



*Lake Tai in China; once a source of drinking water.*

CREDIT: BLOOM

# An algal alternative

**L**ast year saw various environmental crises around the world, one of which occurred in the US and was caused by toxic algal bloom. In Florida, a massive infestation hit four southern Florida counties, causing serious and irreversible environmental and health issues, and wreaking general havoc on the state's delicate ecosystems. The problem became so serious that in June, State Governor Scott was forced to declare a state of emergency.

Originating in the highly polluted Lake Okeechobee, the blooms spread as lake water was dumped into the surrounding waterways to prevent local areas from flooding. The result has been an uncontrollable spread of these algal blooms on lakes, with marine life dying and residents reporting breathing problems. Florida is not alone in having this problem and Utah, California and Colorado have also reported the same thing affecting the quality of drinking water and disrupting local ecosystems.

The problem is a natural response to our treatment of the environment and the US is not the only country affected; China has had a similar problem for 20 years on Lake Tai, in the Yangtze delta plain. It is the third largest fresh water lake in China at 2,250 km<sup>2</sup> in area and was once both picturesque and the main source of drinking water for millions of people. In 2007, however, two million of them were forced to go without this essential commodity due to the severity of the algal bloom that had formed on the lake.

The cause was intense industrialisation in the region in the late 1980s which resulted in up to 36 billion tons of wastewater being dumped into the lake each year. This resulted in a condition called eutrophication whereby nutrients such as nitrates and phosphates cause an algal bloom to form that removes oxygen and reduces water quality to such an extent that fish and other organisms all die. Lakes Tai and Okeechobee share the same problem and for the same reason.

## LEARNING AND BENEFITING

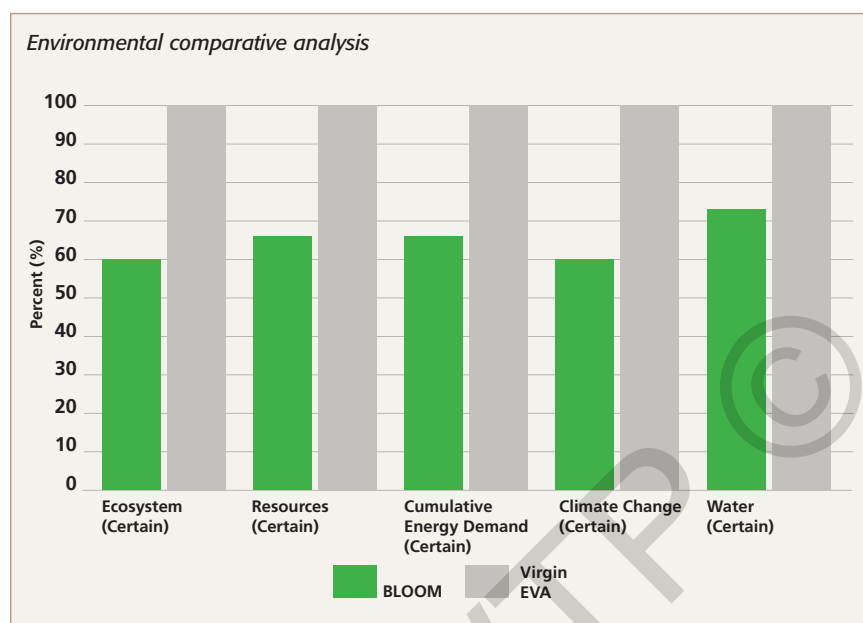
However, they do say that every cloud has a silver lining and it appears that even something as pernicious as algal bloom does indeed have one. It can be used to make foams that have many industrial applications among which is footwear, where it can be used as part of the formulation in the production of Ethylene Vinyl Acetate (eva). The company behind this development is BLOOM Holdings LLC, a joint venture between Algix LLC, a leading algae biomass harvester and Effekat LLC, an environmentally-minded product and material development company. The aim is to offer a more sustainable solution to the synthetic and petrochemical foams prevalent in today's market.

The company, headquartered in Meridian, Mississippi, says that algae should not be vilified, but valued as a plant from which there is much to learn and benefit. Together with Algix, it is working with global infrastructure

services company AECOM, to develop a solution for harvesting algal bloom in Florida and other similarly affected US states, to help mitigate its harmful effects. The mobile harvesting units used are said to offer a simple solution that both protects the integrity of the local habitat and returns clean, filtered water back into the system with 99.7% level of purity. The project is clearly a massive undertaking and it is still early days but the harvesting operation at Lake Tai in China shows how it works.

## HARVESTING PROCESS

Subsurface algae which lies about 15-20cm below the surface of the water is sucked up by industrial-grade pumps (Figure 1). It passes through to large tanks where a coagulant is added to make the algae clump together (Figure 2). Air is added to make it float to the surface after which it is skimmed off into storage tanks (Figure 3). It is then pumped to a conveyor system which occupies the entire roof area under a polycarbonate cover (Figure 4). The conveyor moves the algae gradually across the roof during which



*Bloom has between 20% and 41% fewer impacts in all categories when compared to virgin EVA.*

time it is solar dried. This can take up to three days depending on the amount of sunlight and its intensity (Figure 5). The dried algae is scraped off the belt at the exit where it is bagged ready for dispatch to Algix to be polymerised (Figure 6).

## ALGAL FOAM'S PERFORMANCE

The algae biomass obtained by this harvesting process forms the foundation of Bloom's foam formulations. While these formulations can be tailored to specific customer

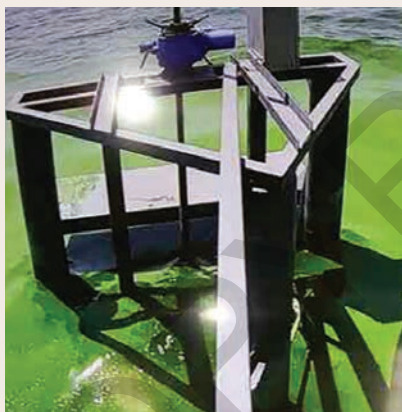


Figure 1

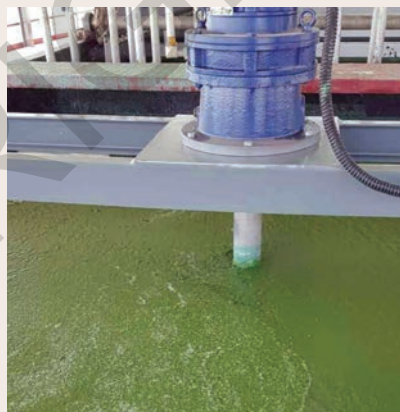


Figure 2



Figure 3

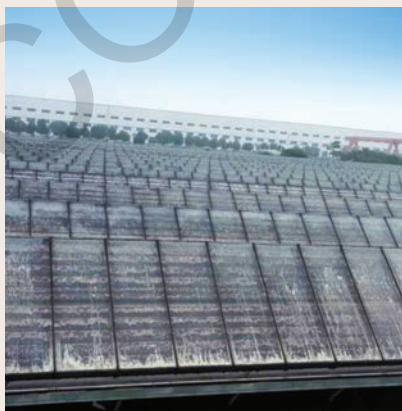


Figure 4



Figure 5



Figure 6

CREDITS: BLOOM



and flexibility. Surface polarity is said to be good so there are no adhesion problems and it is also 8–10% lighter on average in sheet form. Injection moulding performance for the foam is said to be excellent with enhanced mould release and foam set, and that it is eminently suitable for use as a drop-in replacement for conventional EVA foam.

While masterbatch production is currently in Meridian, it is also due to start soon at Dongguan in China. This is of course entirely logical as China is both the world's largest sports footwear producer and therefore user of EVA in footwear. It also has an immense algae problem and therefore an almost limitless supply of the necessary raw material. Actual footwear applications currently include insoles and footbeds, sock liner, midsoles, outsoles and other compression or injection moulded components, which covers all the main areas involved.

## STRESSING THE ENVIRONMENTAL FACTOR

Bloom believes it is essential to work closely with customers to make sure their exact performance specifications are met and currently has active development programmes with over 30 footwear brands. One can understand why brands would be keen to explore the possibilities as if they can achieve their required performance standards while at the same time enhancing their

needs, they typically contain 25% algae biomass. Whichever is the case, it helps offset the use of petroleum-based feedstock without reducing the required performance levels called for whilst, at the same time, affording significant environmental benefits in water remediation and carbon sequestration.

Manufacturing the actual foams involves jet milling the dried algae flakes down to the desired particle size and then extruding them into a chosen carrier resin to create an algae-plastic masterbatch (the actual details of this

process are protected by patents). Conventional foaming techniques are then used to expand it into the final flexible foams which, in addition to the algae-EVA foam covered in this article, can also include algae-PE and algae-PU foams.

Whatever the process involves, it would appear to be effective as Bloom says that algae's natural thermoplastic qualities allow the performance characteristics of conventional closed-cell EVA foams to be equalled and, in some cases exceeded, resulting in improved tear strength, elongation

Quality performance specification for standard Bloom moulded insole (20% algae content)

| Property                 | Test method | Test standard      |                | Remark                              |
|--------------------------|-------------|--------------------|----------------|-------------------------------------|
|                          |             | Unit               | BLOOM Standard |                                     |
| Hardness                 | ASTM D2240  | Asker C            | 37             |                                     |
| Specific gravity         | ASTM D792   | g/cc               | 0.166          |                                     |
| Tensile strength         | ASTM D412   | kg/cm <sup>2</sup> | 14.4           |                                     |
| Elongation               | ASTM D412   | %                  | 223            |                                     |
| Split Tear Strength      | SATR TM65   | kg/cm              | 1.5            |                                     |
| Die-C tear               | ASTM D624   | kg/cm              | 10.2           |                                     |
| Compression set          | ASTM D395   | % loss             | 22.5           | Method B, 25%                       |
| Method B                 |             |                    |                | compression, 22 hours at room temp. |
| UV colour fastness Light | ASTM D1148  | Grade              | 4–5            | 300 W U.V., 50°C, 12 hrs            |
| Shrinkage Test           | ASTM D1917  | %                  | 1.9            | 70°C, 40 minutes                    |

environmental credentials, they have everything to gain.

Indeed, Bloom feels that the positive environmental aspect of its algal foams is so important that it stresses two of the key benefits using an Eco-Facts label that customers can attach to finished footwear or its packaging. This shows the combined calculation for the insoles and midsoles used in producing the shoes in terms of the volume of filtered water returned to the natural environment and the amount of CO<sub>2</sub> kept from entering the atmosphere. The values of course vary depending on shoe size and the amount of algal foam used in their manufacture.

The calculations used to arrive at these values are based on Life Cycle Assessment (LCA) data for the environmental impacts from cradle-to-gate as completed by leading assessment provider EarthShift and the amount of algae biomass used in the foam formulation. For instance, at a 20% loading level and citing a pair of size 9 men's shoes, the level of water remediation would be 57 gallons (259

litres) and the amount of CO<sub>2</sub> sequestered, 40 kg CO<sub>2</sub>-eq\* (CO<sub>2</sub> equivalents).

Bloom says that if these sorts of levels of positive environmental impact per pair are multiplied by the hundreds of thousands of sports and leisure shoes that could potentially be sold, millions of gallons of water would be purified and massive amounts of CO<sub>2</sub> permanently removed from the atmosphere. It appears a positive and

welcome scenario where a natural material formed as a result of industrial damage to the environment, can be turned into a high performance and cost effective material for use in a consumer product as demanding as footwear.

It looks like a winner for all concerned. Man's ingenuity in turning unlikely raw materials into valuable end products seems to have no bounds, which is good for both ourselves and the world we live in. 

\*CO<sub>2</sub>-eq describes the reduction in greenhouse gas impacts by expressing the reduced impact as if it was a given weight of CO<sub>2</sub> that would cause an impact on that scale. For example, if a product or material is used that reduces the global warming impact of overall manufacture of a product by a Global Warming Potential (GWP) of say 10, then rather than reporting each gas that is reduced, a reduction in the weight of CO<sub>2</sub> which would cause this GWP is expressed as 10 kg CO<sub>2</sub>-eq.

Bloom's Eco-Facts label seeks to make these common global warming values easier to understand by using familiar comparisons to things people might be more regularly exposed to. In order to do this, the kg CO<sub>2</sub>-eq metric is converted to a comparable volume of helium which could be used to fill standard 11 inch party balloons. Since these balloons have a fixed volume when properly filled the comparable volume of helium can be used to derive a balloon count which provides a simple visual image.

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