

Don't fight the



Be properly prepared for it

Some thermal protection  
basics

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## What is cold ?

We, human beings, are warm blooded mammals and we need a steady body temperature meaning we have an average core temperature of about 37 degrees Celsius. We need this in order for our vital organs to continue functioning properly. Any deviation from that and we will have a condition we all know as fever. If it is above normal then we will feel hot and the body will transpire in order to loose heat. If the temperature is below 37 degrees Celsius then we will feel cold and our body will try to produce more heat. Involuntary muscle contraction will occur (shivering) . Our body will constantly try to regulate the temperature and this explains that when having fever we successively feel cold and warm and vice versa. This is because we are homeotherms, meaning our body tries to keep the same temperature regardless of most external conditions.

## Cold sensation

Without destabilised thermoregulation of the body we still can get cold. If we are submerged in water we cool about 20% faster than being surrounded in air. This has to do with the great thermal conductivity of water.

This explains why a wetsuit is far more inferior as thermal protection than a drysuit. In a drysuit, the diver is surrounded by air. Moreover a wetsuit gets compressed at depth even losing more thermal protection. Yet, a drysuit diver needs insulating underwear for temperature conservation in order to slow down the cooling from the surrounding air.

The sensation of feeling cold differs from individual to individual. Particularly susceptible to cold are the body regions with a great surface to mass ratio like for instance fingers. Hot French fries cool more rapidly than hot potatoes because fries have a greater surface to mass ratio. Fingers too have a great surface to mass ratio and a process called vasoconstriction narrows the veins so the blood goes from the extremities to the core. This explains why fingers get colder more quickly resulting in loss of manual dexterity.

## Signs of coldness

Shivering, loss of manual dexterity, loss of reasoning ability, lapses in memory, increased gas consumption. These are all in fact signs of getting cold. When not acted upon it can eventually lead to a more dangerous situation called hypothermia (see further on).

**When shivering while diving you should immediately abort the dive.** Even in warmer waters a person can get cold, especially when doing multiple dives a day (see also wind chill factor later on).

**Adequate thermal protection is also needed in warmer waters.**

## Cold water protection

Dry suit protection is the only viable thermal protection option for the diver. Being dry while changing clothes reduces the exposure to convection from moving air (wind chill) and evaporation of the water on the naked skin. While diving using a drysuit the diver stays dry and warm by using appropriate insulating underwear.

### Wind chill

Wind chill is probably the most overlooked and yet important factor to consider. This explains why divers even can get cold in warm or tropical waters.

### Wind chill protection

People often think that temperature alone is the culprit. Not so. It is the rate at which the body has to keep up for temperature loss. This rate is greatly accelerated when the body is unprotected from the wind and wind speed increases. The wind blowing over naked skin or going through clothing actually cools the skin and effectively reduces body temperature. This explains why it sometimes can feel colder than the thermometer shows us. Have a look at the wind chill tables mentioned below in order to have an idea of the importance it has on cooling the body.

When changing clothes between dives, the body should be dry and protected from the wind. So try to change clothing out of the wind and rain as much as you can.

Specialised fabrics exist on the market today which effectively counter the effects of wind chill such as wind stopper.

### Hypothermia

Hypothermia is a dangerous situation. You do not have hypothermia when you are just feeling cold. Hypothermia is a condition when the core temperature drops below 35 degrees Celsius or 95 degrees Fahrenheit. When the signals of getting cold are noticed early it can be avoided.

### Hypothermia prevention

Know the signs of cold and act before things get worse. When tired limit the number of dives per day significantly, especially when doing multiple diving per day during some period like for instance on a liveaboard.

Depending on the kind of diving and the environmental conditions, use the appropriate thermal protection, both on land as in the water.

### Hypothermia treatment

I refer to specialised lectures and links at the end of this document for further study. It is paramount to understand that incorrect treatment can lead to more problems and even death. If in doubt seek help of a specialist for treatment.

### Conclusion

Hypothermia is serious enough to consider. While at first it may seem to be just harmful it can lead to dangerous situations and even to death.

No doubt, when diving in cold water, you should protect yourself by diving dry using a drysuit and using the appropriate amount of insulating underwear. If you do not have a drysuit a drysuit you should limit the exposure time considerably as well as depth. Consider using three finger mittens when not using dry gloves as this effectively reduces the surface to mass ratio of the fingers.

The head is an important region for heat loss, so consider wearing adequate thermal protection on the head, even when diving in warm waters.

When doing technical diving, where exposure times are considerably longer and clear thinking and manual dexterity is paramount, this form of equipment should be mandatory for safe technical diving.

References on next page.

References:

Wind chill table

There are a lot of different tables. The one shown here is for reference purposes only.

The temperature we feel is not the temperature we read from the thermometer, but the effect that the temperature under influence of the wind has on us. Minus 10 degrees Celsius without wind is in fact minus 30 degrees Celsius with hard wind (7 on the Beaufort scale). From minus 37 degrees Celsius, the skin freezes when exposed for a long time. From minus 51 degrees Celsius, the skin freezes in 1 second. From minus 59 degrees Celsius the skin freezes in half a second !

windspeed	temperature (all values are in degrees Celsius)									
<b>no wind</b>	<b>-7</b>	<b>-12</b>	<b>-18</b>	<b>-23</b>	<b>-29</b>	<b>-31</b>	<b>-34</b>	<b>-37</b>	<b>-40</b>	<b>-43</b>
8 km/hr	-9	-15	-20	-26	-32	-34	-37	-40	-43	-45
16 km/hr	-15	-23	-29	-37	-43	-45	-51	-54	-57	-59
24 km/hr	-20	-29	-34	-43	-51	-54	-57	-62	-65	-68
32 km/hr	-23	-32	-37	-45	-54	-59	-62	-65	-70	-73
40 km/hr	-23	-34	-43	-51	-59	-62	-68	-70	-76	-79
48 km/hr	-29	-34	-45	-62	-65	-70	-73	-79	-82	-84
56 km/hr	-29	-37	-45	-54	-62	-68	-73	-76	-82	-84
64 km/hr	-29	-37	-48	-57	-65	-70	-73	-79	-82	-87

### Another wind chill calculator

Exterior temperature	10km/Hr	20km/Hr	30km/Hr	40km/Hr
+14°C	+12°C	+08°C	+06°C	+05°C
+12°C	+10°C	+06°C	+03°C	+02°C
+10°C	+08°C	+03°C	+01°C	-01°C
+08°C	+05°C	+01°C	-02°C	-04°C
+06°C	+03°C	-02°C	-05°C	-07°C
+04°C	+01°C	-05°C	-08°C	-10°C
+02°C	-01°C	-07°C	-11°C	-13°C
+00°C	-04°C	-10°C	-14°C	-16°C
-02°C	-06°C	-12°C	-16°C	-19°C
-04°C	-08°C	-15°C	-19°C	-22°C
-06°C	-10°C	-17°C	-22°C	-25°C
-08°C	-12°C	-20°C	-25°C	-28°C
-10°C	-15°C	-23°C	-28°C	-31°C
-12°C	-17°C	-25°C	-30°C	-34°C
-14°C	-19°C	-28°C	-33°C	-37°C

### Conversion from Celsius to Fahrenheit

$$F = ( C \times 9/5 ) + 32$$

### Beaufort scale

Beaufort	wind speed km/hr
1	01 - 05
2	06 - 11
3	12 - 19
4	20 - 28
5	29 - 38
6	39 - 49
7	50 - 61
8	62 - 74
9	75 - 88

## Recommended further reading

### Internet links

#### HYPOTHERMIA

<http://hypothermia.org>

#### WIND STOPPER

<http://www.gore.com/bikewear/de/produkte/material/windchill.htm>(German)

#### WIND CHILL

<http://www.knmi.nl/voorl/nader/windchill.htm>(Dutch)

<http://www.accuweather.com/iwxpage/paws/windchill.htm>

### Books

Highly recommended lecture:

#### DIVING PHYSIOLOGY IN PLAIN ENGLISH

Jolie Bookspan, Ph.D.

ISBN 0-930406-13-3

#### DRYSUIT DIVING

Steve Barsky – Dick Long – Bob Stinton

Watersport Books

ISBN 0-922769-36-2