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# Computational fluid dynamics: infinite possibilities to optimize energy systems

Computational fluid dynamics (CFD) is an invaluable support in solving industrial equipment combustion problems. It facilitates drawing a picture of the situation, identifying the problems and testing different solutions, all by computer, before implementing the necessary corrections.

Associated with powerful tools and used by experts, CFD allows for the analysis of fluid flows and their effects. It is thus possible to simulate the behaviour of the flame, its shape, the convective and radiative heat transfer, the turbulent flow of products of combustion and the formation of pollutants, such as carbon monoxide (CO) and nitrogen oxides ($NO_x$).

## Method

First, the problem and its scope must be defined. The method most commonly used for fluid flow resolution is the finite volume method, which consists of dividing the geometry under study into small calculation elements and applying mathematical models for resolution of the system on this discretization. The results are presented in the form of graphs and images.

The second stage is to simulate different solutions. The reports generated at the outcome of each simulation illustrate the model's reactions. Several solutions thus can be analyzed before moving on to the equipment "construction/replacement" or "modification" phase.

## Associated tools

Different CFD software exists (Siemens Star-CCM+/Star-CD, ANSYS, etc.). Some firms develop their own models to cover as many cases as possible for modelling combustion phenomena.

CFD may often lead to a substantial gain in productivity.

## A solution adapted to all types of industrial activities

Computational fluid dynamics can be used for many industrial applications.

### Example 1: Rotary dryer

An orchard wanted to dry apple pulp after extracting the juice, but the natural gas rotary drum dryer burned the pulp instead of drying it, forming small hard masses. The finished product did not present a uniform quality.

CFD made it possible to illustrate the behaviour of the dryer’s combustion system and to identify a solution that promised to achieve the expected drying rate by adjusting certain dryer components. The implementation of the solution led to a 300% improvement in the system’s energy efficiency, and the expected drying rate was achieved.

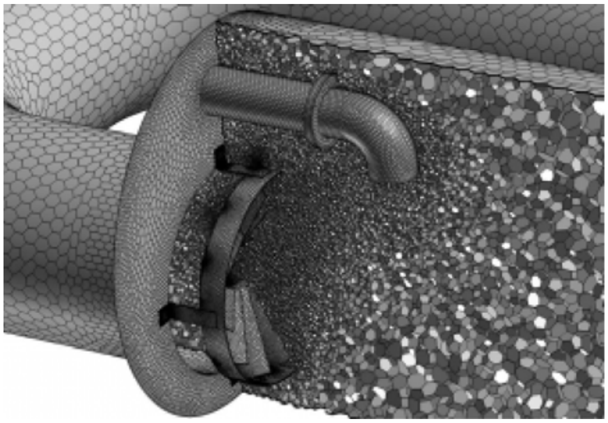

Figure 1: *Meshing of the pulp dryer – Brais Malouin et Associés.*

## Example 2: Air emissions and air quality

Analysis of the products of combustion is important in order to comply with air quality regulations. Control over an incinerator’s air pollutant emissions therefore had to be improved. The design of its new burners had to consider:

- the power, type, number and location of the burners;
- the natural gas needs;
- the combustion air needs;
- the control strategy;
- the type, number and position of the CO and temperature sensors.

CFD made it possible to understand the current system well, evaluate its deficiencies and design new burners to comply with the regulatory requirements.

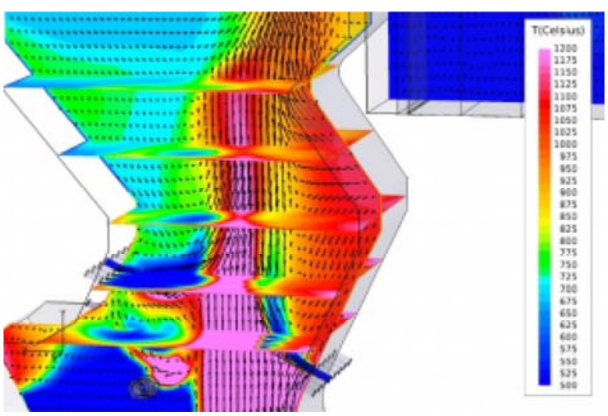


Figure 2: *Multiple temperature contours of the incinerator – Brais Malouin et Associés.*

## Example 3: Continuous process and batch ovens

Paint drying/baking lines greatly benefit from CFD, specifically to optimize flows in forced convection areas (heating and cooling). The use of these areas can increase the oven's productivity by over 50% compared with natural convection ovens and optimize air injection in the ovens to homogenize the temperature of the parts, thus ensuring baking quality.

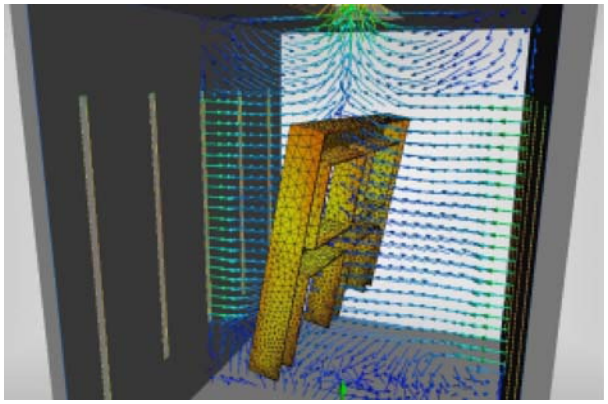

Figure 3: *Temperature increase of a part in a continuous process oven– Valtech Énergie.* (The arrows indicate the direction of the local hot gas flow velocities.)

Temperature homogeneity is essential for many baking and annealing applications in batch ovens. To ensure homogeneous heating of a stacked load, depending on the temperature increase and maintenance time sought, CFD can facilitate designing the following elements:

- ideal stacking of the load;
- power, type, number and direction of the burners;
- optimum excess air.

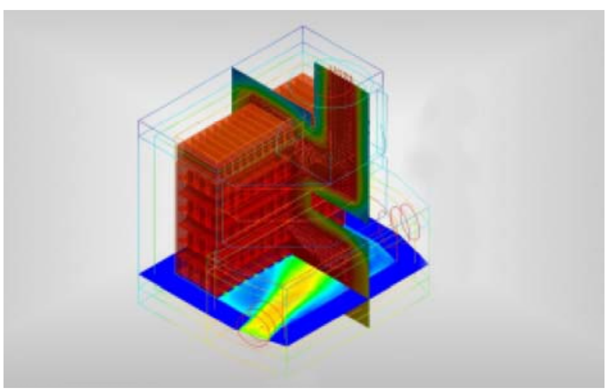

Figure 4 : *Homogeneous heating of a batch oven – Valtech Énergie.*

## Example 4: Heat transfers

Hydraulic presses are used in the production of construction panels. They normally use a heat transfer fluid as a heating source, injected into metal plates that become heat exchangers. The production quality greatly depends on a very precise temperature increase, ensuring temperature homogeneity during baking. CFD allows for the analysis of transient heat transfers (variable conditions over time) and for the determination of the operating modes to achieve and maintain a level of high quality and improve productivity.

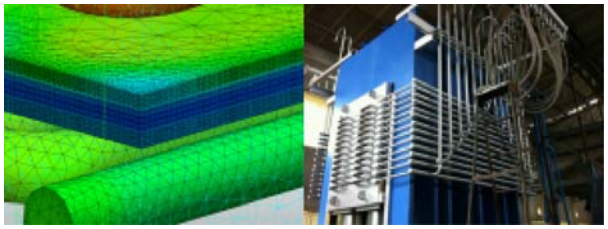

Figure 5: *Optimization of the operating modes of a hydraulic press – Valtech Énergie*.

## Infinite possibilities

As you can see, CFD clearly illustrates the current situation and helps in identifying problems and testing different solutions, a process aimed at improving your systems' performance while limiting expenses.

This method is eligible for Gaz Métro's various energy efficiency financial assistance programs.

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