BUOYANCY CONTROL SYSTEM THROUGH INJECTION OF WATER INTO A PRESSURE TANK

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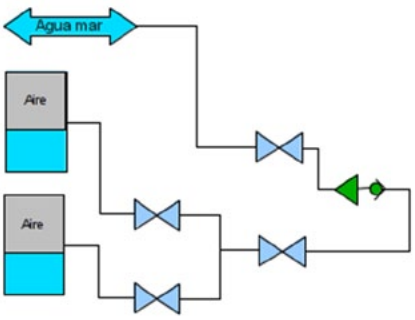
Abstract - The purpose of this report is to present the design and operation of a buoyancy control system for an autonomous underwater vehicle (AUV) that enables rapid construction, high reliability and low cost.

Keywords – AUV, bouyancy system, low cost

I. INTRODUCTION

All ships and submarines on the surface, are in a state of positive buoyancy, weighing less than the equivalent volume of water displaced (according to Archimedes' principle). To submerge hydrostatically (without mechanical assistance), a ship must gain neutral buoyancy (weight equal to water drive) by increasing its own weight or decreasing the water displacement (volume). To control their weight, submarines are equipped with ballast tanks that can be filled with water or air taken from outside.

This system is designed for a vehicle (project VACCA) that will operate in coastal regions, and thus must consider the important density variations found in those regions, resulting, for instance, from upwelling processes or river discharge. This density can vary in the surface from 995.6 kgm-3 for the case of fresh water at 30 degrees to 1028.7 kgm-3 with a salinity of 37 and a temperature of 9 degrees. It should consider that the density can reach 1030 kgm-3 in the event that the unit is used for example in Mediterranean waters.



Moreover, the value of density is not constant with depth The density may be constant in a certain range of depths (mixed layers) and then change abruptly in just a few meters (pycnocline). The device, when profiling should be able to adapt to the changing buoyancy conditions.

On the other hand horizontal variations in the density of water, caused in turn by variations of temperature and salinity, lead to the so-called thermohaline currents. The intensity of these currents is usually very low (about 0.2 knots) but occasionally can reach 1 knot near the coast.

II. SYSTEM DESCRIPTION

The system has three main components of a pressurized tank, a pump and valve system. The system volume can vary by adding or subtracting water. When empty, the tank provides a positive buoyancy and negative buoyancy when the tank is full. The system is controlled by the level of water in the tank. This system is the most flexible of the methods to control the buoyancy of an AUV.

The simplest design is that the tank is at atmospheric pressure and buoyancy of the vehicle diminishes as the water fills the tank. To increase buoyancy, the water is pumped out. In this scenario, the tank has to be sturdy enough to withstand hydrostatic pressure when empty (pressure differential).

You can pre-pressurize the tank thus reducing the pressure differential between the tank and the water. In this case, the preload would reduce the energy consumed in the pump, but would require a more complicated system of valves.

The major advantage of this design is the scalability and utilization of space. This advantage derives from the unique dependence on a single tank for buoyancy control. It is only necessary to find components that meet the required specifications for the operating pressure.

The improvement in performance only requires a larger deposit, since the pump can always work at maximum design power.

It is not possible to fill the tank completely, there will always be air in the tank. The maximum available volume of the tank will be 85-89%.

III:CONCLUSION

It is important to note that the choice of flotation systems relies heavily on the use of the vehicle. In our case, the AUV must make multiple vertical profiles over 24 hours. Hence, we think that a buoyancy control system through water injection is the best way to save energy.

But the main reason for developing a buoyancy control system is the possibility of using this system (or foreground) in future applications of AUV, such as horizontal navigation, maintenance at a certain depth, tilt control, etc.