7. Push water from the Sample bag through the filtration stage of the ESP, collecting the filtered water in the exhaust bag
8. Once filtering of the sequestered sample is complete, close isolation valves to the core ESP
9. Recompress the system to ambient pressure
10. Exhaust water, and prepare for next sampling event

B. Lung Based System

Several different design concepts were formulated for the 4000m DWSM. Some were based upon known architectures, like the 1000m version, but others were new, original ideas. All of these concepts were compared and evaluated against the functional requirements. The concept with the greatest potential to meet the requirements and design goals was modeled after lungs and the biological processes of breathing.

To inhale air into the lungs, the human body generates reduced pressure inside the chest in two ways. Most notably, muscles of the diaphragm contract, increasing chest volume. Also, accessory muscles in the chest lift the ribs upward to additionally expand the volume. When an air passage is open via the mouth or nose, the ambient air pressure drives air in the lungs, filling the volume made available. To exhale, the diaphragm and accessory muscles relax and the weight of the chest places the air inside the lungs at higher pressure than ambient. To exhale more forcefully, abdominal muscles contract to push upward on the diaphragm, increasing the pressure more, and air is forced out.

As described, the 4000m DWSM mimics human breathing action by pumping oil into or out of the hard pressure housing to generate a pressure differential. Inside the pressure housings, the pressure generated by the oil pumps is transferred thru the flexible "lung" membrane bags to the raw seawater, which then flows if allowed to. The raw seawater is drawn into the system, pumped thru the ESP, and exhausted back to the ocean all by pumping hydraulic fluid.

A major benefit of oil pumping systems, instead of piston cylinders like the 1000m version, is the pumps contact only oil, effectively eliminating pump corrosion and contamination concerns. Additionally, the 4000m DWSM pump design decouples the sample volume from the size of the driving mechanisms. The pumps can move greater volumes by simply allowing more pumping time. The sample volume could be increased by using larger chambers and bags, with no significant change to the driving mechanisms.

The 4000m DWSM uses three oil pumps to move the seawater around and decompress the system. The bidirectional Intake/Exhaust Pump (IEP) is used to generate low pressure differentials to ambient, and is used to fill and empty the seawater bags. To create the decompressed environment for the ESP to filter, a unidirectional decompression pump is used to pump oil out to ambient storage at high pressure differential. A third Sample Pump (SP) is used to pressurize one bag versus the other and thereby drive water through the ESP filter stage.

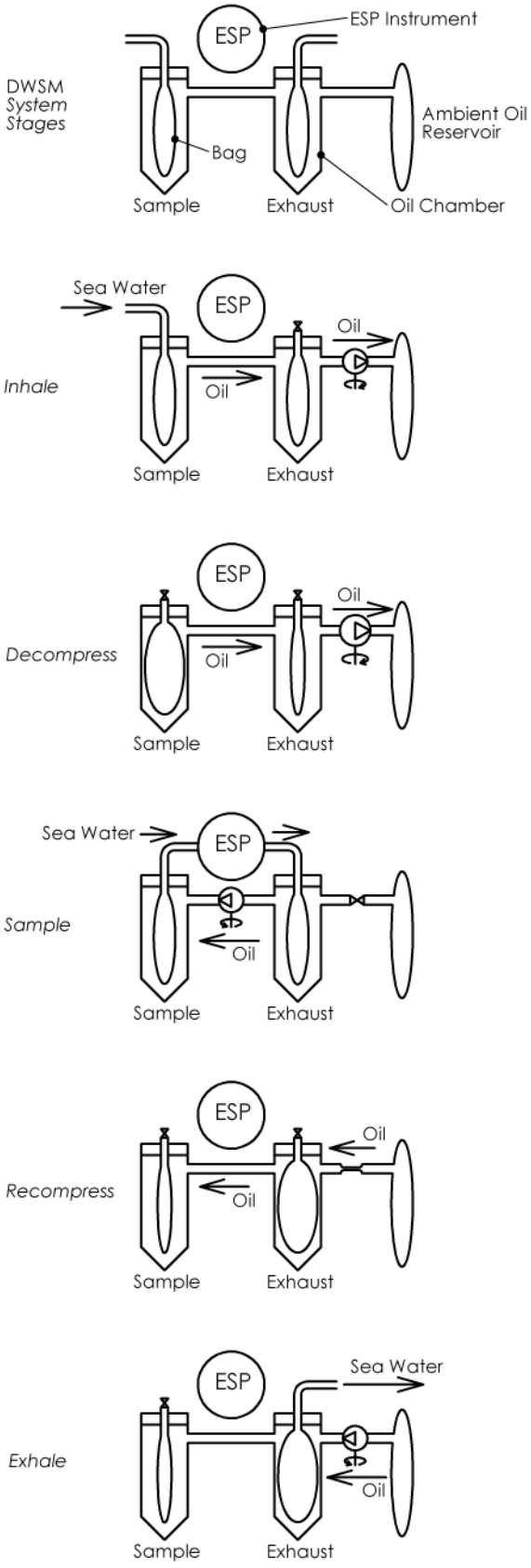

Fig. 2 Simplified schematic of DWSM system showing the stages of inhaling seawater, decompressing, sampling by the ESP instrument, recompressing and exhaling the filtered seawater