
Dive Hookah

Contents

Safety.....	2
The designer.....	2
Application.....	2
Considerations.....	3
The Pump.....	4
Air supply pipes.....	5
Connectors.....	5
Regulator.....	5
Capacitive tank.....	5
Filtration.....	6
Calculator.....	6
Glossary.....	6

Safety

Dive Hookahs are dangerous and can kill you. You have been warned. Do a certified SCUBA dive course before using a dive hookah. You are breathing compressed air like that from a SCUBA cylinder.

The designer

Dear reader,

I am creating this dive hooker for a relatively simple application. The information in this document is for informational purposes only and in no way constitutes as advise. Read the safety description above so you don't severely injure yourself. You could rupture a lung or suffer the consequences of nitrogen narcosis if you don't learn how to SCUBA properly before using a dive hookah. The responsibility is on you and I accept no liability for any injuries you may incur.

The design is based on systems already put together by others. Thanks to Pete and Gary for their input. Also to Dave for his extra safety tips.

Regards,

by Dion Patelis.
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Application

My application for a dive hookah is to clean the bottom of a boat hull. I only need to go to a maximum depth of 2.5m. I have chosen to use 240v @ 50Hz (Australian mains power equivalent) as standard extension cables can be used with minimal power loss. For power loss calculations in cables you may use:

<https://photovoltaic-software.com/solar-tools/voltage-drop-calculator-dc-ac>

Considerations

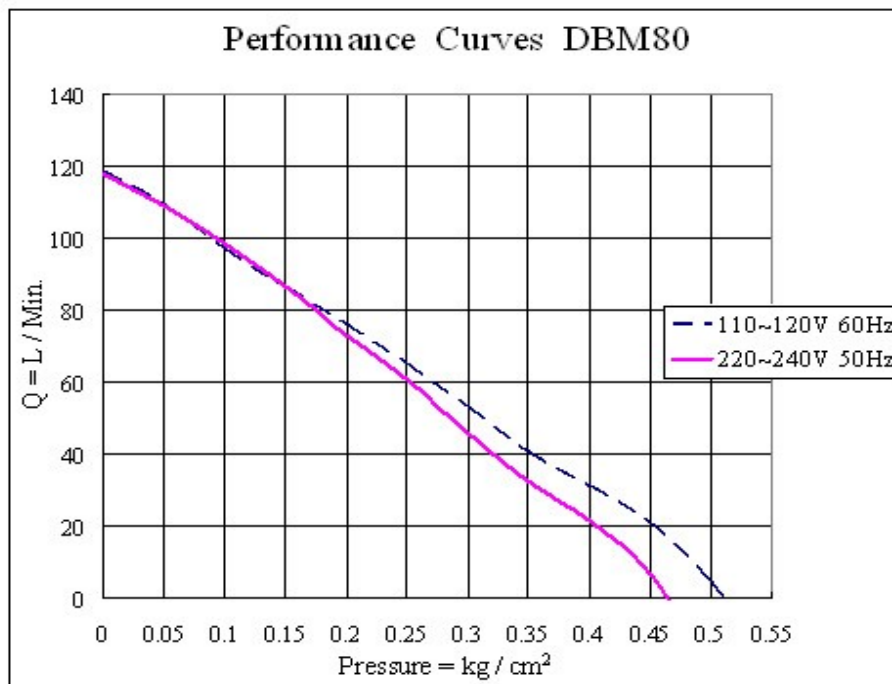
There are two things to consider when designing an air supply:

1. Pressure;
2. Volumetric flow rate.

Pressure is required to lift a column of water equivalent to the depth you're diving to. A hand bicycle pump would create plenty of pressure for this application, but would not provide enough volume of air per minute.

The average man apparently uses about 6-7 Litres per minute of air ^(confirmation needed). Under physical exertion that could be multiplied by 4-5 times. Thus we can say 30ish litres of air per minute.

A graph like the following should be provided from the pump manufacturer. Using the calculator (included in the .zip file) I've set my depth to 2.5m. The calculator returned a pressure of 0.25kg/cm². Thus reading 0.25kg/cm² from the horizontal axis of the graph we see that the Kamair DBM80 air pump will provide about 60Litres of air per minute which will easily provide a man exerting himself at a depth of 2.5m under water.



The Pump

A diaphragm pump is used for this application because:

1. of low power usage and;
2. the simplicity of a rubber diaphragm.

The rubber diaphragm produces relatively clean air. I could have possibly used a diaphragm pump designed for water as it should create a higher pressure for the same price and should be able to run dry. Although I have not tested this.

The other option is a piston style pump. A piston style pump comes in two types:

1. Oil lubricated;
2. Non-oil lubricated.

The piston pumps can produce pressures of greater than 100psi ($>7\text{kg/cm}^2$) which is great for deep diving, however to do so they must consume more power. These pumps can atomise the oil into the air stream which is not great to inhale. There is also the potential to scrape off the moving parts inside the cylinder head and disperse them into the air stream. Equally as harmful. Thus they require an excellent activated carbon and mesh filtration system.

With a rubber diaphragm there are no parts to scrape against each other, nor is there any oil involved.

I have chosen to use a Kamair DBM80.

kamair.com.tw

I would have preferred the DBMX80 as it includes a thermal cutout, but alas it was unavailable. The DBM80 power consumption is 80W which is just under 6.7Amps @ 12v for the 12v enthusiasts out there. Thus you can run this pump on a very small inverter. I use Victron inverters.

The diaphragm pumps are often used in septic aeration or fish farm / aquaponics applications.

Other brands of diaphragm pumps which could be used include Thomas / Yasunaga, Secoh, Hiblow, Nitto Kohki – Medo and Fuji.



Figure 1: Kamair DBM80 air pump

Air supply pipes

The recommendation is SCUBA approved pipes which are reinforced and will not kink or collapse and are internally coated with PVC. There are Standards in each country for dive pipes. However I am only diving to 2.5m and am not worried about the pipe kinking or collapsing. I used Australian standards food grade pipe. If it's good enough for water, it should be good enough for air and PVC is PVC (Except in certain situations). I used 12mm which is equivalent to garden hose.

Connectors

I used the cheapest garden hose connectors from the hardware store. We are running at far less than 7 psi (or half an atmosphere) and these connectors are adequate.

Regulator

Ocean Pro HK10 Hookah 2nd stage only regulator. It is fitted to the hose with a stainless steel hose clamp. It is set for low pressure supplies. The 12mm hose fits over the threaded attachment point and proves an adequate seal for my use.

Capacitive tank

I used an inline capacitive tank. It steadies the air flow and takes up some of the excess pressure when not breathing in. Capacitance is a mathematical function applied to water, air, electrical, chemical and mechanical systems. Analogously capacitors are used in electronics for power conditioning to smooth the voltage discrepancies over time. Here the pulsing from the air pump is smoothed out as the drops in pressure are lifted by the extra pressure in the tank built up inbetween breaths.

I wouldn't use a PVC tank in high pressure (>150psi) applications without checking ratings first. An explosion could be rather nasty. In my application the pump can't push the air any harder than 0.4kg/cm² and thus it's not an issue. To do a physical test on the pipe we could draw a square 1cm * 1cm on the pipe and put something weighing 0.5kg on it. If it handles it, the pipe will be fine.

Using 1m of 100mm PVC sewerage pipe, a standard end cap and a screw end cap from the hardware store I made the tank. The ends were etch primed with acetone and then a high pressure PVC plumbers glue was used. I could have equally used silicone.

To make the connection points in the tank I drilled a 15mm hole and tapped a brass 20mmFM to 15mmM adaptor in each side. You shouldn't need any thread sealer. Put a rubber washer in the 20mm female side and screw in the 12mm brass sprinkler adaptors. The Nylex brand sprinkler adaptors protrude further than the other brands which gives enough length for the hose connector to click into place correctly.



Figure 3: Brass
Threaded Adaptors -
20MM FI X 15MM MI



Figure 2: Nylex
12mm Brass
Sprinkler
Adaptor

A pressure release valve set to 4PSI could also be added if there is no thermal cutout on the compressor.

Filtration

The 100mm diameter capacitive tank makes a good size to put filtration materials into. Thus it has a double use. I use a stocking or some bag made of similar material to hold activated charcoal. The charcoal bag fills the inside diameter of the tank. Activated charcoal is coal that's been heated to a point where everything except the carbon has changed phase to gas and floated away in the atmosphere. Carbon doesn't change phase till 3642°C so it's the only thing left if we heat to high 2000's. The activated charcoal readily bonds with impurities in the air flow and the stocking will filter larger particles. A 5-10 micron filter is then put in line after the capacitive tank to catch any super fine particles. Activated charcoal is available from aquarium suppliers.

Calculator

I've included a calculator spreadsheet called:

20240615_1113_dive_hookah_calculations_web.ods

The file opens with [LibreOffice](#) which can be installed on Mac, Microsoft and Linux systems.

The calculator allows you to type in the depth requirement and then it gives back the pressure of the pump required.

Glossary

~ (tilde) = Approximately equal to