Thinking Inside the Box

Can New Temperature Control Packaging Initiatives Meet Cold Chain Sustainability Goals Without Compromising Performance?

The idea of sustainability as we know it today began to step out of the shadows around 30 years ago.[1] Back then, healthcare executives and practitioners couldn't know whether this would prove to be a will-o'-the-wisp or a guiding light on a critical journey. Yet much of what was mooted in the 1980s is illuminating pharma and medtech strategy now. It's easy to see why when you consider — according to Health Care Without Harm's Jean-Yves Stenuick — that 'healthcare's climate footprint totals 4.4% of global net emissions'.[2] The production of pharmaceuticals and equipment may inherently devour natural resources, but decarbonisation missions are not something that can be tackled alone. In their quest to reach 'carbon net zero', executives are having to look beyond core business and enforce sustainability objectives on partners, suppliers and vendors. One area in particular makes a considerable greenhouse gas contribution: the supply chain.

The Sustainability Landscape

The sources of the industry's emissions are incredibly varied. One gets a sense of this in Deloitte's predictive paper on healthcare and life science, where in a 2025 landscape, 'organisations have adopted mitigation strategies to reduce their carbon footprint and are implementing carbon-neutral solutions, such as using renewable clean energy and sustainably-sourced materials, across their clinical development and supply chain functions. Likewise, healthcare organisations prioritise suppliers that have zero-carbon landfill policies and recycle water and waste. They are also reducing demand through preventive care, choosing supplies and equipment with lower carbon footprints, and reducing travel through increased telemedicine availability.'[3]

Despite this diversity, Jean-Yves Stenuick notes that a whopping '71% of healthcare emissions are linked with the supply chain, including the production, transport, disposal of pharmaceuticals, other chemicals and medical devices.'[4]

This prioritises logistics — and more specifically, temperature control packaging (TCP) — as one area that can reduce its environmental impact. Some companies have adjusted parts of their modus operandi to align with these greener initiatives. And the pioneers have rallied to expand their portfolios by incorporating easily-recyclable TCP systems. Innovation has been put into overdrive of late, galvanised by heightened market activity. But to what extent have these new initiatives been embraced by the life science sector? And are they here to stay?

Scaling the Priority Ladder

In a recent Temperature Control Sustainability Report, industry leaders regarded the implementation of sustainability in TCP as a key aspect of their future plans. In fact, almost 90% of the managers polled stressed its importance, while 70% already have it on their radar.[5] The driving forces? Corporate strategy and customer demand. The preference for being able to move temperature-sensitive pharmaceuticals around the globe in easily-recyclable shipping systems supported by sustainable processes has shifted from being a nice-to-have to an imperative.

Paper, cardboard, plant-based fibres and compostable substances are widely regarded as the materials that will propel the movement forward. They enable the reduction of plastics which in turn reduces the impact of CO_2. The awareness, the intent and policy are falling into place. But when it comes to key buying criteria for TCP systems, there are other factors that must be taken into account, some of which are regarded as non-negotiable.

Global availability and total shipping costs are inevitably in the mix. Minimising 'dead space' in transportation and storage holds by utilising appropriate packaging sizes is a useful differentiator. But these are all superseded by the need for qualified temperature control. They have to be. Product efficacy and patient safety are never up for debate. Furthermore, the period for which products remain safe is part of the overall safety package, with the time-temperature conundrum working together to guarantee the integrity of temperature-sensitive pharmaceuticals.

The big shift has been where the environment is concerned. It has hauled itself off the priority basement to become a serious consideration where purchase decisions are concerned, to the point where the 're-use, recycle, renew' message featured as a number one priority with over 68% of respondents in the Temperature Control Sustainability Report.[6]

The Foundation for a New Era

The progression from single use, to reusable, to totally recyclable TCP systems is clearly gathering momentum. Traditionally, 'ship and forget' solutions could either be repurposed or upcycled into products such as mattresses, cushioning, boards or mouldings.

This was a precursor to a reusable era where advanced, robust, high-performance shippers have ensured product integrity by combining vacuum insulation panels with phase change materials to sustain shipments within their required temperature range throughout transportation. But even these higher-performing systems come with a caveat: multiple uses are required to achieve sustainable cost-effectiveness. This necessitates the use of returns programmes which also means there is some impact on carbon footprint.

Inevitably, life science companies with committed sustainability initiatives have called for environmentally-sound TCP alternatives that can easily be recycled locally and globally (it's worth noting that many products labelled as recyclable are not easily recyclable, which means they're unlikely to ever be recycled at all). The brains departments in the TCP organisations have been busy. Not only have new sustainability product developments had to ensure value at the end of life by encompassing carbon and plastic neutrality, but they've also had to encapsulate functionality while measuring up against regulatory and cultural criteria. Attempts to level the cost of innovation

have only magnified the challenges facing developers.

All of this has had to happen without any compromise on the one thing healthcare companies can't budge on: performance.

Satisfying Performance and the Planet

Although there's still some latitude for reusable or renewable high-performance TCP systems to work alongside recyclable solutions, TCP companies have been compelled to find new ways of making their product lines effective, sustainable and economically viable. Calls for a rudimentary parcel shipper fashioned in this mould have been growing louder, primarily to protect shipments of routinely-dispensed prescription products and over-the-counter medicines at 2°C to 25°C. In their search for a remedy to satisfy all criteria, the TCP industry's research and development teams have done their thinking inside the box and found new innovation in an old friend: paper. And for good reason. Currently, the infrastructure is in place for recycling paper, much more so than plastic.

Recovery rates for packaging and food-service plastics [in the US] are about 28%. In Europe, the plastic-packaging recycling rate reported is somewhat higher at approximately 40%, compared to approximately 80% for paperboard.[7] That said, a switch to paper can increase weight. But the carbon footprint trade-off means there would still be a reduction in CO_2E/kg of anything between 10% and 30%. So can a paper-based TCP system do the job, and literally tick all the boxes?

When continuously tested on packaging prototypes in environmental chambers, certain configurations of layered, corrugated cardboard have been found to offer superb insulation, as well as considerable impact resistance. The thermal capabilities have then been bolstered by temperature-regulated, water-gel cool packs to provide prolonged temperature protection. This has culminated in a handful of market leaders being able to manufacture reliable, bio-based, plastic-free TCP systems for use in the wide-stability temperature bracket.

Effective for anything up to 72 hours, the latest iterations are easily recyclable and leverage kerbside-collectable mentality but for industrial purposes. Importantly, the compliance demands for pharmaceuticals, clinical trials and diagnostics are able to be met by the pioneers; they offer a superior level of packaging qualification.

Going the Extra Mile

The science behind this new wave of systems may meet regulatory compliance and performance benchmarks, but as we move forward, healthcare organisations will need

more from their partners if they are to reach their decarbonisation goals. Encouragingly, 24% of senior management are already required to work with sustainably-minded TCP vendors, and that figure is set to surge over the next few years.[8] In the not-too-distant future, standard benchmarks will almost certainly have to be met right across the board, perhaps even through eco audits.

As it stands, vendors which are transparent about their sustainability efforts are being prioritised. Some TCP companies are now adhering to ISO 14000 international standards and integrating elements of the environmental management system into their core business processes. They may even, for example, have a recycling service available where used systems are collected for you and recycled into new industrial products.

Others are going further. In a bid to protect the raw material that enables the manufacture of eco-based systems, they are working with forestry commissions and replanting trees as they're used. But is there a cost to embracing this approach? The answer is yes — and no.

The Cost of Eco-conformity

As with most innovations, the corporate wallet takes an initial hit. But businesses often look first to costs on paper, whereas there are savings to be made off paper. This is a case where what's taken away with one hand is given back with the other.

Best estimates indicate an uplift in costs on actual paper-recyclable solutions of somewhere between 10% and 15%. Then the counter punches weigh in. Tax on single-use plastic products increases year-on-year; a switch to paper removes it. Then as part of the green dot verification process, plastic users also have a corporate responsibility to make contributions to the plastic industry in their fight against waste; a switch to paper removes that too. And although paper-based products may require an outlay for recycling services, landfill costs also disappear (100% kerbside-recyclable means materials can be collected by local municipalities). Even a change of transportation method from air to ocean freight can reduce costs and carbon footprint.

Perhaps surprisingly, all of this may not matter. Feedback in the Temperature Control Sustainability Report also indicated that almost two-thirds of senior executives are prepared to back up their green ambitions with financial outlay, and more than one-third would put at least an additional 10% on top of their current budgets to make it happen.[9]

A Future All Wrapped Up

If the past is anything to go by, TCP innovation of the paper-based variety may only be in its infancy. This is an industry where new developments go from 0 to 60 in about six seconds — or, quite literally, just six months if you look at the speed with which temperature-controlled shippers for COVID vaccines were developed. Given the design, production, testing and qualification involved, that's pretty fast.

Now that the green seeds have been sown, 100% recyclable solutions could extend beyond protecting pharma products at 2°C to 25°C into other temperature brackets. More thermal products could also follow suit. The next logical step would be for easily-recyclable thermal packaging and temperature protection — such as covers — to hit the market. We shall see. Either way, the general forecast consensus clearly points to passive single-use systems gradually giving way to reusable and recyclable systems over the next few years.

What's certain is this: TCP solutions that are sustainable but only at great expense are unlikely to get traction. It is the balance of performance, affordability and sustainability that will trigger adoption and ensure pound-for-pound value at the end of life. On the surface, a shift to easily-recyclable, paper-based systems may only appear to be one small step towards the greater goal of reaching carbon net zero, but it could well transpire that it's a giant one.

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