

Brake Pad Wear Debris Copper Extraction Test Summary

- High-quality experimental procedures were used. Clemson University developed a rapid, quantitative standard operating procedure for determining the total concentration of copper in wear debris from disc brakes. Clemson used standard extract test methods and some modified methods to measure the ability of copper in brake pad wear debris to leach out in the environment.
- Wear debris from only one copper-containing brake pad was tested. There are several different chemical forms of copper used in brake pad formulations. The Brake Pad Partnership plans to repeat these tests with wear debris from a representative composite sample of copper-containing brake pads to determine if these results are representative of all copper-containing brake pads.
- If the results from this one brake pad are typical, copper from vehicle brake pads probably behaves in the environment like copper from other environmental copper sources. Test results (see table below) show that a substantial fraction of copper in the tested brake wear debris can be mobilized in the environment. In the long term, most of the copper can probably be mobilized from brake pad wear debris that remains exposed to water flows.
- Copper solubility in brake wear debris is probably due to the high surface area of brake pad wear debris and the chemical form of the copper in the wear debris. Brake wear debris has a much higher specific surface area (31 m²/g) than the standard copper-containing minerals tested (< 1.5 m²/g).

Brake Pad Wear Debris Copper Leaching Test Results (Test material from one Copper-Containing Brake Pad; 48-Hour Extractions)

Extracting Solution	Copper fraction leached (%)
Federal Hazardous Waste Classification Test (Toxicity Characteristic Leaching Procedure)	92% (± 7%)
California Hazardous Waste Classification Test (Waste Extraction Test*)	102% (± 8%)
U.S. EPA Synthetic Precipitation Leaching Procedure	13.2% (± 0.5%)
Deionized distilled water	18.2% (± 1.7%)
Synthetic rainwater (Chemical composition of Los Angeles rain)	40% (± 1.7%)
Water with humic acids** (Standard soil humic acids)	22.7% (± 0.3%)
Water with humic acids* (Standard river humic acids)	23.9% (± 0.8%)

*Test used for compliance with the California Soluble Threshold Limit Concentration (STLC).

**Humic acids—natural acids found in soils and plants—are commonly found in urban runoff and creeks.