DESCRIPTION OF A LOW-COST, SHALLOW-WATER, SURFACE-SUPPLIED DIVING SYSTEM

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Research and maintenance diving tasks that are conducted in shallow water, particularly those involving extended periods of time, are cumbersome using SCUBA. Consequently, these tasks are often conducted using gasoline-powered small air compressors. These air sources have several drawbacks which may compromise the health and safety of divers or support personnel. A relatively low-cost ($200-225) alternative surface-supplied system is described that performs as well as gasoline-powered systems, and yet improves the safety of diving operations and is also more reliable and requires much less maintenance. Air is supplied easily and economically from large volume SCUBA cylinders (80-100 ft³). This system should be useful to researchers as well as to persons involved in underwater inspection and maintenance operations, and may be of interest to shallow water fisheries such as sponge and clam industries.

INTRODUCTION

Many research and maintenance diving tasks are conducted in shallow water (5-30 ft). These tasks often involve extended periods of time underwater and, because of the depths and bottom time involved, are cumbersome using traditional SCUBA gear. Consequently many divers involved in shallow water surveys, periodic maintenance of experiments, hull cleaning, etc., use small gasoline-powered low-pressure compressors which feed one or two low pressure hoses and second stage demand regulators. This system allows a diver to be relatively unencumbered, but presents other inherent problems.

Paramount are potential health and safety risks to both the diver and the support personnel. The air quality of gasoline- powered "hookah" systems is questionable and unpredictable. Most models simply draw air through a valve in the head of the compressor. Since the compressor is driven by a shaft from the gasoline engine, this places the air intake in close proximity to engine exhaust. Unpredictable wind conditions may cause carbon monoxide, carbon dioxide, and hydrocarbon emissions to enter the compressor. Since these low pressure
compressors are oil free, they deliver unfiltered air directly into the low-pressure hose. Other problems associated with the air delivery systems include water vapor and temperature. Because the air is unfiltered, water vapor is also carried into the low-pressure hose in appreciable amounts, and the temperature of the air leaving the compressor may reach 88°C (190 °F). In addition, engine failure may place a diver at risk, although the use of an in-line reserve tank may help mitigate the temperature, moisture, and engine failure drawbacks. Finally, gasoline used to power the engine is a fire hazard, the noise of the engine running as well as its emissions are a health hazard to the tender, and the engine and compressor require significant maintenance.

An alternative surface-supplied diving system exists that performs as well as the gasoline-powered hookah, and yet improves the safety of diving operations, is more reliable, and requires much less maintenance. In this paper we describe the system, its components and assembly, and provide examples of its use in research diving tasks undertaken by FMRI scientists and technicians.

MATERIALS AND METHODS

Our system differs from most traditional low-pressure hookah systems in that it provides intermediate pressure air to the second stage, not low pressure air. This eliminates the need to have the second stage modified to accept low-pressure air. The heart of the system is a conventional single hose SCUBA demand regulator complete with a pressure gauge. The first stage mounts on a conventional SCUBA valve which is threaded into a high-volume cylinder, 80-100 ft³, although any compressed air cylinder is acceptable. The second stage is connected to the first stage by 100 ft. of Synflex 3600-06 light weight intermediate pressure hose (working pressure 250 p.s.i.) with an in-line non-return or check valve. This quantity of hose weighs only 10 lb. and floats above the diver's head during diving operations. Based on the equation of Somers (1972) for surface-supplied requirements, this hose is more than adequate for delivering air at shallow depths. In fact if one conservatively assumes that the first stage provides 110 p.s.i., then this type of hose will adequately supply a diver to a depth of 100 ft.

Both ends of the hose are fitted with 3/8" female hose fittings. In order to mate the Synflex hose with the regulator first stage a modified intermediate-pressure hose must be fabricated; this involves removing the female fitting from the distal end of the intermediate-pressure hose and replacing it with a 3/8" male fitting. The check valve is mounted to a surface-supply harness with a fabricated aluminum bracket and plate, and the distal end of the long hose threads into this valve. On the distal end of the check valve a swivel cross is fitted to facilitate the connection of three intermediate pressure hoses, one for the regulator second stage, and two for inflator hoses. The long intermediate pressure hose is connected to the harness by a snap shackle so that strain on the distal fitting is reduced, and all threaded connections are wrapped with Teflon tape (Fig. 1). For depths greater than 15-20 ft a
A low-cost, shallow-water, surface-supplied diving system is utilized. This consists of a 14 ft³ cylinder and a single hose demand regulator strapped to the diver's harness, with the valve in a position which is easy for the diver to reach. The cost of this surface-supplied system, without the redundant air supply, is one regulator and approximately $200-225. With the bailout bottle the cost is two regulators and approximately $325-350. All equipment necessary to fabricate this system is available from any commercial diving supply firm. Air hose fabrication can be performed by any pneumatic or hydraulic supply firm.

**RESULTS AND DISCUSSION**

The surface-supplied system is operated in the following manner: The harness is simply strapped on over the diver's environmental suit as the last piece of equipment donned. In shallow water (less than 15 feet) we do not wear a buoyancy control device because the diver can easily swim to the surface and then ditch the weight belt if the situation arises. The tender assists the diver in dressing, especially if a dry suit is being worn, monitors the diver's air supply and tends the intermediate pressure hose. In depths exceeding 15 feet both a buoyancy compensator and a redundant air supply is worn. We most commonly use the system with 100 ft³ cylinders, and regularly experience bottom times of 3-4 hours on one cylinder. We find great advantage in this system when multiple stations must be dived because a diver can enter and exit the water with ease, greatly reducing fatigue and greatly increasing the efficiency of the diver. As many as 25-30 stations can be sampled in one day by one diver using this system.

Most of the dives using this surface-supplied system have been in association with the hard clam project in the Indian River lagoon and Florida's east coast. We have used it to survey densities of adult clams, and in a variety of field-monitoring and manipulative experiments. A good deal of our research has involved sampling for juvenile clams in the lagoonal substrate. This involves placing a circular aluminum 0.25 m² quadrat into the substrate and removing the substrate to a depth of 5-10 cm using a venturi-powered suction dredge. The surface-supplied system allows an unencumbered diver to wrestle around with the quadrat and the suction dredge underwater without great difficulty, however experience has demonstrated that it is desirable to be overweighted while suction dredging in shallow water. This same technique has been used by us to survey areas of the Looe Key National Marine Sanctuary reef flat for spiny lobster prey items. It works equally well in both soft-sediments and in seagrass meadows. Other projects at the Florida Marine Research Institute utilize the surface-supplied system to survey seagrass beds, to monitor the progress of restored seagrass habitat, and to inspect and clean fish ponds at the redfish and snook stock enhancement facility in Port Manatee, Florida. In addition, members of DNR's Division of Marine Resource Regulation and Management use the surface-supplied system to survey oyster reefs in Apalachicola Bay.

This system could be utilized by any project which involves long hours of underwater survey or observation work, especially where tasks involve a lot of manipulating of collecting
gear or require divers to perform maintenance tasks. It is limited by the length of the intermediate pressure hose to perhaps 30 ft, but is extremely useful in depths of less than 20 ft. Other possible uses for the system would be in commercial fisheries such as clamming or sponging where a great deal of diving is performed in very shallow water, and a large number of operations are currently using gasoline-powered compressors. Additionally, hull cleaning and inspection services will find this a safe and useful alternative to the traditional low-pressure compressors.

Maintenance of this system is no more difficult than maintaining a conventional SCUBA regulator. Freshwater rinses are all that are routinely needed, and the entire system should be overhauled by a certified regulator repair technician at least once a year. With 4 systems currently in operation and over 300 hours of diving to date, we have experienced only one free-flowing second stage and one worn o-ring, in both cases requiring minimal repair. We consider this system to be safe, easy to use, and economical, and recommend it to all scientific diving programs that perform diving tasks similar to those described in this paper.

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LITERATURE CITED

Figure 1. Schematic of shallow-water surface-supplied diving system.