METU-GÜNAM's CST Research Activities and Capacities

Prof. Dr. Ilker TARI
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Facilities

- High flux concentrating solar simulator
  - Operators: Ilker Tari, Sinan Uygur and Onur Polat
  - Open for Transnational Access thru SFERA-III
- Gravity driven particle flow receiver set-up, Evan Johnson
- PTC Simulator and olive mill wastewater spray dryer
  - Operators: Deniz Degirmenci and Ertugrul Cubuk
- Hot disk thermal characterization, Zeynep Uykun
- Workstations for ray-tracing, ANSYS, OpenFoam and TRNSYS simulations

High Flux Solar Simulator and Gravity Driven Particle Receiver Set-up

Pre-heating hopper, 700 °C

Test section, receiving concentrated light

Scale for mass flow rate

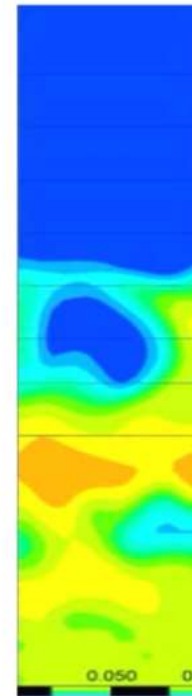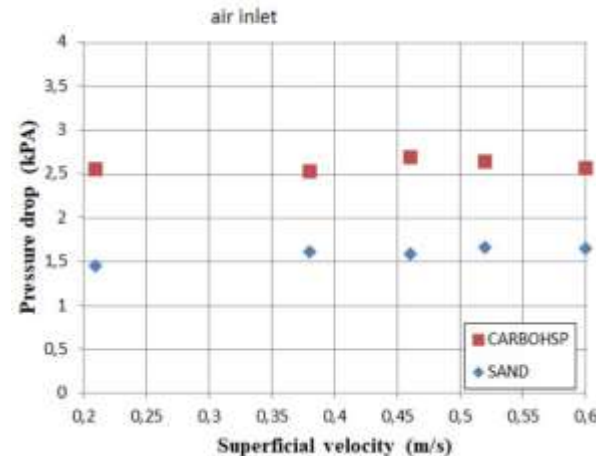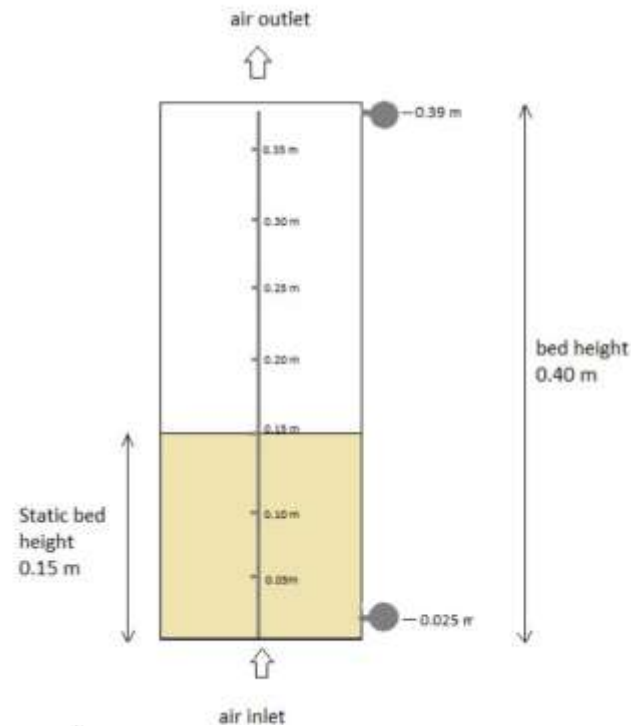Three 6 kW bulbs, with concentrating dishes

Parabolic Through Collector Simulator and Solar Spray Dryer Set-up

The PTC simulator and solar spray dryer prototype were developed within METU-CRTEn bi-lateral project 217M062

# Particle Fluidized Bed TES Experimental Setup

Experimental and Simulation Work

- Gravity driven particle flow receiver simulations, Evan Johnson

- Particle TES experiments and simulations, Esra Polat

- Mechanical and thermal characterization of particles, Zeynep Uykun

- PTC Simulator and olive mill wastewater spray dryer
  - Experiments and simulations by Deniz Degirmenci and Ertugrul Cubuk and previously by Selin Erdogan

- PTC ray-tracing and ANSYS Fluent simulations, Sinan Uygur

- Solar hybridization of high temperature industrial processes, Simulation works by
  - Basil Abu Zanouneh for Seydisehir Aluminum Plant
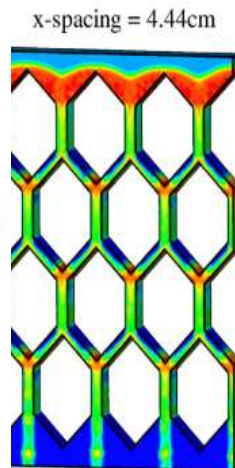 - Onur Polat and Shadi Salehian for Gaziantep Cement Plant

Modeling of Solar Receivers and Heat Exchangers

➢ Solar receivers:
- Collaboration with DLR on centrifugal solar receiver

➢ Particle-fluid heat exchangers:
- Moving bed heat exchangers with tubes
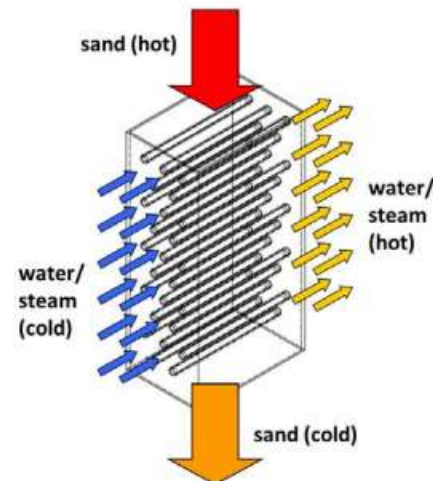- Flat plate heat exchangers

Centrifugal Receiver, DLR
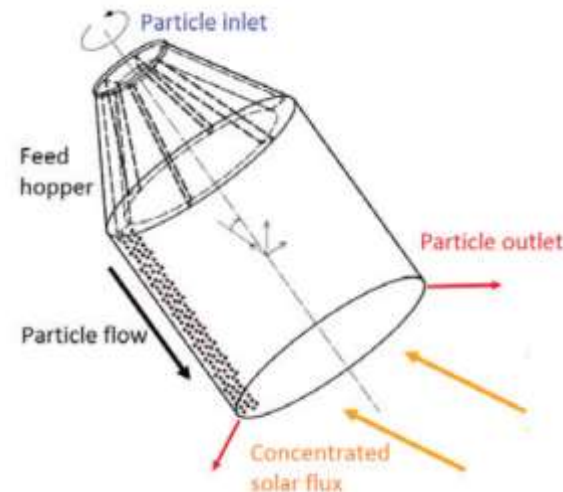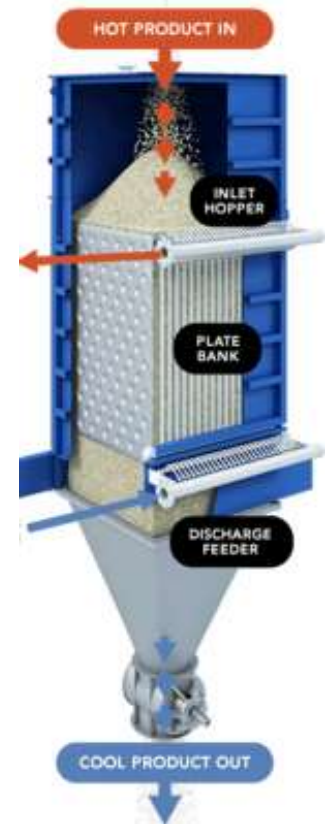
Internal flow receiver, NREL

Granular flow receiver, METU
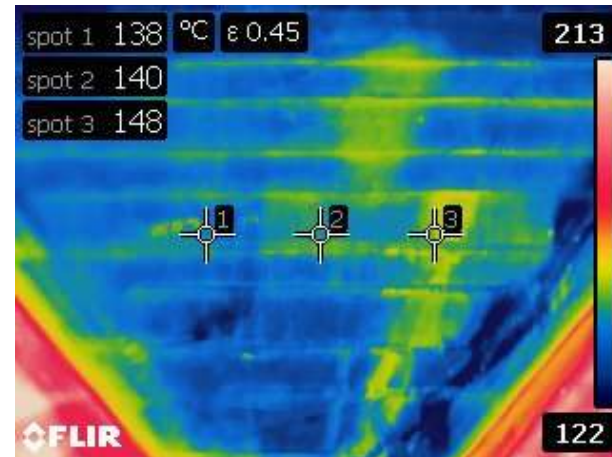
Moving bed heat exchanger, DLR

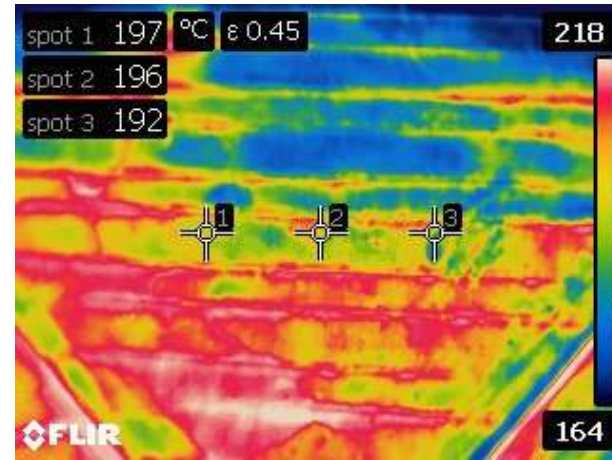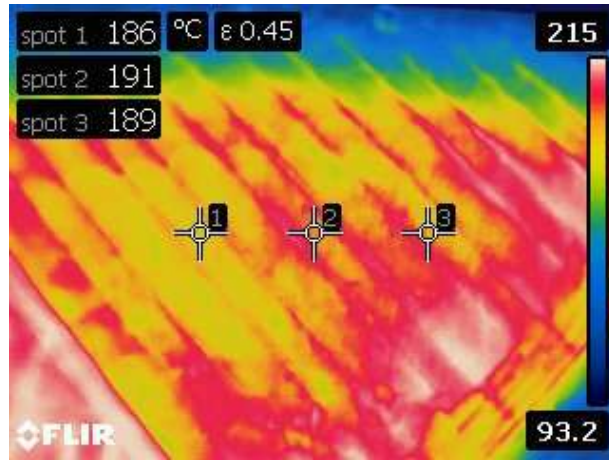Flat plate heat exchanger, Solex Thermal
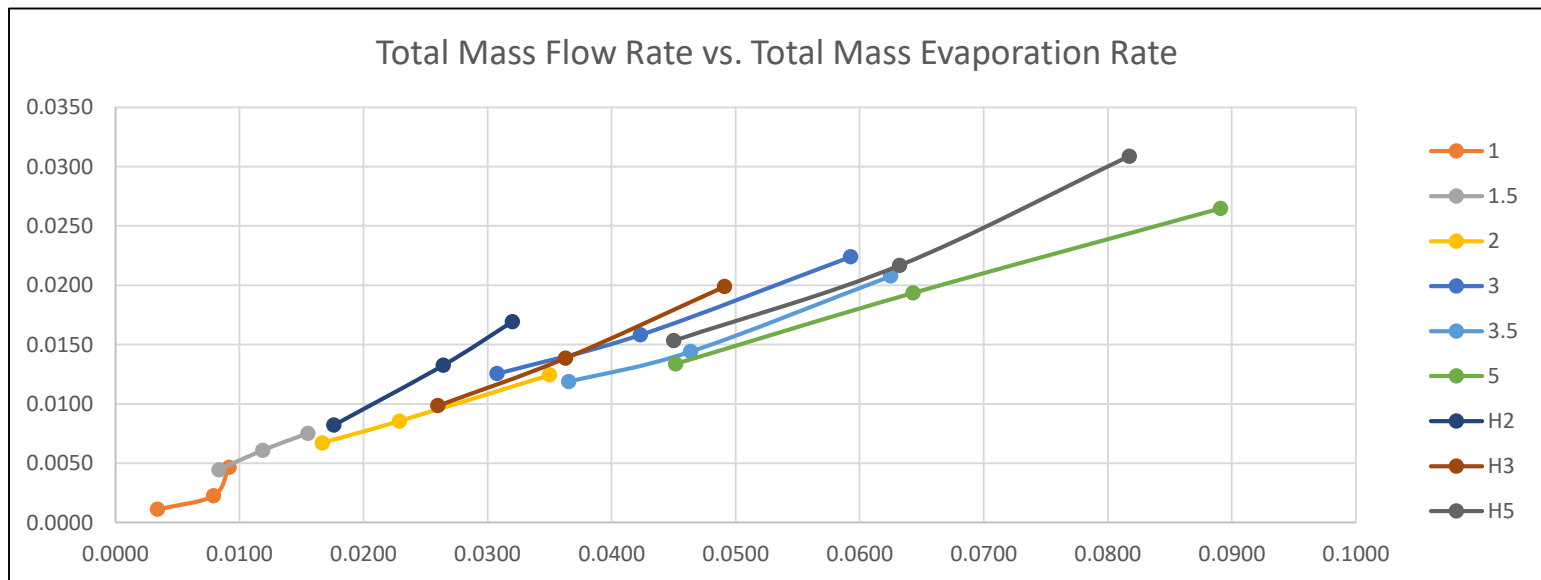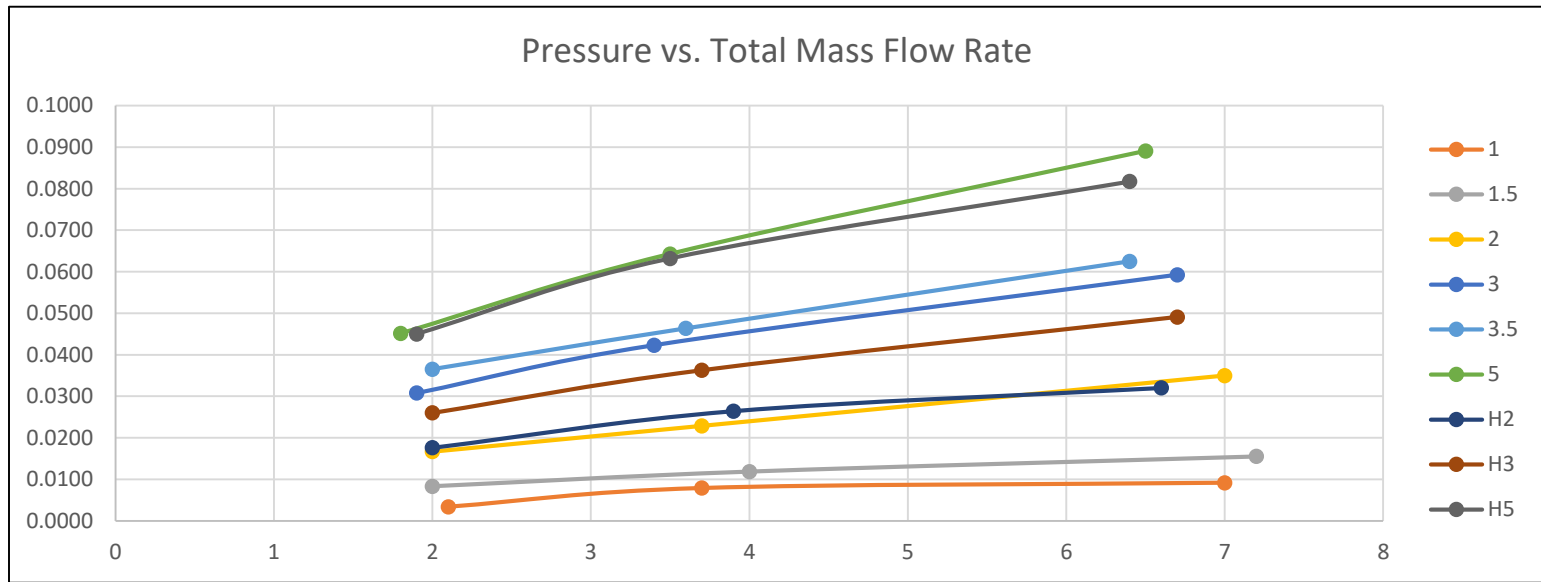
Parabolic Through Collector Simulator

Experimental Results from 4 different dryer surfaces

Results from 9 different spray nozzles

Mechanical and Thermal Characterization of Sand and Sintered Bauxite Particles
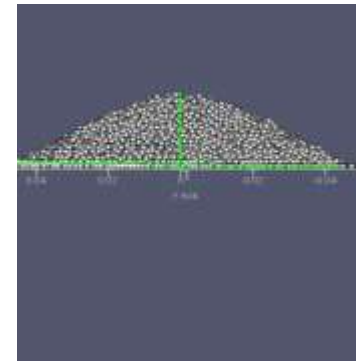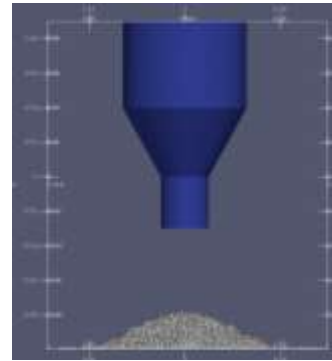
1. Direct Measurement Approach

Particle-Wall Friction Coefficients

Inclined Plane Test
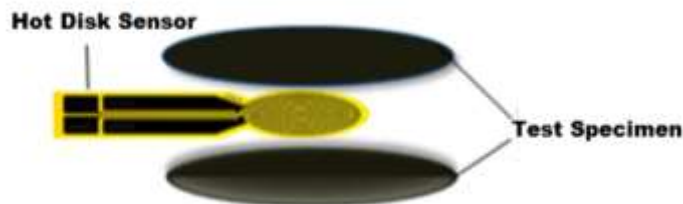
2. Calibration Approach

Particle-Particle Friction Coefficients
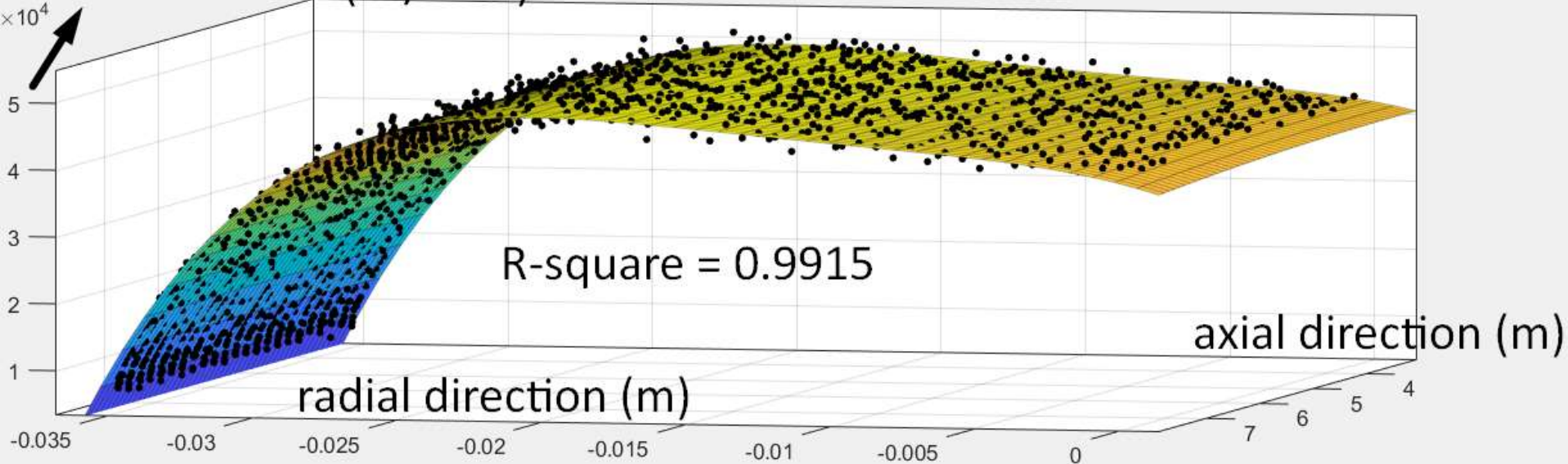

Discharge Time and Angle of Repose Test

3. High Tempreture Test and Thermally Cycled Particles
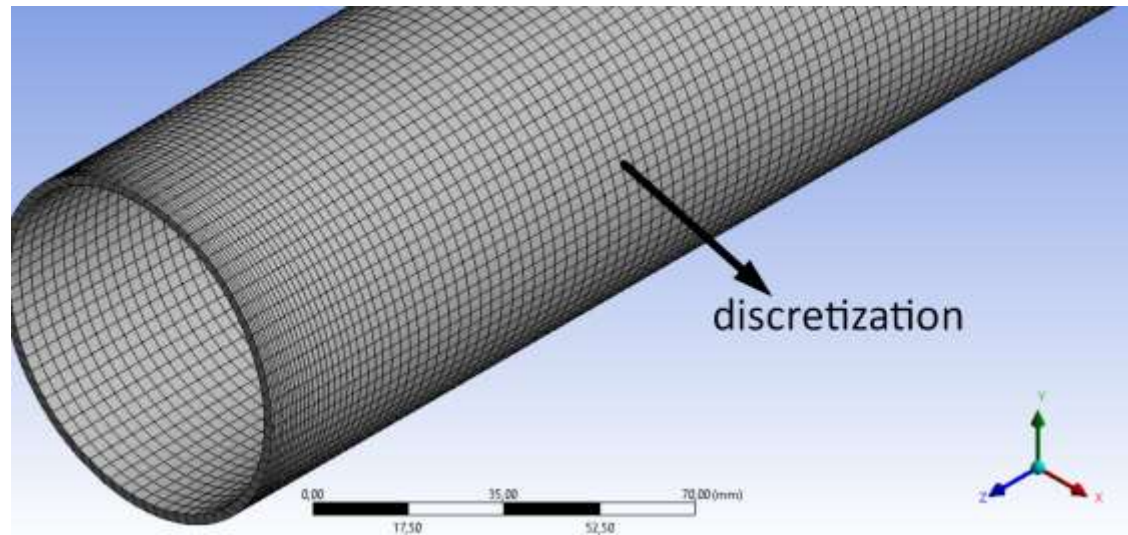
4. Thermal Characterization using HotDisk

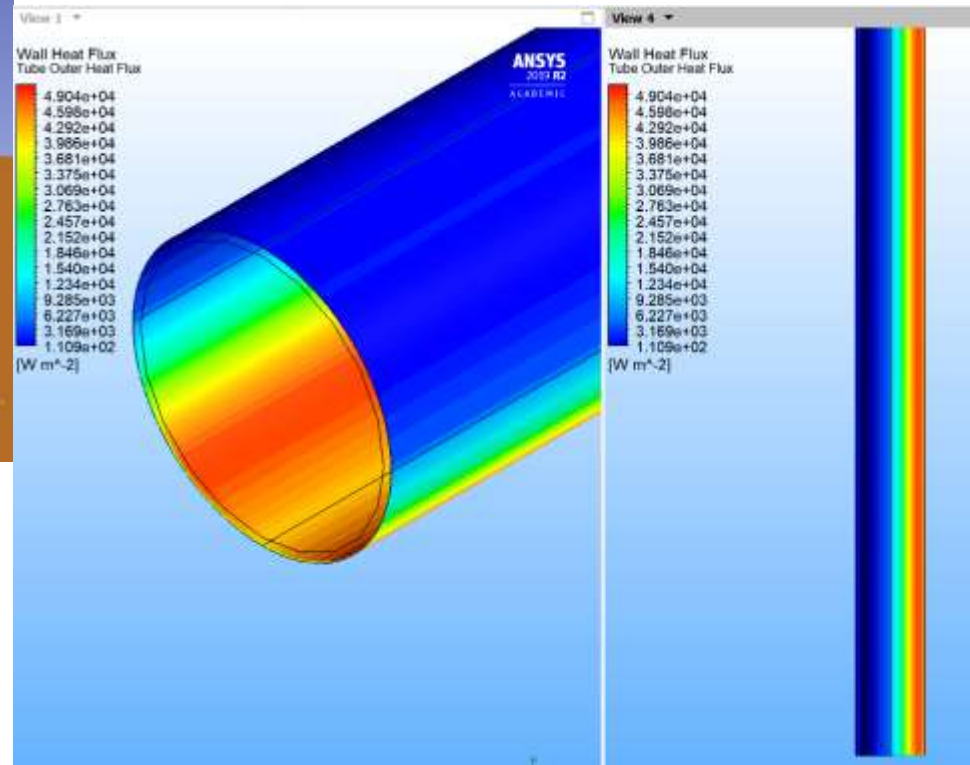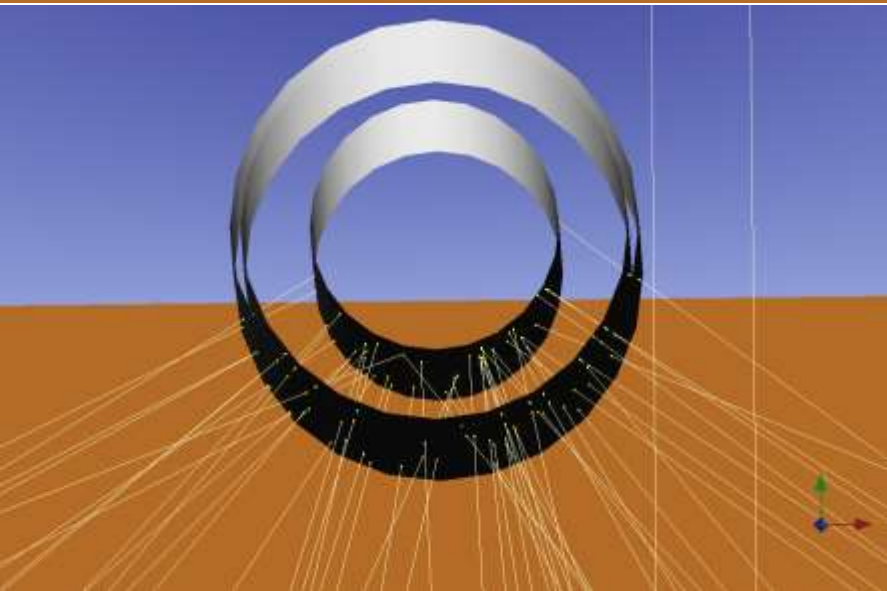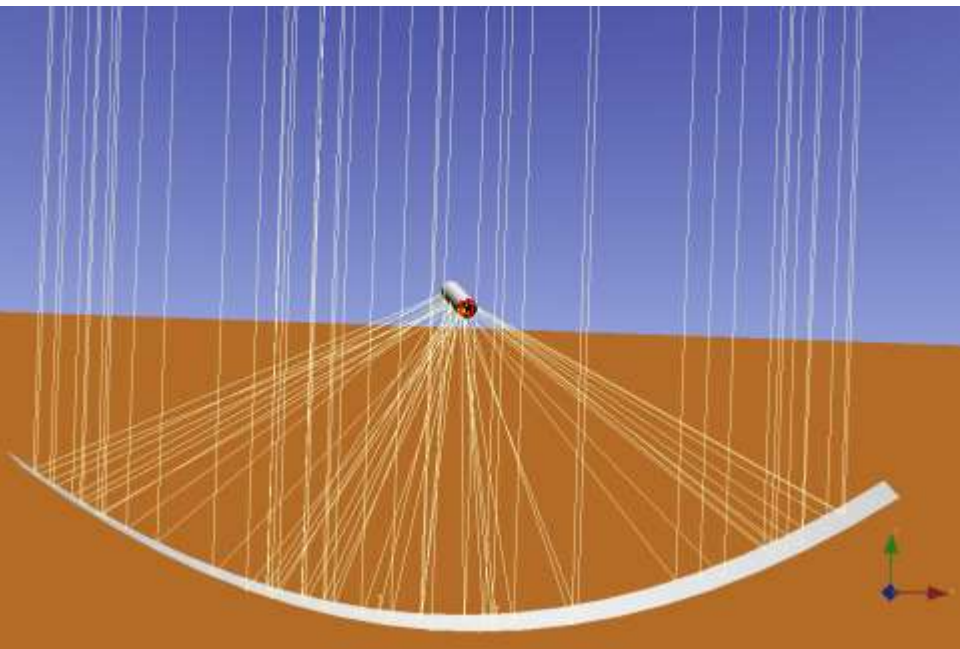# PTC simulations using Tonatiuh, MATLAB and ANSYS Fluent

heat flux values (W/m^2)

R-square = 0.9915

axial direction (m)

radial direction (m)

$f(x,y) = p00 + p10*x + p01*y + p20*x^2 + p11*x*y + p02*y^2 + p21*x^2*y + p12*x*y^2 + p03*y^3 + p22*x^2*y^2 + p13*x*y^3 + p04*y^4$
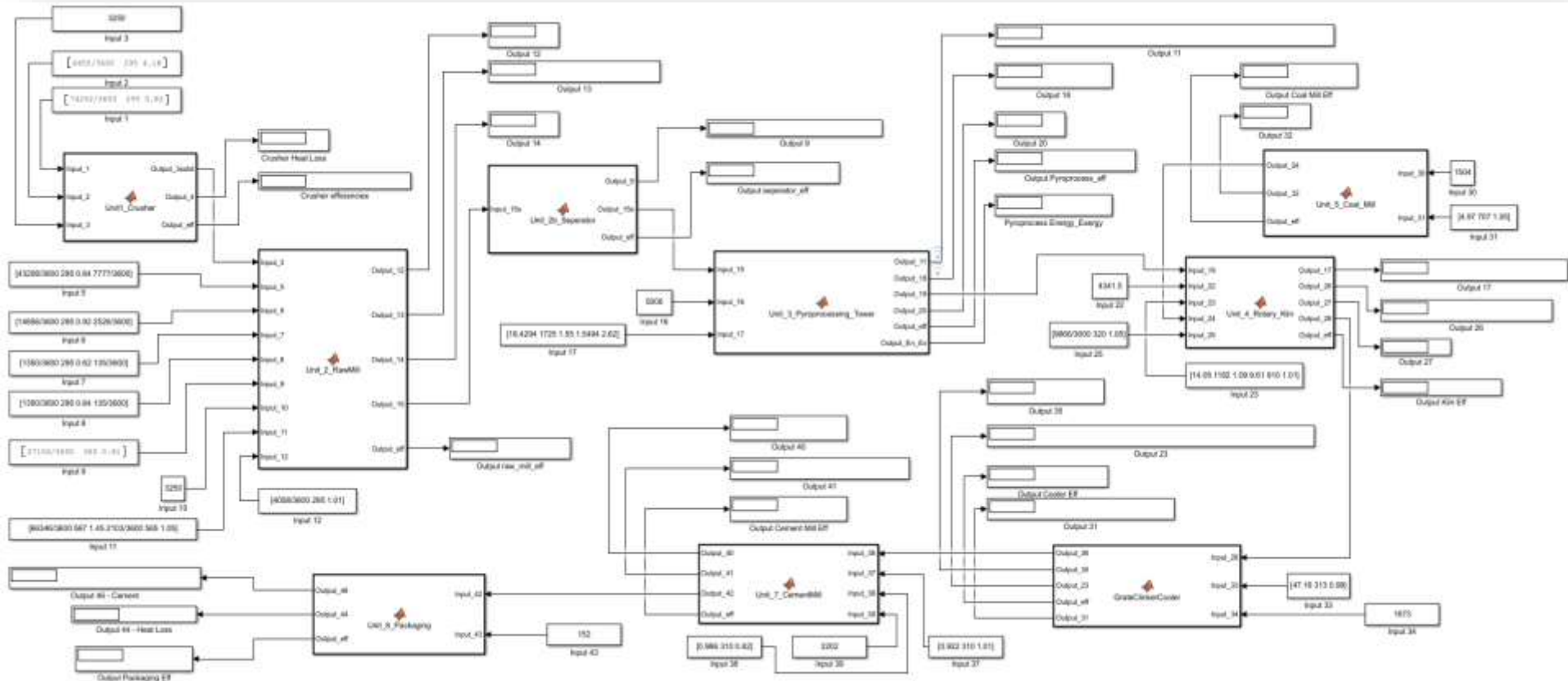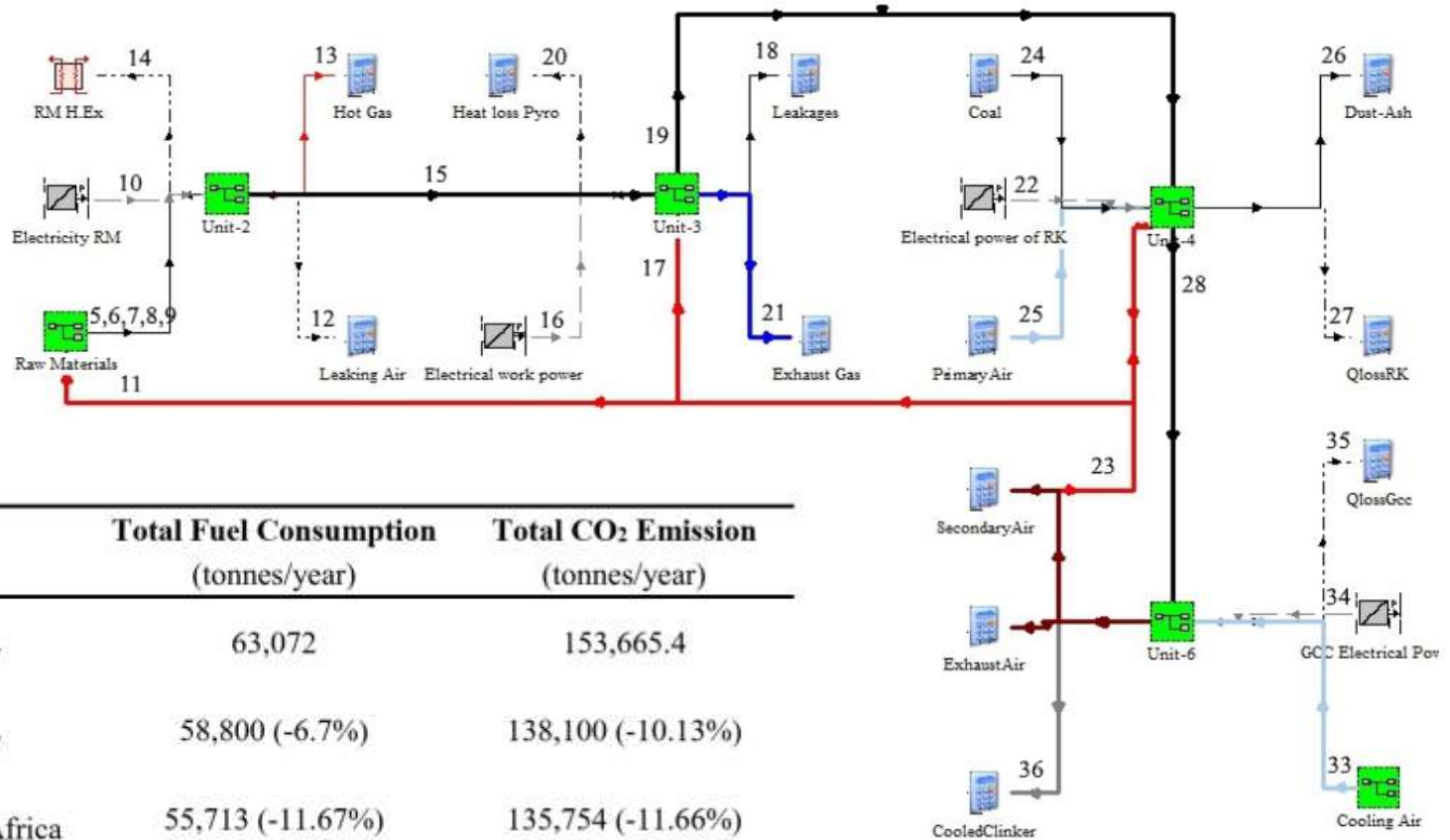
discretization

Output: 3D non-uniform heat flux distribution
Heat transfer enhancement inside the tube

Matlab Simulink Model of Cement Plant

Solar Hybridization of Cement Plant

Results	Total Fuel Consumption (tonnes/year)	Total CO$_2$ Emission (tonnes/year)
Model-1 Gaziantep, Turkey	63,072	153,665.4
Model-2 Gaziantep, Turkey	58,800 (-6.7%)	138,100 (-10.13%)
Model-2 Upington, South Africa	55,713 (-11.67%)	135,754 (-11.66%)
Model-3 Gaziantep, Turkey	51,80 (-17.86%)	126,230 (-17.85%)