Return to Value


# FROM WASTE TO ENERGY UP TO SUSTAINABLE DEVELOPMENT

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# Waste – Affordable, Sustainable and Renewable Energy Source

**Sustainable Development Strategy**

**Strategy and instruments for promoting renewable energy sources**

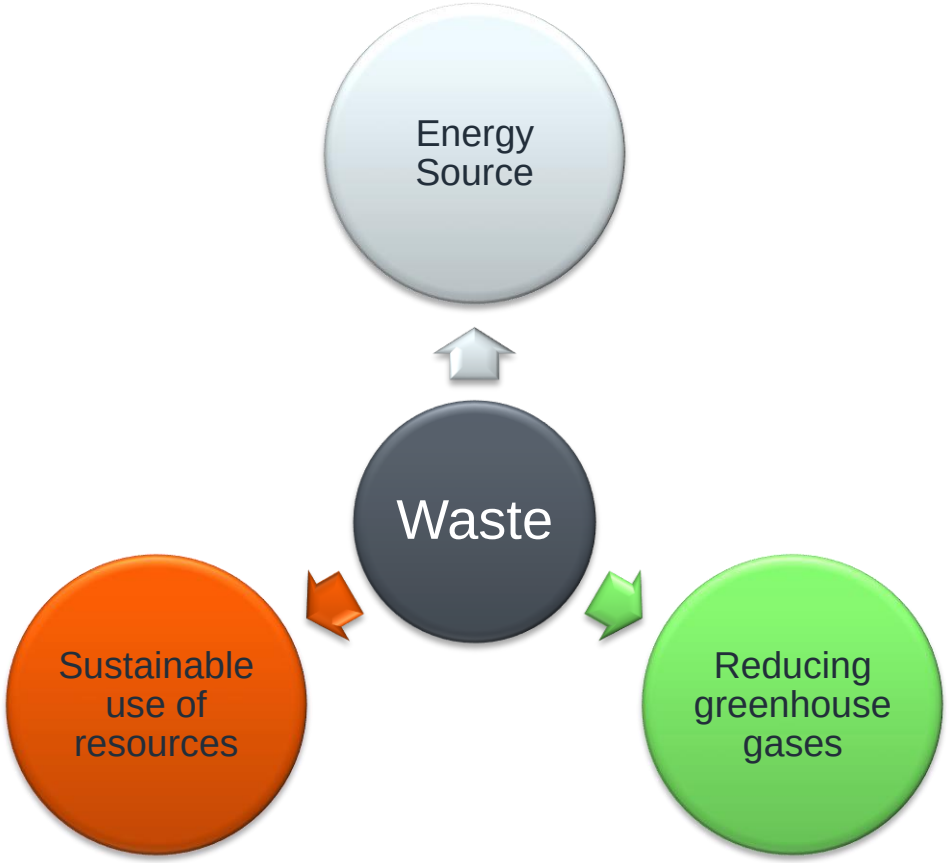
**Strategy for Energy Efficiency**

**UN Framework Convention on Climate Change**

**Kyoto Protocol Treaty**

**Waste Management Strategy**

**Thematic Strategy on the prevention and recycling of waste**



# Experimental Research

**Production capacity**

**3,000,000 t/year**

**Waste used as alternative fuel**

**30,000 t/year**

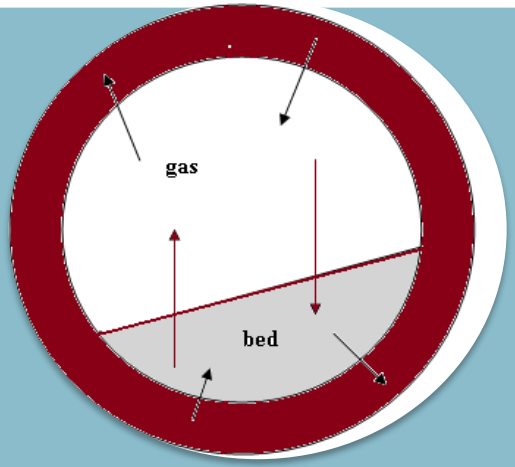
**Waste quantity permitted to be used as alternative fuel – 400,000 t/year**

**Alternative fuel (waste) should be increased from 3.5 t/h to 46 t/h**

**The effects of substitution of traditional fuels with wastes**

**2 rotary clinker kilns with heat exchanger**

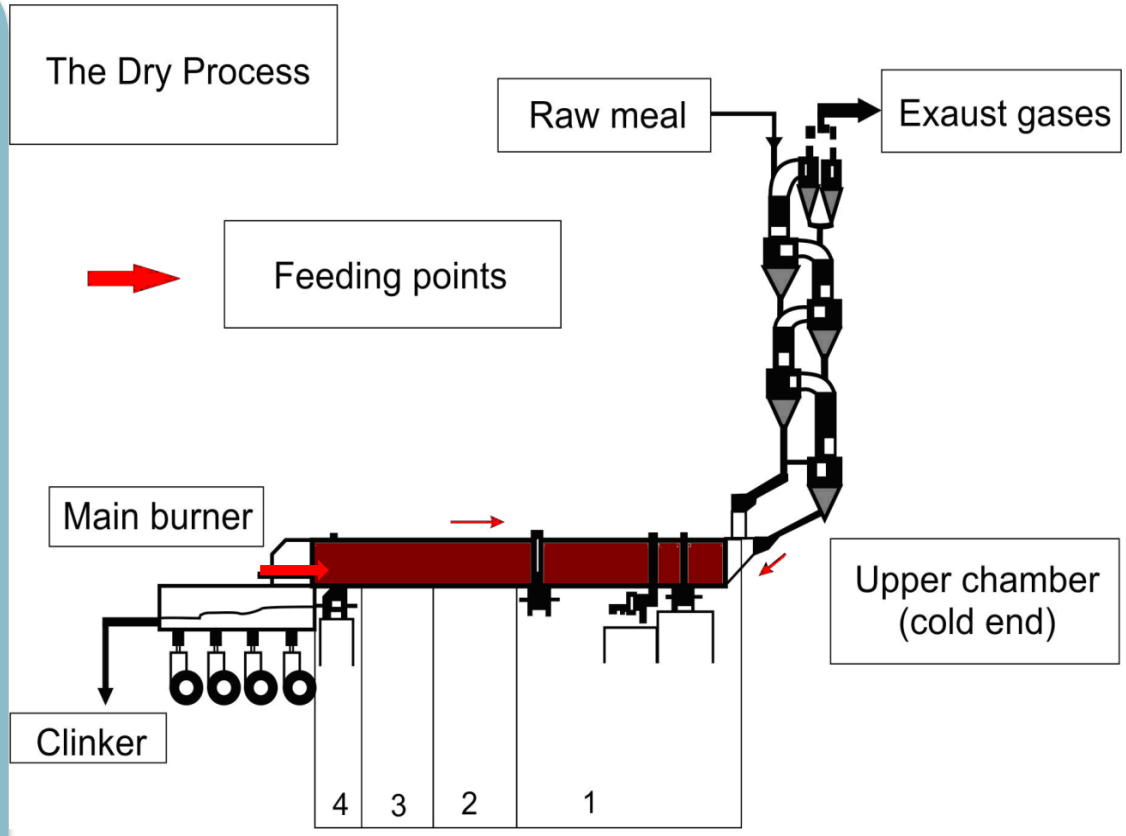
# System under Study



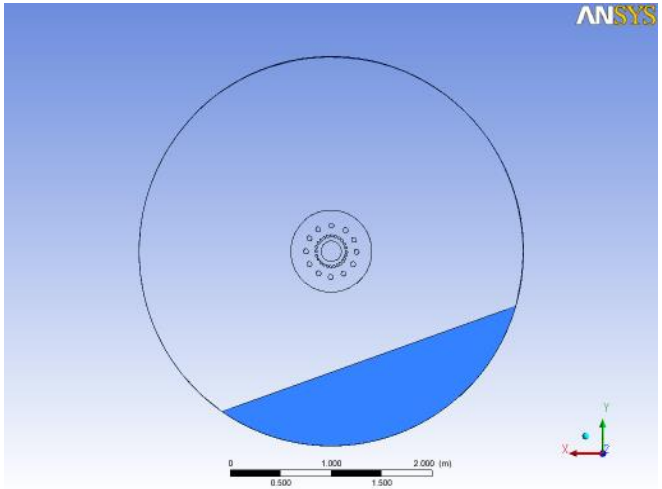

**Heat Transfer - Cross section of the kiln**

**Main zones of the kiln:**

1. Calcination zone 800 – 1000 ºC
2. Transition zone 1000 – 1350 ºC
3. Sintering zone 1350 – 1500 ºC
4. Cooling zone 1450 – 1250 ºC

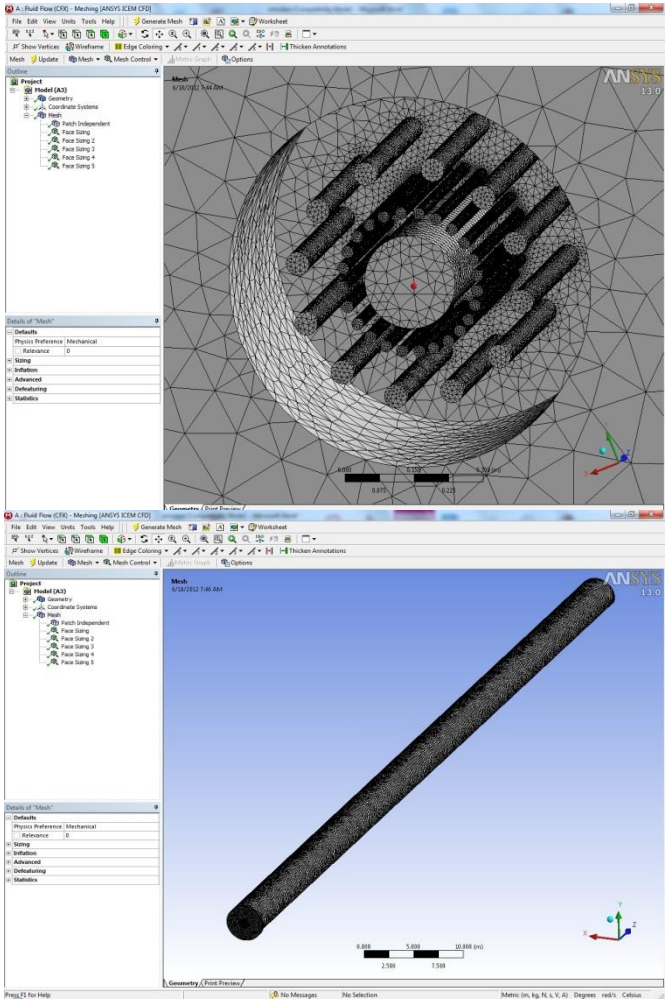


# Simulation Experiment





- Geometry creation




- Mesh generation

# Initial and Boundary Conditions

## Technical characteristics of the rotary kiln

- Length = 97 m; Internal diameter = 3.8 m
- Inclination = 3%

## Operational variables

- Temperatures of clinkerization = 1300 – 1450 °C
- Air mass flow and temperatures
- Excess air = 4.5% - 12%

| Air stream | | Mass flow rate (kg/s) | Temperature (˚C) |
|---|---|---|---|
| Primary air | Coal carrier air | 0.579 | 70 |
| | Swirl air (tangential air) | 0.279 | 70 |
| | Axial air | 1.18 | 80 |
| Secondary air | | 25.97 | 800 |

Fuels mass flow is 25.55 kg/s, fractional flow of the mixture being variable as follows:

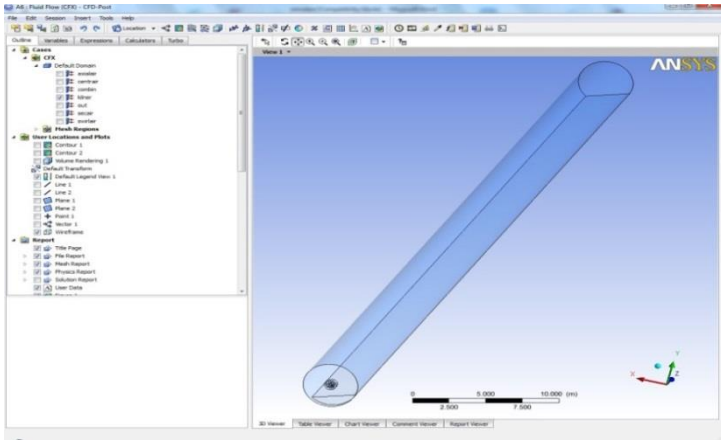
- 24.578 kg/s traditional fuel and 0.972 kg/s fuel from waste, respectively

- 19.16 kg/s traditional fuel and 6.39 kg/s fuel from waste.

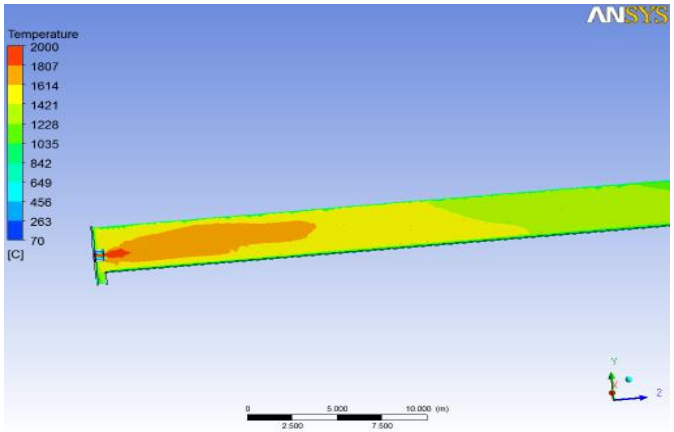
Fuel calorific value is presented in Table.

| Type of fuel | Fuel | Calorific value MJ/kg | % in the mixture |
|---|---|---|---|
| Traditional | Natural gas | 50 | 75 % |
| | Coal | 26-30 | |
| | Heavy oil | 40-42 | |
| | Mixture - recipe | 33.5 | |
| Alternative | Liquid wastes | 30 | 25% |
| | Solid waste small dimensions | 27 | |
| | Tires & large solid wastes | 26 | |
| | Mixture - weighted | 25.65 | |
| Calorific value of the mixture | | 31.54 | 100% |

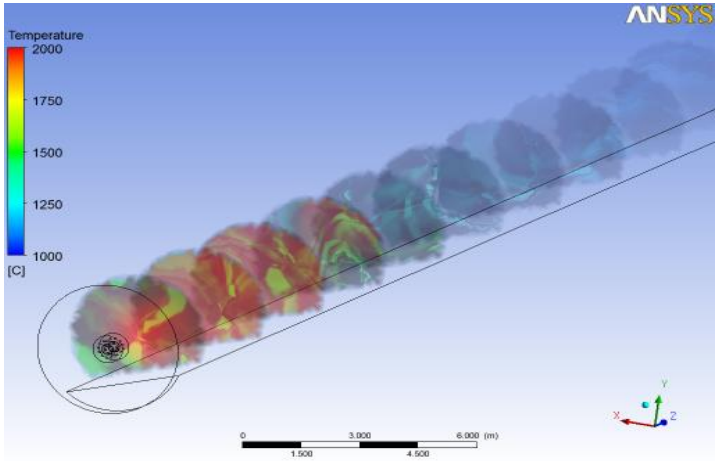
# Postprocessing



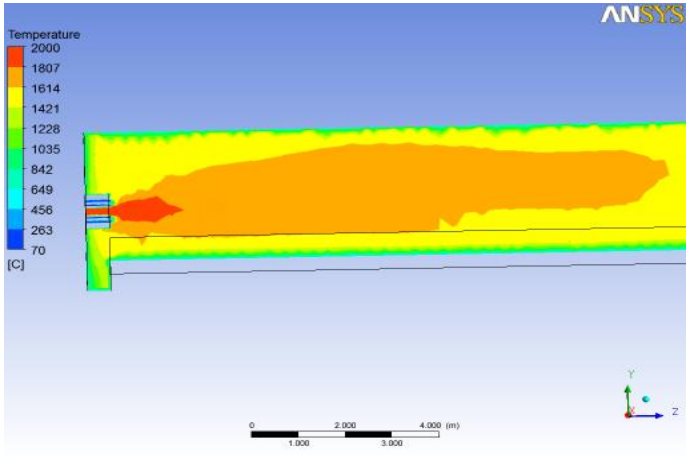

Virtual model of rotary kiln




Temperatures profile in longitudinal section

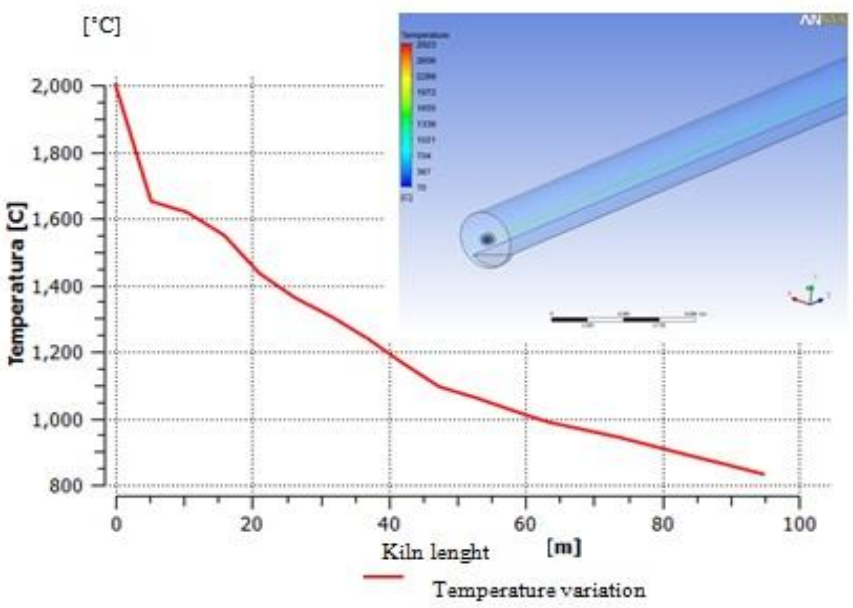


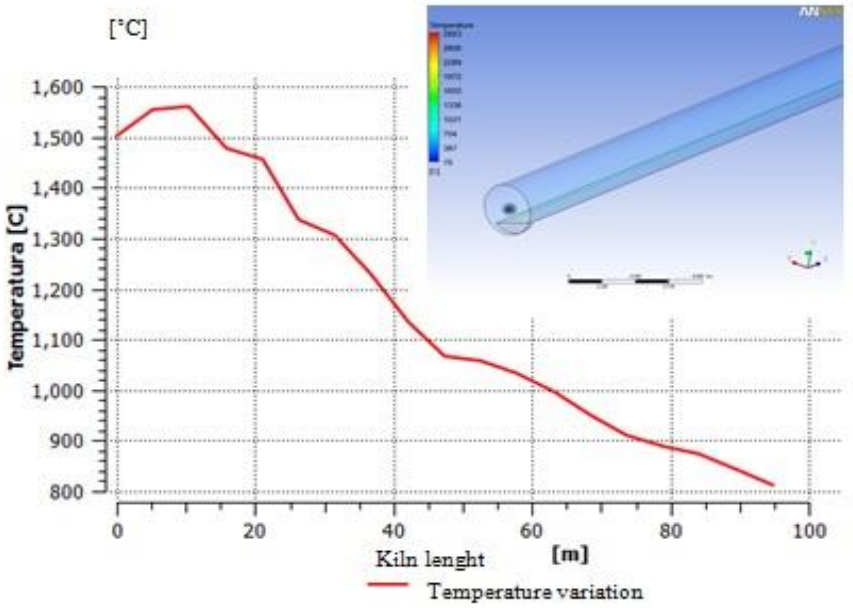

Temperatures profile in transversal section




Temperatures profile in the burner zone

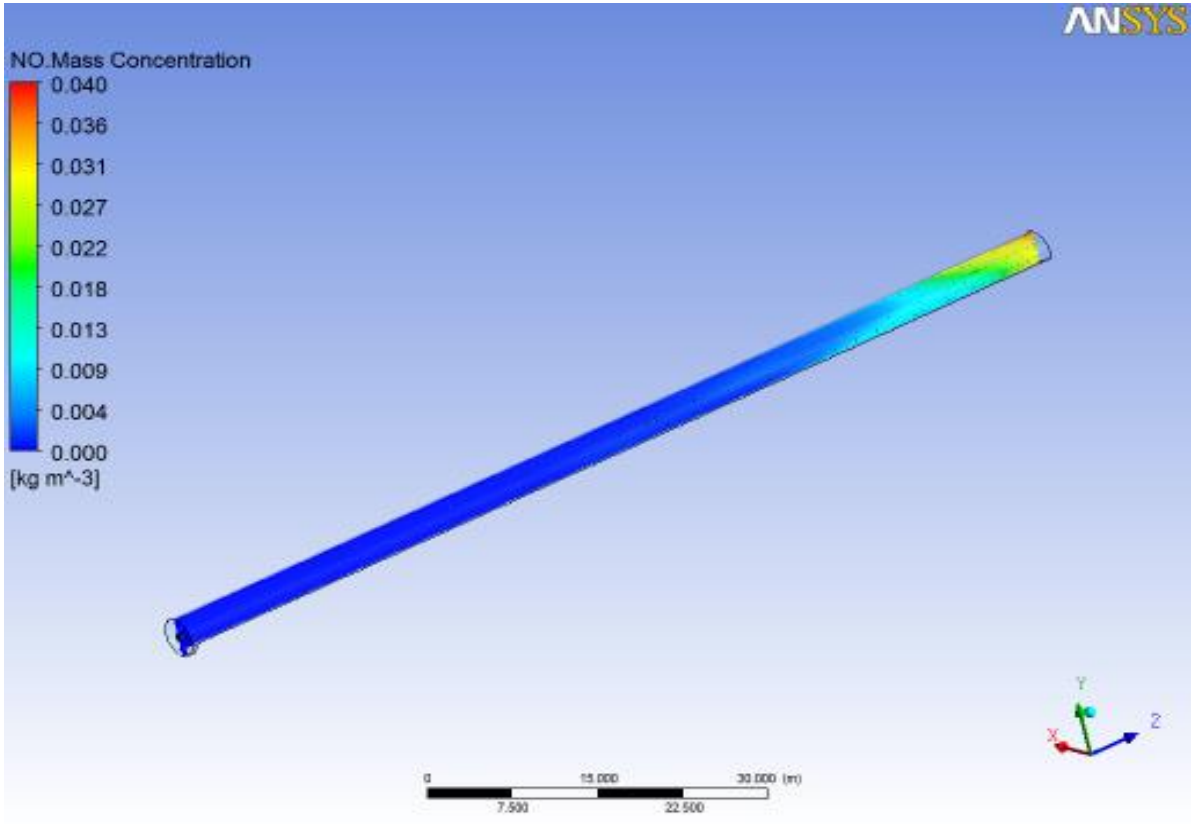
# Simulation Analysis – Temperatures distribution




**Temperature at the bed line and at the burner level along the kiln**

# Simulation Analysis – Greenhouse gas Emissions

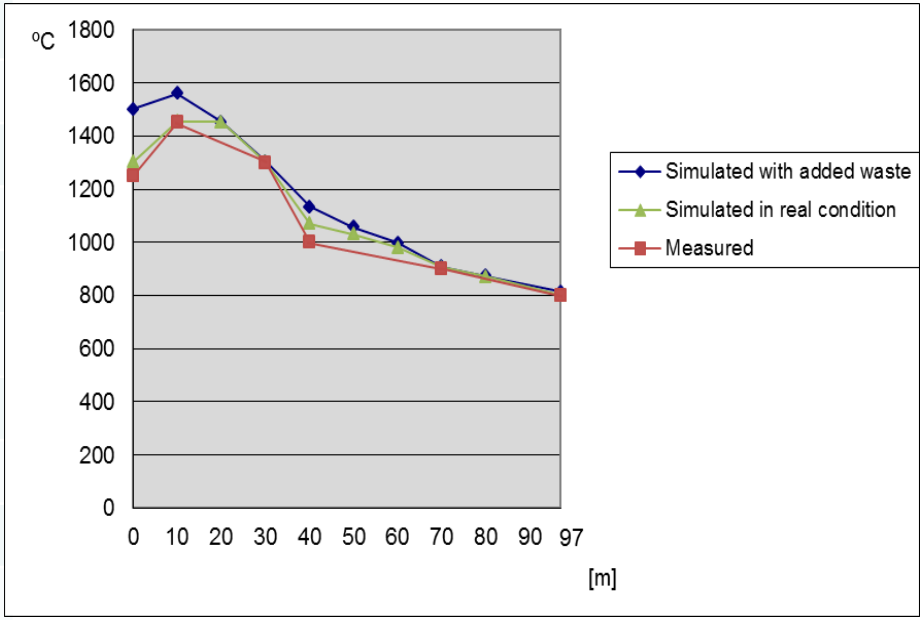



**Simulation of NOx emissions**

# Results and Discussions

| Kiln Length [m] | Temperature (simulated) Initial conditions [˚C] | Temperature (simulated) Experimental conditions [˚C] | Temperature (measured) [˚C] |
|---|---|---|---|
| 0 | 1302 | 1500 | 1250 |
| 10 | 1455 | 1560 | 1450 |
| 20 | 1452 | 1454 | |
| 30 | 1303 | 1304 | 1300 |
| 40 | 1070 | 1133 | 1000 |
| 50 | 1031 | 1056 | |
| 60 | 980 | 997 | |
| 70 | 905 | 909 | 900 |
| 80 | 870 | 873 | |
| 97 | 800 | 814 | 800 |

## Results validation



# Conclusions

Mathematic simulation of heat transfer in rotary kiln is very useful for the assumption of necessary operational parameters for safe incineration of hazardous wastes, and for improving the combustion by optimization of air flow in existing installations.

By using CFD software from ANSYS, we successfully analysed the effects of replacing 25 % of the traditional fuels used in an existing cement factory with fuels obtain by a mixture o wastes. By running CFD simulations, we determined a number of subtle process changes (ex. additional excess air supplying) and adjustments required by the new fuels, ultimately discovering the optimal set of conditions under which green fuels can be used to support a high-quality cement product.

Based on the simulations we proved that the cement producers can successfully replace the traditional fossil fuels with alternative secondary fuels having result economic and environmental benefits.

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