In many industrial furnaces, one way of obtaining energy savings is the recovery of waste heat by using recuperators to preheat the combustion air to the furnace burners. An added advantage of preheated air is improved efficiency of the combustion process. A novel gas to gas ceramic heat exchanger developed by Société BERTIN is presented. The following goals are reached: capability to handle exhaust gases at temperatures up to 1200°C, large overall heat transfer coefficients (viz. 150 W/m²°C and above) by using both radiative and jet impingement convective heat transfer, capability of being assembled in the form of modules, prospective cost which must be comparable to metallic heat exchangers currently available at much lower temperatures (800°C). A thermal equilibrium mathematical model of the heat exchanger module is set up to optimize the module efficiency and pressure drops as a function of jet impingement heat transfer characteristics, hot and cold gas flow characteristics, ceramic material (silicium carbide) properties. A thermo-mechanical study conducted with CERAVER (France) leads to the following optimal design for SiC made core (0.340 m long, 0.250 m wide, 0.080 m high): module efficiency 0.2 to 0.3, module NTU : 0.2 to 0.3, overall module heat transfer coefficient around 150 W/m²°C, module pressure drop (air side): 200 to 300 Pascal. Further testing of the core is needed to conclude about the proposed design both on technical and prospective economical grounds.
1. INTRODUCTION

In many industrial furnaces, the furnace exhaust gases are directly vented to the stack: furnaces that run at temperatures of about 1000°C or above lose about 50% of the input energy in the flue gas exhaust, or more.

One way of obtaining energy savings is the recovery of waste heat by using recuperators to preheat the combustion air to the furnace burners. An added advantage of preheated air is improved efficiency of the combustion process.

Société BERTIN is developing a novel gas-gas ceramic heat exchanger with the following characteristics:
- capability of handling exhaust gases at temperatures up to 1200°C, and future goals up to 1500°C,
- large overall heat transfer coefficients by using both radiative and jet impingement convective heat transfer,
- capability of being assembled in the form of modules, to operate over the wider possible range of industrial applications,
- cost objectives comparable to metallic heat exchangers currently available at much lower temperatures (800°C).

Ceramic materials were screened to finally end up with Silicium Carbide, a CERAVER made material. In the present progress report, a summary of the methodology (viz. computational efforts as well as experimental program) and preliminary results are presented, together with the final experimental program and economical assessment which are to be carried out before the end of the program.

2. PROGRAM OBJECTIVES (1, 2)

The program proposed by BERTIN is divided into 4 complementary sub tasks.

Sub task 1: a review of existing industrial needs is performed to assess:
- potential applications in various processes whose exhaust gas temperatures lie above 1000°C
- load spectra for those furnaces including temperature and flow rate data, hot gas composition and particulate concentrations
- present day technology (viz. metallic heat exchanger) with price quotes to set economical constraints on the BERTIN project.

Sub task 2: system analysis and thermal optimization of the heat exchanger configurations which goes through:
- the building of a mathematical model which describes local as well as global energy balances
- experimental "cold" tests (viz. below 600°C) which allows comparisons with theoretical results as found by the mathematical model as well as further refinements to adequately predict overall heat exchange data (+ 15% accuracy)
- a step-by-step optimization study to end up with various designs to be checked in the context of the mechanical study.

Sub task 3: thermo-mechanical study jointly with CERAVER to end up with a first design to be tested on a thermal test rig. The following steps are considered:
- size study to yield overall dimensions that are compatible with existing cold pressing equipment at CERAVER.