Abstract Accepted for technical paper publication at IMECE (ASME), Salt Lake City, Utah, November 11-14, 2019

Joining Techniques for Novel Metal Polymer Hybrid Heat Exchangers

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Low-grade heat (<220 °C) comprises between 50 to 60% of the unrecovered energy from industrial processes [1]. Traditional heat exchangers (HX) are typically too expensive for such applications where the payback period is typically less than 3 years [2]. Polymers, though more affordable, are usually unsuitable for HX applications due to their low thermal conductivity (~0.2 W/mK). Here we show that metal-polymer hybrids may be attractive from both performance and cost perspectives. The use of polymers further increases the resistance to fouling by sulfuric and carbonic acids. An ongoing work explores different configurations of layered Kapton-copper composites for HX applications using numerical simulations. This paper explores a manufacturing pathway for producing such layered Kapton-copper composite tubes that involves directly rolling and bonding tapes made of polymer and copper foil into tubes. We propose and develop a prototype computer-controlled tube roll-bonding machine, capable of fabricating composite tubes with diameter 25 mm and lengths of 200 mm. A critical problem in the fabrication process is the bonding of metal and polymers [3]. We explore approaches involving adhesives (epoxy, acrylic, silicone) and as well as direct welding (laser and ultrasonic) that can be integrated into the manufacturing process. We report characterizations of the thermomechanical properties of these joining processes. This work paves the way for realizing cost-effective manufacturing of heat exchangers for low grade waste heat recovery.

Keywords: copper, polymer, Kapton, joining techniques, adhesives, dissimilar materials heat exchangers, roll-to-roll process

References

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