Following the sequential pick-up of OH and CO by helium nanodroplets, the infrared depletion spectrum is measured in the fundamental OH stretching region. Although several potentially accessible minima exist on the associated OH + CO reactive potential energy surface [e.g. J. Ma, J. Li, and H. Guo, J. Phys. Chem. Lett. 3 (2012) 2482], such as the weakly bound OH-OC dimer and the chemically bound HOCO molecule, we only observe the weakly bound OH-CO dimer. The rovibrational spectrum of this complex displays narrow (0.02 cm\(^{-1}\)) Lorentzian shaped peaks with spacings that are characteristic of a linear complex with unquenched electronic angular momentum, similar to what was previously observed in the gas phase [M.I. Lester, B.V. Pond, D.T. Anderson, L.B. Harding, and A.F. Wagner, J. Chem. Phys. 113 (2000) 9889]. Analogous spectra involving OD were collected, for which we also only observe the OD-CO isomer. From the Stark spectra, the dipole moments for OH-CO are determined to be 1.85(3) and 1.89(3) D for \(v=0\) and \(v=1\), respectively, while the analogous dipole moments for OD-CO are determined to be 1.88(8) and 1.94(5) D. The computed equilibrium ground state dipole moment at the CCSD(T)/Def2-TZVPD level of theory is 2.185 D, in disagreement with experiment. The role of vibrational averaging is investigated via the solution of a three-dimensional vibrational Schrödinger equation, which is constructed in internal bond-angle coordinates. The computed expectation value of the ground state dipole moment is in excellent agreement with experiment, indicating a floppy molecular complex.