

Modeling and Optimization of refrigeration facilities

H2020 SOCIETAL CHALLENGES: Climate action, environment, resource efficiency and raw materials

Economic sector: Food

PROBLEM DESCRIPTION

Application of mathematical simulation, optimization, observation and control techniques to the improvement of refrigeration systems, which the COFRICO company designs, develops, executes and maintains.

CHALLENGES AND GOALS

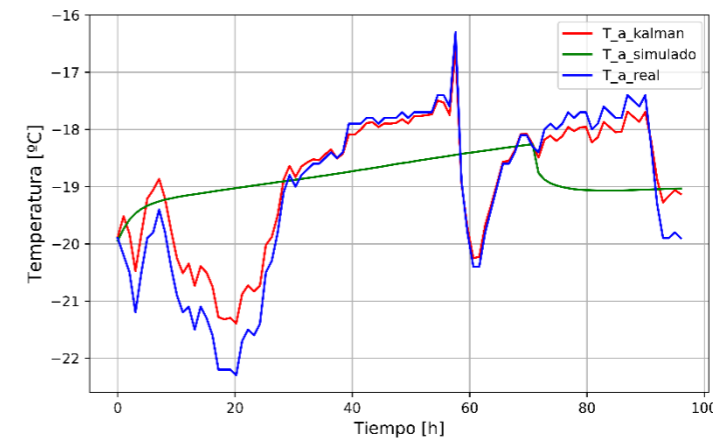
To develop a digital twin to simulate an industrial refrigeration system in which ammonia is used as a refrigerant fluid, building and solving numerically a mathematical model, based on physics and data, of the different elements that compose it.

To optimize the operating conditions of an industrial refrigeration plant through the use of mathematical algorithms and establish the set point that allows this optimal operation.

To develop a system for condition-based predictive maintenance, starting from an estimation of the health status of the system using Kalman filters and using the digital twin developed previously.

MATHEMATICAL AND COMPUTATIONAL METHODS

- ✓ Ordinary and algebraic differential equations.
- ✓ Transient models of the whole refrigeration system.
- ✓ Determination of thermodynamic magnitudes of the refrigerant fluid.
- ✓ Digital twin of a refrigeration plant: simulation of the operation of the plant.
- ✓ Optimal control and predictive control of the installation: establishment of the set point that leads to the optimal operation of the installation.
- ✓ Condition-based predictive maintenance (CBM): use of the Kalman filter.
- ✓ Software: Python.



Air temperature of a single chamber: digital twin results with and without Kalman filter and measurements.

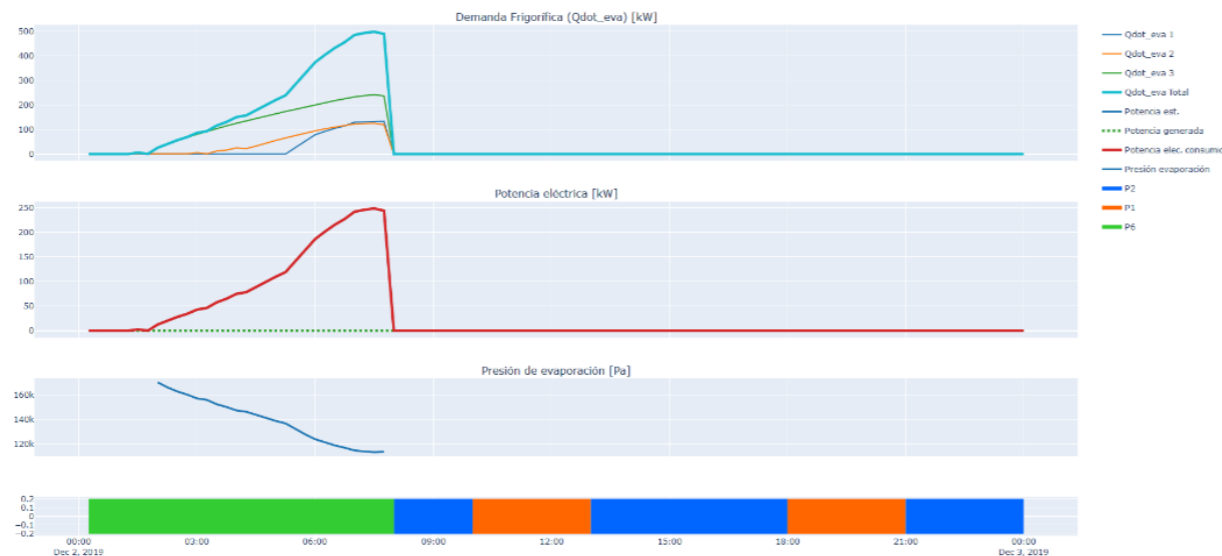
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Results and Benefits

Improvement of the refrigeration systems, minimizing construction and operating costs, but at the same time respecting all requirements and guaranteeing food safety.

More efficient facilities are achieved, with lower operating costs and which also reduce their environmental impact, preserving food safety. The technological innovation that would be being introduced in this company and in the industrial refrigeration sector in general, would bring three improvements or competitive advantages: efficiency, cost reduction and reduction of environmental impact.

The application of mathematical simulation, optimization, observation and control techniques allow to achieve more efficient refrigeration facilities, with lower maintenance costs and which also reduce their environmental impact.



Set point provided by optimal control.

