

Comparative Carbon Footprints

TerraRack vs. Injection-molded Tip Racks

The designs of most pipette tip racks have not changed for many years, and come from an era when autoclaving was necessary to eliminate any nucleases or microorganisms which may have been present on the tips.

METTLER TOLEDO Rainin is the pioneer of high purity 'BioClean' tips, creating a range of super-clean tips which are certified to be free of biological contaminants. Gamma or electron (e-beam) irradiation can be used to sterilize the tips, eliminating the need of autoclaving. Given the reduced need to autoclave and an increased concern about the lasting environmental impact of plastic, the time to develop greener tip rack packaging solutions is now. This white paper compares different rack options available with regard to rack weight, type of plastic and resulting carbon footprint. It shows that Rainin TerraRack is an easy recyclable and low environmental impact tip packaging.



Figure 1: Rainin TerraRack tip racks

TerraRacks

The lightweight Rainin TerraRack range of pipette tip racks (Figure 1) is unique in the marketplace. They use a thermoformed, single-piece base and lid made from highly recyclable PETE (polyethylene terephthalate) – the same material used for beverage bottles and take-out food containers – with an integrated hinged lid and front latch. This shell has a series of vertical ribs to provide structural rigidity, and is combined with a polypropylene tip deck to ensure the racks have the strength and stability required to withstand loading the tips onto pipettes. Available in several tip sizes for both universal formats and Rainin's popular LTS tips, TerraRacks dramatically reduce the amount of plastic per rack. Figure 2 compares the relative weights of various 200 μ L tip racks (minus tips), demonstrating the material savings associated with the TerraRack design.

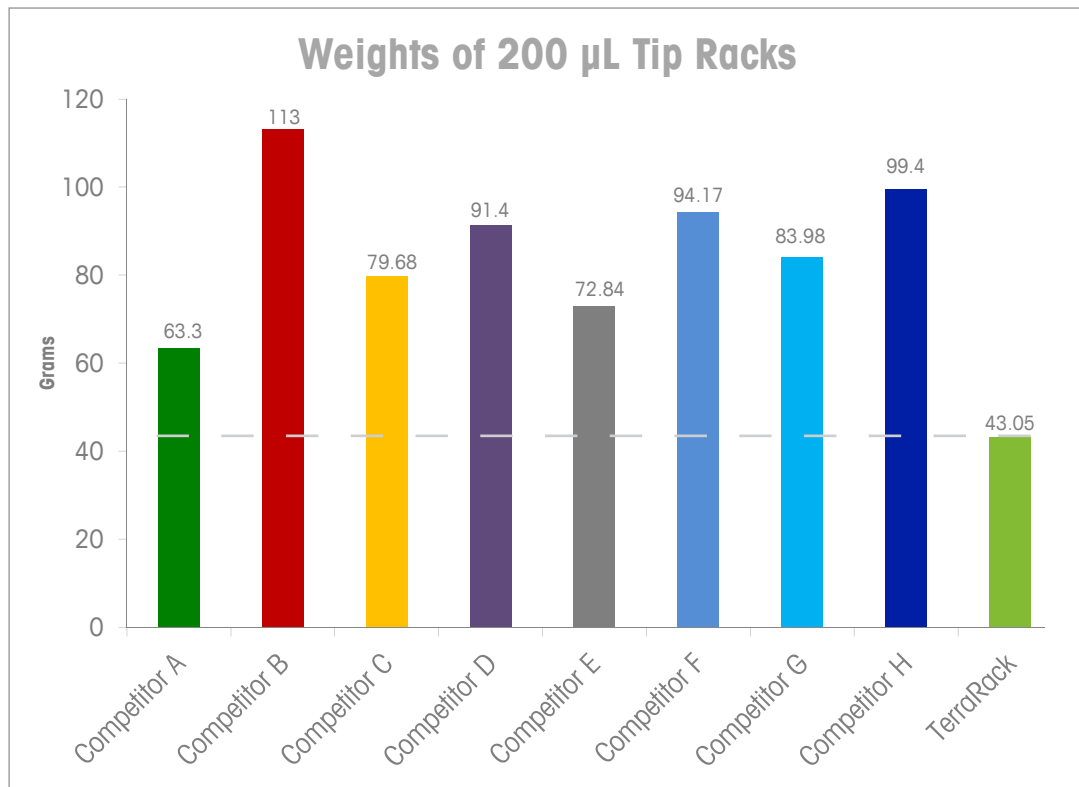


Figure 2: Comparison of the weights of empty tip racks.

Carbon Footprints

The substantial reduction in materials required for TerraRacks would be expected to be reflected in a corresponding improvement in carbon footprint (CF) and environmental impact. Calculation of the CF takes into account the release of carbon associated with both the manufacture and disposal of the product. In the case of plastics, carbon is first obtained from a geological source – petroleum – then subjected to a number of physical and chemical processes to produce the desired polymer. Each of these processes requires energy, generating additional CO₂ from the combustion of fossil fuels. Following polymer synthesis, the resin is molded into the desired product, which is packaged and transported to the customer, with each step requiring additional energy.

At the end of its life, a plastic component may meet with a variety of fates, including deposit into landfill, incineration, photolytic degradation, biologic degradation, etc. If it is sent to landfill, the plastic is regarded as remaining intact indefinitely, whereas incineration or degradation releases various carbon-containing by-products into the environment. Plastic components may also be reused and recycled, delaying the release of

their intrinsic carbon and acting as a negative feedback mechanism to suppress the synthesis of new plastic components. The calculation of carbon footprints relies upon subdividing the life cycle of a particular plastic component into various logical stages, each of which requires the release of carbon in a specific manner. Typically, the life cycle of plastic is also subdivided into two phases:

1. Cradle to factory gate (CTFG)

- Mobilization of petroleum as source of hydrocarbons for polymer synthesis
- Combustion of fossil fuels to produce energy for:
 - Synthesis of plastic resin
 - Molding of plastic components
 - Assembly, packaging and storage of plastic components

2. Factory to grave (FTG)

This phase begins the moment the product is picked for shipment to the customer, and ends with the disposal of the plastic component. Generally speaking, this does not mean final conversion to CO₂, but it is assumed that a certain percentage* of the plastic will be deposited into landfill, and some will be incinerated. The following activities are taken into account:

- Combustion of fossil fuels to produce energy for:
 - Transport of the product to the customer
 - Transport of the product to landfill or incineration
- The production of CO₂ and other forms of carbon (soot, tar, etc.) during incineration

3. Cradle to grave (CTG)

The total release of CO₂ associated with the genesis, shipment, use and disposal of a plastic component or product.

* Approximately 75% landfill deposition (no carbon release) and 25% incineration is used as a basis for the factory-to-grave CF calculations.

Carbon Footprints

This analysis compares the carbon footprint of 200 µL TerraRacks (without tips) with that of various other 200 µL injection-molded tip racks (also without tips).

	CTFG	FTG	CTG
Competitor A	2001.28	3152.01	5153.29
Competitor B	3572.6	5626.86	9199.46
Competitor C	2519.13	3967.64	6486.77
Competitor D	2889.69	4551.27	7440.96
Competitor E	2302.91	3627.08	5929.99
Competitor F	2977.28	4689.21	7666.49
Competitor G	2655.1	4181.79	6836.89
Competitor H	3144.32	4952.09	8096.41
TerraRack	1388.87	1748.62	3137.49

Table 1: Comparison of carbon footprints (kg CO₂ per 10k units) for each life cycle phase of various rack types (CTFG = Cradle to factory gate; FTG = Factory to grave; CTG = Cradle to grave).

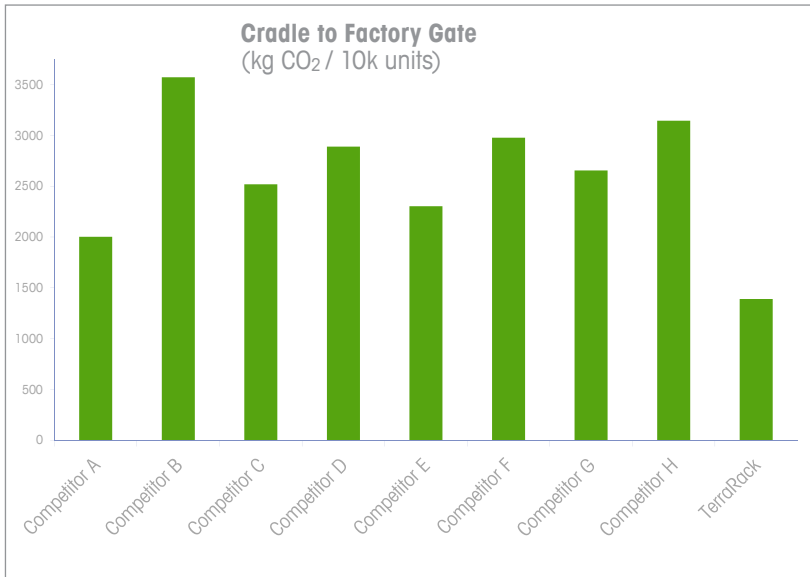


Figure 3: Comparison of carbon footprints from cradle to factory gate for various rack types.

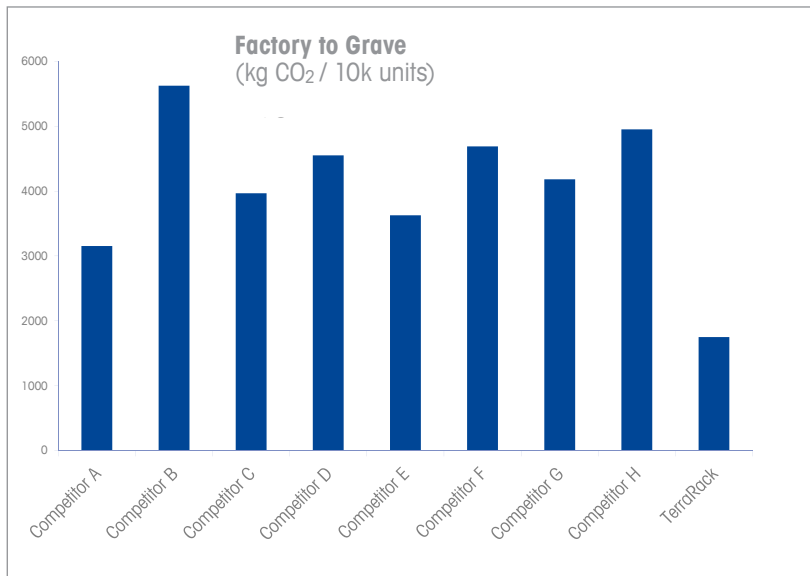


Figure 4: Comparison of carbon footprints from factory to grave for various rack types.

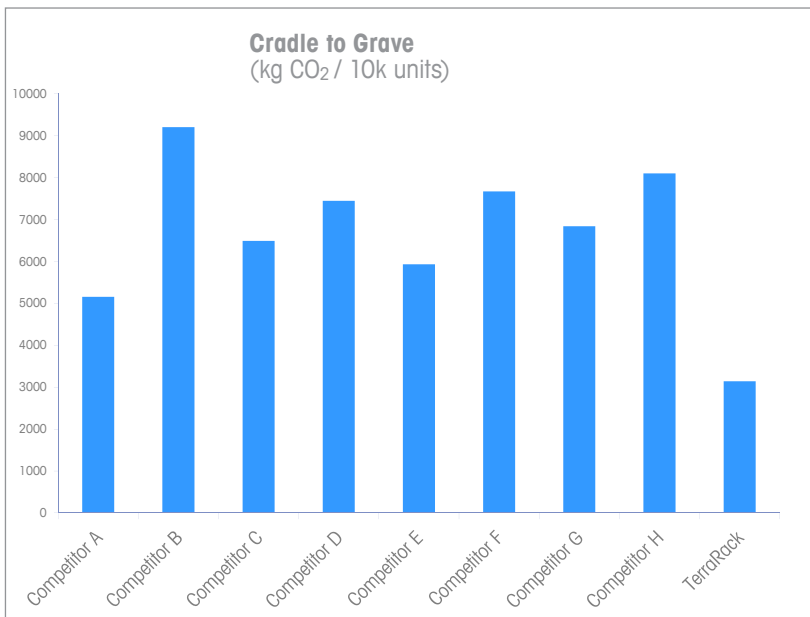


Figure 5: Comparison of carbon footprints for various rack types.

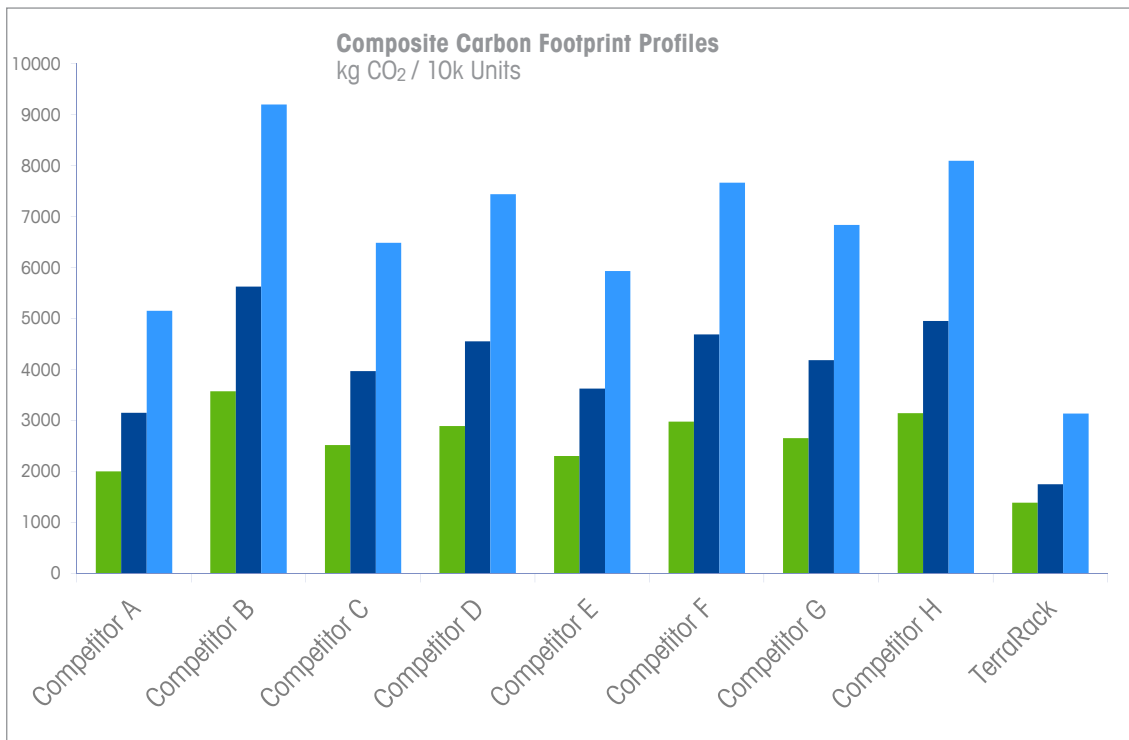


Figure 6: Compilation of carbon footprints for the life cycles of various rack types.

Conclusion

The data depicted in Table 1 and Figure 3 demonstrates that there is a strong correlation between the mass of each rack type and the CO₂ generated in its production, indicating that components with greater mass require more energy to manufacture and manipulate. Figure 4 shows a similar correlation between component mass, energy consumption and carbon production from factory to grave, while Figure 5 depicts the total carbon footprint associated with the entire life cycle of each rack type. The data clearly indicates a direct, cumulative correlation between the mass (weight) of the rack and the amount of CO₂ released, and so the use of lighter weight, highly recyclable materials – such as thermoformed PETE – will result in a dramatic reduction in the carbon footprint. This will also lead to lower transportation costs – both to the customer and for disposal – for the lighter TerraRack products. The enhanced recyclability of TerraRack’s PETE shell will further reduce the total carbon footprint but, as the level of recycling will vary from customer to customer, this was not factored into these calculations.

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