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Vacuum pyrolysis mechanism and parameter optimization for recycling renewable resource from waste liquid crystal display panels

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In this study, the vacuum pyrolysis kinetics, mechanism and parameters were studied to understand the vacuum pyrolysis process which was used to recover the organic parts of the LCD panels. The kinetic analysis showed that the apparent activation energy of the LCD panels at 30 °C/min is 70.68 kJ/mol, which means the LCD panels are easy to decompose under the vacuum condition. The vacuum pyrolysis mechanism was analyzed with the help of kinetic analysis and AM1, semi-empirical molecular orbital method. The decomposition and recombination of C-O bonds are identified as the main vacuum pyrolysis reactions. The heat values of the competing reactions decide the proportion of the products. The TPP, triacetyl-d-mannosan and its isomers are the main products due to the low boiling point and the low heat of formation. The optimal parameters were determined as 300 °C, 50 Pa and 35 minutes on the bases of Response Surface Methodology (RSM). The organic materials can be decomposed into oil of 80.38 wt.%, gas of 5.64 wt.% and residue of 13.98 wt.%, respectively. Based on above study, the vacuum pyrolysis process was developed to recover the organic materials of the LCD panels effectively and environmental friendly.

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