DIVING SUITS; AREAS OF USE AND PROPERTIES

Okşan Oral[1], Esra Dirgar[1], M. Çetin Erdoğan[2]
[1] *Ege University, Bergama Vocational High School, Bergama, İzmir, Turkey*
[2] *Ege University, Faculty of Engineering, Department of Textile Engineering, Bornova, İzmir, Turkey*
oksan.kansoy@ege.edu.tr

ABSTRACT

A diving suit is a garment or device designed to protect a diver from the underwater environment. There are five main types of diving suits. These are dive skins, wetsuits, semi-dry suits, drysuits, and hot water suits. A diving suit may also incorporate a breathing gas supply but in most cases applies only to the environmental protective covering worn by the diver. Diving suits make different materials, these are usually rubber, neoprene, polyurethane. In this study, diving suits, their properties, areas of use, their accessories, materials that are used have been investigated.

Keywords: Diving suits, drysuits, wetsuits, neoprene.

1. INTRODUCTION

A diving suit is a garment or device designed to protect a diver from the underwater environment. There are five main types of diving suits. These are [1]:

- Dive skins
- Wetsuits
- Semi-dry suits
- Drysuits
- Hot water suits

1.1. Dive Skins

Dive skins are used when diving in water temperatures above 25 °C (77 °F). They are made from spandex or Lycra and provide little thermal protection, but do protect the skin from jellyfish stings, abrasion and sunburn. This kind of suit is also known as a 'Stinger Suit'. Some divers wear a dive skin under a wetsuit, which allows easier donning and (for those who experience skin problems from neoprene) provides additional comfort. The Dive Skin was originally invented to protect scuba divers against the jellyfish

1.2. Wetsuits

Wetsuits are relatively inexpensive, simple, neoprene suits that are typically used where the water temperature is between 10 and 25 °C (50 and 77 °F). The foamed neoprene of the suit thermally insulates the wearer. Although water can enter the suit, a close fitting suit prevents excessive heat loss because little of the water warmed inside the suit escapes from the suit to be replaced by cold water, a process referred to as flushing.
Proper fit is critical for warmth. A suit that is too loose will allow too much water to circulate over the diver's skin, robbing body heat. A suit that is too tight is very uncomfortable and can impair circulation at the neck, a very dangerous condition which can cause blackouts. For this reason, many divers choose to have wetsuits custom-tailored instead of buying them off-the-

rack. Many companies offer this service and the cost is often comparable to an off-the-rack suit.
Wetsuits are limited in their ability to provide warmth by two factors: the wearer is still exposed to some amount of water, and the insulating neoprene can only be made to a certain thickness before it becomes impractical to do and wear. The thickest commercially-available wetsuits are usually 10mm thick. Other common thicknesses are 7mm, 5mm, 3mm, and 1mm. A 1mm suit provides very little warmth and is usually considered a dive skin, rather than a wetsuit [1].

1.3. Semi-dry suits

Semi-dry suits are effectively a thick wetsuit with better than usual seals at wrist, neck and ankles. They are used typically where the water temperature is between 10 and 20 °C (50 and 68 °F). The seals limit the volume of water entering and leaving the suit. The wearer gets wet in a semi-dry suit but the water that enters is soon warmed up and does not leave the suit readily, so the wearer remains warm. The trapped layer of water does not add to the suit's insulating ability. Any residual water circulation past the seals still causes heat loss. But semi-dry suits are cheap and simple compared to dry suits. They are made from thick Neoprene, which provides good thermal protection. They lose buoyancy and thermal protection as the trapped gas bubbles in the Neoprene compress at depth. Semi-dry suits are made in various configurations including a single piece or two pieces, made of long johns and a separate jacket' Semi dry suits do not usually include boots or gloves, so a separate pair of neoprene insulating boots and gloves are worn [1].

1.4. Drysuits

Drysuits are used typically where the water temperature is between −2 and 15 °C (28 and 59 °F). Water is prevented from entering the suit by seals at the neck and wrists. The suit insulates the wearer in one of two main ways: By maintaining pockets of air between the body and the cold water in standard air-containing fabric undergarments beneath the suit (in exactly the way that insulation garments work in air) or via (additional) foamed-neoprene material which contains insulative air, which may be incorporated into the outside of the drysuit itself.
Both fabric and neoprene drysuits have advantages and disadvantages: A fabric drysuit is more adaptable to varying water temperatures because different garments can be layered underneath. However, they are quite bulky and this causes increased drag and swimming effort. Additionally, if a fabric drysuit malfunctions and floods, it loses nearly all of its insulating properties. Neoprene drysuits are comparatively streamlined like wetsuits, but in some cases do not allow garments to be layered underneath and are thus less adaptable to varying temperatures. An advantage of this construction is that even it if floods completely, it essentially becomes a wetsuit and will still provide a degree of insulation.
Special drysuits are worn by commercial divers who work in contaminated environments such as sewage or hazardous chemicals. The drysuit has integral boots and is sealed to a diving helmet and dry gloves to prevent any exposure to the hazardous material [1].

1.5. Hot water suits

Hot water suits are used in cold water commercial surface supplied diving.[4] An insulated pipe in the umbilical line, which links the diver to the surface support, carries the hot water from a heater on the surface down to the suit. The diver controls the flow rate of the water from a valve near his waist, allowing him to vary the warmth of the suit in response to changes in environmental conditions and workload. Pipes inside the suit transport the water to the limbs, chest, and back. Special boots, gloves, and hood are worn. These suits are normally made of foamed neoprene and are similar to wetsuits in construction and appearance, but they do not fit as closely by design. The wrists and ankles of the suit are open, allowing water to flush out of the suit as it is replenished with fresh hot water from the surface.[1]
Hot water suits are often employed for extremely deep dives when breathing mixes containing helium are used. Helium conducts heat much more efficiently than air, which means that the diver will lose large quantities of body heat through the lungs when breathing it. This fact compounds the risk of hypothermia already present in the cold temperatures found at these depths. Under these conditions a hot water suit is a matter of survival, not comfort. Just as an emergency backup source of breathing gas is required, a backup water heater is also an essential precaution whenever dive conditions warrant a hot water suit. If the heater fails and a backup unit cannot be immediately brought online, a diver in the coldest conditions can die within minutes; depending on decompression obligations, bringing the diver directly to the surface could prove equally deadly.[1]
When controlled correctly, the hot water suit is safe, comfortable and effective, and allows the diver adequate control of thermal protection, however hot water supply failure can be life threatening.[1]

Figure 1. Diving suit

Figure 2. Wetsuits

Figure 3. Semi-dry suits

Figure 4. Drysuits

Figure 5. Hot water suits

2. FABRICS AND ITS PROPERTIES

2.1. Rubber

Natural rubber consists of suitable polymers of the organic compound isoprene, with minor impurities of other organic compounds plus water. Rubber is harvested mainly in the form of the latex from certain trees. Natural rubber is used extensively in many applications and products, either alone or in combination with other materials. In most of its useful forms, it has a large stretch ratio, high resilience, and is extremely waterproof [5].

2.2. Neoprene

Neoprene (CR), also called polychloroprene or chloroprene rubber, synthetic rubber produced by the polymerization of chloroprene. A good general purpose rubber, neoprene is valued for its high tensile strength, resilience, oil and flame resistance, and resistance to degradation by oxygen and ozone; however, its high cost limits its use to special-properties applications [6].

2.3. PUR

Polyurethane (PUR) is a polymer composed of a chain of organic units joined by urethane links [7]. Polyurethanes may be thermosetting or thermoplastic, rigid and hard or flexible and soft, solid or cellular with great property variances [8].

3. DIVING SUITS ACCESSORIES

Figure 6. Gloves

Figure 7. Hood

Figure 8. Vest

Figure 9. Boots

Figure 10. Fins

Figure 11. Masks

Figure 12. Socks

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