HPLC and UHPLC

Sustainability assessment of Vanquish HPLC and UHPLC Systems

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At Thermo Fisher Scientific, sustainability is at the core of our mission to enable our customers to make the world healthier, cleaner, and safer. We recognize that our responsibility extends beyond providing innovative scientific solutions; it encompasses our commitment to environmental stewardship and sustainable practices. By integrating sustainability into every aspect of our operations, from product design to manufacturing and beyond, we strive to minimize our environmental impact and contribute to a more sustainable future.

High-performance liquid chromatography (HPLC) is a critical technique in many laboratories, yet it can also be a significant source of carbon emissions. The primary contributors to these emissions include energy consumption, solvent usage, and waste generation. Traditional HPLC systems often require substantial amounts of power to operate, leading to higher energy consumption and increased carbon footprints. Additionally, the use of large volumes of organic solvents not only poses environmental hazards but also contributes to greenhouse gas emissions during production and disposal. At Thermo Fisher Scientific, we understand the importance of transparency in sustainability and are committed to providing guidance on making environmentally informed purchasing decisions.

To reinforce our commitment to sustainability, Thermo Fisher Scientific proudly partners with My Green Lab® to incorporate the ACT® Ecolabel 2.0 into our product offerings. The My Green Lab ACT Ecolabel, which stands for Accountability, Consistency, and Transparency, is a trusted third-party certification that provides clear, comprehensive information about the environmental impact of laboratory products. Our Thermo Scientific™ Vanquish™ HPLC and UHPLC Systems have been assessed and **certified with the ACT Ecolabel**, underscoring our dedication to transparency and sustainability in the scientific community.

The ACT Ecolabel evaluates aspects such as product and packaging, including recycled or renewable content, recyclable materials, product lifetime and support, as well as energy consumption. These comprehensive results are published in the respective ACT Ecolabels. Energy consumption is one of the largest contributors to the lifecycle carbon emissions of an HPLC or UHPLC instrument,[1] having an even greater contribution than solvent consumption (methanol as the organic eluent) or instrument manufacturing (Fitch et al.). To maximize transparency for this critical aspect, we performed the energy consumption measurements for the ACT Ecolabel certification following a standardized third-party protocol specific to the instrument type.

As the Vanquish platform is modular, a standard instrument setup was defined for each HPLC and UHPLC system (Table 1).

Table 1: System configurations used for energy measurements

	Thermo Scientific™ Vanquish™ Core Quaternary HPLC System	Thermo Scientific™ Vanquish™ Core Binary HPLC System	Thermo Scientific™ Vanquish™ Flex Quaternary UHPLC System	Thermo Scientific™ Vanquish™ Flex Binary UHPLC System	Thermo Scientific™ Vanquish™ Horizon UHPLC System	Thermo Scientific™ Vanquish™ Duo UHPLC System	Thermo Scientific™ Vanquish™ Neo UHPLC System
Pump	Quaternary Pump C	Binary Pump C	Quaternary Pump F	Binary Pump F	Binary Pump H	Dual Pump F	Vanquish Neo UHPLC System
Autosampler	Split Sampler C	Split Sampler C	Split Sampler FT	Split Sampler FT	Split Sampler HT	Dual Split Sampler FT	
Column compartment	Column Compartment C	Column Compartment C	Column Compartment H	Column Compartment H	Column Compartment H	Column Compartment H	n.a.
Detector	Variable Wavelength Detector C	Variable Wavelength Detector C	Diode Array Detector FG	Diode Array Detector FG	Diode Array Detector HL	2 x Diode Array Detector FG	n.a.

Table 2: Energy consumption protocol for HPLC systems used for Vanquish Core HPLC systems and for UHPLC systems used for Vanquish Flex, Vanquish Horizon, and Vanquish Duo UHPLC systems

	HPLC			UHPLC		
	Idle	**Ready**	**Run**	**Idle**	**Ready**	**Run**
Power	On	On	On	On	On	On
Pump flow	Off	On (1.5 mL/min)	On (1.5 mL/min)	Off	On (0.8 mL/min)	On (0.8 mL/min)
Elution mode	n.a.	Isocratic	Isocratic	n.a.	Gradient	Gradient
Sample cooling	Off	Off	Off	On (4°C)	On (4°C)	On (4°C)
Column thermostating	Off	On (40°C)	On (40°C)	Off	On (40°C)	On (40°C)
UV lamp	Off	On	On	Off	On	On

Table 3: Energy consumption protocol of Vanquish Neo UHPLC system energy consumption measurements

	Vanquish Neo UHPLC System		
	Idle	**Ready**	**Run**
Power	On	On	On
Pump flow	Off	On (1.3 µL/min)	On (1.3 µL/min)
Elution mode	n.a.	Gradient	Gradient
Sample cooling	On (4°C)	On (4°C)	On (4°C)

[1] Carbon contribution will vary based on the emission intensity of the electricity consumed and can be eliminated entirely with the use of 100 percent renewable electricity.

The daily energy consumption was calculated based on the following assumptions of the instrument being in idle mode for 15 hours, in ready mode for one hour, and in run mode for eight hours (Table 4).

Table 4: Daily energy consumption of Vanquish HPLC and UHPLC systems

Instrument	Daily energy consumption (kWh)
Vanquish Core Quaternary HPLC System	2.1
Vanquish Core Binary HPLC System	2.1
Vanquish Flex Quaternary UHPLC System	3.8
Vanquish Flex Binary UHPLC System	4.3
Vanquish Horizon UHPLC System	4.8
Vanquish Duo UHPLC System	5.3
Vanquish Neo UHPLC System	3.6

Vanquish Core HPLC systems exhibit significantly lower energy consumption. The difference between the Vanquish Core and Vanquish Flex instruments is attributed to the additional sample cooling to 4°C. While sample cooling is often necessary to maintain sample integrity, from both a cost of operation and sustainability perspective, cooling should be employed only when required.

Another noteworthy aspect of energy consumption is the comparison between a single-channel UHPLC system and the Vanquish Duo UHPLC system. The Vanquish Duo is a dual-channel UHPLC system capable of doubling throughput while maintaining full application flexibility. Assuming a runtime of 10 minutes, a single-channel UHPLC system would analyze 48 samples per day, resulting in an energy consumption of 0.079 kWh per sample (calculated for a Vanquish Flex Quaternary UHPLC System). In contrast, the Vanquish Duo UHPLC System would analyze 96 samples in the same period, resulting in an energy consumption of 0.055 kWh per sample. This corresponds to a 30% energy savings per sample. These energy savings not only reduce costs per sample but also significantly lower the carbon footprint. Reducing energy consumption by 30% can substantially decrease the carbon footprint of the single-channel HPLC or UHPLC instrument.

The ACT Ecolabel provides the opportunity to include the "cradle-to-gate"[2] product carbon footprint (PCF) of the product for greater transparency and to support Scope 3 reporting. The PCF for our HPLC and UHPLC systems is provided in Table 5 below.[3] Due to the inherent variability allowed by PCF frameworks, methodologies, and emission factors, Thermo Fisher Scientific does not recommend the use of the provided values for comparison purposes.

Thermo Fisher Scientific believes PCF values will evolve as improvements are made to data collection processes and methodologies. Specific to the referenced systems, we have taken a conservative approach and believe the values overestimate the true impact. By understanding and taking action to reduce our company's footprint and the corresponding footprint of our products, we are contributing to a more sustainable future and helping enable our customers to do the same.

Table 5: Summary of the cradle-to-gate PCF of Vanquish HPLC and UHPLC systems

Product	Vanquish Core Quaternary HPLC System	Vanquish Core Binary HPLC System	Vanquish Flex Quaternary UHPLC System	Vanquish Flex Binary UHPLC System	Vanquish Horizon UHPLC System	Vanquish Duo UHPLC System	Vanquish Neo UHPLC System
PCF (kg CO2e)	4,805	4,962	5,115	5,277	5,935	5,563	4,218

[2] Cradle-to-gate represents the impact from extraction of raw materials, manufacturing, and distribution prior to the product leaving the factory gate. The product's use phase and end-of-life are excluded.

[3] The PCF values provided herein were determined using an allocation methodology based on the 2024 value chain greenhouse gas emissions associated with the product's manufacturing site. The methodology is guided by the WBCSD's Partnership for Carbon Transparency (PACT). Methodology available at https://www.carbon-transparency.org/.

Learn more at **thermofisher.com/vanquish**

References

1. Fitch et al., Life cycle analysis and sustainability comparison of reversed phase high performance liquid chromatography and carbon dioxide-containing chromatography of small molecule pharmaceuticals, Green Chem., 2022, 24, 4516-4532