Modeling & Simulation with EcosimPro at CERN

Benjamin BRADU

CERN, EN-ICE

February 2011
Contents

- A Process & Control Simulator (PROCOS)
- Helium Cryogenics
- Water Cooling
CERN control architecture with UNICOS

Data Server
SCADA (PVSS)

Supervision
controles
(PVSS)

Supervision
Layer

Réseau technique Ethernet / MOD ou S7

Control
Layer

Field
Layer

Cryogenic Process Simulator (CPS)

PLC
Schneider

Unity
(Simatic WinLC
simulator)

Simatic WinLC
(Simatic WinLC
simulator)

I/O (Field bus)

I/O (Field bus)

EcosimPro
algorithm

C++ application

C++ class
EcosimPro
model

OPC client

Process model (EcosimPro)

Real process

C++ application

EcosimPro
algorithm

C++ class
EcosimPro
model

OPC client

Process model (EcosimPro)

Real process

C++ application

EcosimPro
algorithm

C++ class
EcosimPro
model

OPC client

Process model (EcosimPro)

Real process
Helium Cryogenics

- A dedicated EcosimPro Library for helium cryogenics
  - Helium thermodynamic properties on large ranges
  - Materials properties at very low temperatures
  - Usual cryogenic equipments
    - Valves, turbines, compressors…
    - Heat Exchangers, Phase separators, transfer lines…
LHC refrigerator at 4.5 K

- 4.5 K LHC refrigerator
  - Linde 18 kW @ 4.5 K

- Operator training tool

- High Pressure control optimization (IMC)

- New control strategies to reduce operation costs (floating pressure)
Example of a model in EcosimPro

Linde 18kW cold-box for the LHC
LHC refrigerator simulations

Cool-down cold-box alone

Stable state reached with LHC (16 kW @ 4.5 K)
Operator Training

- A dynamic simulator for CERN cryogenic plants
  - "Cryo Simulation Lab" available at CERN for TE-CRG (building 36)
LHC refrigeration units at 1.8 K

- Allow to cooldown LHC magnets from 4.5K to 1.8K
- Set-point management optimization for cold compressors

Operator Training Tool

Ligne B : Pompage hélium gazeux très basse pression (3 K / 16mbar)
Central Helium Liquefier

- CERN central helium liquefier (B165)
  - Provide liquid helium for small CERN experiments
  - Commercial Linde TCF 50 – 70 Lhe / hour

VIRTUAL COMISSIONING
- Sequence errors (timers, threshold, etc.)
- Bad calibration of sensors
- PLC-coding errors
- New turbine starting sequence
- PI tuning
Water Cooling

- A dedicated library for water Cooling
- Modeling and simulation of STP18 cooling plant
- Modeling of the future RFQ cooling plant for LINAC4
SF18 model

Virtual commissioning of the PLC programs
Virtual commissioning of the PLC programs
LINAC 4 RFQ Cooling plant Model

Will be used for Virtual commissioning of the PLC programs

Familiarize operators with new control systems under PVSS
To Resume

- EcosimPro allows Process modeling & Simulation
- Models can be linked to CERN control systems using UNICOS

Several applications:
- Virtual Commissioning of control systems
- Safe Operator training tool
- Control optimization for complex processes
- Design of future plants