ALBERTA INNOVATES

CLIMATE CHANGE INNOVATION AND TECHNOLOGY FRAMEWORK

Awardee Summary

CCITF PROGRAM	Clean Technology Development
PROJECT TITLE	High-strength Coating-based Waste Heat Utilization Heat Exchangers for Energy Recovery in the Natural Resources Industry of Alberta
SECTOR	Low Carbon Electricity, Waste to Value-Added, Energy Efficiency
ORGANIZATION	University of Alberta
PROJECT LEAD	André McDonald
AI PROJECT ADVISOR	Babatunde Olateju
GRANT AMOUNT	$96,000
START DATE	TBD
END DATE	TBD

PROJECT OBJECTIVE: To strengthen the heat exchanger coating by including particulate reinforcement of alumina into the metal coating, and apply the novel coatings-based heat exhanger in the field.

OVERVIEW: The use of flaring in the Energy sector is recognized as a necessary safety measure, but results in the release of greenhouse gases (GHG) and excessive heat. Flaring is a high-temperature process that is used to burn waste gas fuels from industrial operations in order to control the accumulation of the gases to pressures that would render the operations unsafe. The burning of the waste fuels produces low-grade heat, which, if recaptured could be used to generate electrical power for the plant and its operations. The recaptured low-grade heat from flaring could be used to pre-heat or vaporize an organic working liquid fluid or water that would be a part of an Organic Rankine Cycle or a Waste Heat Rankine Cycle, respectively. The working fluid would be heated further in a heating plant or boiler of reduced heating capacity and the heated or superheated fluid would be expanded in a turbine or other expander, thus converting mechanical energy from the expansion of the pressurized fluid to electrical energy by way of a generator that is connected to the turbine or expander. The generation of electrical energy through the Organic or Waste Heat Rankine Cycle would use little or no additional fuel, thus mitigating both GHG and low-grade heat emissions from burning of fuel for electricity.

The process is thus highly dependent on a successful and efficient means of extracting the low-grade waste heat energy from the flares. The development and application of high-efficiency foam-based thermal-sprayed coating heat exchangers will be one way of recovering the waste heat for the cycles. Thermal spraying is a highly scalable manufacturing process in which powder particles or wires are fed into a heat source such as an oxy-acetylene flame or plasma to melt and accelerate particles of the material to impact and form a coating on a surface. The applicants have already developed compact heat exchangers in which Inconel or stainless steel is deposited as a thermal-sprayed coating on to foam structures. The structure and the coatings have high surface area to volume ratios, allow for flow of hot gases through the porous foam structure to enhance heat collection, and resist the detrimental effects of high-temperature corrosion. The application of these heat exchangers for the collection of waste heat from flares to mitigate GHG emission has never been attempted. Flare temperatures tend to be on the order of 500 to 1,100 degrees Celsius, which will result in oxidation and phase change of stainless steel. The thermal cycling will also induce stresses in the coating, which may result in cracking and delamination. Also, present in the flare gases and flame are particulate matter, usually carbon, with sizes that may range from 3 to 300 microns, which may erode the coatings over time. Thus, in addition to applying this novel coatings-based heat exchanger in the field, the applicants will strengthen the coating by including particulate reinforcement of alumina into the metal coating. This will produce a heat exchanger system with enhanced strength to resist cracking and delamination due to thermal cycling while still retaining superior heat transfer properties.

GHG EMISSION REDUCTION SUMMARY: