DAS, Condensation Point and Clothing Systems

DAS or dead air space is the most effective form of insulation for clothing systems and arguably the ONLY effective form of insulation for clothing systems.

Dead air space = air that is not moving. If we are getting really picky this is very difficult to achieve but the deader the better. This means we need to stop the air from moving by blocking wind and convection. Clothing generally does this with a combination of;

a.) “flat” materials, usually woven threads, not much thicker than a sheet of paper e.g. shell fabrics which stop or slow air movement through them but not along them.

b.) “puffy” materials such as down, un-woven synthetic fibers (quilting, wadding, batting etc.), fleece, knit wear etc. which slow air movement through and along them.

Thickness is good. A 2 inch thick sleeping bag is much warmer than1 inch thick, as long as the insulation used is equally effective at stopping air movement/the air inside each is equally dead.

Moisture in a clothing system is bad, it replaces DAS with water. Water transfers heat 25x faster than air. In fact moisture is about the worst thing you can have in a clothing system, it has a higher specific heat (the amount of energy required to raise temperature of a substance) than pretty much anything else. Again being picky 100% dry is hard to achieve but the drier the better.

Materials such as cotton and down are hydrophilic that means they like water and can hold a lot of it for a long time. That’s why cotton is such a great material for bath towels (as long as you have a means of drying them between uses). Wrapping yourself in a dry towel feels warm and snug after your bath, but you will not get the same effect from a wet towel, it will start drawing heat away from you at an alarming rate, the same goes for that warm, comfy cotton hoody or those cute blue jeans.

Synthetics are generally hydrophobic which mean they don’t like water and try and get rid of it as quickly as possible. A good base layer will wick or transfer moisture away from your body without becoming wet its self, this creates a break in the water which is conducting heat away from your body x25. Fleece, wool or unwoven synthetic etc. also “drain” or drip dry very quickly allowing DAS to reform.

Moisture also causes some fabrics to clump or stick together. For example the down insulation that gave a garment 2 inches of DAS when dry will collapses to almost zero thickness when it gets wet giving no DAS. Down also dries very slowly. Knitted wool, unwoven/puffy synthetic wadding, fleece etc. collapses very slightly or not at all when wet and drys/drains quickly allowing DAS to reform.

This moisture can come from 2 places, outside or inside the clothing system.

We have many options for blocking moisture from outside these can be broken down in to impermeable and semi permeable. Impermeable tries to stop everything from both sides passing through which can be a problem because it traps moisture which is already inside. Semi permeable is a little more complicated, at the high tech very protective end of the spectrum it could be a Gore-Tex like fabric

which allows gas (moisture vapor) to pass through but not liquid (water) this can be measured but how much water pressure it can stop and how much gas it can pass. At the other end it could be a simple woven fabric that creates less of a barrier to water but allows much more gas to pass.

Moisture from the inside has one main source, us. When we get hot we sweat. Work produces heat, so ideally as we start working we reduce insulation to maintain a comfortable temperature and stop or minimize sweating. This isn't always possible and even when we are not sweating we exude some moisture. Ideally we keep this moisture as vapor/gas, it passes through our clothing system and disappears (albeit taking some heat with it). Worst case scenario it changes from gas to liquid (condenses) as it passes through our down jacket and makes our prime source of insulation useless.

A useful term here is Dew point, this is the temperature below which water vapor in the air becomes liquid, this could be seen as clouds in the sky, visible breath on a cold day, steam coming off of your buddy as he trudges up the trail etc. When possible we want to keep dew point outside our clothing system, in a warm dry environment this is relatively easy but as the temperature drops and/or humidity goes up it becomes more difficult.

Often we need to accept that the dew point will be within the layers of our clothing system / some moisture will condense in our clothing system. This is more likely and more of an issue in winter when we need thick DAS to keep us warm and the outside temperature is low. We can deal with this by;

1. Positioning a barrier to force or encourage condensation at a certain point e.g. using a vapor barrier liner (VBL) this is an impermeable layer next to or very close to the skin which stops the moisture from ever reaching the insulating layers. Or placing semi permeable layer between insulating layers e.g. a thin wind proof garment between two puffy layers, the moisture will tend to attach to the wind proof (think breathing on a mirror) and not compromise the puffy layers, this would be better than the condensation happening somewhere in the middle of one thicker puffy layer.
2. Allowing some air movement within the clothing system to move the stale humid air away before it condenses. E.g. loose clothing, general body movement will "pump" some air around, a little heat will be lost but the insulation will not become compromised.
3. Carefully choosing what materials we use at different points in our clothing system. We could just use materials which are hydrophobic but Down is such an effective insulator it is hard to ignore especially when weight is an issue so we need to use it in the right place E.G. some people get into trouble by wearing extra clothing inside their down sleeping bag and forcing the condensation point to the middle of the down insulation. A better option might use a down bag inside a synthetic bag, forcing the condensation into the synthetic layer. Or we could pull on a down jacket over our outer garments when we are inactive and remove it before we start activity again.

In reality it is usually going to be a combination of all of the above and we need to adjust as conditions or our activity change. E.g. Late fall/early winter when there is still moisture in the air compared to mid

winter when the temperature maybe similar but the moisture has frozen out of the air. Or if we know that we sweat a lot choosing a synthetic over a wool base layer.

Sooner or later our clothing will become saturated, we have options for dealing with it in the field. Dealing with it as a liquid i.e. wiping, wringing or letting it drain. Dealing with it as a solid i.e. brushing, shaking or beating the ice off. Turning it back into gas/evaporating. Some fabrics regain a lot of their DAS after draining, wringing, shaking. Synthetics are generally good at this, followed by wool but down is still pretty much at zero as far as DAS is concerned (note, new developments in down treatments may make this less of an issue).

Whatever the material the final stage of drying requires evaporating, this requires heat and/or a drier environment. In the field this usually means exposing to wind and sun, drying over a fire or stove or wearing it. The first method requires the right weather. Fire or stove require a fire or stove and either take time and fuel and risk damage due to burning, melting or drying too rapidly (leather boots). Wearing to dry can be very effective in a wide range of conditions and is often the only viable method but it needs to be remembered that it takes a lot of energy to evaporate water (higher specific heat than pretty much anything else remember)and that energy is coming from you.

Ask any refrigeration/air conditioning engineer, changing a substances from Solid to Liquid to Gas (changing state) involves a LOT of energy. It takes 1 calorie to raise the temperature of 1 gram of water by 1 Celsius, it takes 570 + or – to evaporate the same amount. Yes that's right every gram of sweat evaporating = lots of heat/calories lost. Great if you want to cool down, that's one reason why humans can successfully deal with wide range of climates but also potentially dangerous if you are trying to stay warm.

Here is a useful link if you want to find out more about water.

http://science.howstuffworks.com/dictionary/geology-terms/water-info2.htm