The removal of micron-sized carbon black particles from capillary tubes (outer diameter 1.46 mm, inner diameter 1.12 mm, length 50.00 mm) using cyclic vacuum cavitation (VC) cleaning was investigated. As the first objective of this study, the VC apparatus was constructed. This VC setup allowed video monitoring of the cleaning process. Photographs, video recordings, and gravimetric analysis tests were used to identify the cleaning efficiencies. As the second part, the carbon black powder removal efficiencies were used to compare cyclic VC and ultrasonic cavitation (UC) cleaning. Cyclic VC coupled with deionized (DI) water was able to remove 67 ± 7% of carbon black powder from contaminated capillary tubes. Solutions of 1% sodium lauryl sulfate (SLS) in DI water successfully removed 82 ± 7% of carbon black powder using fifteen vacuum cycles at room temperature. The UC process was unable to flush the carbon black soil from the internal volume of the capillary tubes. The cleaning was more effective with cyclic VC than UC cleaning at given conditions. Optimization of the VC process parameters of 25 vacuum cycles, 1% SLS in DI water, with vigorous stirring, at 40 °C removed 99 ± 1% of the carbon black powder. This study showed experimental evidence that cyclic VC is a good cleaning approach for cleaning parts that have deep blind holes.