Applied mathematics in industrial cooling systems

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VII Partial differential equations, optimal design and numerics

Benasque 2017

Crystal Lagoon
Thinking in a beache

Beach in Chile

punta de lobos, Pichilemu, Chile

Viña del Mar, Chile

The dream

San Alfonso del Mar, Chile

The problem

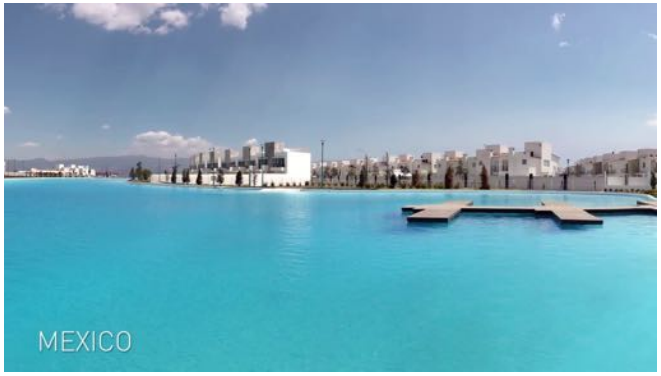
- 25,000 [m^3] of water
- 20 Olympic-size swimming pools
- 500 normal swimming pools

The innovation

- Desinfection: 100 times less than the amount used by traditional swimming pool systems or drinkingwater technology.
- Ultrasonic system: 50 times less than the energy used for conventional filtration systems


STO. DOMIGO, CHILE


THAILAND


MEXICO


JORDAN


PANAMA

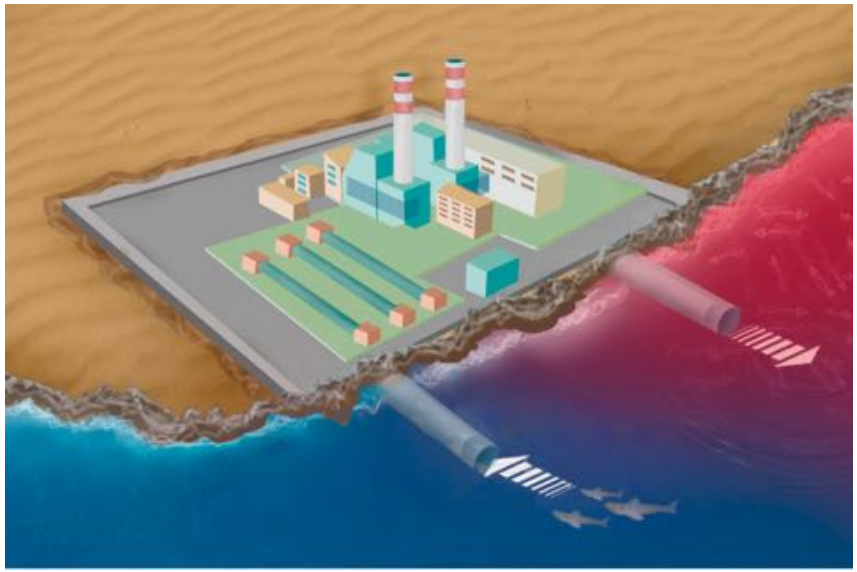

PERU


DUBAI


EGYPT


ANTOFAGASTA, CHILE

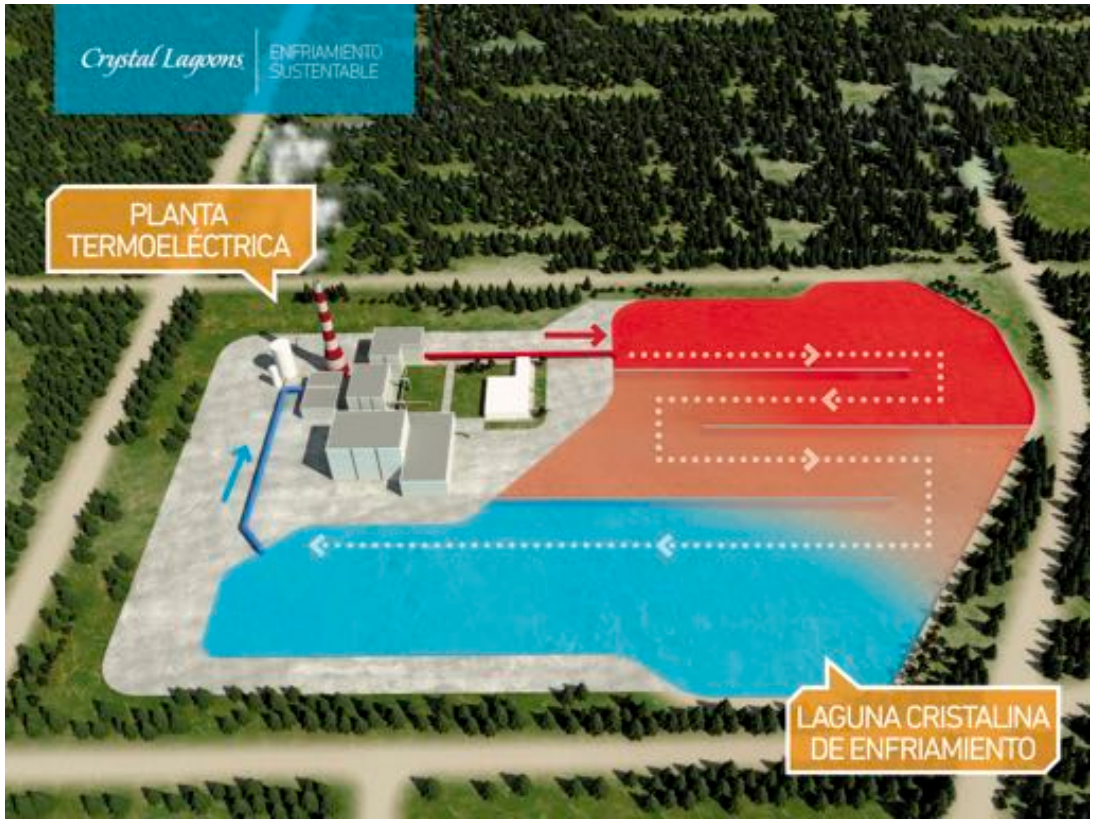
New application:
ONCE-THROUGH COOLING SYSTEMS



THERMAL POWER PLANTS

WET COOLING TOWERS

CRYSTAL LAGOONS SUSTAINABLE COOLING TECHNOLOGY



The model

$$u_t - \nu \Delta u + V \cdot \nabla u = 0, \text{ in } \Omega \times (0, T)$$

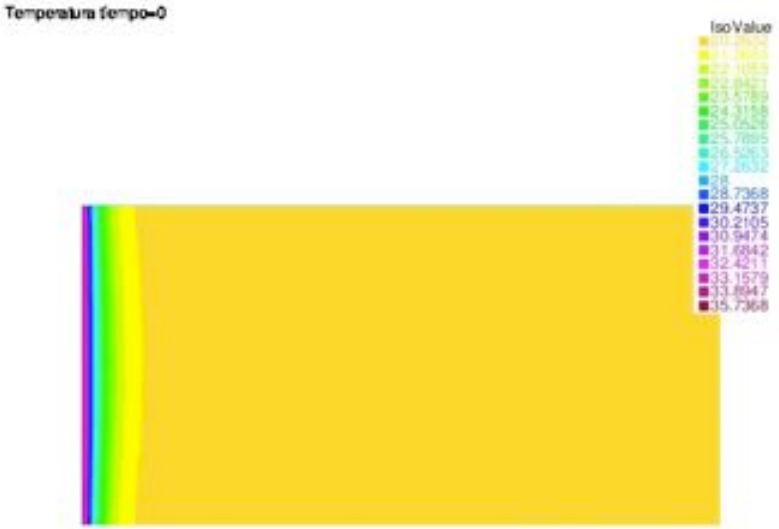
$$u = u_D, \text{ on } \Gamma_D$$

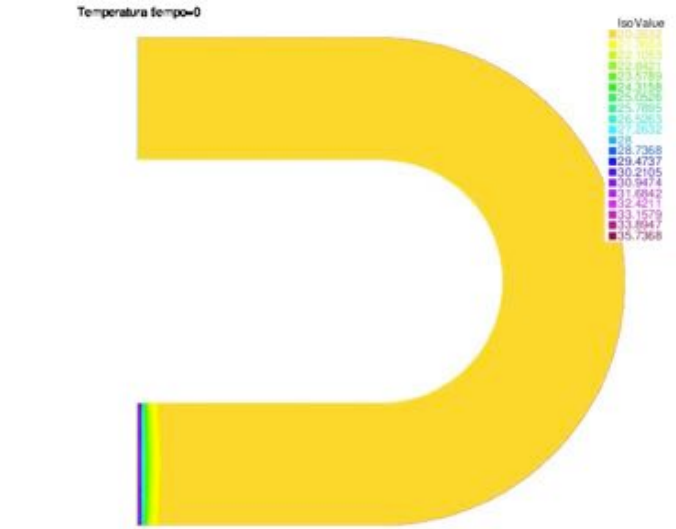
$$\nu \frac{\partial u}{\partial n} = uV \cdot n + g, \text{ on } \Gamma_{in} \qquad g = -\alpha(u_a - u), \text{ on } \Gamma_{top}$$

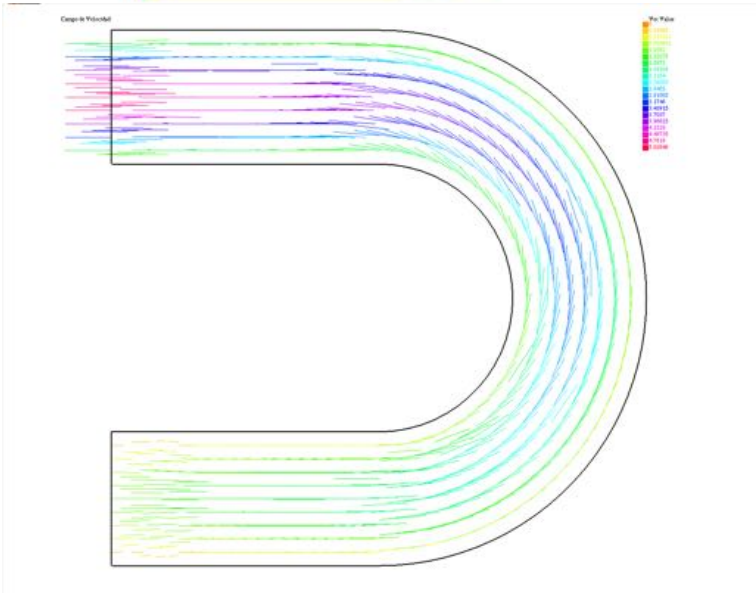
Fluid equation for V:

- Stokes
- Navier-Stokes

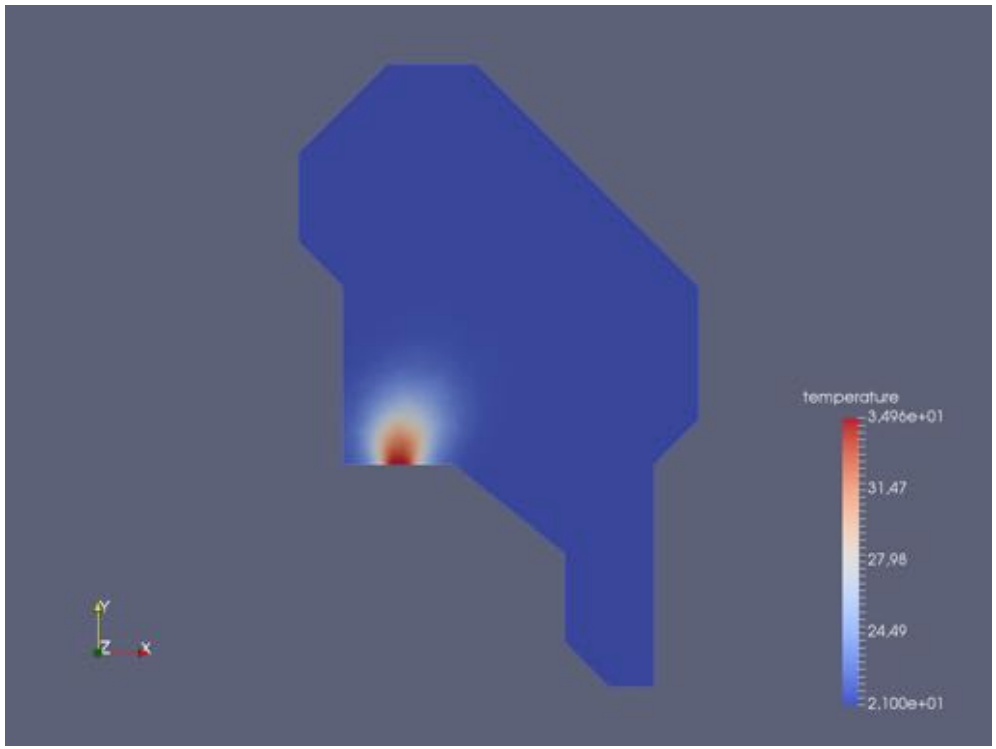
Experiences

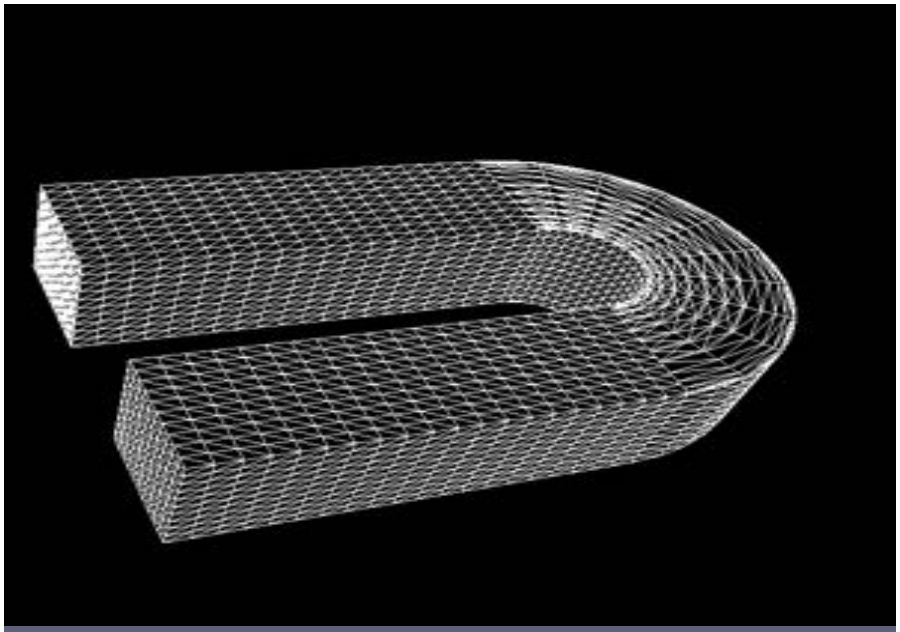


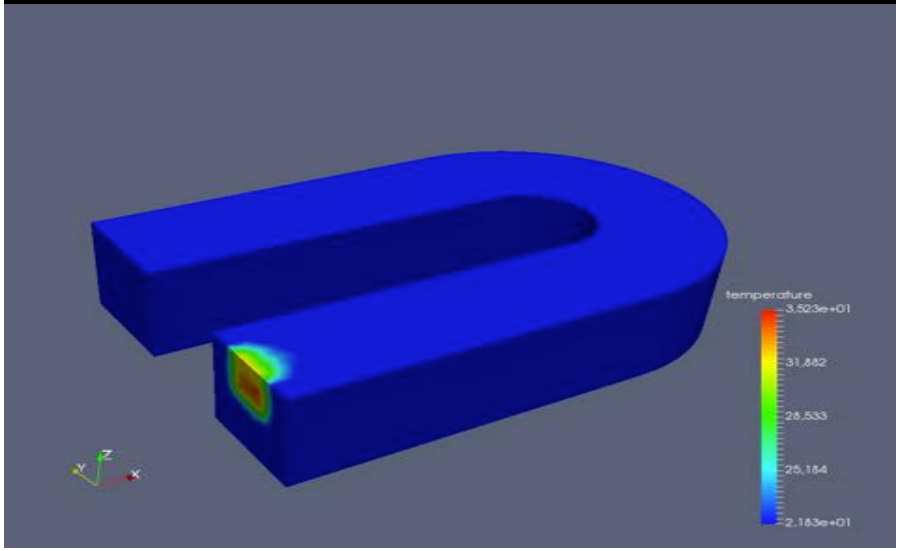




Experiences







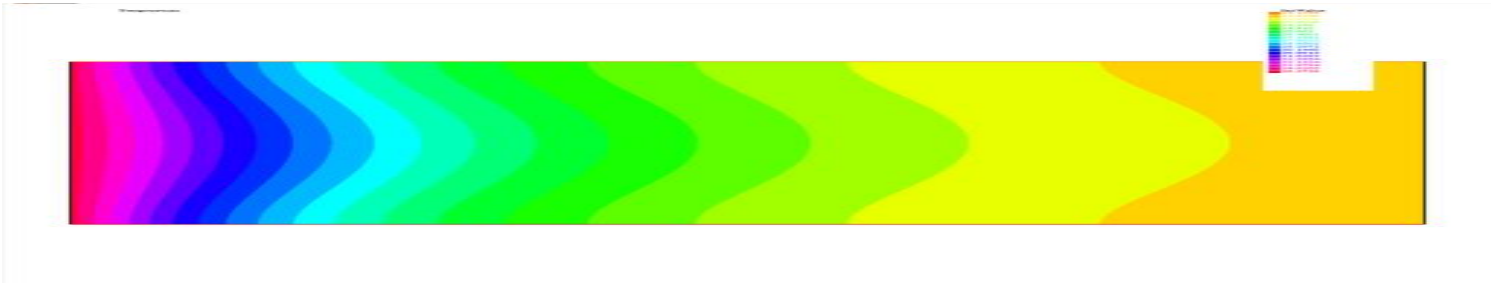
San Isidro, Chile

First questions

- What is the shape of the domain?
- What is the size of the domain?
- What kind of motions systems for the fluid are necesary?
- What is the performance of this cooler system?
- What complementary system is necesary ?
- What is the importance of the environmental temperature?
  - Weather forecast
  - Economic aspect.

Toy model in 1D and V=constant.

$$u_t - \nu u_{xx} + V u_x = \alpha(u_a - u), \text{ in } (0, L) \times (0, T)$$
$$u(0, x) = u^0 \text{ in } (0, L)$$
$$u(t, 0) = u_{in}$$
$$\nu \frac{\partial u}{\partial n}(t, L) = V u(t, L)$$



Prevent evaporation

Crystal Lagoons city

Thank you!