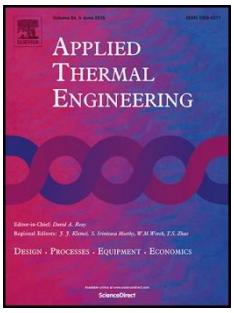
Accepted Manuscript



Title: Polymer heat exchanger design for condensing boiler applications

Author: R. Trojanowski, T. Butcher, M. Worek, G. Wei

PII: S1359-4311(16)30295-2
DOI: http://dx.doi.org/doi: 10.1016/j.applthermaleng.2016.03.004
Reference: ATE 7871

To appear in: *Applied Thermal Engineering*

Received date: 24-8-2015
Accepted date: 1-3-2016

Please cite this article as: R. Trojanowski, T. Butcher, M. Worek, G. Wei, Polymer heat exchanger design for condensing boiler applications, *Applied Thermal Engineering* (2016), http://dx.doi.org/doi: 10.1016/j.applthermaleng.2016.03.004.

Polymer Heat Exchanger Design for Condensing Boiler Applications

R. Trojanowski[1], **T. Butcher**[1,3], M. Worek[2], G. Wei[1]
[1] Brookhaven National Laboratory, Sustainable Energy Technologies- Energy Conversion Group, PO Box 5000, Upton, NY, 11901, USA.
[2]University of Illinois at Urbana-Champaign, Engineering Physics, Champaign, IL, 61801, USA.
[3] Corresponding Author - Thomas A. Butcher - butcher@bnl.gov

Highlights
ATE-2015-9835R1

- The use of a thermally conductive polymer for flue gas heat recovery is explored.
- The polymer composite is extruded and coiled to form the heat exchanger.
- Sensible heat recovery is similar to that achieved with metal.
- With lower conductivity, surface temperature is higher and condensation rate is lower.
- With oil as a fuel, latent heat is only a small part of the heat recovered.

Abstract

Condensing boilers achieve very high efficiency levels by recovering both sensible heat and water vapor latent heat from the flue gas. Research since the 1980's has focused on corrosion in such condensing heat exchangers related to the acidic condensate and material selection. Polymers in condensing heat exchangers have been considered to avoid the cost and corrosion concerns of metallic designs. Past efforts have shown polymers offer the advantage of corrosion resistance and cost, however lower thermal conductivity limited their application. More recent developments have introduced thermally conductive polymers which now offer promising conductivity values. This project focused on the evaluation of a thermally conductive polymer heat exchanger for this application.

Computational fluid dynamic results indicated thermal conductivity values of stainless steel, a typical heat exchanger material, do not need to be achieved for similar heat transfer performance. An increase in thermal conductivity from about 10 times that of the base polymer can achieve an overall heat exchanger effectiveness similar to that achieved with stainless steel. A polymer composite thermal conductivity of approximately 2.5 W/m·K would be adequate. Thermally conductive polymer materials are now commercially available which offer values up to 20 W/m·K. In this work, one Nylon-12 and one thermally conductive polymer composite heat exchanger prototypes were constructed for a condensing boiler application. Tests demonstrated