Gas outflows are expected to play a pivotal role in regulating star formation and supermassive black hole growth in galaxies. However, there have been few detections of outflows, especially those of molecules, in galaxies at redshift $z > 6$, making it difficult to evaluate the impact on star formation and quasar activity in the epoch of reionization. To search for molecular outflows, we performed observations of the OH 119 $\mu$m line doublet toward J2054-0005, a quasar at $z = 6.04$, at 0.2$''$ (1 kpc) resolution using the Atacama Large Millimeter/submillimeter Array. The quasar exhibits a relatively high total infrared luminosity ($L_{\text{IR}} \sim 1.3 \times 10^{13} L_\odot$) and [O III]88 $\mu$m/[C II]158 $\mu$m luminosity ratio (2.1 ± 0.4), making it a promising case-study source. We report the discovery of an OH outflow, the highest-$z$ detection toward a quasar. The OH line exhibits blueshifted absorption that can be explained by outflowing gas, and systemic emission that traces the warm and/or dense gas in the host galaxy. We found that the mean line-of-sight outflow velocity is $\sim 700$ km s$^{-1}$, and that the maximum velocity is $\sim 1500$ km s$^{-1}$. Simple models yield a mass outflow rate of $\gtrsim 250 M_\odot$ yr$^{-1}$ (optically-thin limit), and possibly as high as $\sim 1400 M_\odot$ yr$^{-1}$, indicating a significant impact on star formation. The results suggest that OH 119 $\mu$m can serve as a robust tracer of molecular outflows in quasars at $z > 6$. 

Molecular outflow in the reionization-epoch quasar J2054-0005 revealed by OH 119 $\mu$m observations