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Pyrohydrolysis of $CaCl_2$ waste for the recovery of HCl acid upon the synergistic effects from $MgCl_2$ and silica

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An efficient HCl acid recovery method from the mixture of alkaline earth metal chlorides waste was demonstrated via co-pyrohydrolysis in a lab-scale horizontal furnace at a temperature range of 700-1000°C and fixed additions of SiO_2 and steam. The synergistic effect of $MgCl_2$ on the HCl recovery from $CaCl_2$ was explored intensively. A double-sided effect was revealed. For the reaction temperatures below 1000°C, the $MgCl_2$ addition delayed the HCl release through competing with $CaCl_2$ for the inclusion into silica matrix. In contrast, once the chloride mixtures were subjected to 1000°C with a noticeable residence time (e.g. 2 hours) and at a minimum molar ratio of 0.5 of $MgCl_2$ to $CaCl_2$, the $MgCl_2$ addition promoted the HCl release remarkably, via promoting the conversion of $Ca_3(SiO_4)Cl_2$ into $Ca_8Mg(SiO_4)_4Cl_2$. A portion of Mg^{2+} derived from the early decomposition of $MgCl_2$ substituted the Ca(I) site in $Ca_3(SiO_4)Cl_2$, thereby resulting in the formation of weak Mg-Cl bond that is in favor of the HCl release. Additionally, the remaining Mg^{2+} consumed the excessive SiO_2 so as to cause the skeleton of $[SiO_4]^{4-}$ to be fully affiliated and balanced by cations to form $Ca_8Mg(SiO_4)_4Cl_2$, in which the weaker ionic polarization between Ca^{2+} and adjacent anions further enhanced the breakage of the Ca-Cl bonds.

Biography

Song Zhou is currently a PhD student at Monash University. He is a Member of Clean Solid Fuel Laboratory (CSFL). His present research interest is mainly on chloride waste treatment and atomic structure analysis based on X-ray Adsorption Fine Spectroscopy (XAFS) analysis.

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