Supplementary Information (SI) for New Journal of Chemistry.

**Supporting Information**

In order to explore the reaction mechanism of catalyzed oxidation of HCHO, the MnCe-MOFs-500/ZSM-5 catalyst with the best catalytic oxidation performance was placed in the environment of HCHO/$N_2$ and HCHO/$O_2$ at room temperature for in-situ infrared spectrum analysis (Fig. S1). The experimental results showed that the positions of vibration peaks in the in-situ infrared spectra of catalysts were similar, but the intensities were different under anaerobic and aerobic conditions. The adsorption peaks at wave numbers of 3710 cm$^{-1}$ and 1660 cm$^{-1}$ were caused by the bending vibration of $H_2O$ adsorbed on the catalyst surface and hydroxyl group on the surface. The peak at the wave number of 3660 cm$^{-1}$ belongs to the stretching vibration peak ν (OH) of the structural hydroxyl group. In Fif. S1 (a), the strength of the vibration peak decreases gradually with time; in Fig. S1 (b), the strength of the vibration peak is basically unchanged, indicating that hydroxyl (OH) groups will be consumed in the catalytic oxidation process of HCHO. In the presence of $O_2$, it can replenish the consumed groups. The wide peak at the wave number of 3480 cm$^{-1}$ is the association peak formed by the superposition of hydrogen bond and $H_2O$ symmetric stretching and asymmetric stretching vibration, indicating that water will be produced during the reaction of catalyst and HCHO, and water will further participate in the adsorption and dissociation process of HCHO. The peaks at the wave number of 3240 cm$^{-1}$ correspond to formate C-H stretching vibration peak ν (CH), while the peaks at the wave number of 2840cm$^{-1}$ and 1060 cm$^{-1}$ are attributed to the CH stretching vibration peak ν (CH) and CO stretching vibration peak ν (CO) associated with dioxymethylene (DOM). These species are intermediate products of HCHO oxidation process.

Its peak strength gradually weakens in the HCHO/$N_2$ environment, and gradually becomes stronger in the HCHO/$O_2$ environment, indicating that the presence of $O_2$ can produce reactive oxygen species on the catalyst surface, thus oxidizing and decomposing HCHO. The peak at 2340 cm$^{-1}$ is the adsorption peak of $CO_2$, indicating that the catalytic reaction process of HCHO will produce $CO_2$. The peak at 1560cm$^{-1}$

corresponds to COO asymmetric stretching vibration ν (COO), the peak at 1460 cm$^{-1}$ corresponds to CH bending vibration δ (CH), and the peak at 1360 cm$^{-1}$ corresponds to COO symmetric stretching vibration $\nu_s$ (COO).

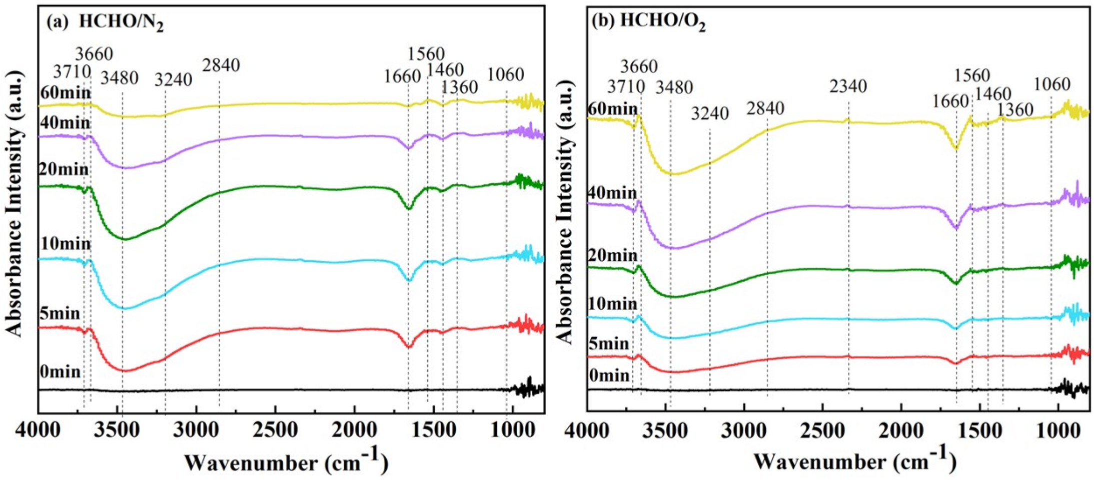

Fig. S1 The *in situ* FTIRs of MnCe-MOFs-500/ZSM-5 catalysts