The properties of fiber-reinforced plastics are characterized by the type and structure of their textile reinforcement, especially in the field of producing fiber-reinforced articles. This is a wide range of application for multidirectional layer fabrics.
A high exploitation of the fiber-specific properties is given by the exact longitudinal positioning of the fibers, furthermore the structure of the layer fabric is highly adaptable to the application of the fiber-reinforced article in angle and structure of the layer fabric.

Process

The manufacturing process of producing the multidirectional layer fabric consists of two steps: 1) producing a predefined unidirectional fabric and 2) producing the multidirectional layer fabric (Fig. 1).
Roving spools with the reinforcement fiber material form the basis for step one. The fiber roving will be spread, the filaments are paralleled and positioned as a predefined fibrous web and then fixed. In step two, the production of the multidirectional layer structure on the MD machine is realized. Hereby, unidirectional fabric produced in step one will be wound round on a further unidirectional fabric at an angle α to manufacture the multidirectional layer fabric in a continuous way. The winding and layering up of the unidirectional fabric is made in a manner that a homogenous layer fabric is built [1, 2].

Production of prefixed unidirectional fabrics

The rovings are supplied free from twist from the spools to an UD machine. At the UD machine the roving will be spread to the required area weight. The result is a homogeneous fibrous web consisting of fibers oriented in parallel. All kinds of reinforcing fibers, e.g. glass, carbon or aramid fibers are suitable for this technology.
The produced fiber area is fixed by a chemical binder in a predefined structure. Hotmelt or permanent adhesives are used as chemical binders. The binders are compatible with the matrix of the fiber-reinforced plastics.

Production of multidirectional fabrics

On the MD machine the multidirectional layer fabric will be produced in a special winding process wherein one width at an angle is wound around the edges of a second width which is transported into the longitudinal direction. On the fixing device the layer fabric will be bonded to a workable fabric width with a layer structure of +α/0°/-α (Fig. 2).
There exist special geometric and kinematic parameters for the winding process (Fig. 3). Under this process the laying width b and the laying length L result from the defined working width B and the laying angle α. Based upon the given geometrical parameters the definition of the rotation of the system about the system axis x results in the kinematics for the interconnected motion functions for the laying of the α-fabric width, the production and the fixing of the multidirectional layer fabric.
Further variants of the winding process, e.g. the winding of two α-fabrics on each edge of the 0°-fabric and the use of a number of α-fabrics per edge, with a variation of the α-geometry, are possible. Moreover, a variation of the kinematics by the rotation of the α-fabrics while the 0°-fabric is fixed and a combination of these variations are possible, too.

Experimental plant

For practical experiences and for producing first multidirectional layer fabrics according to the procedure described an experimental plant was built. On this experimental MD machine multidirectional fabrics with a width of 600 mm are producible. The multidirectional structure is fixed by the chemical binder of the unidirectional prefixed fabrics on the calandering device.
The rotation of the 0°-fabric forms the basis of the machine concept. The 0°-fabric is taken from a revolving plate trough the calandering device to the winding-up. In the space between the revolving plate and the calander the α-fabric is wound around the edges of the

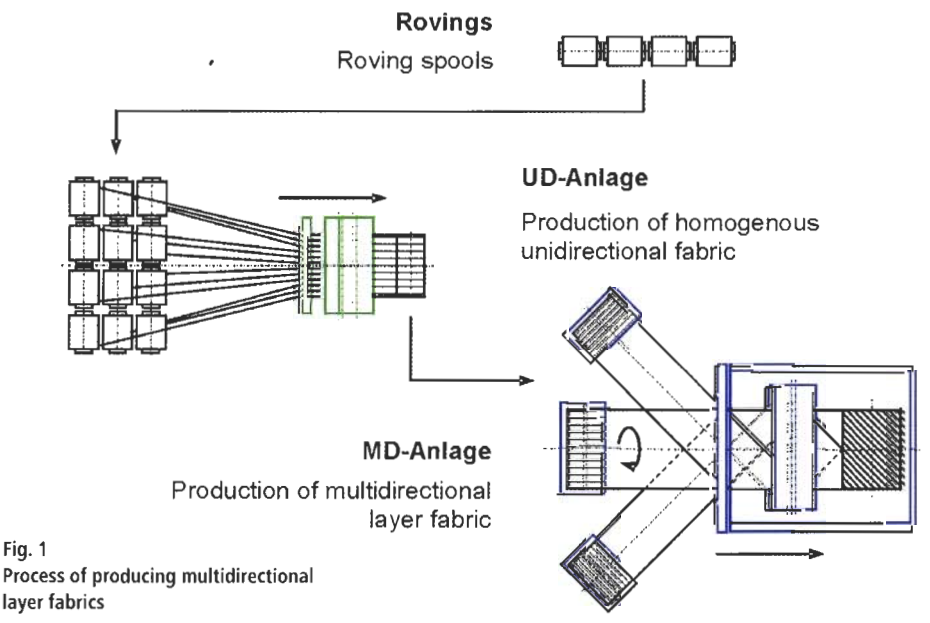


Fig. 1
Process of producing multidirectional layer fabrics

Fig. 2
Process of producing multidirectional layer fabrics

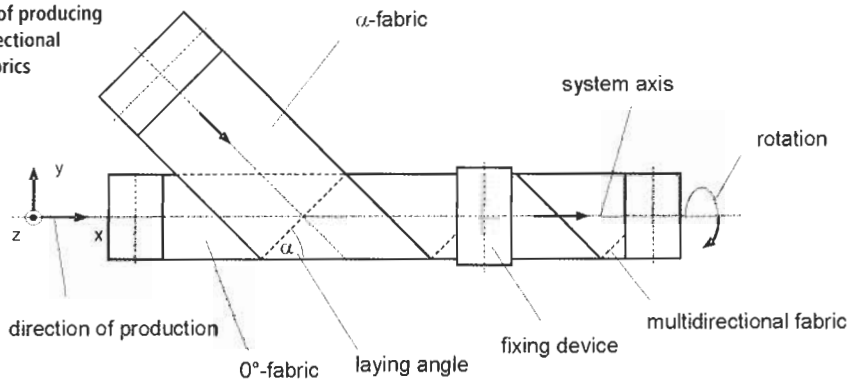
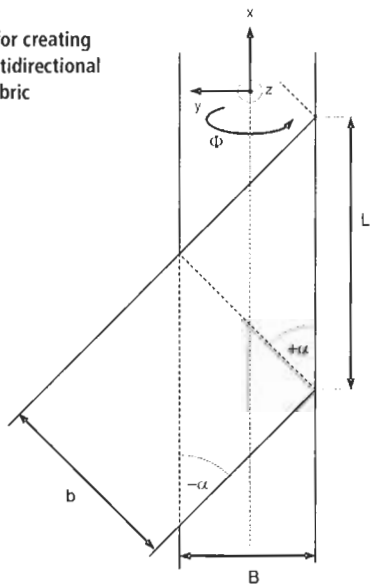


Fig. 3
Model for creating the multidirectional layer fabric



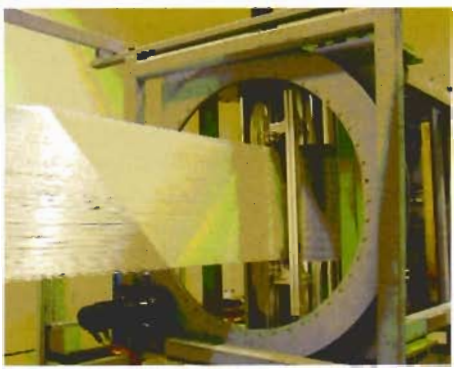
0°-fabric. The adhesive surfaces of the prefixed unidirectional fabric layer are arranged in opposite to each other. In the following calander device the unidirectional layer fabric will be fixed by pressure. Calander and winder are positioned in a revolving frame. For exercising the winding process, both revolving plate and frame rotate synchronously.

All important drives of the experimental MD machine are designed as stationary servo drives with the possibility to control the kinematics of each motion parameter irrespective of the main rotation of the system axis.

First tests of the winding process (Fig. 4) were done by using prefixed unidirectional glass fiber fabrics. The produced multidirectional layer fabric had the layer structure +45°/0°/-45°.

As a result of the first tests a numerous range of aspects with a high complexity arose and had to be considered. The main feature is the behavior of the edges of the 0°-fabric in the winding process for creating a correct layer structure. An other feature is the motion control of the α-fabric based on the process kinematics.

Fig. 4
Producing multidirectional fabric on the experimental MD machine



Further proceeding

One main aspect of further workings concerning the production of multidirectional layer fabrics by winding is the continued development progress in the field of the winding process by practicing numerous tests to reach the reliability of the process and to use several materials.

In order to this, there are two directions of research. First, the further development of the machine technology and second, the further development of the procedure based on the requirements of the customers and producers of fiber-reinforced textiles and plastics. ■

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