Cylinder Buoyancy Calculator

Version 3.0

Overview

The Cylinder Buoyancy Calculator is a tool to enable divers calculate various buoyancy values of Scuba cylinders pre and post dive and the amount and weight of gas used on a dive. It is designed to run on PCs running Windows operating systems.

The tool will calculate the following:

- The amount and weight of gas in a filled cylinder.
- The buoyancy of a cylinder at the start and at the end of a dive.
- The buoyancy of a cylinder at 50 bar or 500 psig i.e. on the safety stop.
- The buoyancy of a cylinder when “empty” i.e. at 1 bar or 14.7 psia.
- The weight of gas used on a dive and hence the amount of extra lead needed to compensate for it.

Note: I use the term “gas” to mean air or nitrox within the context of this document.

Please note that this tool does not calculate a diver’s overall buoyancy. A diver’s overall buoyancy in the water is dependent upon many factors and can only be determined by a properly conducted buoyancy check using all the equipment that will be used on a dive. The “Amount of extra lead needed on weight belt” figure that the tool calculates is the amount of lead needed to compensate for the air used on a dive and not the total lead needed on a weight belt or weight system. This value is in addition to the weight need to achieve neutral buoyancy.

Performing a buoyancy check

To perform a buoyancy check a diver needs to enter the water fully equipped for the dive with all the equipment he or she would normally wear on a dive, carrying any torches, cameras etc. The cylinder should contain the amount of air that will remain at the safety stop on the dive, this will typically be 50 bar or 500 psig. Entering the water the diver then adds or removes weight from his or her weight system until he or she can float, with an empty BCD and holding a normal breath, at eye level. By exhaling the diver should slowly sink and by inhaling the diver should slowly rise. This gives the diver neutral buoyancy for the safety stop. Extra weight then needs to be added to allow for the gas that will be used during the dive. The diver will now be negatively weighted and this will allow the diver to easily descend at the start of the dive. As the diver descends he or she will add air to his or her BCD (or dry suit) to compensate for this extra weight (and for the loss of buoyancy due to the compression of the thermal protection suit). Throughout the dive, as air is used up, the diver will get progressively more buoyant and this is compensated for by periodically dumping small amount of air from the BCD (or dry suit) throughout the dive. When the dive comes to the safety stop there should be only a small amount of air left in the BCD (or dry suit) and the diver should be perfectly neutral in the water to safely perform this stop.

Installation

Download, unzip and save the tool to a suitable location on your computer. Go into the “Cylinder buoyancy calculator ver 3.0” folder and click on the setup.exe file. The program will be installed on your machine and will appear on your Start menu under “All programs”. It may be removed by using the Windows “Add or Remove programs” utility found in the “Control Panel”.

Using the tool

Entering values

The tool will cater for both metric and imperial units by the user selecting “Metric” or “Imperial” as appropriate under the “Units” setting.

Under the “Water” setting select either “Salt” or “Fresh” water as appropriate. Due to their slightly different specific gravities small differences in the results will occur. The specific gravity of salt water has been set at 1.03, which is a fairly widely accepted average value for sea water worldwide.

Select “Single” or “Twin” cylinders as appropriate. Note for this option the cylinders are assumed to be identical. This tool does not cater for a single cylinder with pony. As a diver should plan his dive to not use the pony this would be an irrelevant option for this tool as the start and end buoyancy values of a pony should be the same. However, a pony’s buoyancies can be calculated individually by treating it as a single cylinder and performing a separate calculation.

Select “Steel” or “Aluminium” as appropriate for the type of cylinder metal.

Under “Manifold used” you have the option, if you have selected twin cylinders above, to select “No” for an independent configuration or “Yes” for a manifolded configuration.

The “Cylinder weight” and “Cylinder capacity” values are to be found on the neck of the cylinder. Because there are so many different sizes of both steel and aluminium cylinders the only realistic way for this tool to determine these values is for the user to input his or her own particular values. Note that the metric system uses unpressurised capacity values and the imperial system uses pressurised capacity values. Typically a metric capacity would be 12 or 15 litres and imperial 80 or 100 cubic feet.

The “Cylinder working pressure” value refers to the imperial system only. Because the imperial system uses a pressurised capacity value we need to establish at what pressure this capacity relates to. For example, a typical US cylinder will be rated at 80 ft^3 when it is filled to a certain pressure, commonly 3000 psig. This is the cylinder manufacturer’s quoted capacity value and can also be found on the neck of an imperial cylinder.

The “Start pressure” is the pressure of the gas in the cylinder at the start of the dive. Likewise, the “End pressure” is the pressure of the gas in the cylinder at the end of the dive.

The “Valve weight” and “Manifold weight” (if used) are weights of these items in air. The valve weight is for a single valve only. The tool will automatically calculate for two valves if using twin cylinders. There is the option to configure for twin independent cylinder configurations by selecting “No” to “Manifold used”. If selecting “Yes” to “Manifold used” then you will need to enter a separate weight for the manifold. If using a combined arrangement of cylinder valves and manifold then enter half the weight of this item in the “Valve weight” box and leave the “Manifold used” option set to “No”.

The “Reset” button will clear all displayed results and reset the tool back to default values.

The “Calculate” button will check that inputted values are acceptable and then calculate and display the results. Any inputted values which are out-of-range will result in a warning alert and the mouse cursor will select the incorrectly entered value. This button will also recalculate after inputted data or parameter is changed.

Click “Exit” to close the program.

A useful function of the tool is the ability to compare how buoyancy changes when changing from a steel cylinder to an aluminium cylinder or vice versa. For example, steel cylinders tend to be more negatively buoyant than a similar sized aluminium cylinder. Steel cylinders tend to remain negatively buoyant throughout the whole dive whilst aluminium cylinders tend to start negative and go positive towards the end of the dive. So divers used to diving with steel cylinders may have to use more weight when using aluminium cylinders and the tool can show the difference.

Displayed results

“Weight of valves + manifold”	The combined weight of these items. For twin cylinder configurations the tool will automatically allow for two valves.
“Total amount of gas”	The total amount of gas in a single or twin cylinder configuration at the start of the dive.
“Total weight of gas”	The total weight of the gas in a single or twin cylinder configuration at the start of the dive.
“Total weight in air”	The overall weight of the cylinder(s), valve(s), manifold and gas at the start of the dive.
“Buoyancy dive start”	The overall combined buoyancy of the cylinder(s), valve(s), manifold and gas at the start of the dive.
“Buoyancy dive end”	The overall combined buoyancy of the cylinder(s), valve(s), manifold and gas at the end of the dive.
“Buoyancy at 50bar / 500 psig”	The overall combined buoyancy of the cylinder(s), valve(s), manifold and gas for a typical end-of-dive cylinder pressure.
“Buoyancy empty”	The overall combined buoyancy of the cylinder(s), valve(s) and manifold with “empty” cylinder(s). Actually, an “empty” cylinder will always have a minimum of 1 bar / 14.7 psia of air in it.
“Amount of gas used”	The amount of gas consumed on the dive.
“Weight of gas used”	The weight of the gas consumed on the dive.
“Amount of extra lead needed”	This is the amount of extra weight needed on the weight system to compensate for the weight of air used on the dive. This is the same value as “Weight of gas used” above.

Whenever an inputted parameter is changed after a calculation has been performed any affected results will dim to a light grey colour. These values have been updated due to your change(s) and the “Calculate” button will then need to be clicked again to update them.

Correct values will be shown in the Windows default colour (normally black).

Terminology

psig: pound-force per square inch gauge. The unit of pressure relative to atmospheric pressure at sea level. A submersible pressure gauge shows psig and will show 0 psi at sea level, i.e. 14.7 psia.

psia: pound-force per square inch absolute. Pressure relative to a vacuum.

Version

Changes to this version

Imperial units option added.
Manifold used option added.
Total weight of gas and Amount of gas used calculations added

The Recreational Nitrox Calculator was completely re-written for version 3.0 to update the tool for newer Windows operating systems and features a cleaner looking user interface. The tool now requires to be installed on the user's machine.

Please contact me for any errors or inaccuracies to: stevecain@o2.co.uk

Comments or requests for improvements or additions are welcome.