THERMAL CHARACTERISTICS OF DIVING GARMENTS WHEN USING ARGON AS A SUIT INFLATION GAS

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INTRODUCTION

Argon gas has frequently been used by cave divers and technical divers as a drysuit inflation gas to augment thermal protection when diving in cold water. While argon has a thermal conductivity that is approximately 30% lower than that of air, not all are in agreement as to the thermal benefits that can be achieved with argon suit inflation. The objective of this study, sponsored by the Office of Naval Research, was to quantify the potential thermal benefits that are obtainable when using argon instead of air as a drysuit inflation gas.

METHODS

The thermal insulation characteristics of two drysuit ensembles, consisting of the same tri-laminate outergarment with differing undergarments, were measured on a 21-zone thermal manikin when using air and argon alternatively as the suit inflation gas. Suit insulation values were measured by recording the electrical power levels required to be delivered to each manikin zone to maintain a fixed manikin skin temperature of 30ºC (86ºF) while submerged in a constant temperature water bath. Prior to manikin submergence, the drysuits were repeatedly inflated and then purged with either air or industrial grade argon for a minimum of 6 cycles to insure the purity of the inflation gas inside the drysuit.

Figure 1. 21-zone thermal manikin outfitted in a tri-laminate drysuit .

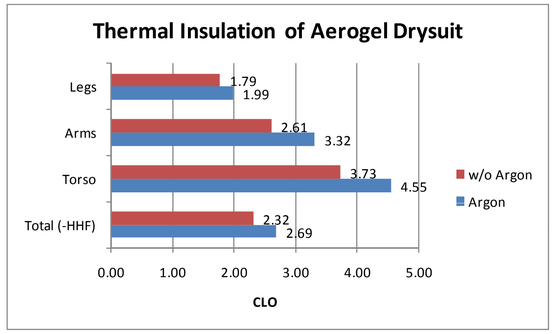

Figure 2. Comparisons of localized insulation values for an aerogel drysuit when using argon and air as suit inflation gases.

$$1\ CLO = 0.155\ \frac{m^2 \cdot {}^oC}{watt}$$

or

$$1\ CLO = 0.18\ \frac{m^2 \cdot hr \cdot {}^oC}{kcal}$$

1 Clo is the equivalent insulation of a business suit worn in still air

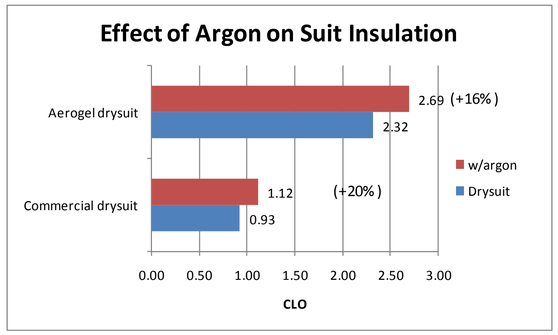

Figure 3. Comparisons of overall insulation values for an experimental aerogel drysuit and a commercial drysuit when using argon and air as suit inflation gases.

RESULTS

Improvements in localized thermal insulation values were seen throughout both drysuit ensembles when using argon as an inflation gas when compared with those while using air. Overall, the total suit insulation values increased by 16 – 20% for the two drysuit ensembles.

CONCLUSIONS

This investigation has demonstrated that significant improvements in drysuit thermal protection can theoretically be achieved when using argon instead of air as a drysuit inflation gas. It should be noted however that these improvements can only be achieved by carefully and repeatedly purging (a minimum of 6 purge cycles) with pure argon prior to water entry.

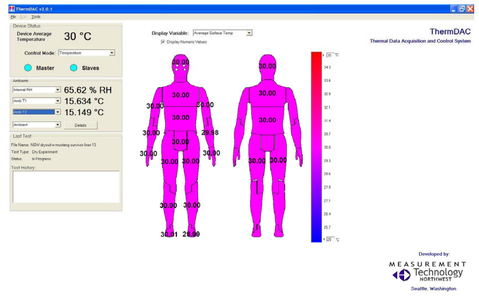

Figure 4. Data acquisition system used to monitor electrical power levels required to to maintain a fixed manikin skin temperature of 30ºC (86ºF) while submerged in a constant temperature water bath.

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