Suunto Fused™ RGBM

SUUNTO

CONQUER NEW TERRITORY

THE PATH TO FUSED™ RGBM

At the heart of every Suunto dive computer is an algorithm that calculates decompression for a dive, called the reduced gradient bubble model (RGBM). Relentlessly pursuing ever safer models for divers of all types, Suunto continues to push for RGBM perfection. A storied history full of science, development, and underwater experience lies within every Suunto dive computer.

This document explains detailes of our algorithm, and how the new Suunto Fused™ RGBM has been developed.

Suunto's work on decompression models for dive computers spans over three decades. A pioneer in the field, Suunto's modelling has adopted the latest scientific know-how and theories from leading experts.

Suunto's first dive computer was the Suunto SME ML (1987). Given the technology available at the time, it was essentially an electronic dive table. This was obviously not adequate, and soon Suunto's Ari Nikkola implemented the Buhlman model for Suunto dive computers.

Over the next decade, the algorithm was further improved to increase diver safety. These include, for example, voluntary safety stops, asymmetric on and off-gassing, as well as modifications based on the work of Dr. Merrill P. Spencer.

During this time, the dive community was still seeing too many accidents. To address these problems, Suunto launched the Suunto Vyper in 1999 which featured the new Suunto Reduced Gradient Bubble Model (RGBM).

The Suunto RGBM was developed in co-operation with Dr. Bruce Wienke. The new algorithm could account for diver behaviors which increase health risks. These behaviors include multiday diving, reverse dive profiles and short surface intervals.

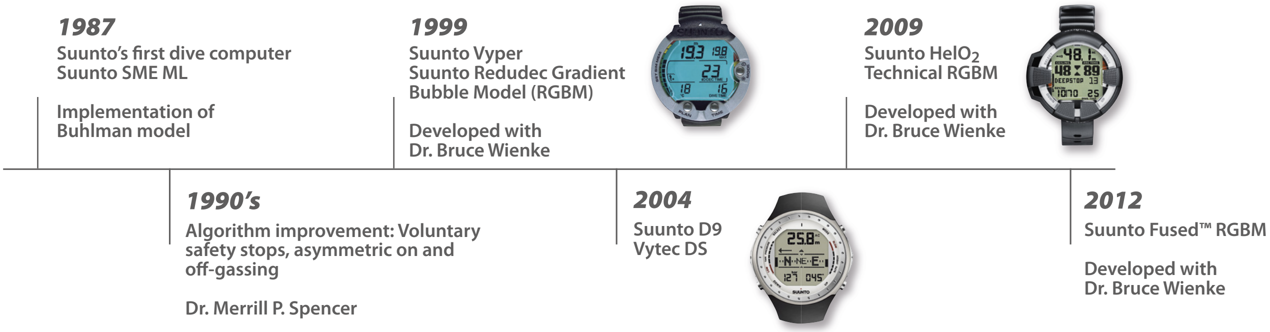
When deep stops (Pyle stops) became a proven beneficial method for decompression, they were added to the Suunto D9 and Vytec DS (2004) as a voluntary notification.

With the launch of the Suunto $HelO_2$ in 2009, Suunto introduced a new decompression model, the Suunto Technical RGBM, also developed with Dr. Wienke. This algorithm included all previous implementations and added new features for handling helium gas.

Since the late 1980s, Dr. Wienke had been working at the Los Alamos Nuclear Laboratory on the so-called 'full' RGBM. This development was targeting the needs of deep divers and military personnel carrying out difficult dives.

The new Suunto Fused™ RGBM combines the benefits of Suunto's Technical RGBM and the 'full' RGBM, bringing the benefits of both to recreational divers and technical divers.

None of this development would have been possible without the pioneering work of Dr. Wienke. Despite the range of dive computers offered by Suunto for most any type of diver, he has played a vital role in the practical implementation of his theories.



Suunto has been working together with Dr. Bruce Wienke for well over a decade.

Dr. Wienke is a Program Manager in the Nuclear Weapons Technology Simulation And Computing Office at the Los Alamos National Laboratory (LANL), with interests in computational decompression and models, gas transport, and phase mechanics. He is the developer of the Reduced Gradient Bubble Model (RGBM), a dual phase approach to staging diver ascents over an extended range of diving applications (altitude, nonstop, decompression, multiday, repetitive, multilevel, mixed gas, and saturation).

"RGBM is the most realistic model in science. The parameters are correlated with real data of thousands of dives which makes it good physics, and the data is validated and correlated. I have been working with Suunto since the 90's and Suunto's progression from Suunto RGBM to Technical RGBM and now to Suunto Fused™ RGBM is a very natural one. The new algorithm is a supermodel that covers all types of diving."

- Dr. Bruce Wienke

DIVING AND YOUR BODY

Diving is a great activity with the potential for one-of-a-kind experiences you can only get in an aquatic environment. Our land-loving bodies, however, can react negatively to diving if we are not careful. Whenever you enter the water, be aware how your behavior before, during and after the dive can affect your health.

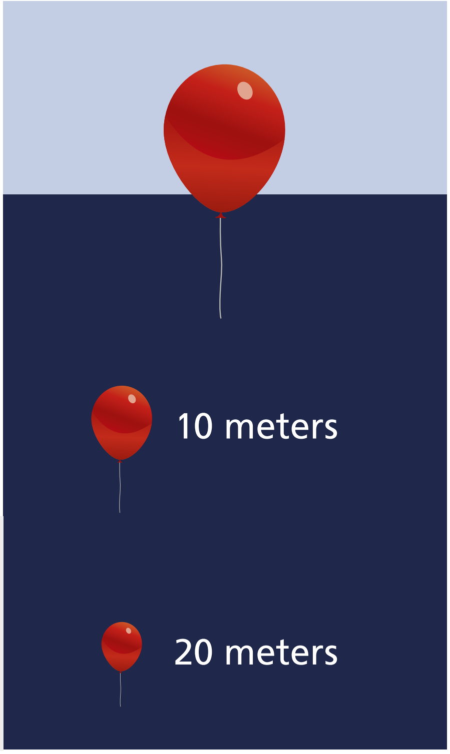
Under water your body is being pushed in from all sides. This added pressure changes how your body functions. Some of the changes you notice, like with breathing. Other changes you may not immediately feel, but the effects can cause serious damage to your body, and even lead to death.

The pressure change under water can affect sensitive areas such as your ears and sinuses. Discomfort in the ears when taking off in an airplane is also felt just diving down to the bottom of a pool that is three meters deep.

But the most significant impact is on your circulatory and respiratory systems. These need to be taken seriously as they can lead to major health risks. To understand and avoid these risks, we need to first have a look at the world of gases.

Ambient pressure

Ambient pressure increases much faster underwater because water is denser than air. Ten meters down is already twice the pressure at the surface.



A WORLD OF GASES

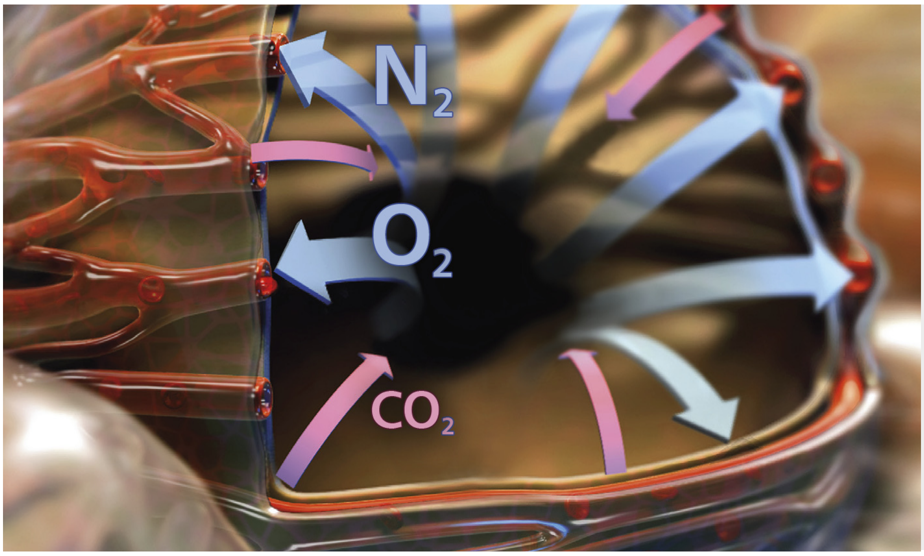
In the physical world, we are most familiar with three phases of matter – gas, liquid and solid. Certain elements and compounds are naturally in one state or the other at a given temperature.

Typically we think of water being merely a liquid, but that is only true for pure H_2O (between 0-100 C). Both liquids and solids naturally contain gas. The oxygen dissolved in water, for example, is what allows fish and other aquatic life to breathe.

Our bodies are also full of dissolved gases. Some of them, like oxygen, our bodies actively use. Other so-called inert gases like nitrogen and helium, are not used by our bodies, but are carried in blood and tissues nonetheless.

It is these gases that can cause so much trouble for divers. Even oxygen which our bodies thrive on at surface pressures can become toxic under certain conditions.

Nitrogen and helium are the main culprits when we look at the number one risk divers are concerned about: decompression sickness (DCS).



Gas exchange in alveoli

When air enters the lungs, it goes through a maze of smaller and smaller tubes until it reaches tiny sacs called alveoli. Woven into the walls of these sacks are very fine, almost transparent, capillaries.

DECOMPRESSION SICKNESS

The amount of gases dissolved in our bodies depends on the ambient pressure around us. Each gas has a specific partial pressure, and the combined pressures of the gases in our bodies stays in equilibrium with our environment.

Your body is fully saturated with gases at the elevation where you typically reside. If you hike up a mountain, air pressure drops, so your body can hold less gas. Your tissues are at this point supersaturated relative to the new ambient pressure. To get back to equilibrium, our bodies release gas through diffusion and breathing. This is called off-gassing.

When we go down to sea-level and then under water, we increase the pressure on our bodies, allowing more gas to be carried by blood and tissues. Again, to equalize the pressures, our bodies take on more dissolved gas from the air we breathe. This is called on-gassing.

If we come up from a dive too quickly (dropping ambient pressure), the natural off-gassing mechanisms are overloaded. Like the bubbles you see when you pop open that soda, the dissolved gas in our bodies comes out of solution too fast, forming bubbles which can ultimately cause DCS.

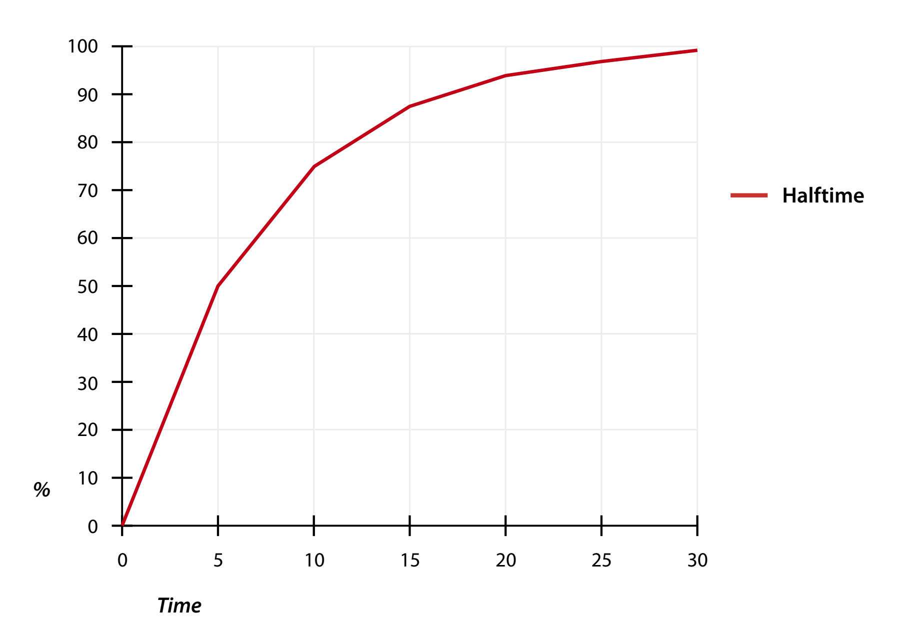
There are different stages and forms of DCS. Symptoms can range from minor joint pain and skin irritation to severe nerve damage and death. For a diver with DCS, the symptoms may commence while still underwater, or it may take several hours after surfacing. In some cases the symptoms may not show for several days. Most cases are treatable with, for example, recompression chamber treatment (hyperbaric oxygen treatment).

DECOMPRESSION MODELLING

A century ago, our understanding of DCS was fairly rudimentary and there were no good ways to ensure divers avoid it. In the early 20th century, work by John Scott Haldane helped lay the foundations for future decompression models which divers could follow to minimize risks of DCS.

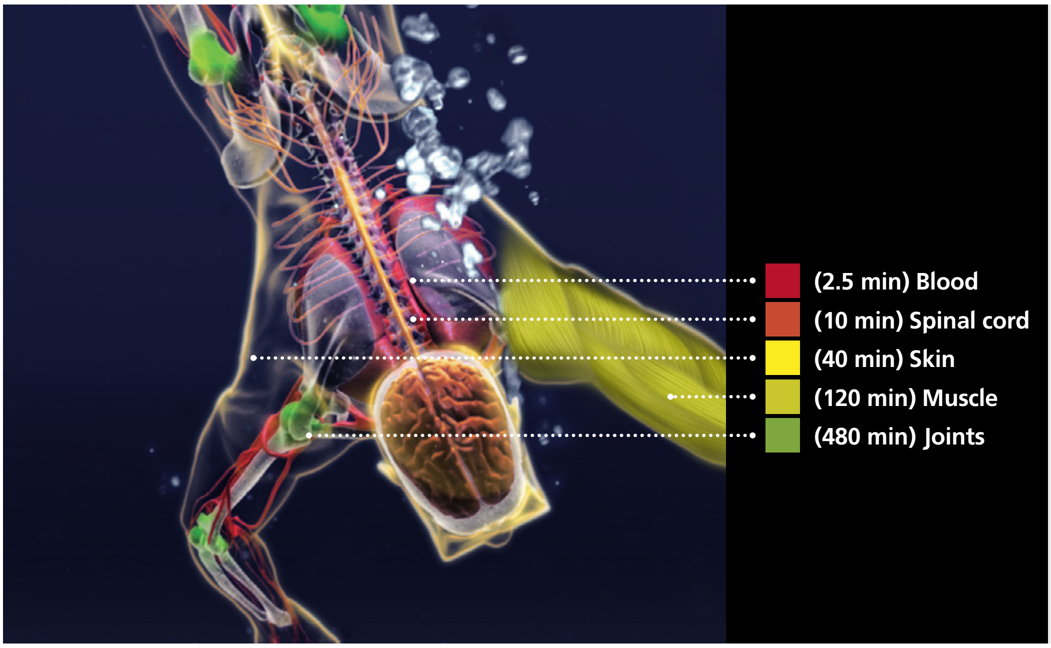
During a dive, tissues saturate at different rates. This is determined by the blood flow to the tissue in question. The brain, for example, has a very good blood supply, and is classified as a "fast" tissue, whilst joints have poor blood supply and are rated as "slow" tissue. There are several others in between.

The length of time that it takes for a tissue to reach a 50% saturation level at a given depth is called the tissue halftime and is usually measured in minutes. However, the saturation rate does not remain linear. A tissue reaches 50% saturation relatively quickly. After that, the rate slows. It takes another five halftimes for a given tissue to, theoretically, reach saturation.



Tissue half time

For all practical purposes, it takes 6 halftimes for a given tissue to reach full saturation. This graph represents a 5 min tissue.



Tissue Compartment

The Suunto Fused™ RGBM divides the human body into 15 theoretical tissue compartments according to the rate at which each tissue group on- or off-gasses. These halftimes range from 1 to 720 minutes

In decompression modelling, tissues are categorized into theoretical compartments which share a common halftime. Haldane used six compartments. The Suunto Technical RGBM uses nine compartments, and the latest model, the Fused™ RGBM, uses 15 compartments.

It is important to understand that a compartment is not a specific tissue but a group of tissues with theoretical properties. Real tissues are exceptionally complex and varied, making it nearly impossible to know their exact properties.

Decompression models assign each compartment a theoretical critical or "maximum" pressure ratio (meaning the difference between tissue and ambient pressures) above which bubbles form. This ratio, called the M-Value, changes at depth.

Haldane's model proved to be effective and showed that the tissue halftime theory was correct. His model assumed that the mechanisms for on and off-gassing were equal. Off-gassing was considered simply the reverse of on-gassing and happened at the same rate. Although correct, Haldane's decompression model was incomplete because it assumed that off-gassing only happens via diffusion. Today's research has revealed that off-gassing also happens via perfusion.

Further advances in technology allowed scientists to get a more accurate view of how gases behave in the body. What they discovered was that not all gas bubbles cause DCS.

NOT ALL BUBBLES ARE EQUAL

With the use of Doppler technology and later electron microscopes, scientists discovered that the body can have "silent" bubbles that are present throughout blood and tissues. They are called silent because they do not cause DCS. Some of these are small microbubbles while others are full-blown, easily detected bubbles. And yet neither kind necessarily causes DCS symptoms.

Although it is not yet clear the exact relationship between these and DCS-causing bubbles, studies have shown that higher microbubble counts increase the likelihood of DCS and other illnesses.

What has also been established is that once formed, these bubbles are unstable. They have an ability to attract dissolved gas from surrounding tissues and the likelihood of a bubble either expanding or collapsing is determined by a range of factors. These factors include the surface tension of the bubble, the pressure within the bubble and the ambient pressure relative to the bubble.

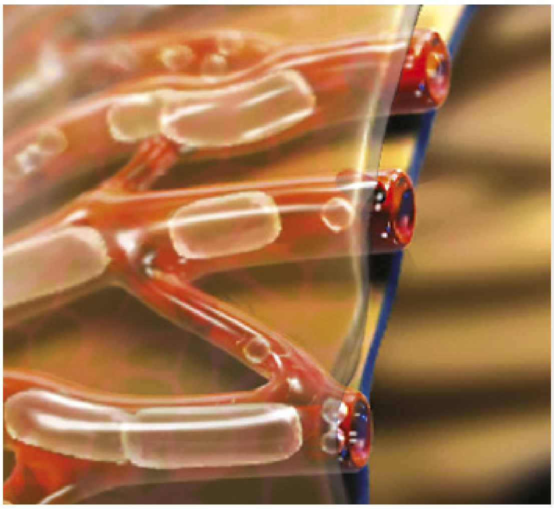
A diver who completes multiple dives within a given day or even over a number of days may have a build-up of silent bubbles. The accumulation of bubbles may lead to a higher risk of DCS. It is also known that microbubbles can cause longer-term problems such as neurological damage.

This is particularly relevant to professional divers such as instructors, who complete many of repetitive dives, often with many ascents in one training session. Microbubbles can collect inside the alveoli, obstructing and slowing off-gassing.

Bubbles form much easier in human tissues than in pure liquids, 200 times easier, in fact. Careless diving practices are exceptionally risky because of this.

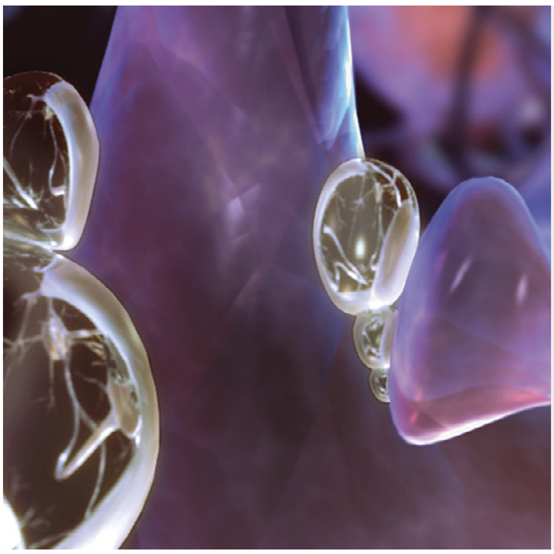
A process called nucleation is the reason behind the rapid bubble formation in tissues. The human body has what are called micronuclei, microscopic pockets caused, for example, by friction between tissue surfaces or changes in tissue dimensions (like muscle contractions). These micro-nuclei can fill with gas and act as seeds for bubbles.

It is unknown how many micronuclei are in the body at any given time, but it appears heavy exercise creates more. Studies have also shown that rapid increase in pressure crushes micronuclei and reduces the overall count. Regular exercise also reduces overall count.



Microbubbles obstruct blood flow

Microbubbles in the capillaries around the alveoli may obstruct the blood stream and inhibit off-gassing.



Microbubbles block nerves

By shutting off the blood flow, microbubbles can also cause tissue death, for example in the sensitive retina of the eye. The synapse is the junction between a nerve terminal and the nextneurone in a long chain of neurones. Microbubbles can interpose themselves in these junctions causing long term neurological damage by preventing electrical transmissions.

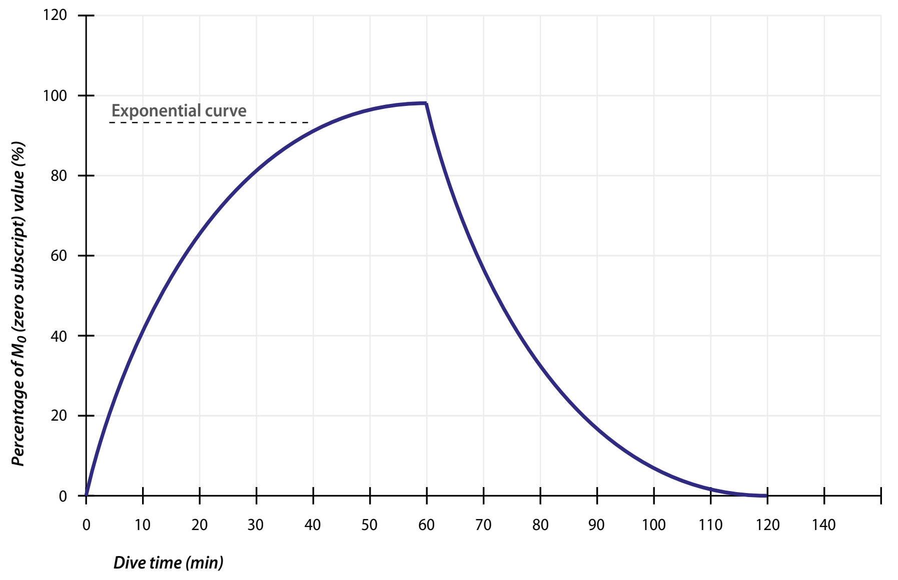
SUUNTO FUSED™ RGBM IN PRACTICE

Earlier Haldanian dissolved gas models assumed that in order to decompress, a diver should ascend as quickly as possible to a shallow depth to maximise off-gassing. However, by quickly reaching that shallow depth, the diver may have already formed microbubbles.

At the very least, these microbubles could potentially obstruct off-gassing and at the worst, may have already caused some tissue damage. Therefore, there is a need to keep the micronuclei from forming into microbubbles and prevent any pre-existing bubbles from growing by applying an appropriate ascent protocol.

The Suunto Fused™ RGBM is a state of the art algorithm for managing both dissolved gas and free-gas (microbubbles) in the tissues and blood of a diver.

It is a significant advancement over the classical Haldane models, which do not predict microbubbles or micronuclei. The advantage of the Suunto RGBM is a more accurate representation of what is happening in reality in your body during (and after) a dive. It has the ability to adapt to a wide variety of situations with little or no manual input from the diver.



The Suunto RGBM uses exponential formula for calculating the uptake of inert gases such as nitrogen

Because of the added safety from proven RGBM factors, Suunto now uses symmetric gas elimination. Additional safety is provided by the RGBM model developed by Dr. Bruce Wienke. This combination allows divers to maximize dive time without decompression obligations. If decompression is needed, the Suunto model calculates the most efficient decompression possible.

The RGBMs address a number of diving circumstances that have not been considered by previous decompression models, adapting to:

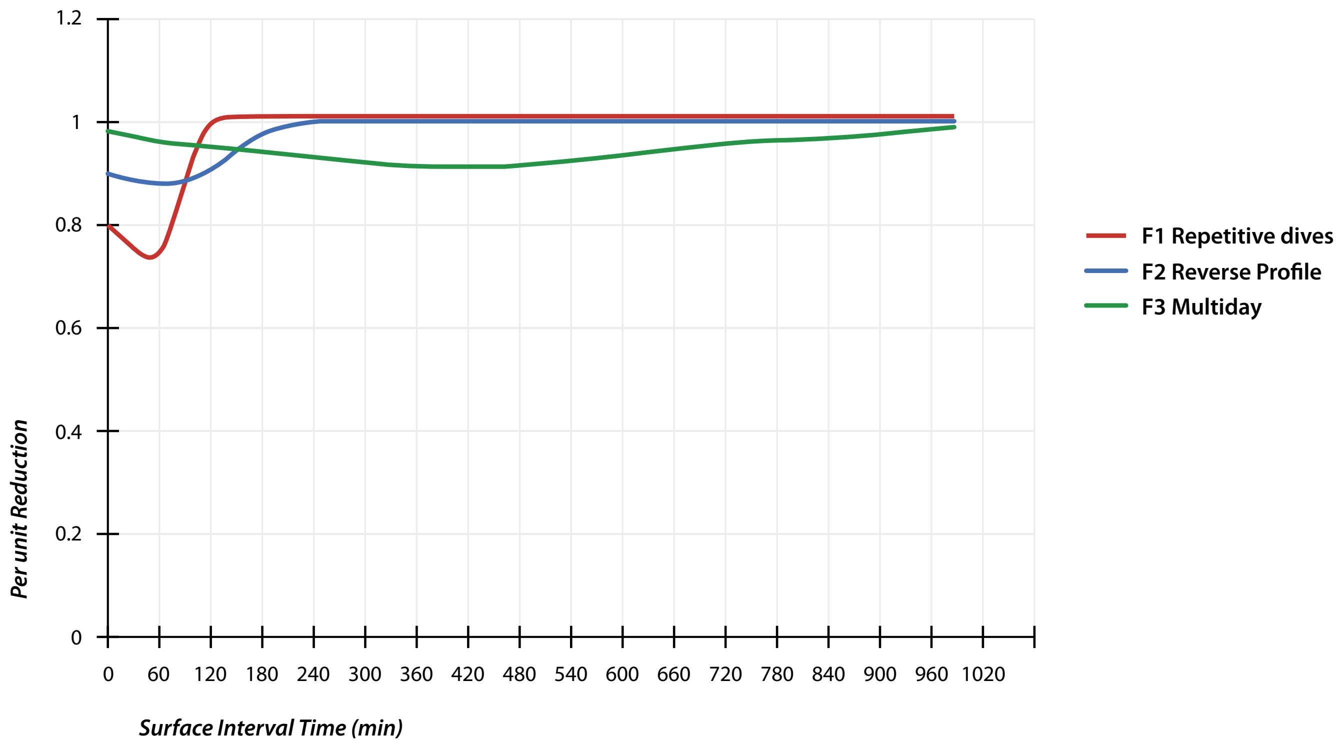
- Continuous multiday diving
- Repetitive dives with short surface intervals
- Dives deeper than the previous dive
- Rapid ascents which produce high microbubble build up

The algorithm automatically adapts its predictions of both the effects of microbubble build up and adverse dive profiles in the current dive series. It will further modify these calculations according to the personal setting that a diver can select.

Depending on the diver's behaviour during the dive and the personal setting, the Suunto RGBM model adjusts the M-values downwards in order to protect the diver from the effects of the generated free-gas.

Note that M-values are only relevant to the calculations for the decompression model, so it is not critical to understand their theoretical background. The key thing to remember when diving is that microbubbles will always form.

There are no actual supersaturation limits above or below which bubbles would not form. The aim of decompression models is to prevent formation of bubbles. Starting already with the Suunto Technical RGBM, Suunto's modelling adds an additional layer of protection by managing existing microbubbles and other silent bubbles.



Repetitive dives - F1 *- Microbubbles mainly occur in the venous circulation during the surface intervals between dives. They are washed with the blood to the pulmonary filter (lungs), where they may reduce the surface area and inhibit off-gassing. This effect will continue until the production of microbubbles ceases and the bubbles in the lungs dissipate. This continues for about three hours after surfacing. The Suunto Fused™ RGBM algorithm calculates correction factors to cope with this issue.*

Reverse Profile - F2 *- In any series of dives, the Suunto Fused™ RGBM calculates that diving deeper than the previous dive stimulated mic-ronuclei growth. During the surface interval following such an event, Fused™ RGBM recalculates future decompression obligations based upon the depth excess of the last dive compared to the one before it.*

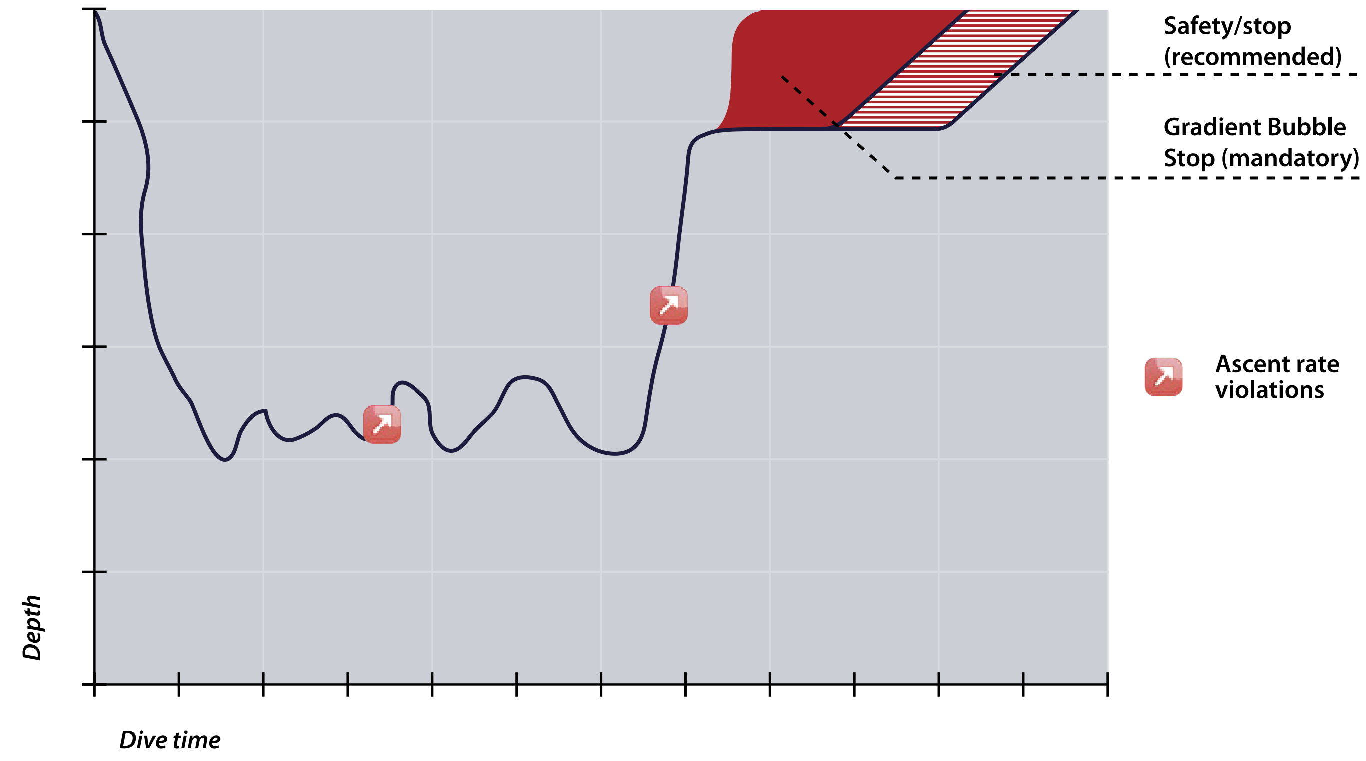
Multi-day- F3 *- Pre-existing micro-nuclei are excited into a higher energy state by diving (compression and decompression). They are thought to return to their normal energy level over time scales of days. The Suunto Fused™ RGBM multi-day factor calculates adjustments for a surface interval period of 100 hours. The combination of the correction factors is applied to the Suunto M-values, which affects the required decompression obligation.*

Some diving patterns cumulatively add a higher risk of DCS, such as dives with short surface intervals, repetitive dives deeper than earlier ones, multiple ascents (and descents) and substantial multiday diving. Depending on the circumstances, the automatic adjustments built into the Suunto RGBMs may:

- Add Mandatory Safety stops
- Reduce no-decompression stop times
- Increase decompression stop times

Dive alarm

If a Suunto RGBM model predicts an excess of micro-bubble build up after the dive, a flashing warning sign will prompt the diver to extend the surface interval.



Automatic adjustments in Suunto's RGBM algorithms

Recommended and mandatory safety stops are added depending on the actual profile of the real dive with possible ascent rate violations.

CONTINUOUS DECOMPRESSION

Traditionally, since Haldane's 1908 tables, decompression stops have always been deployed in fixed steps such as 15m, 12m, 9m, 6m and 3m. This practical method was introduced before the advent of dive computers. However, when ascending, a diver actually decompresses in a series of more gradual mini-steps, effectively creating a smooth decompression curve.

The advent of microprocessors has allowed Suunto to more accurately model the actual decompression behaviour. A continuous decompression curve is included in the Suunto Fused™ RGBM's working assumption.

During any ascent involving decompression-stops, Suunto dive computers calculate the point at which the control compartment crosses the ambient pressure line (that is the point at which the tissue's pressure is greater than the ambient pressure), and off-gassing starts. This is referred to as the decompression floor. Above this floor depth and below the ceiling depth is the "decompression zone". The range of the decompression zone is dependent on the dive profile.

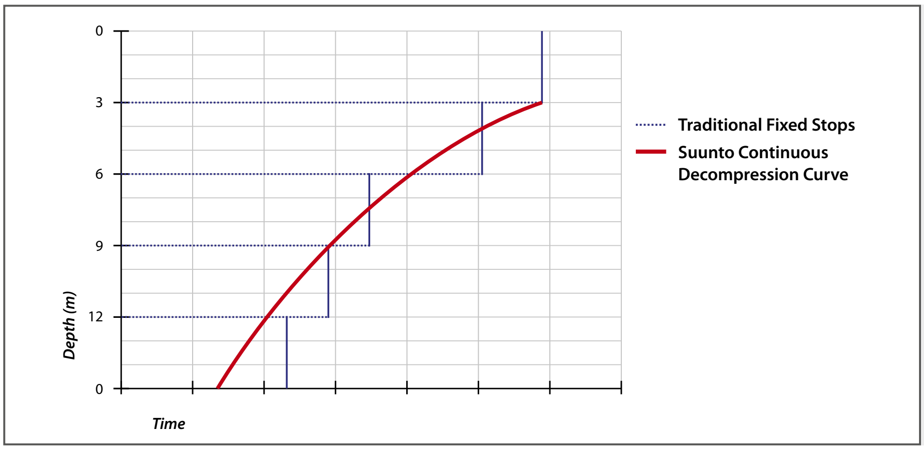
Off-gassing in the leading fast tissues will be slow at or near the floor because the outward gradient is small. Slower tissues may be still on-gassing and given enough time, the decompression obligation may increase, in which case the ceiling may move down and the floor may move up.

Suunto RGBMs optimise these two contradictory issues through a combination of a slow ascent rate and continuous decompression curve. It all comes down to proper control of the expanding gas during an ascent. This is why all Suunto RGBMs use a maximum ascent rate at 10m/minute, which has proven over the years to be an effective protective measure.

The decompression floor represents the point at which the RGBM is seeking to maximise bubble compression, while the decompression "ceiling" is maximising off-gassing.

The added advantage of having a decompression ceiling and floor is that it recognises that in rough water, it might be difficult to maintain the exact depth to optimise decompression. By maintaining a depth below the ceiling but above the floor, the diver is still decompressing, although slower than optimal, and provides an additional buffer to minimise the risk that waves will lift the diver above the ceiling. Also, the continuous decompression curve used by Suunto provides a much smoother and a more natural decompression profile than the traditional "step" decompression.

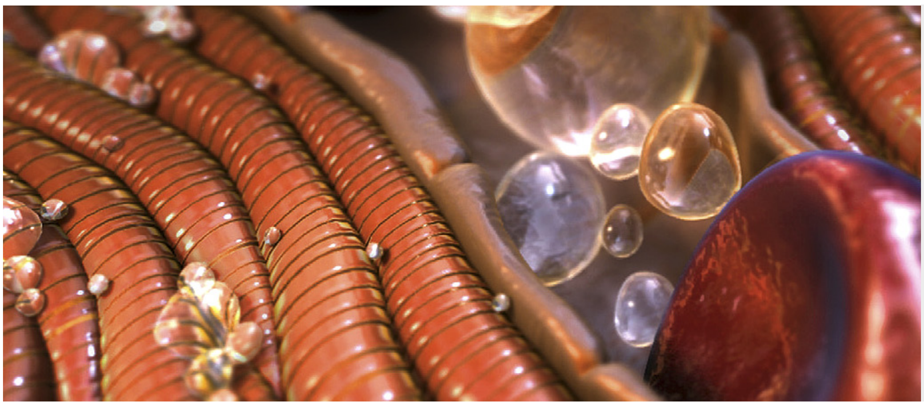
Suunto dive computers have a unique feature of displaying not only the decompression ceiling, but also the decompression floor. As long as you are below the "floor", i.e. still on-gassing, an upward arrow is displayed. Once above the floor, the leading tissues start off-gassing, and the upward arrow disappears. The optimal decompression occurs in the ceiling zone, which is displayed by both upward and downward arrows. If the ceiling depth is violated a downward pointing arrow and an audible alarm will prompt the diver to descend back to the ceiling zone.



Continuous decompression

The unique continuous decompression used by Suunto computers provides a smooth and more natural decompression curve compared to traditional predetermined ceiling depths.

If preferred, the diver may still decompress at traditional fixed depths.



Microbubbles

In this illustration we can see a cross-section of a capillary delivering blood to muscle tissue.

Friction between the muscle cells create micronuclei which attract dissolved gas from the surrounding tissue, forming microbubbles that disturb the blood flow and slow off-gassing. Microbubbles are present after almost any kind of dive.

YOUR PERSONAL DECOMPRESSION MODEL

Decompression models can be conservative or aggressive. Generally speaking, conservative means safer. In practice it means that a dive at a given depth is shorter due to the decompression obligation (the no decompression time is short).

Conservative also means that the time the diver needs to spend on decompression is longer. So for recreational divers, a conservative model means less time in the water in order to avoid decompression requirements. For technical divers, however, conservative means more time in the water because of the longer decompression requirements imposed during ascent.

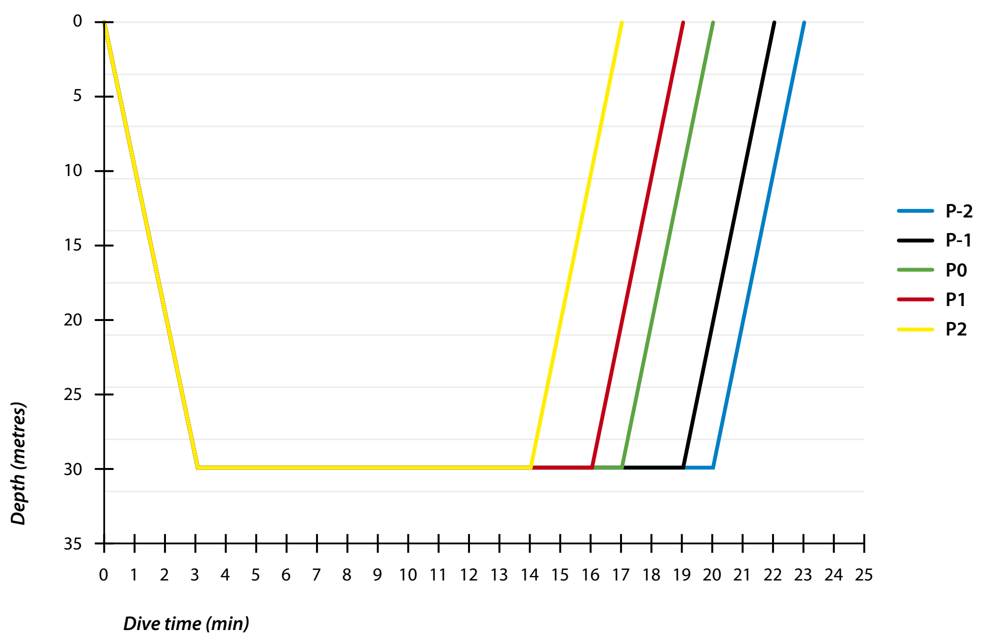
Aggressive models, on the other hand, increase the potential health risks of a dive. For recreational divers, an aggressive model allows more time at depth, but may significantly increase the risk of DCS.

The Suunto Fused™ RGBM adapts its predictions of both the effect of microbubble build up and adverse dive behavior in the current series of dives. The default setting for the Suunto Fused™ RGBM is to use a compromise (P0 setting) between conservative and aggressive. With the Personal Modes, you can select gradually more conservative or more aggressive calculations.

The Personal Modes reflect the fact that personal health and behaviour have an impact on your DCS susceptibility. Any of the following can potentially increase your risk for DCS:

- BMI that is considered obese
- Poor physical fitness
- Age, particularly for divers over the age of 50
- Fatigue, for example from over exercising, strenuous travel, or lack of sleep
- Cold water exposure, which can cause the blood vessels at the body's extremities to close down and maintain the body's core temperature
- Exercising after a dive increases the potential for bubble formation
- Strenuous activity during a dive, which can increase blood flow, bringing additional gas to tissues
- Tight fitting equipment, which can slow off-gassing
- Dehydration, which effects circulation and can slow down off-gassing

Personal adjustment value	Condition	Description
P-2	Ideal conditions, excellent physical fitness, highly experienced with a lot of dives in the near past	Progressively less conservative
P-1	Ideal conditions, good physical fitness, well experienced with dives in the near past	
P0	Ideal conditions	Default
P1	Some risk factors or conditions exist	Progressively more conservative
P2	Several risk factors or conditions exist	



Example: Effect of personal adjustment setting to bottom time on a 30 m dive

BEST OF BOTH WORLDS WITH SUUNTO FUSED™ RGBM

Over 30 years of development and thousands upon thousands of test dives have resulted in what is today the Suunto Technical RGBM. The real breakthrough in this model came when Suunto added the ability to the behaviour of microbubbles.

Divers who properly follow the instructions of a dive computer that utilises the Suunto Technical RGBM are certain to reduce the risks of diving incidents. This is accomplished without requiring a more conservative decompression model for most dives.

The Suunto Technical RGBM, despite the name, is ideal for recreational diving, maximizing bottom time while minimizing ascent time. However, beyond a certain depth, the complexity of DCS risks increase significantly, requiring a different modelling approach.

To meet the needs of both recreational diving and more demanding technical or deep diving, Suunto together with Dr. Bruce Wienke created the new Suunto Fused™ RGBM.

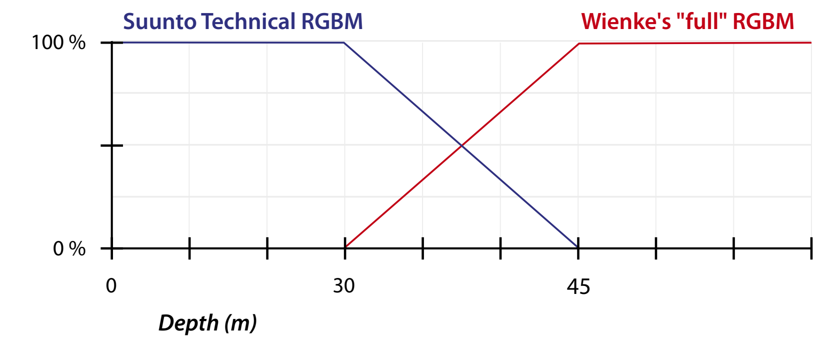
The Suunto Fused™ RGBM seamlessly combines the benefits of the Suunto Technical RGBM with Dr. Wienke's latest full RGBM for deep dives. Without any input from the diver, the Fused™ RGBM automatically switches between these two models to effectively manage the risks of DCS.

Under normal conditions, the transition is linear between depths of 30m to 45m. If there is little to no helium in the breathing gas, the transition range starts up to 10 meters deeper depending on the gas mixture.

For recreational divers, the new Fused™ RGBM not only maximizes bottom time while minimizing ascent time, but it also means your Suunto dive computer is ready when you are to go further with your dive hobby. You can use the same Suunto dive computer including Fused™ RGBM in the more challenging dives.

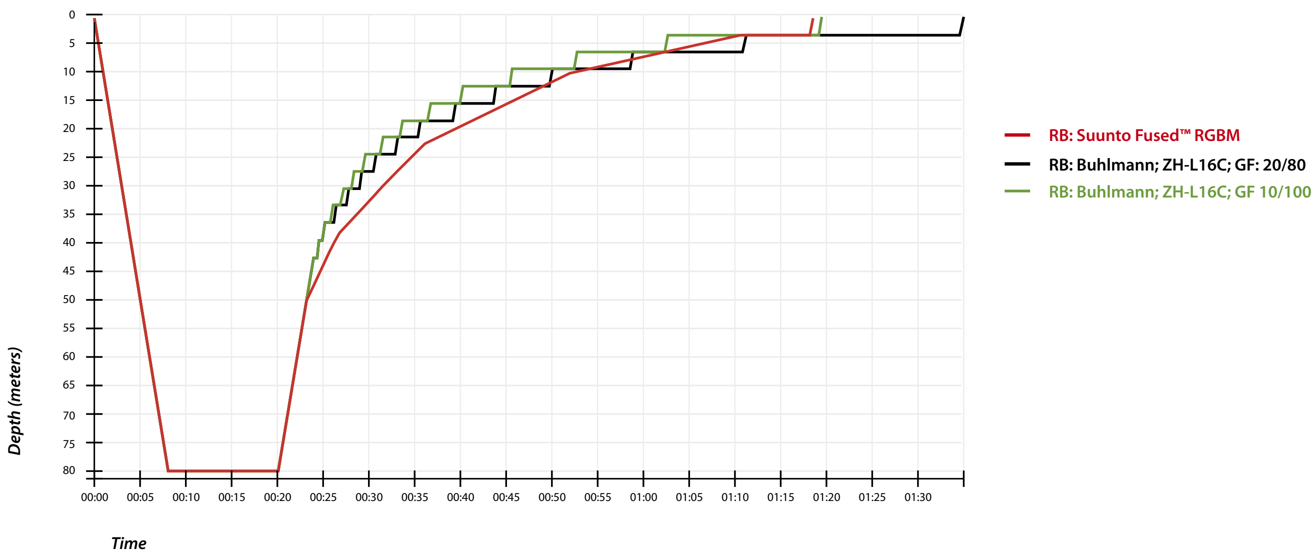
Advanced divers performing technical or deep dives can be sure their Suunto dive computer using Suunto Fused™ RGBM is going to give them the most optimum dive profile providing them a slow continuous ascent from depth leading to shorter total decompression time. The Fused™ RGBM will guide advanced divers using the most sophisticated of RGBMs available today, taking full advantage of the combined experience and development of Suunto and Dr. Wienke.

Suunto's testing team has been thoroughly testing the Suunto Fused™ algorithm with over 1000 actual dives making sure that divers around the world can enjoy the benefits of this new and advanced algorithm.



Suunto Fused™ RGBM at work

Linear transition between the two algorithms starts at 30 m and ends at 45 m when diving on gas mixes containing > 20% of Helium. On air/nitrox the transition begins at 40 m and gas ends at 55 m.



RGBMs an decompression

In this example there are Suunto™ Fused on red compared with Buhlman algorithm with different gradient factors. You can see that Suunto Fused™ algorithm provides a slow continuous ascent leading to shorter total decompression time.

SUUNTO FUSED™ RGBM FOR REBREATHER DIVING

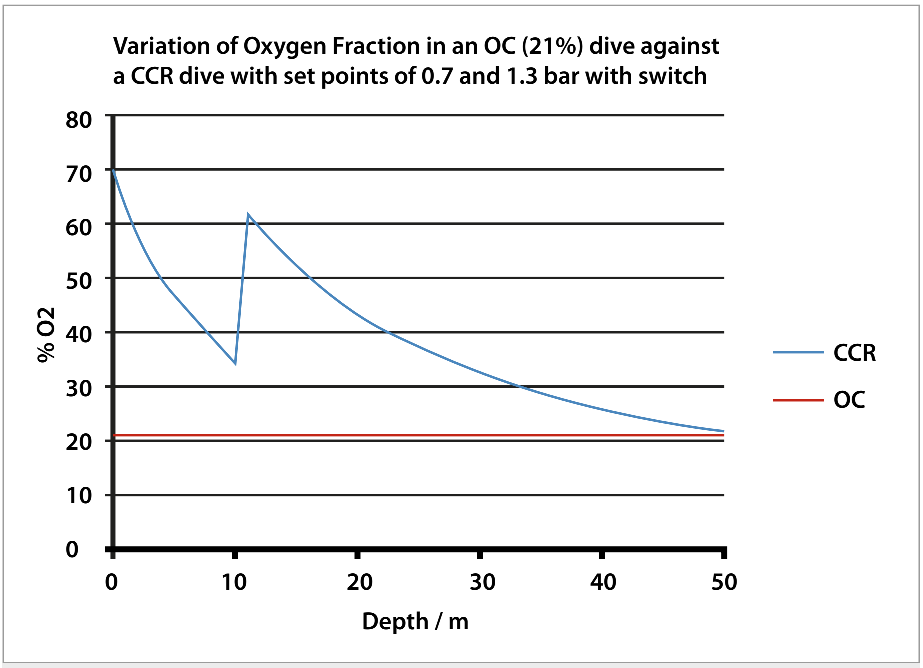
Whilst implementing and testing Bruce Wienke's Full RGBM for dive computers, Suunto took on massive task of implementing and testing constant PO2 mode at the same time. Now using Fused™ RGBM and rebreather together is possible! Just define the PO2s and set points of your dive computer to match those of your rebreather, and you will get the benefits of the latest decompression researchon your wrist and on your dive.

The development of the Fused™ RGBM algorithm has for the first time in Suunto's history allowed the implementation of a CCR constant PO2 mode. This means that the algorithm is now suitable for shallow recreational dives through to 150m CCR (Closed Circuit Rebreather) dives. The decompression requirements for these two types of diving vary significantly and the introduction of Fused RGBM with its transitional zone of adjustment from Suunto Technical RGBM to 'full' RGBM allows for one algorithm to be suitable for both.

There are several important distinctions between diving open circuit and closed circuit systems. When diving open circuit the gas you breathe always consists of the same mixture regardless of depth (air = 21% oxygen etc) and it is the partial pressure of gas that changes with depth (Daltons Law). In open circuit nitrox diving we are used to monitoring the PO2 (partial pressure of Oxygen) as it varies with depth. However, a significant advantage of diving a rebreather is that you can select a constant PO2 for various stages of your dive to ensure the most optimal decompression obligation. The rebreather does this by having a fixed PO2 and as your depth varies the gas composition you are breathing is altered to maintain the set PO2.

Set points are the constant PO2 limits set for the dive. It is usual that you would have a low and a high set point. Typical values for the low set point are 0.7bar and 1.3bar for the high set point but of course this is dependent on the type of dive you are conducting. The low set point is usually used at the beginning of the dive until a predetermined depth is reached where a switch to the high set point is made. The high set point is normally used for the deeper phase of the dive and for decompression to optimize your decompression requirement. During a dive it is possible to swap between set points.

Suunto Fused™ RGBM allows the use of constant PO2 mode in the CCR mode and together with the planning software will allow you to plan and conduct dives using a Closed Circuit Rebreather.



Oxygen % Variation of OC dive and CCR dive illustrating how gas changes in constant PO2

TERM LIST

Conservative (vs. aggressive): in decompression modelling, conservative is used to indicate a calculation that aims to minimize the risks of DCS; an aggressive calculation allows longer no-deco time and/or shorter deco but increases risk of DCS.

Control compartment: the tissue compartment that dictates the ascent profile of a given dive because of its on and off-gassing properties

Decompression illness (DCI): a term used to refer to illness cause by DCS or lung trauma (pulmonary barotrauma)

Decompression sickness (DCS): an illness caused by gas bubbles in the human body, the symptoms of which range from minor aches and pains to death

Diffusion: the process by which dissolved gas is transferred from one location to the next through the effect of pressure differences

Microbubble: microscopic bubbles that are not visible with ultrasound or Doppler, yet can affect the likelihood DCS by slowing off-gassing; they can also have long-term health impacts, for example, in the nervous system

Micronuclei: microscopic cavities throughout the human body that act as bubble seeds by attracting dissolved gas

M-value: a mathematical expression of the supersaturation limit of give tissue compartment used in decompression algorithms

On-gassing: the process by which the human body accumulates dissolved gases through the blood circulation and tissues

Off-gassing: the process by which the human body releases dissolved gases back into the surrounding environment

Partial pressure: the pressure a gas would have if it alone filled a given volume; the partial pressure of a gas determines its behavior in a mixture with other gases or liquids

Perfusion: the process of delivery of blood to a capillary bed in the biological tissue. Tissues like the heart are considered overperfused and receive more blood than would be expected to meet the metabolic needs of the tissue. In the case of skin, extra blood flow is used for thermoregulation. In addition to delivering oxygen and inert gases, the blood helps dissipate heat by redirecting warm blood close to the surface where it can cool the body through sweating and thermal dissipation.

Pressure gradient: the difference between tissue pressure and ambient pressure

Supersaturation: a principle property of human tissues allowing them to temporarily hold more dissolved gas than ambient pressure theoretically dictate; in other words, this allows us to survive when our internal body pressure is not equal to ambient pressure

Supersaturation limit: the theoretical pressure ratio between tissue pressure and ambient pressure above which the off-gassing process is overloaded and DCS bubbles (likely) form

Tissue compartment: a theoretical group of tissues that share similar gas saturation properties