Development of a New Testing Bench for Textile Through-Thickness Permeability Characterization

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Introduction

The thickness of polymer composites parts is generally much smaller than its length and width. A number of new LCM processes, such as compression resin transfer moulding (C-RTM) and resin film infusion (RFI), have been developed to promote the resin flow along thickness direction of fibre preform to increase production efficiency. For purpose of studying the resin flow behaviour in thickness direction, different methods for through-thickness permeability (*Kz*) determination have been reported in literatures. In this study, a new through-thickness permeability bench, based on Darcy's law in one-dimensional porous medium flow, has been fabricated and series of validated experiments have been done in order to obtain high precision.

Experiments and Results

Figure 1 shows the schematic of the new *Kz* test system. Pressure stability tests were conducted in different pressures (0.25bar, 0.5bar, 1bar, 1.5bar and 2.5bar). Each of these tests lasts 1200 seconds. Results illustrate that the fluctuation of pressure increases as the setting pressure decreases because the loss of pressure is too slight to be detected by the relief valve. It increases to 4 percent when the setting pressure is 0.25bar, which is less than 1 percent at a setting pressure of 1bar.

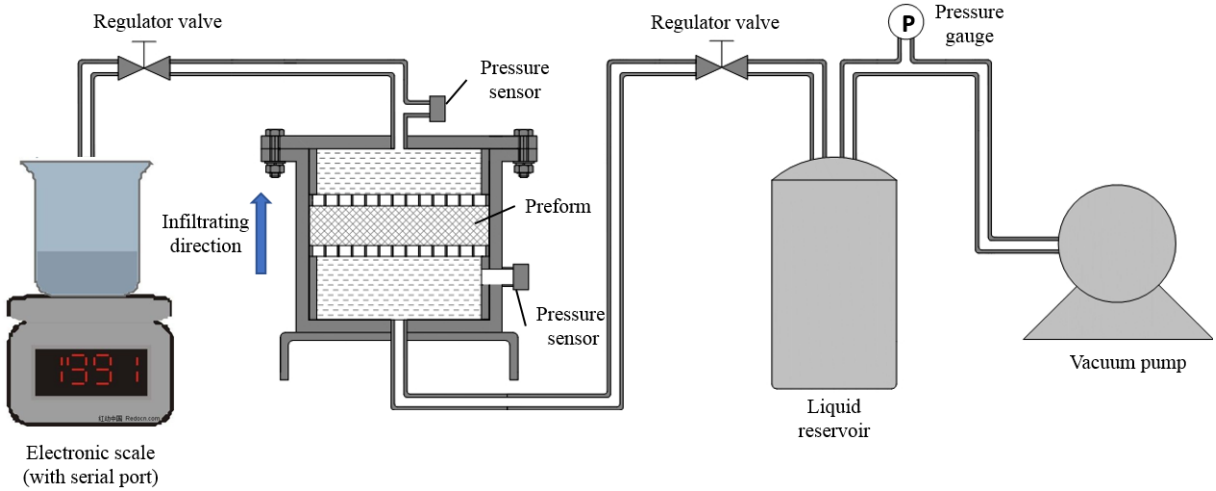

Figure 1: *Schematic of the Kz test system*

During the test period from 0 to 1200s when the setting pressure is 1bar, the pressure fluctuation is 1.22% and it reaches the minimum value after 400s. The fluctuation of pressure is reduced to 0.71% from 400s to 1200s. It tends to be constant as time goes on.

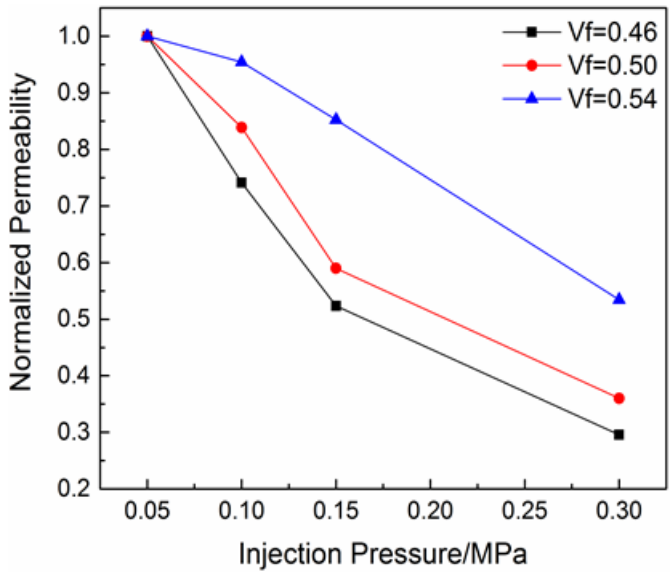

Figure 2: *Normalized Kz of Non-crimp fabric preform*

It shows that with the increase of injection pressure, the test results of *Kz* decreased gradually. The through-thickness permeability of the preform is significantly affected by the injection pressure. It's because the difference of pressure between the upper and lower surfaces of the preform will lead to further compression when the injection pressure is increased and the resistance of the fluid flowing through the preform is greater, which is manifested by the decrease of the permeability test value.

The C.V of permeability is around 5 percent while the fiber volume content (V_f) is 54w.%, which proves the through-thickness permeability measured by this new device is relatively accurate, and has a high reference value.

Conclusion

The *Kz* test system has been verified by experiments which proved the accuracy and reliability of hardware and software programmed for the new *Kz* tester.

It was also observed that the dispersion of *Kz* at high compression rate level is significantly lower than low compression rate level. As the injection pressure increasing, the through-thickness permeability *Kz* decreases significantly, showing a significant tendency of pressure dependant.

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