

Useful Formulas for Gas Math



Calculating Atmospheres Absolute

$$ATA = \left(\frac{D}{33}\right) + 1$$

In the above formula D=depth

To calculate the atmospheres in absolute pressure at 125 the math is done as shown below:

$$ATA = \left(\frac{125}{33}\right) + 1$$

$$ATA = 4.78$$

Calculating Maximum Operating Depth

$$MOD = \left(\frac{PPO_2}{FO_2} \times 33\right) - 33$$

PPO₂ is the maximum partial pressure of oxygen we want to have during the dive.

FO₂ is the percentage of oxygen in the mix. i.e. EAN32 is expressed as .32

To calculate the MOD of EAN32 the math is done as shown below:

$$MOD = \left(\frac{1.4}{.32} \times 33\right) - 33$$

$$MOD = 111 \text{ fsw}$$

The Maximum Operating Depth (MOD) for EAN32 then is 111 feet of sea water.

Calculating Best Mix For Maximum Depth

$$\text{Best Mix} = \frac{1.4}{\text{ata}}$$

To calculate the Best Mix for a maximum depth of 125 feet the math is done as shown below:

$$\text{Best Mix} = \frac{1.4}{4.78}$$

$$\text{Best Mix} = .29$$

EAN29 then would be the best mix to yield a maximum PPO2 of 1.4 ata at 125 fsw.

Calculating the Baseline for SCUBA Cylinders

Calculating the baseline for scuba tanks is very important for gas planning. Two variables are needed. The rated volume of the tanks and the rated pressure. For example Low Pressure (LP) 85's hold 85 cubic feet (which is their rated volume) when filled to 2640 psi (which is their rated pressure). In the equation below we multiply by 2 because we are using twin tanks. We multiply by 100 to express the baseline in units of 100 psi.

$$\text{Baseline} = \left(\frac{\text{Rated Volume}}{\text{Rated Pressure}} \right) \times 2 \times 100$$

$$\text{Baseline} = \left(\frac{85}{2640} \right) \times 2 \times 100$$

$$\text{Baseline} = 6.4 \text{ ft}^3 \text{ per } 100 \text{ psi}$$

The baseline of 6.4 means that for every 100 psi used is = 6.4 cubic feet of gas.

Calculating the Equivalent Narcotic Depth (END)

For a given depth using trimix an END is the depth at which you would expect the same narcosis if diving with air.

$$\text{END} = [(1 - f_{\text{He}}) \times (D + 33)] - 33$$

f_{He} = Fraction of Helium in the mix

Example: What is the END at 240 feet when diving 17/45?

$$\text{END} = [(1 - .45) \times (240 + 33)] - 33$$

$$\text{END} = [(.55) \times (273)] - 33$$

$$\text{END} = 117 \text{ fsw (feet of sea water)}$$

In other words, diving trimix 17/45 at 240 feet has the same narcotic effect as diving air at 117 feet.

Calculating the Equivalent Air Depth (EAD)

EAD is an adjusted depth on air tables when diving EANx. EAD is based on finding the depth at which air has the same partial pressure of nitrogen (PN₂) as the EANx blend. EANx has less nitrogen than air so the EAD is less than the actual depth. Calculate the EAD by the formula below.

$$EAD = \frac{[(1 - fO_2) \times (D + 33)]}{.79} - 33$$

Example: What is the EAD of EAN32 at 100 fsw?

$$EAD = \frac{[(1 - .32) \times (100 + 33)]}{.79} - 33$$

$$EAD = \frac{[.68 \times (133)]}{.79} - 33$$

$$EAD = 81 \text{ fsw}$$

Calculating the Partial Pressure of a Gas at Depth

This is a two step process. Step one is to calculate the maximum ata of the dive.
Step two is to multiply the ata X the fraction of the gas we want to know the partial pressure of.

Example: What is the Partial Pressure of Oxygen in EAN32 at 100 feet?

$$\text{Step One: } ata = \left(\frac{D}{33}\right) + 1$$

$$ata = \left(\frac{100}{33}\right) + 1$$

$$ata = 4.03$$

$$\text{Step two: } PPO_2 = 4.03 \text{ ata} \times .32$$

$$PPO_2 = 1.28 \text{ ata}$$

In other words the partial pressure of oxygen at 100 feet while breathing EAN32 is 1.28 ata (atmospheres absolute)

Calculating Surface Air Consumption (SAC) rate

Calculating the SAC rate is a several step process and calculating the SAC rate several times under varying dive conditions, comfort levels and workloads is required to get an average SAC rate so that it becomes a usable number for you.

1. Calculate the average ata of the dive.
2. Calculate the volume of gas used during the dive.
3. Record the duration of the dive.

$$SAC = \left(\frac{\text{Volume of gas used}}{\text{Time of dive}} \right) \times \text{average ata of dive}$$

Example: The diver used 1000 psi out of a set of double 104's (rated at 2640 psi) over a period of 40 minutes at a depth of 70 feet. Calculation of the SAC rate is shown below.

$$SAC = \frac{78 \div 40}{3.12}$$

$$SAC = .625 \text{ ft}^3/\text{minute}$$

In the above example we assumed a square profile so the ata was the same as average ata. If we were doing a multi-level dive we would need to get the average depth from our dive computer or bottom timer.

*Note several of the above formulas were used to calculate the SAC rate.