Condensation in Garment Systems

Introduction to Shell Garments

Our temperate climate has extremes, maybe beyond other areas of the world. This is characterised by the fact that most of our mountain regions have a closer proximity to costal weather effects than in Alpine mountain regions.

It is the lower pressure areas which create a considerable problem for a dry microclimate beneath waterproof breathable outer clothing.

A brief survey of the finest shell clothing currently available does not include warpknit polyester or polyester pile garments covered by a synthetic microfibre; neither of these are sufficiently waterproof in rain with winds exceeding 15mph.

Condensation and its Effects

In outdoor working situations, when undertaking average physical activity such as valley walking, the P.T.F.E. and hydrophilic P.U. combination, with a face fabric with excellent D.W.R. meets moisture vapour transmission demands and the inner clothing layer remains dry.

Other claimed waterproof breathable shell fabrics do not, from our field tests using miniature sensors, achieve as good a comfort level as the above P.T.F.E. combination.

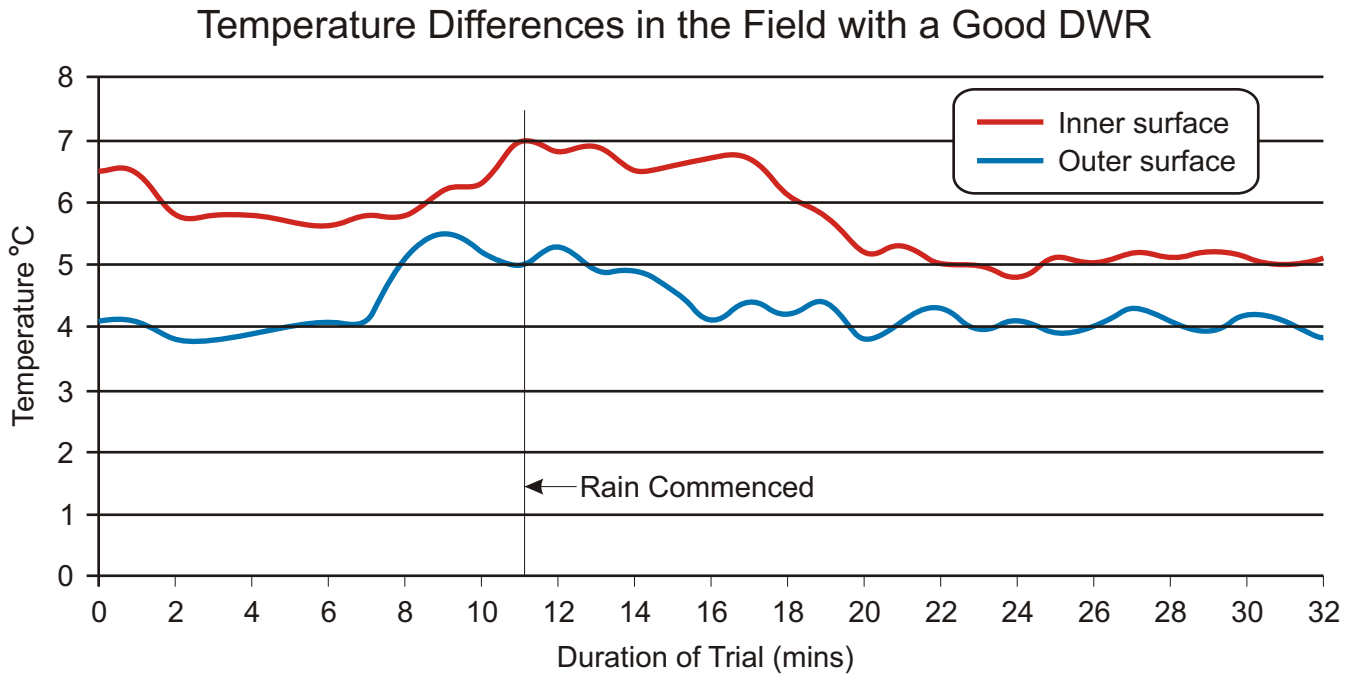
However, when undertaking strenous activity, such as mountaineering carrying a loaded rucsac in wind blown rain at temperatures less than 20 degrees C, the moisture vapour generated by the body exceeds the ability of every waterproof breathable, known to us, to transport the moisture vapour from the inside of the garment to the outside environment. In such conditions, condensation will often occur in the clothing system unless sufficient provisions are made in the design of the garment for venting.

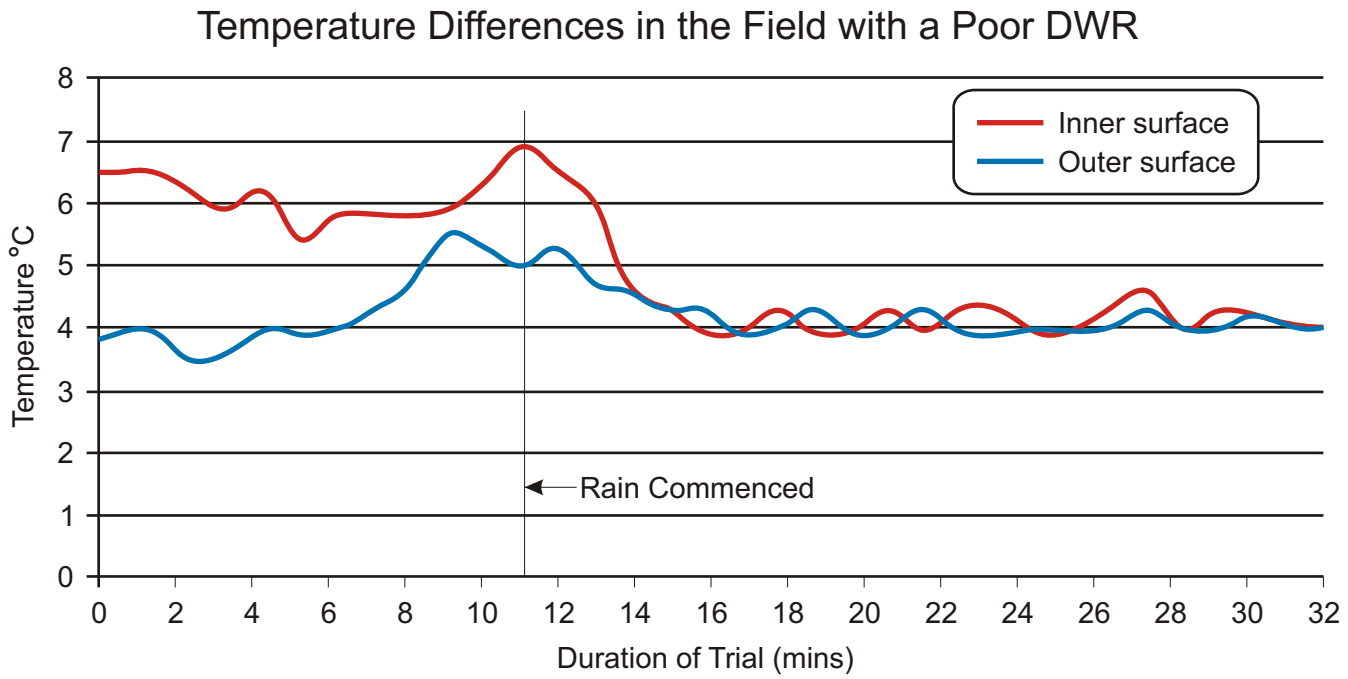
Under such weather conditions, the performance of the water repellent finish considerably affects the ability of the shell fabric to transmit moisture vapour. An excellent water repellent finish prevents rain from wetting out the face fabric and hence less cooling occurs and the dew point is reached later. Performance can be worsened by the use of a highly textured or peached/emerised face fabric, since the water repellent finish tends to be less durable. The rain therefore, wets out the face fabric earlier. This has a cooling action which accelerates the rate at which dew point is reached.

Ken Ledward Equipment Testing Service

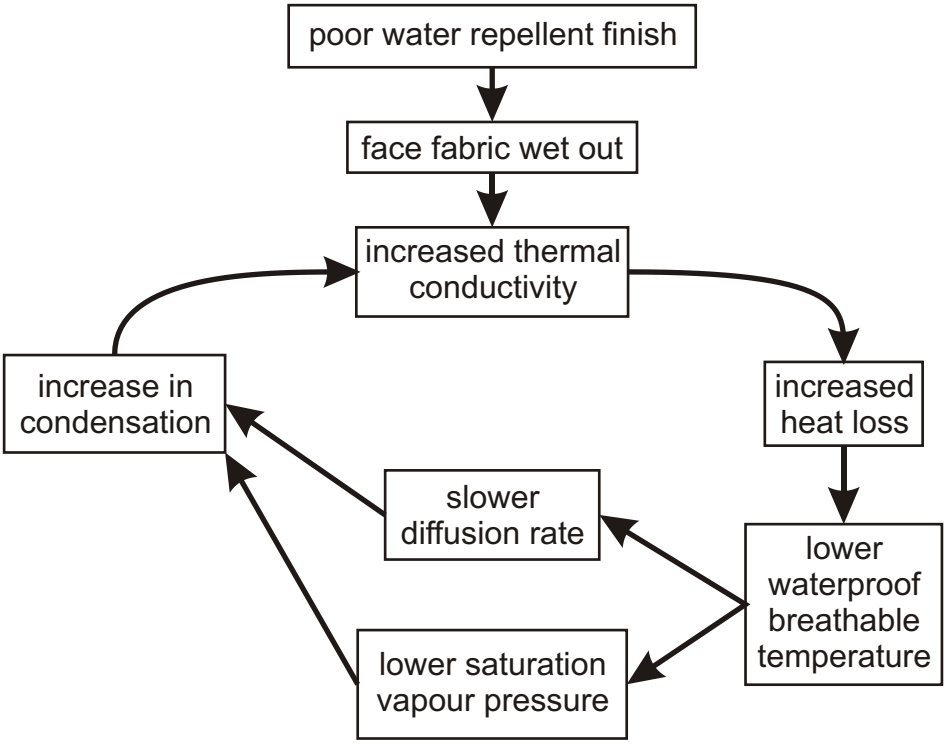
The importance of DWR

The graphs below indicate the effect of water repellency under rain conditions. The fabric with a poor DWR is affected by rain immediately. Both the inner and outer fabric temperatures decline as soon as rain commences. After 4 minutes, the heat losses have been sufficient to result in no temperature difference across the waterproof breathable fabric. This, accompanied by the lower temperature, reduces the rate of diffusion and lowers the saturation vapour pressure on the inner surface of the waterproof breathable fabric and hence condensation can form with a smaller amount of water vapour. If condensation forms, the conductivity of the system increases and greater heat losses occur leading to a vicious circle of events as shown below.





Vicious Circle of Events



As it starts to rain onto the fabric with a good water repellency, the inner and outer fabric temperatures decline slightly, reflecting the rain droplets hitting and running of the fabric. However, since the face fabric does not wet out the temperature gradient remains across the fabric and less heat is lost from the clothing system. This has three main consequences.

Firstly, the larger temperature difference across the fabric, increases the driving force for moisture vapour transmission.

Secondly, the higher temperature of the fabric results in a faster motion of the polymer chains in the waterproof breathable membrane/coating and also the moisture vapour itself thus increasing breathability.

Thirdly, the higher temperature results in a higher saturation vapour pressure and therefore more moisture vapour is required for condensation to form.

These three factors further restrict heat losses due to a lower fabric conductivity and hence a positive cycle of events occurs as shown below.

Positive Circle of Events