Ocean 11

SCUBA

Free Diving

For the pre-20th century Greek sponge-divers, equalizing of the ears was not necessary. These freedivers had burst their eardrums since early childhood, on purpose, through diving without equalization. The perforated eardrum would not heal, since they would continue diving every day. This was thought to be a small price to pay for the ability to earn a decent living via the sponge trade. This involved risks from infections and also balance problems, but it didn't seem to affect them significantly.

In general, it is not clear if these early sponge divers of the Aegean knew about equalization techniques. Diving techniques were considered a trade secret and were carried from one generation to the next without much information leaking out to the competition. Even if they knew how to equalize, they would still prefer the above technique, since the amount of air lost to ear equalization is not trivial, and compromises their working depths.

This was the method used by the local Greek hero, Stathis Hatzis, in July 1913, when he secured a line to the fouled anchor chain of an Italian battleship off the island of Karpathos.

Reaching a depth of 88m in an incredible dive lasting more than 3 ½ minutes, he was rewarded with a gold medal and the right to travel free for life on any Italian ship of his choice.

During **Constant Buoyancy Control Diving** the athlete reaches the maximum depth and returns to the surface just by muscular strength.

1999 Brett Master -81m

During **Variable Buoyancy Control Diving** the athlete makes use of ballast (no more than 30 Kg) to reach the maximum depth, and returns to the surface just by muscular strength.

2001 Umberto Pelizzari -131m

Audrey Mestre

May 13th, 2000: Off the coast of La Palma Island in the Canary Islands, Spain, Audrey broke the Female World Record in Free Diving, No Limits Category.

She reached a depth of 412.5 feet (125 meters) in 2 minutes, 3 seconds. With this dive she became the Female World Champion as well as the 5th deepest person in the world.

On May 19th, 2001, Audrey ratified her status as a World champion beating her own mark, plunging to a depth of 426.5 feet or 130 meters, off the coast of Ft. Lauderdale, Florida. With this dive, she maintains her rank of 5th deepest freediver of the world, male or female.

During **No Limits Diving** the athlete reaches the maximum depth trailed by a ballast with no weight limitations, and returns to the surface lifted by a buoyancy device.

1996 "Pipin" Ferreras -133m

1999 Umberto Pelizzari -150m

Video: “Pipin” Ferreras

15 minutes

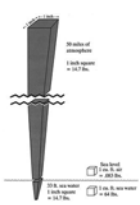
Water Pressure

Pressure is a force *or weight* per unit area. All matter, *including air*, has weight due to earth's gravity.

Accordingly, anything exposed to air is under pressure equal to the weight of the atmosphere above it.

This weight of air, due to gravity, is known as *atmospheric pressure*

A column of air one inch square and about 50 miles high weighs 14.7 pounds.



The surrounding pressure, on land or under water, is referred to as the *ambient pressure.*

If the surrounding pressure is from the weight of air, it is the *atmospheric* pressure.

If the surrounding pressure is from the weight of water, it is the *water* pressure.

At 33 feet depth, a diver is under 1 atmosphere of pressure from the surrounding water.

AND the diver is also under 1 atmosphere of pressure from the air above, making a total of 2 atmospheres.

Sea water weighs about 64 pounds per cubic foot, depending on salt content.

Using this value, 33 cubic feet of water weighs 33 x 64 = 2,112 pounds.

A diver lying horizontally at 33 feet depth, will have 2,112 pounds of water over every square foot of the body.

This comes to 14.7 pounds per square inch, which is the atmospheric pressure at sea level.

Gas Laws

The increases in component gas pressures account for some of the major problems inherent in compressed air diving: nitrogen narcosis, decompression sickness and oxygen toxicity.

Boyle's law states:

At constant temperature, the volume of a gas varies *inversely* with the pressure, while the density of a gas varies *directly* with pressure.

Simplified: If temperature is kept constant, as air pressure increases the volume of a gas decreases, and vice versa.

Mathematically,

$$PV = K$$

A container open on one end has one liter of air at one atmosphere. The air is compressed by taking it under water.

Boyle's law predicts that at two atmospheres pressure the volume of air in the container will decrease by one half and the density of air will double.

At 3 atmospheres pressure, the volume of air will be 1/3 of that at sea level; and the density triples; etc.

The most important *rule in diving* is *never to hold your breath.*

Charles's law states:**At a constant volume, the pressure of gas varies directly with absolute temperature.**

Simplified: Given a constant volume of gas, the higher the temperature the higher the gas pressure, and vice versa.

Mathematically,

$$P_1/P_2 = T_1/T_2$$

where P_1 and P_1 are the beginning and final pressures, and T_1 and T_2 are the beginning and final temperatures (remember, volume is kept constant).

Convert T_1 and T_2 into absolute temperatures by adding 460 to each Fahrenheit temperature.

Dalton's law states:

The total pressure exerted by a mixture of gases is equal to the sum of the pressures that would be exerted by each of the gases if it alone were present and occupied the total volume.

Simplified: The pressure of any gas mixture (e.g., air) is equal to the sum of pressures exerted by the individual gases (e.g., oxygen, nitrogen, and each of the minor gases).

Mathematically,

$$P_{total} = P_1 + P_2 \ \dots + P_{other}$$

where P_{TOTAL} is the total pressure of a gas mixture (e.g., air), and P_1 and P_2 are the *partial* pressures of component gases (e.g., oxygen and nitrogen). The term P_{OTHER} is used to signify partial pressures of all other gases in the mixture.

Partial pressure is the pressure exerted by an individual gas, whether that gas is part of a mixture (such as air) or dissolved in a liquid (such as blood) or in any body tissue.

Partial pressure of a gas (P_G) is determined by the fraction of the gas in the mixture (F_G) times the total pressure of all the gases (excluding any water vapor present):

In air at sea level, the partial pressures of oxygen and nitrogen are:

$PO_2 = F_G$ x total gas pressure

PO_2 .21 x 1 atmosphere

PN2 .79 x 1 atmosphere

The percentage of gases making up air is the same throughout the breathable atmosphere.

Regardless of altitude, the composition of air is about 21% oxygen, 78% nitrogen, 1% other.

As air pressure increases or decreases, the partial pressure of each gas *will do the same.*

With increasing altitude, for example, the partial pressure exerted by each gas in the air will decrease.

With increasing depth, the partial pressure exerted by each gas in the air we breathe will increase.

Henry's law states:

The amount of any gas that will dissolve in a liquid at a given temperature is a function of the partial pressure of the gas in contact with the liquid and the solubility coefficient of the gas in that particular liquid.

Simplified: As the pressure of any gas increases, more of that gas will dissolve into any solution with which it is in free contact.

Mathematically,

$$VG/VL = aP_g$$

where VG is the volume of a particular gas, VL is the volume of a particular liquid, *a* is the solubility coefficient for the gas in that liquid, and P_g is the pressure of the gas in contact with the liquid.

Henry's and Dalton's laws predict that, with descent, inhaled PO_2 and PN_2 will increase and cause an increased amount of nitrogen and oxygen to enter the blood and tissues.

The opposite occurs on ascent: inhaled PO_2 and PN_2 decrease, and allow the excess nitrogen and oxygen to leave the blood and tissues.

1) When ambient pressure is lowered (as at altitude), the partial pressure of oxygen and nitrogen in the body must fall, and there will be fewer molecules of each gas dissolved in the blood and tissues.

2) When ambient pressure is raised (as when diving), the partial pressure of oxygen and nitrogen in the body must rise, and there will be more molecules of each gas dissolved in the blood and tissues.

The second statement is the physiologic basis for three important problems associated with compressed air diving: decompression sickness, nitrogen narcosis, and oxygen toxicity.

The Bends

"The bends" is the term given to the increased nitrogen in the tissues, as a result of staying too deep and not observing decompression stops on the way to the surface.

The nitrogen is released from the tissues as bubbles, which collect in the joints and cause severe pain and the diver bends over.

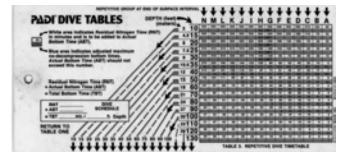
Nitrogen Narcosis

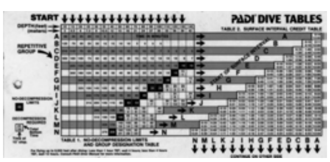
Nitrogen narcosis is caused by a build-up of nitrogen in the tissues, caused by being too deep for too long. It causes a feeling of extreme well-being. The diver may offer his regulator to the fish and as a result, drown.

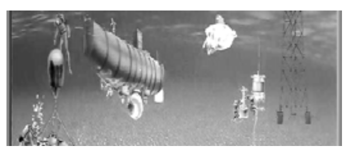
Air Embolism

Air embolism results from a diver holding his/her breath on the way to the surface. Air in the lungs expands, rupturing the alveoli.

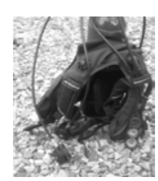
Decompression Tables







Dive Gear



Self-contained Underwater Breathing Apparatus

S C U B A

Since early times, man has had the desire to explore beneath the sea. The first attempts were free dives below the surface with divers holding their breath. Later attempts included holding an overturned container over one's head and using the trapped air as an oxygen supply. The method of using hollow reeds to bring an air supply from the surface is restricted to depth. Otherwise, the increased pressure of water would collapse the reeds and the expelled carbon dioxide would build up, causing death. The increased pressure of water on a diver's lungs at depth would prevent inhalation. Diving tubes using compressed air from the surface helped divers in salvage work, but these hoses and suits were very awkward.

In 1943 Jacques Cousteau invented the "aqualung", another term for scuba tank. A scuba tank is filled with compressed air. This pressurized air is passed to the diver by a hose and regulator.

A weighted belt helps to maintain a proper buoyancy level in the water, as does a buoyancy compensator (air bag).

The suit used in colder water is made of neoprene, a material that has nitrogen bubbles embedded. A layer of water between the suit and skin provides additional insulation. A dry suit is used for diving in extremely cold water. It provides a layer of air as insulation. Along with thermal underwear, it allows for diving even under ice.

Scuba Questions

1. What made diving easier?
2. What does SCUBA stand for
3. Why was Jacques Cousteau important?
4. What is "the bends"?
5. How do they try to cure the bends?
6. What is nitrogen narcosis?
7. How does a wetsuit keep a diver warm?
8. How do divers control their buoyancy?
9. Describe an early diving method and tell why it was unsuccessful.
10. List the different items required by a diver and tell why each is important.

Answers

1. The "aqualung" made diving easier.
2. SCUBA means "self-contained underwater breathing apparatus".
3. Jacques Cousteau was a French naval captain, who invented the aqualung in 1943.
4. "The bends" is the term given to the increased nitrogen in the tissues, as a result of staying too deep and not observing decompression stops on the way to the surface. The nitrogen is released from the tissues as bubbles, which collect in the joints and cause severe pain and the diver bends over.
5. In order to cure the bends, the diver must be recompressed. This is done in a "decompression" or "recompression" chamber.
6. Nitrogen narcosis is caused by a build-up of nitrogen in the tissues, caused by being too deep for too long. It causes a feeling of extreme well-being. The diver may offer his regulator to the fish and as a result, drown.

7. A wetsuit keeps the diver's body warm by insulating the body with neoprene and a layer of water between the skin and suit.

8. A diver can control his or her buoyancy by using a weight belt and a buoyancy compensator.

9. An early diving method was to breathe through a hollow reed or tube. It was unsuccessful because with any substantial length the carbon dioxide would accumulate and suffocate the diver. Also, at depth, air pressure would be required in order for the lungs to expand.

10. Different items that a diver needs are:
Scuba tanks to provide air
Weight belt to assist in maintaining depth
Buoyancy compensator to control depth
Fins for maneuvering and propulsion
Facemask for vision
Depth gauge to give the exact depth
Wetsuit for warmth
Powered sub in order to extend the range of exploration

Nervous Wrecks Dive Club

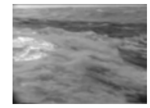
A CB Diver Presentation

Try-a-Tank

ATV NEWSTIPS
1-888-565-NEWS

Video: Sea Treasures

42 minutes



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