# Training in an Aspen HYSYS-based Valeraldehyde Virtual Plant

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**Outline**

- The new plant in Perstorp context
- Why we chose to invest in a simulator
- Start-up results, benefits and two control problems

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The Westin Waterfront Hotel | Boston, MA
aspentech | Global Conference

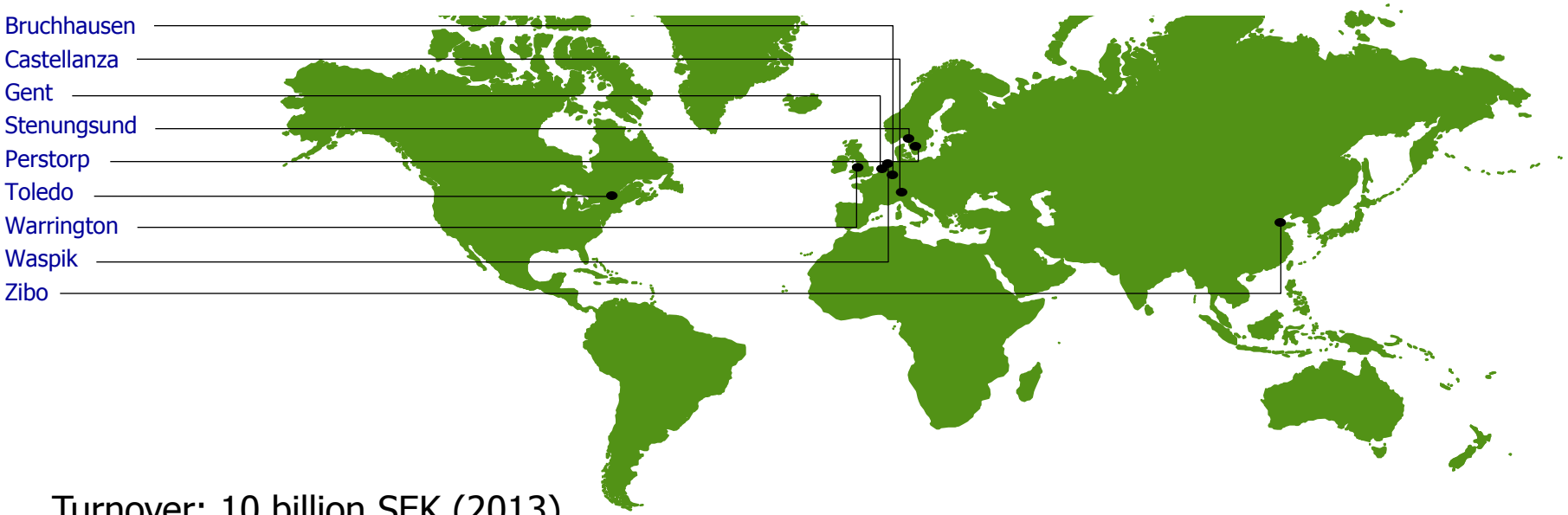
# Lesser known about Sweden

- Sweden is the 3rd largest EU country in land area, after France and Spain.
- As of 2006, Sweden had won 588 (winter and summer) Olympic medals, a feat only excelled by 6 much more populous countries (the USA, the USSR, Italy, France, Germany and the UK).
- As of 2006, Sweden was the most generous country in the world regarding aid to poor countries. It is the only nation where donations exceed 1% of the GDP.

**What do you know about Sweden?**

- Sweden has the highest number of McDonald restaurants per capita in Europe (although that is only about half of the US ratio).
- Sweden is set to become the first country in the world to phase out petrol for biofuel.
- Total taxation in Sweden amount to 54.2 % of GDP, the highest level worldwide.
- The Royal Palace of Stockholm could be considered the world's largest palace still used for its original purpose. With a total area of 61,210 m² (658,850 sq ft), it is slightly larger than the Winter Palace in Saint Petersburg and only a bit smaller than the Palace of Versailles in France. The construction of the Stockholm Palace started in 1697, before Versailles was completed.

# Nine production sites




Turnover: 10 billion SEK (2013)

Employees: 1400 in 22 countries

In total: ~40 plants ~50 000 variables ~4 000 controllers

# Our products enable key properties in a broad range of products

…smooth finish on leather (Bis-MPA)

…durable appliance surfaces (BEPD)

…toe & heel counter reinforcement in shoes (Capa™)

…shatterproof windshields (2-EHA)

…natural freshness in breads & cheeses (Profina™)

…paint made from renewable raw materials and energy (Voxtar™)

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WINNING FORMULAS

…additives that protect grain and grass feed during storage (ProMyrTM and ProSidTM)

…lubricants for air conditioners that do not damage the ozone layer (Penta and 2EHA)

…environmentally friendly and safe drilling muds (potassium formate)

…scratch-resistant coatings for plastics in handheld electronics (Di-Penta)

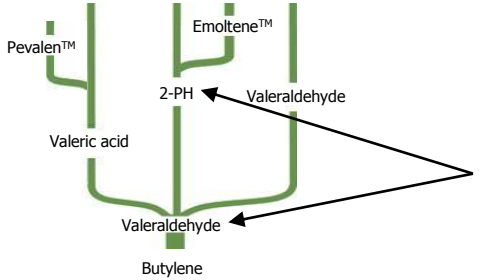
…performance skateboard wheels (Alkoxylate 3990)

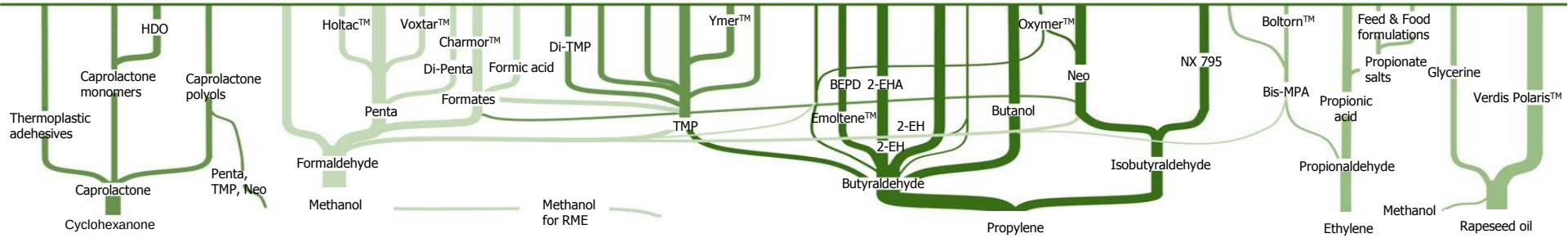
…intumescent coatings to provide safety in public buildings (Charmor™)

# Valerox - two new plants

Perstorp works with four main manufacturing platforms, in which we have operational leadership: **oxo products, polyalcohols, caprolactones and RME (Rapeseed Methyl Ester**).

**Valerox** provides us with a new product tree



# Operator Training Simulator (OTS) for the Valeraldehyde plant

**Two plants to start-up**

- Valeraldehyde: Green-field plant (Perstorp in-house design). With OTS.
- 2-PH: Modifications to an existing plant. Without OTS.

**Background Valeraldehyde plant**

- Green-field design → More than usual validation expected
- Project advanced 3 months → very little time for plant validation
- Take-or-pay contract with supplier (due to investments on their side as well)

**Objective**

- Timely start-up
  - Meet high market demands
  - Avoid penalty (take-or-pay contract)

# Direct-Connect OTS

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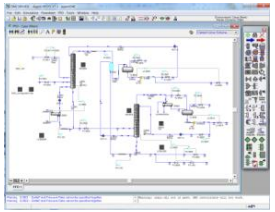
REAL WORLD

OPERATOR TRAINING SYSTEM

Real Plant



HYSYS
Dynamic
Model

AIs, DIs

AOs, DOs

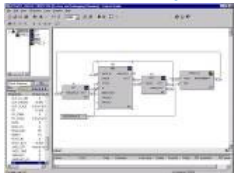
AIs, DIs

OPC

AOs, DOs

Experion
Control
System
Hardware

DOWNLOAD
XML DATABASE



Experion
Software
emulation

Experion
Operator
Console

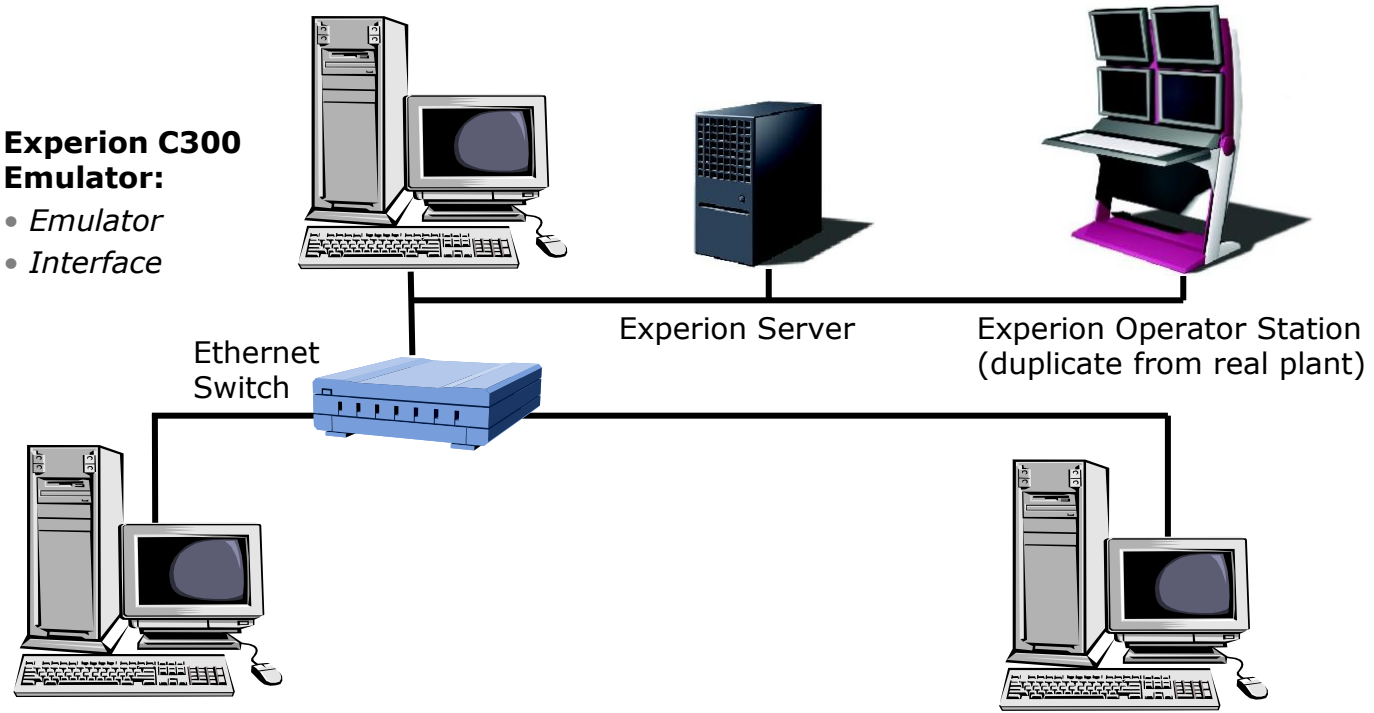
DOWNLOAD
html GRAPHICS

Experion
Operator Console

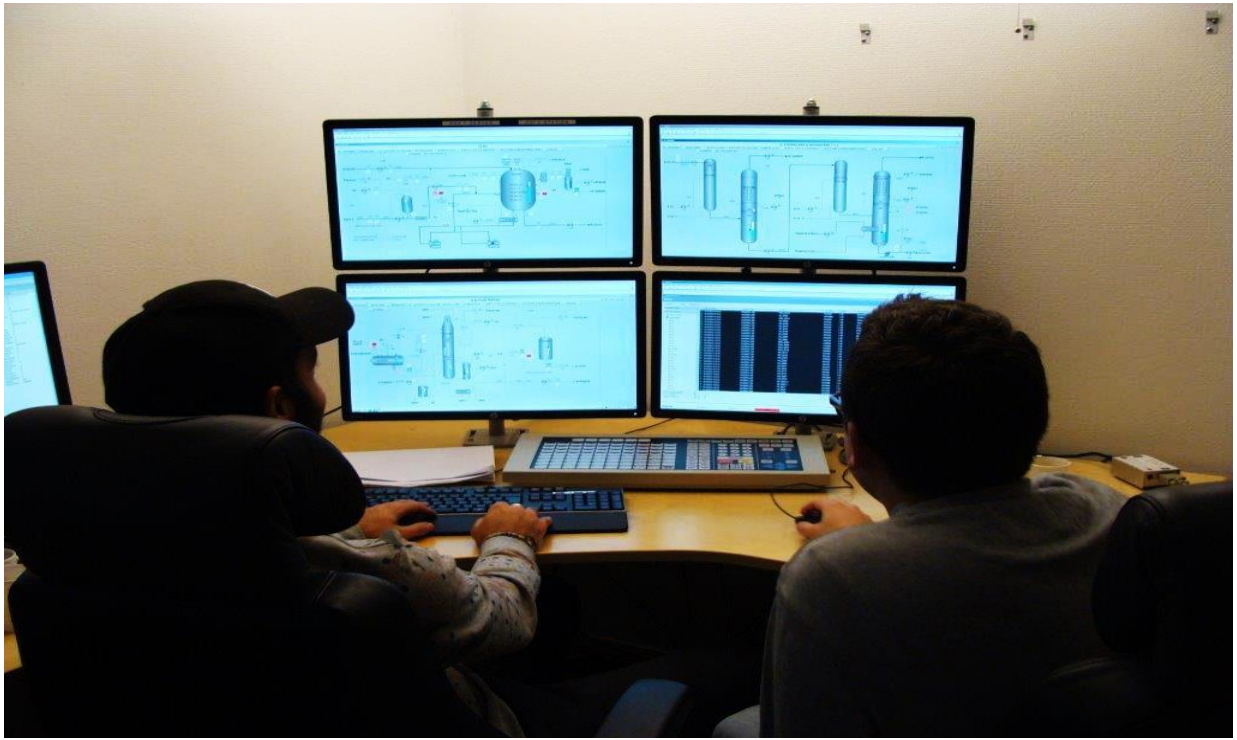
Instructor
Station

# Operator training simulator

**built together with Inprocess Technology and Consulting, Spain**

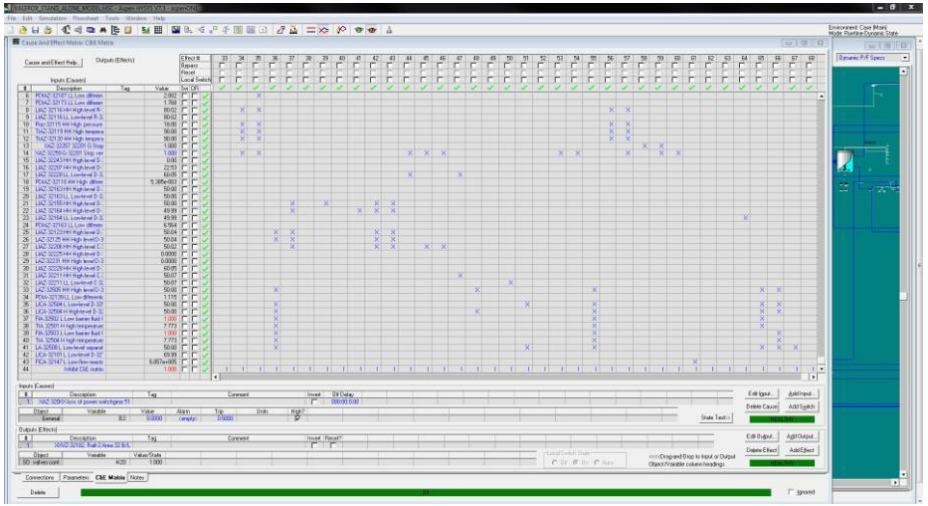


# Operator station, replica from real plant



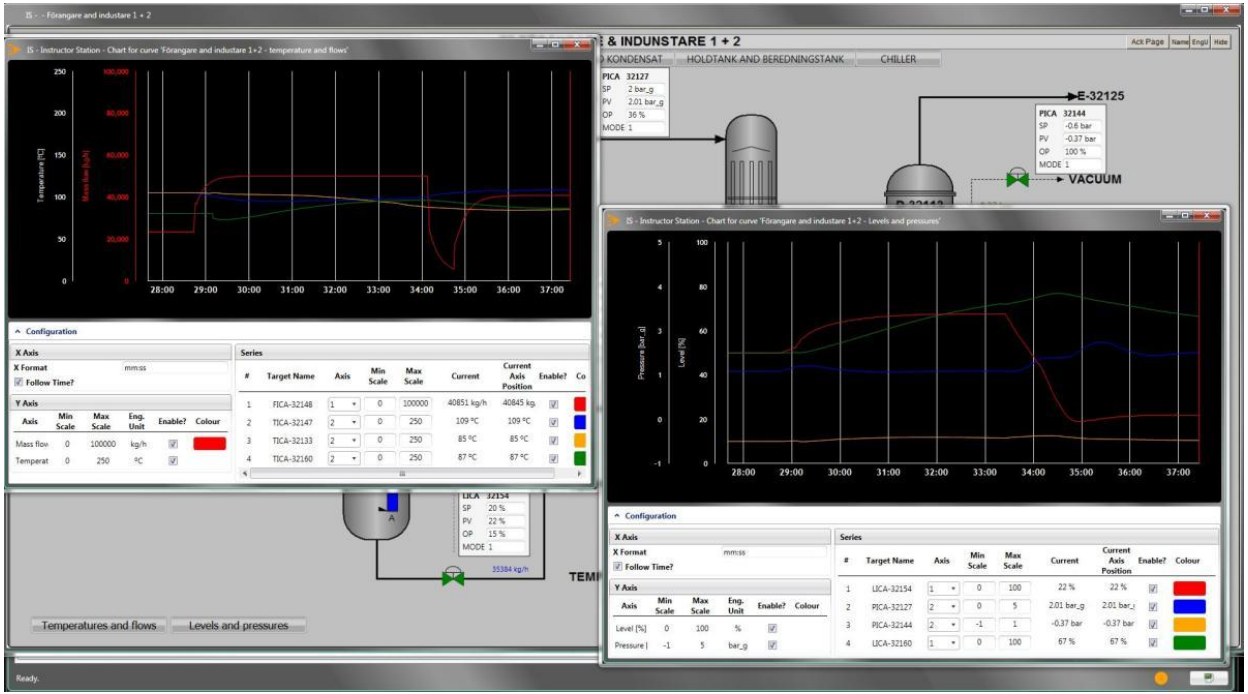
# HYSYS Dynamics model

- The Valerox-plant design was developed by Perstorp using Aspen HYSYS with Aspen Properties package.
- The reactor includes 12 equilibrium reactions with their kinetics parameters. It also include the agitator influence in the reactions.
- The HYSYS Cause&Effect Matrix was used to model the basic logic of the SIS. Additional logic associated to the outputs was coded in HYSYS spreadsheets.



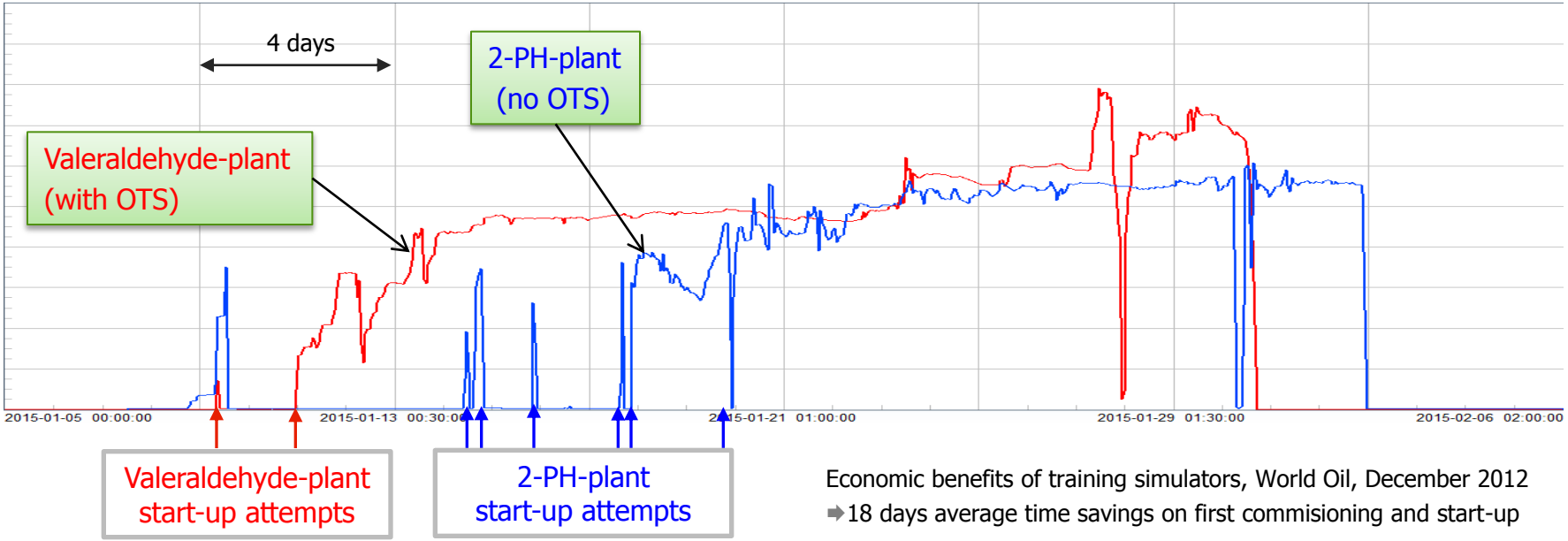
# Instructor Station

- The OTS used the Inprocess Instructor Station (IIS) software to provide all the instructor functionality and to manage all the communications with the HYSYS model, the Experion emulator and IIS



# Comparison of the two startups

- Valeraldehyde plant start-up stable (after initial hardware troubles)
- 2-Ph-plant rockier start-up (some hardware issues, but also programming)



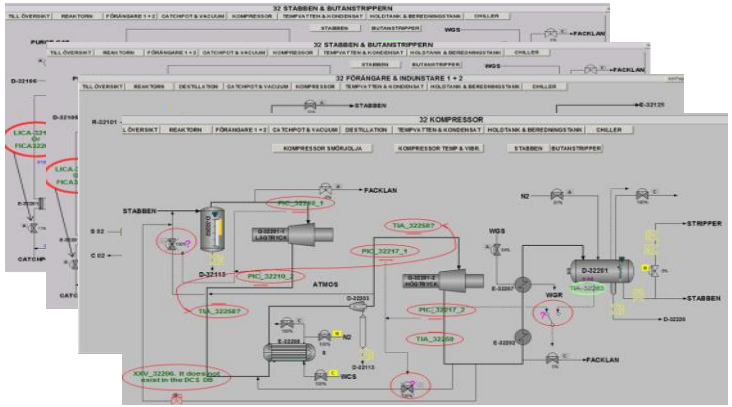

Economic benefits of training simulators, World Oil, December 2012

- 18 days average time savings on first commisioning and start-up

# Benefits from operator training simulator

**Simulator contributions**

- Process validation (sizing, layout, control philosophy)
- Control system validation (c&e matrix, graphics displays, pre-tuning)
- Operator training (process familiarization, startup-training)



”The OTS gave us confidence that the plant design would also work dynamically; the first stable simulation was a great relief”

– Mattias Kindstrand, lead process engineer

“It’s important that it is very realistic, so it looks exactly like the environment where the process operators will work in the actual plant”,

- Project leader Johan Rönnberg.

# Outcome from operator training simulator

**Simulator contributions**

- Operator training (process familiarization, startup-training)

"There are scenarios in a plant that can't be practiced, or is very hard to practice – shutdowns, hazardous scenarios, new operating points and start-ups for instance. With the help of a simulator, this is made possible",

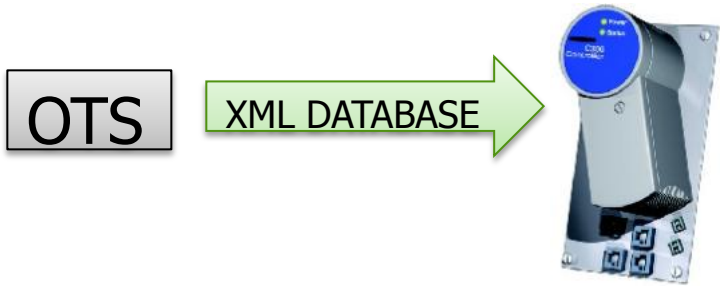
Project leader Johan Rönnberg

"I got really upset when I first ran the simulator. The reactor was creeping – this cannot be true I thought! Now I know, the reactor is actually this slow…"

– Mathias Molldén, process operator

# DCS Database review

- During 4 weeks all the DCS database was integrated with the model. Perstop´s Automation contractor was involved during this phase in the Inprocess Offices to gather all DCS code corrections:
  - Instrument ranges
  - Feedforward controller
  - Identify controllers issues
  - Improvement of Cause&Effect Matrix
  - Alarms setting
- After all integration and corrections, the post-SAT OTS control system database was exported in xml format and used for the real Experion C300 controllers and plant startup.



# Simulator indicated control problems Compressor intercooler

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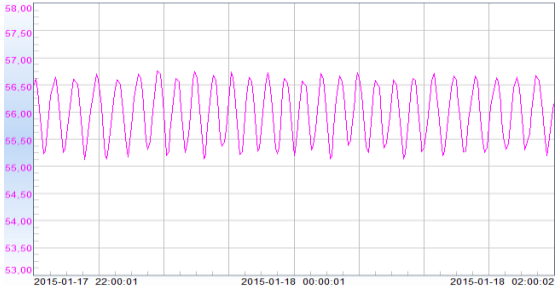
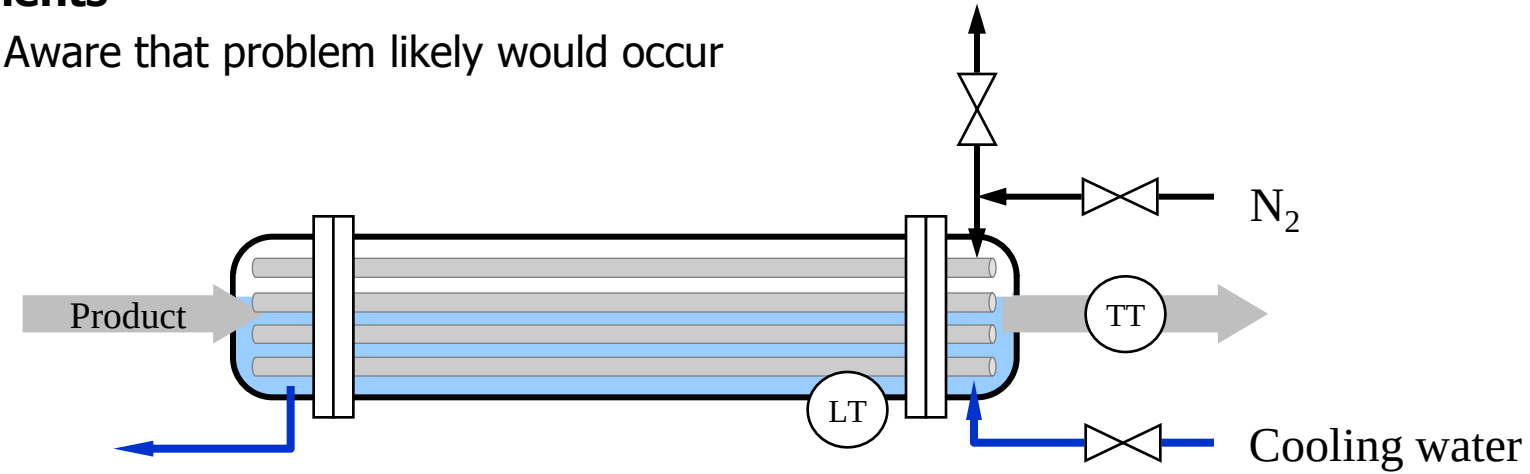
**Observation in simulator**

- Unstable operation in simulator
- Unstable operation in reality




**Benefits**

- Aware that problem likely would occur



# Used for dynamical analysis

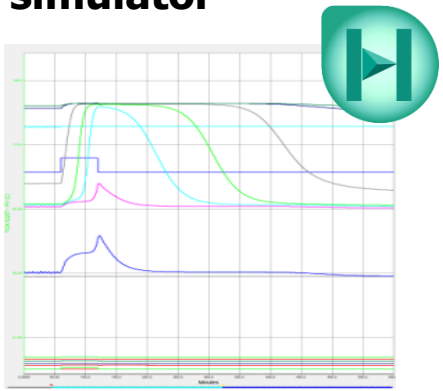
## Stabilizer Column

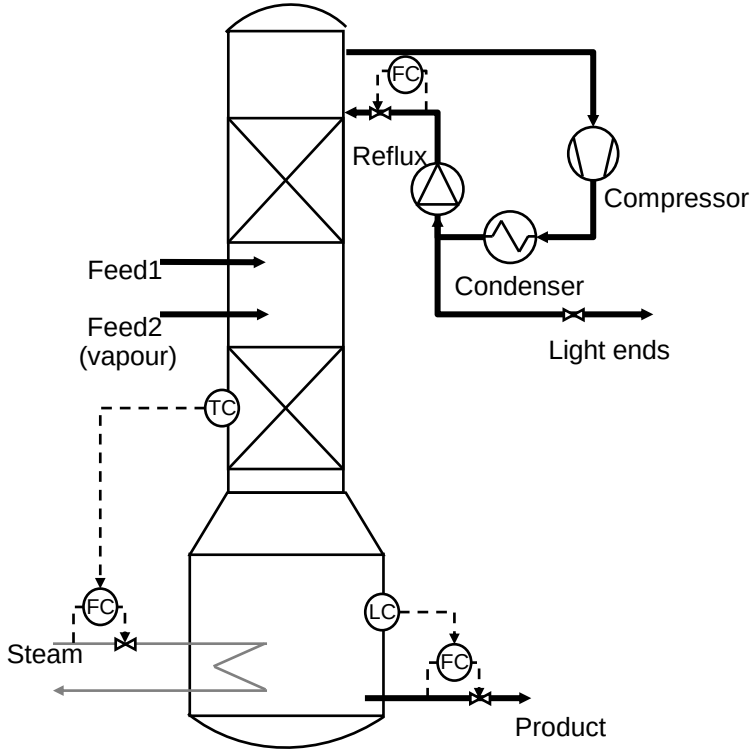
### Challenging because of

- Sharp split (100 C boiling point difference)
- Light-ends require compressor to condense
- Feed2 is vapour

### Extracted relevant part of simulator

- Performing dynamical analysis





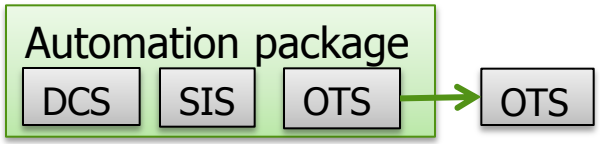

### Benefits

- Many process control concept iterations with Inprocess; timely!

# Freedom to choose

If the process and the control system can be verified deeply with simulation,

Why there are still plants that only use the OTS for Operator Training or don´t even consider an OTS?




➡Some Operating Companies are unable to separate the OTS from the "Automation package" scope

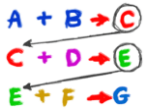

➡Some Operating Companies don´t know how to request an OTS

➡With Inprocess, Perstop was able to request a custom OTS using their Aspen HYSYS simulation platform based in their specific process and schedule constraints

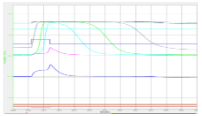
# HYSYS added value

Using HYSYS as the simulation engine of the OTS brought the following advantages:

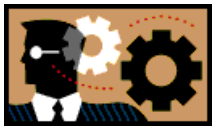

1.- Used same simulation platform that was used for plant design (known software, trustable thermo, data consistency, faster execution)




2.- Scalable rigor. Allows to increase/decrease the number of reactions/components. Ultimately as plant design model.



3.- Truly process dynamics verification. Since model is built from Equipment data it will reveal the same potential issues of real plant.



4.- Engineering analysis. Model can be used by plant engineers to reproduce/analyze plant issues and develop improvements.

5.- Robust and Powerful software. Can handle large models in multiple realtime without decreasing the rigor.

# Summary

**Valerox start-up with operator training simulator**

- Comparison with/with-out operator training simulator
- Benefits of virtual validation
- Two pin-pointed control problems

- Remarks? Questions?