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INPUTOUTPUT

Letting Surfers Vent

Sealed enclosures like telecommunications boxes, GPS receivers, or electric toothbrushes can go through rapid temperature swings requiring vents that not only equalize pressure but also keep moisture out. One engineer's insight into the surfboard as just such an enclosure led him to a solution for a contemporary design problem.

At one time, surfboards were made of wood. In the 1950s, lighter boards were introduced consisting of a polyurethane foam core with fiberglass cloth and polyester resin overtop. Polyurethane became the material of choice until the leading supplier of blanks to surfboard makers went out of business in 2005. Manufacturers turned to expanded polystyrene as a replacement.

EPS foam had been around since the mid-1970s and was first used in sailboards to make them lighter than polyurethane types. EPS consists of closed cell beads, which are more difficult to shape than an open-cell, denser polyurethane. And EPS must be glassed with epoxy which costs more than polyester resin.

EPS works well for the core, but when boards are exposed to the sun, either on roof racks or on the beach, thermal expansion becomes a problem.

A board sitting on a Los Angeles beach for several hours in June during peak solar time can reach a surface temperature exceeding 130 °F, or 55 °F above ambient temperature. Since the epoxy skin on an EPS board is less than 0.1-inch thick, the foam directly under it will see the same temperatures.

Expanded polystyrene is only 3 percent plastic by volume. The rest is the CO_2 blowing gas and air between the closed-cell beads. Heat expands the beads and the air spaces between beads. The expansion can cause delamination, when the bond between the foam and epoxy skin yields. Or the skin can break to create a leak path.

The damage will interfere with the behavior of the board in the water and will almost certainly increase over time.

Designers have tried to solve the problem with plugs that could open and close to allow for pressure differentials, but they weren't user-friendly. Users would leave them open when they were supposed to be closed, or forget to open them.

▲ Bubble trouble: Surface layer delamination caused by thermal expansion of EPS.
▼ Pressure relief: A Gore ePTFE vent is open to air; closed to water, salt, and sand.

As a lifelong surfer, Pete Casica, owner of Casica Engineering, was interested in coming up with a solution. He had designed electronic packages for marine applications and looked at the surfboard as a sealed enclosure, which needed venting to continuously equalize pressure. Using an open vent wasn't sufficient because it would let in water, salt, and sand that could damage the core or reduce its buoyancy, so Casica approached W. L. Gore & Associates about using one of its protective vents.

He worked with a Gore application engineer to come up with the proper vent. The abrupt temperature change caused by taking a surfboard from the hot beach into the cold ocean causes significant pressure differentials inside the product, which can put enough stress on seals to cause them eventually to fail. The question was which design would provide adequate venting.

After evaluating all of the enclosure's variables, the applications team decided on Gore's PolyVent/M12x1.5. Made with expanded polytetrafluoroethylene (ePTFE), the microporous membrane used in the vent equalizes pressure because it is constantly breathing, with a typical airflow of 400 milliliters per minute. The ePTFE membrane is inherently hydrophobic, so it keeps out water, in addition to sand, salt, and other solid contaminants.

The vent is positioned near mid-board. It covers a 3/8-inch diameter air shaft drilled three-quarters of the way through the board. Expanding air will vent, thereby balancing pressure and internal volume. Since the ePTFE vent is always open, there is constant equalization for every temperature and pressure differential.

Casica's vent is also applicable to newer designs of surfboards, which have hollow cores. These designs use internal formers similar to aircraft wing construction. Some are wood (with planking), and others are aluminum with carbon fiber cloth and epoxy skins. The internal expansion of the air is much greater than in EPS-core boards, and it must be vented. Because of the larger air volume, the flow rate of the vent is critical and larger or multiple vents are often needed, Casica said.

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