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Novel waste printed circuit board recycling process with molten salt

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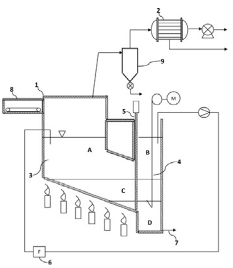
GRAPHICAL ABSTRACT



ABSTRACT

The objective of the method was to prove the concept of a novel waste PCBs recycling process which uses inert, stable molten salts as the direct heat transfer fluid and, simultaneously, uses this molten salt to separate the metal products in either liquid (solder, zinc, tin, lead, etc.) or solid (copper, gold, steel, palladium, etc.) form at the operating temperatures of 450–470 °C. The PCB recovery reactor is essentially a U-shaped reactor with the molten salt providing a continuous fluid, allowing molten salt access from different depths for metal recovery. A laboratory scale batch reactor was constructed using 316L as suitable construction material. For safety reasons, the inert, stable LiCl–KCl molten salts were used as direct heat transfer fluid. Recovered materials were washed with hot water to remove residual salt before metal recovery assessment. The impact of this work was to show metal separation using molten salts in one single unit, by using this novel reactor methodology.

- The reactor is a U-shaped reactor filled with a continuous liquid with a sloped bottom representing a novel reactor concept.
- This method uses large PCB pieces instead of shredded PCBs as the reactor volume is 2.2 L.
- The treated PCBs can be removed via leg B while the process is on-going.

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Method details

Description of the laboratory process

A P&ID of the laboratory scale waste PCB recycling process is presented in Fig. 1. The pyrolysis vessel, essentially a U-shaped reactor, was manufactured from a 6″ (125 mm) and a 4″ (100 mm) ANSI schedule 40, 316 L stainless steel pipe (6″ pipe = 7.1 mm wall thickness, 4″ pipe = 6.02 mm wall thickness) with a 7 mm 316L stainless steel plate welded onto these pipes as the bottom wall of pyrolysis vessel 1 which was sloped 45 degrees. Both legs of the pyrolysis vessel 1 could be opened; leg A by unbolting the top flange which ensures an airtight vessel, whereas leg B was open to the

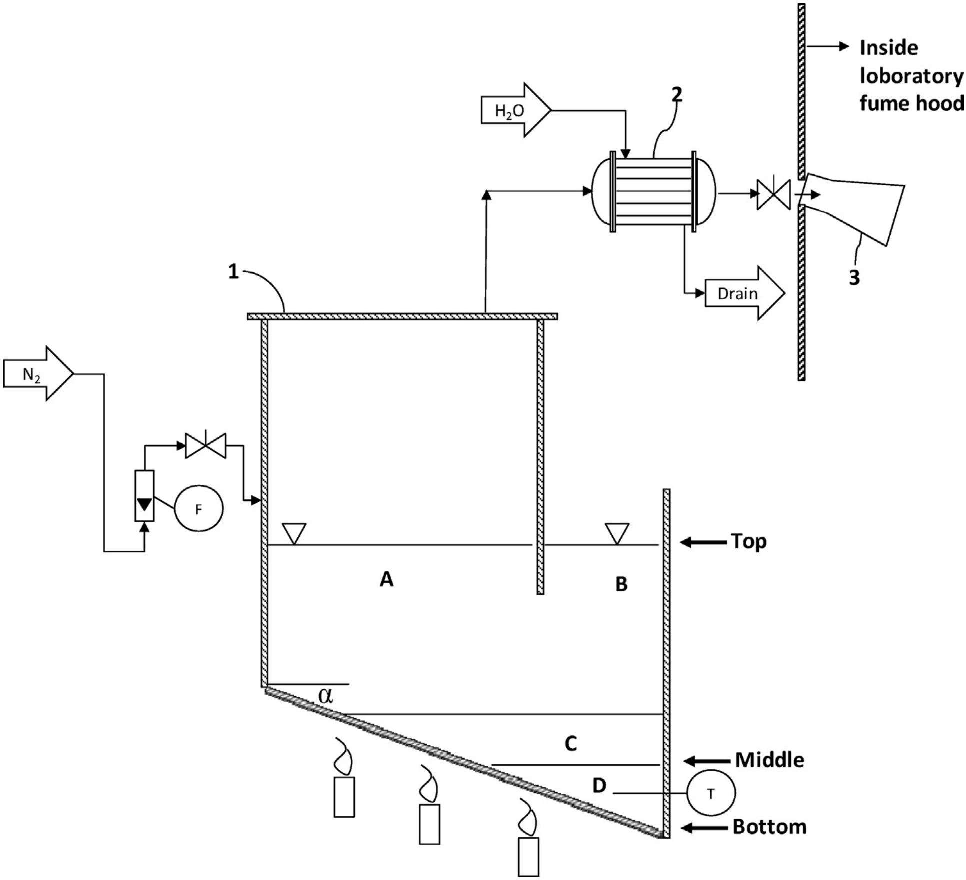

Fig. 1. Layout and P&ID of the laboratory scale PCB separation/pyrolysis experiments (T = temperature gauge, F = nitrogen flow meter, N_2 = nitrogen, α = 45 degrees, 1 = pyrolysis vessel, 2 = condenser, 3 = glass flask). Leg A and B: molten LiCl–KCl; area C: molten LiCl–KCl and glass and copper; area D: molten metals i.e., solder and heavy solid materials for example gold.