Winding movement trajectory optimization of composite elbows based on four-dof winding machine

Abstract: In order to solve the problems that four-dof winding machine with continuous commutation and tremor is not smooth, the quality of product is poor and the low productivity as well in the process of composite elbow winding. Optimize the winding movement trajectory of composite elbows to acquire a better trajectory of a four-dof winding machine. The mathematical model of filament-wound composite elbows is presented. The torus part is overwound using geodesics, and the both cylindrical parts are produced using non-geodesics. In order to access the stable trajectory of each axis, and analyze the influence of the process parameters such as the length of the hanging filament and enveloping form on trajectory of each axis, and plan a stable winding trajectory for a four-dof winding machine on elbows. Adopt the joint simulation platform of ADMAS and MATLAB to simulate on the trajectories of each axis, and obtain the kinematic characteristic curves of each axis, as shown in the following figure, and optimize the winding trajectory as well.

The filament winding experiment adopt the optimized winding trajectory and it is carried out on the elbows. In the winding, car’s movement curve has no obvious sawtooth or mutation, which shows that the movement of the car is more smooth and less prone to shaking. In contrast, the non-geodesic winding is obviously distorted when the car is reversing. Meanwhile, the reversing arm also appeared speed mutation and nozzle motion curve has individual sawtooth,
the geodesic winding method is relatively better by considering obvious jitter of the outrigger and wire mouth in the event of non-geodesic winding. So further optimizations are needed to eliminate velocity mutations. Through the comparative analysis of three types of movement, we conclude that the winding machine trajectory curve which is acquired by adopting a constant fiber length, smaller suspension length and geodesic winding model is more smooth and can be used as the ideal path of winding machine.

The winding experimental results show that the winding machine moved smoothly, and there are no continuous commutation, no tremor, no pause and other phenomena in the process of movement; the fiber paths designed by this system are accurate, and there are non-bridging, no slip yarn and overlapping. And it is verified that the optimized winding trajectories can be applied to the four-dof winding machine for stable and high-quality winding of the composite elbow.

Keywords: composite; elbows winding; four-dof winding machine; trajectory optimization

References:


