



Hi-Tec production in Indonesia. CREDIT: P2i

WHAT CONSTITUTES A WATERPROOF SHOE?

Most of us will accept that no form of footwear other than a fully-moulded Wellington boot is totally waterproof and even that ceases to apply if it is punctured. So, the most that can be hoped for is a degree of water resistance. Many footwear brands have latched on to this and, until recently, have found membranes offer the maximum protection. Despite the claims of membrane suppliers however, they do restrict airflow to a degree that many wearers say affects foot comfort due to excess internal heat and moisture producing an aptly named 'boil-in-the-bag' feeling.

In the November/December 2007 issue of *World Footwear*, we drew attention to a revolutionary new water resistance treatment developed by UK-based company P2i, called ion-mask. It has since caused something of a stir, winning the Coolmax Sportswear Award at ISPO Winter 2008. It is also being used by sports brand Hi-Tec on a 2,000 pair per day production line in Indonesia and the company was short-listed for the Lenovo Technological Innovation in Sports Award at the Sports Industry Awards 2008 based on its use of ion-mask.

BACKGROUND

There are three main approaches to preventing water penetration of shoe uppers.

The first is to use an after-care spray or wash-in treatment designed to impart a degree of water and oil repellency. Unfortunately, good penetration is difficult, while take-up varies from material to material. There is also a fairly limited effective life.

The second involves applying a durable water repellent (DWR) finish to the main upper components during manufacture. Mostly used on fabrics, they are applied while in the roll form and the upper is then constructed in the normal way. Despite the repellency imparted to the fabric, stitches, seams and construction joints have none and will still let water in, therefore cancelling most of the advantage gained by treating the fabric.

The third is to incorporate a membrane. Made of either microporous PTFE or a continuous hydrophilic sheet, these are located between upper and lining in the form of a 'bag' which, when properly constructed and installed, effectively keeps all water away from the foot. As already indicated, it

does however tend to make the foot hot. In addition, the upper itself will still absorb water which will sit next to the membrane adding to the weight of the shoe and further reducing breathability.

Ion-mask on the other hand is applied to the completed shoe by a chemical plasma process which permanently attaches it to every surface including the needle holes of stitched seams, so creating an all-over hydrophobic effect. It is also claimed that it does not inhibit the upper's breathability to the same degree as other treatments provided the actual upper itself is constructed from materials that already have that intrinsic quality themselves. Although all this sounds too good to be true, exhaustive testing would seem to suggest that it does indeed do all the things claimed for it. While there is not space to include details of every test carried out, those in key areas clearly show significant improvements over the three other methods already mentioned.

WATER RESISTANCE

As the main aim is to keep water out, we will take this as a starting point. A number of tests were conducted in this area, the results of which can be seen in the following graphs.

Figure 1 shows the water repellency of treated fabric. This test indicates a significant improvement over the other three methods. These results are mirrored in the whole shoe flexing tests shown in Figure 2.

The car wash test, Figure 3, replicates walking in long wet grass and shows how ion-mask has reduced water uptake and increased protection in a membrane-containing shoe. The reduced angle and increased wetting of the untreated shoe would result in membrane wetting and reduced breathability.

The results of water uptake testing can be seen in Figure 4. While a recognised immersion test exists, in this instance, it was thought that an actual field trial would yield a truer result. This involved six days of five hours walking and running on tracks and trails. The columns for ion-mask show that the shoe components have all been made hydrophobic resulting in limited water uptake and dry feet for the wearer.

Figure 1 – Water repellency of treated fabric 9AATCC 193-2005

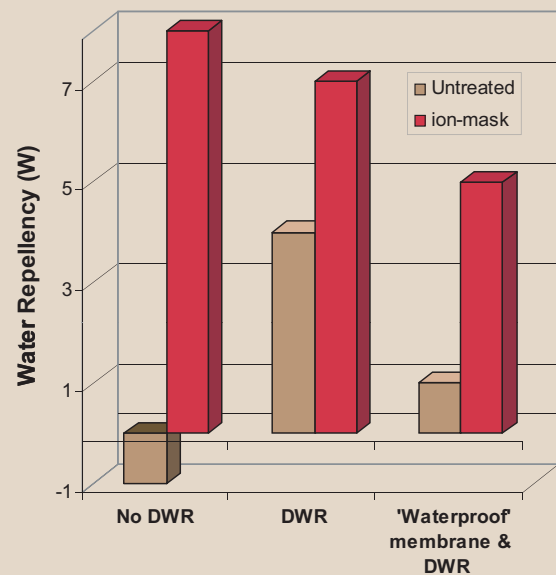


Figure 2 – Whole shoe flexing TM 77:1992

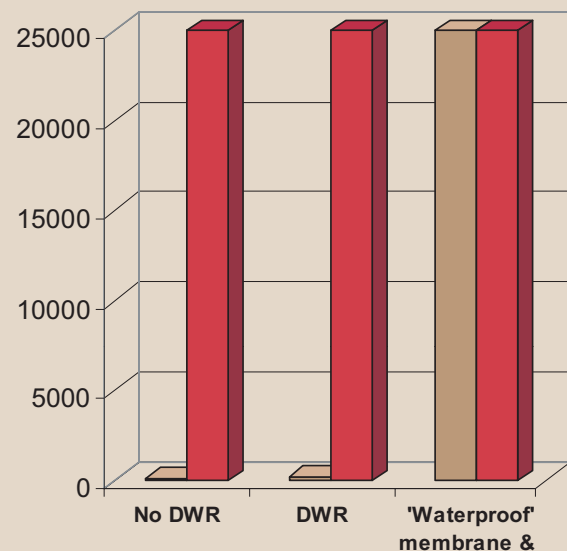


Figure 3 – Car wash test EN ISO 20344:2004 (E)

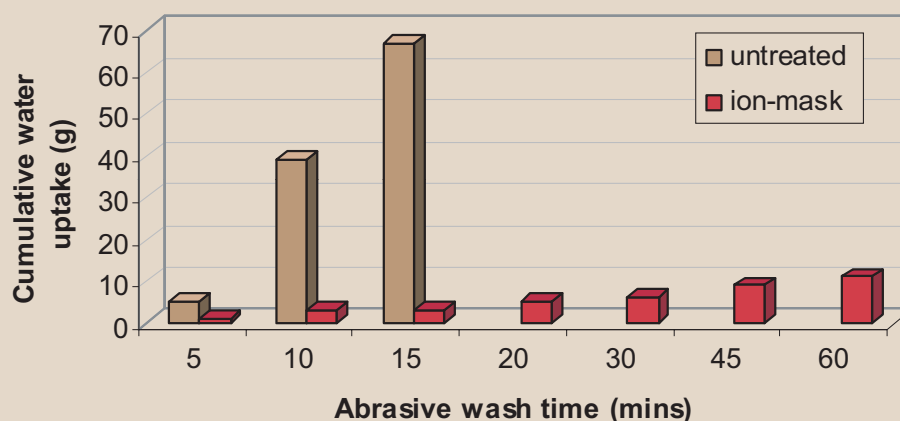


Figure 4 – Water uptake

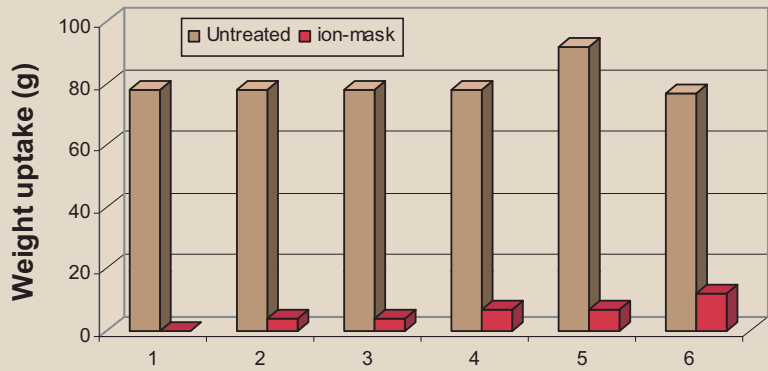


Figure 5 – Shirley air permeability rig ISO 9237-1995

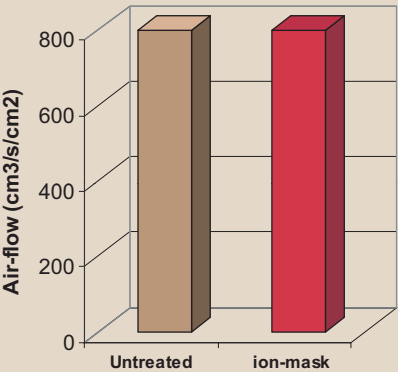
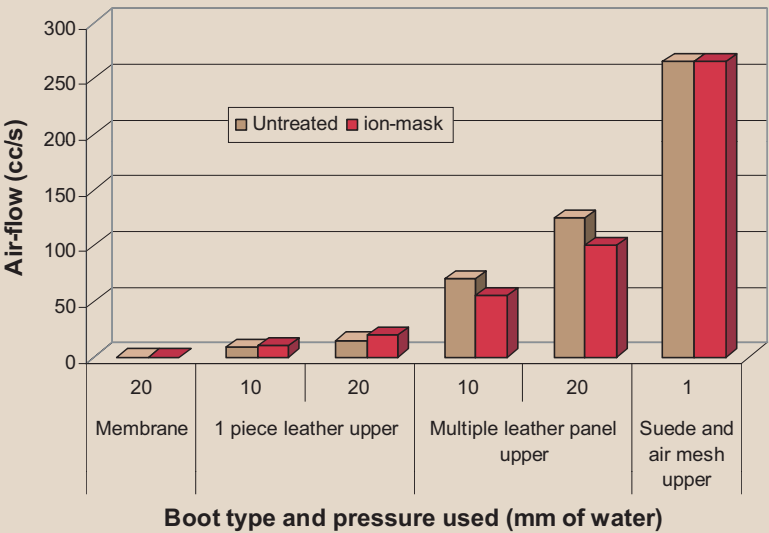


Figure 6 – Airflow through boot



Eliminating the membrane and using air mesh materials looks to be a viable alternative in some instances as further tests indicate that ion-mask while inhibiting water penetration does not block a mesh fabric's porous structure.

In addition to all this, 2Pi says it has test evidence showing superior water shedding properties (Martindale ISO 12947 abrasion followed by ISO 12947 spray tests) on shoe fabrics using its treatment. It also claims that tests under AATCC 118-2000 (oil) and AATCC 193-2005 water-based liquids show markedly improved resistance to staining.

DESIGN RULES FOR SHOES

So, is it merely a case of making shoes the normal way, treating them with a magic coating and shoving them in a box?

Not quite. However water resistant the materials used may be, the shoes' actual construction needs to allow at least the same level of water resistance. This will be mainly influenced by seam design and stitch hole and how the latter change during flexing—plus the fundamental issue of sole attachment.

BREATHABILITY

This is the other major selling point and various tests were carried out in order to measure the airflow with ion-mask compared to membranes.

Figure 5 shows that ion-mask appears not to impair existing airflow characteristics compared to membranes which have a low airflow that affects the air exchange needed to influence the warm microclimate generated inside the shoe and not just allow transmission of moisture vapour through the upper.

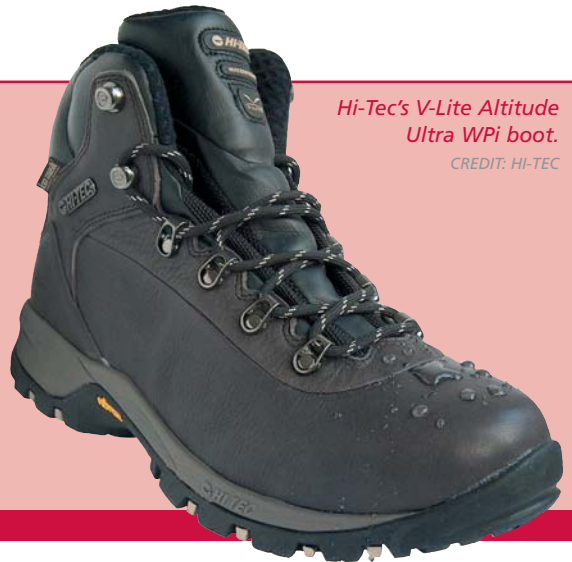
Many tests for airflow focus purely on materials rather than the whole shoe. While this is good for establishing benchmarks, it does not always reflect what the wearer may experience. 2Pi therefore developed its own test apparatus in conjunction with SATRA. As its name suggests the Mk1 whole shoe airflow tester measures airflow throughout the entire shoe. As airflow through the shoe effectively replaces hot damp air with cool air, it obviously has a strong influence on foot comfort. By measuring a particular boot or shoe, its design and construction can be tailored to produce maximum foot comfort. Figure 6 and Table 1 show the airflow measurement in four different types of boot tested.

TABLE 1: AIRFLOW THROUGH BOOTS

Boot type	Airflow (cc/s at 10mm of water)	
	Untreated	ion-mask
Membrane-containing walking boot	0	0
1 piece leather upper walking boot	8.5	10.5
Multiple leather panel upper safety boot	70	55
Suede and air mesh upper leisure boot	> 265	>265

“...and it should be noted...”

Hi-Tec in fact launched its new range of boots using ion-mask technology at the London Aquarium on August 27th with a series of eye-catching displays and interactive activities designed to show the potential benefits for consumers. Eighteen months has been spent working closely with P2i to bring the concept to market and Simon Bonham, Hi-Tec Group's Head of Marketing expressed the company's pleasure in being the first footwear brand in the world to use the new technology commercially. The first product became available in September and is called the V-Lite Altitude Ultra WPi walking boot. It will be followed by a full range of boots and shoes during the course of 2009.



Hi-Tec's V-Lite Altitude
Ultra WPi boot.

CREDIT: HI-TEC

Keeping the number of seams to a minimum is a good start, followed by ensuring they are situated away from flexing and high stress areas in the vamp. Facing seams downwards towards the sole to allow water to run off and not become trapped is also a sensible precaution as is avoiding ones that penetrate both upper and lining. Other useful measures are to seal the inside of seams with tape or suitable sealant, use a bellows tongue and minimise material cut edges. Most of this

is common sense, but we have all overlooked small details at some time or other, so a timely reminder is always welcome.

As we stated in the earlier article, ion-mask really does appear to be something different and to have enormous possibilities. Leading sports shoe brand Hi-Tec certainly seems to think so and one would be surprised if they had gone into bulk production without first having examined the treatment in fine detail. 🍷