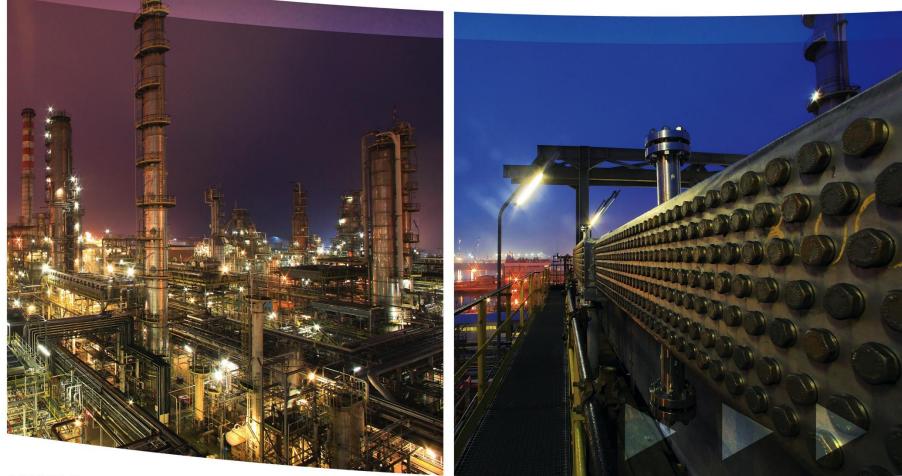


1-3 June 2015 | Jumeirah at Etihad Towers | Abu Dhabi, UAE







┽┝ CEPSA 西石油

Operator Training Simulator for a new Cumene & Phenol plant

Manuel Pedraza, Pierre Lahaie, Zhen Li (CEPSA Chemical Shanghai) JoseMaria Ferrer, JoseMaria Nougues, Rodolfo Tona, Carlos Alcoverro (Inprocess)



Outline

- Piloting a process plant
- Project background
- > Why OTS investment
- ➤ The OTS
- ➢ OTS value





Piloting a process plant

If your process plant were the Saturn V, your panel operators will be the astronauts



Now, think about the training hours of an astronaut





Process plant vs. Saturn V

	Ethylene plant	Saturn V			
Throughput	800 kty ~ 90 t/h of Naphta	1 st Stage burns 14200 t/h (Kerosene) with 32200 t/h Liquid Oxygen			
Working time	~ 50 years	4 hours, 20 minStage-1 about 900 instruments, Stages 2&3 ¿?Per launch: \$494 million in 1964–73 dollars (~\$3 billion today)~ 20 faceplates in Command Module			
Instruments	~ 5000 AI/DI				
Cost	~ 1.5 Billion\$				
PID loops	~ 800 loops in ICSS				
Training time before launch	3-9 months	Two years for Apollo missions (they are test pilots before)			
OTS cost	0.8 – 1.2 Million\$	All simulators > 50 million\$			

OTS is a multiplier of every hour invested in training

Source: https://www.hq.nasa.gov/alsj/NASATND7112.pdf





Project background

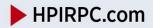


CEPSA Chemical Shanghai ("CCS") is building the new Cumene and Phenol plants in the Shanghai Chemical Industry Park (SCIP), with a capacity to produce: 250kMt of phenol and 150kMt of acetone

CCS is using OTS to reinforce the training for all the operation staff, with plenty of scenarios, to improve the economical operation of the plant, such as normal operations, start-up and shutdown, equipment malfunction and emergency conditions.

Inprocess Technology and Consulting Group ("Inprocess") has rich modeling and project experiences for OTS (Operator Training System).

www.youtube.com/watch?v=NJxIXR3ZAKs





Why OTS investment

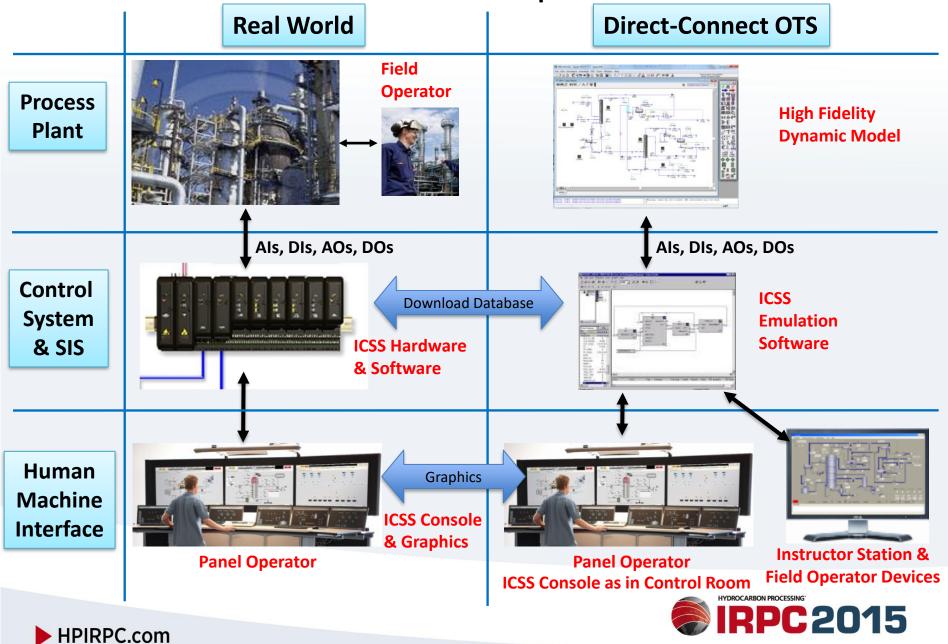
The OTS overall objectives were:

- Train the Chinese operation staff on the process and the DeltaV system in Shanghai.
- Train the support Spanish operation staff on the DeltaV system in Huelva (Spain).
- Reduce the risk of major operational incidents
- Reduce start-up time
- Increase plant on-stream time and performance
- Verify Process Control System (PCS) operation
- Verify Safety Instrumented System (SIS) operation
- Avoid equipment damages
- Provide a test-bed system for engineering analysis

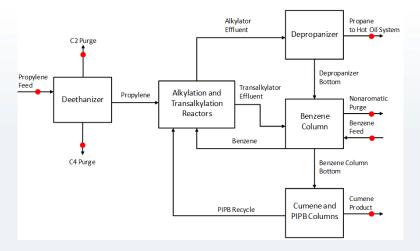




The OTS: Concept



The OTS: Model Scope



Simulation Scope Cumene

60

20

91

132

62

41

204

2000

Equipments:

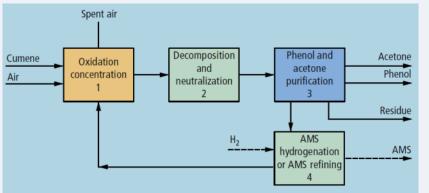
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- Isolation valves:
- Control valves:
- Relief valves: 20
 - PID loops: 90
- I/O Count: 1000

Component List-Cumene					
H2O	Benzene				
Methane	Toluene				
Ethylene	E-Benzene				
Ethane	Cumene				
Propene	n-Pbenzene				
Propane	AMS				
Cyclopropane	i-BBenzene				
Propadiene	m-Cymene				
M-Acetylene	p-Cymene				
1-Butene	1-E-4-iP-BZ*				
i-Butene	13-iP-BZ				
i-Butane	n-Hexyl-BZ				
13-Butadiene	135-iP-BZ*				
n-Hexene	DiPhenylC3				

Component List-Phenol



Simulation Scope Phenol

- Equipments:
- Isolation valves:
- Control valves: 210
- Relief valves:
 - PID loops:
- I/O Count:

H2O diAcetone-ol BZoicAcid Hydrogen Nitrogen o-Cresol m-Cresol Oxygen Methane p-Cresol CO M-PH-Ketone Formaldehyde 2MBenzoFuran FormicAcid AMS Methanol Cumene Oxalic Acid DMPHCarbinol AceticAcid CumHyPeroxid Propanal o-Cymene Acetone m-Cymene Acetol p-Cymene Benzene pCumylPhenol Phenol **DCumPeroxide** H2SO4* Mesityloxide 3Mcycpentene

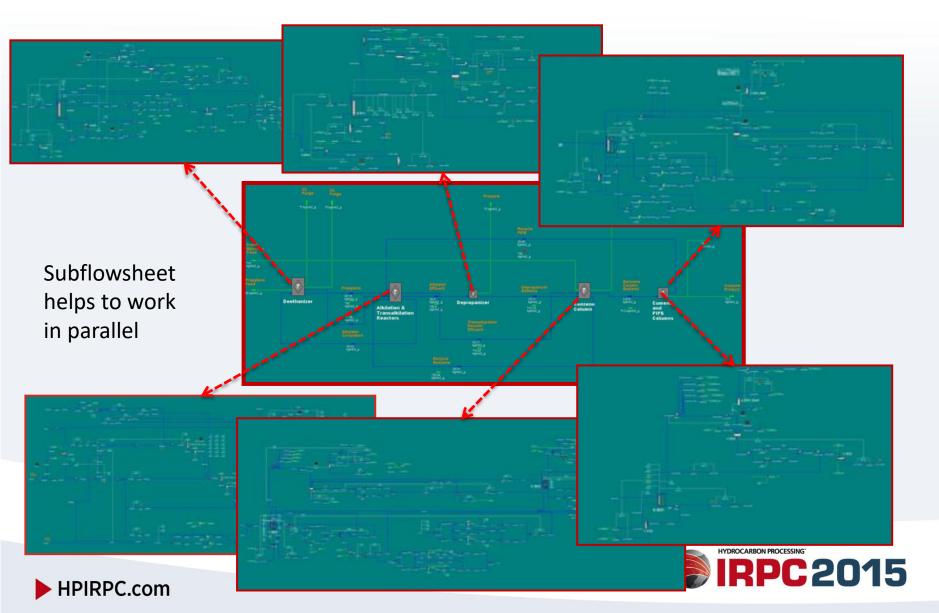
Challenge

Multiple chemical reactions, many separation units (18 distillation columns) and large recycles

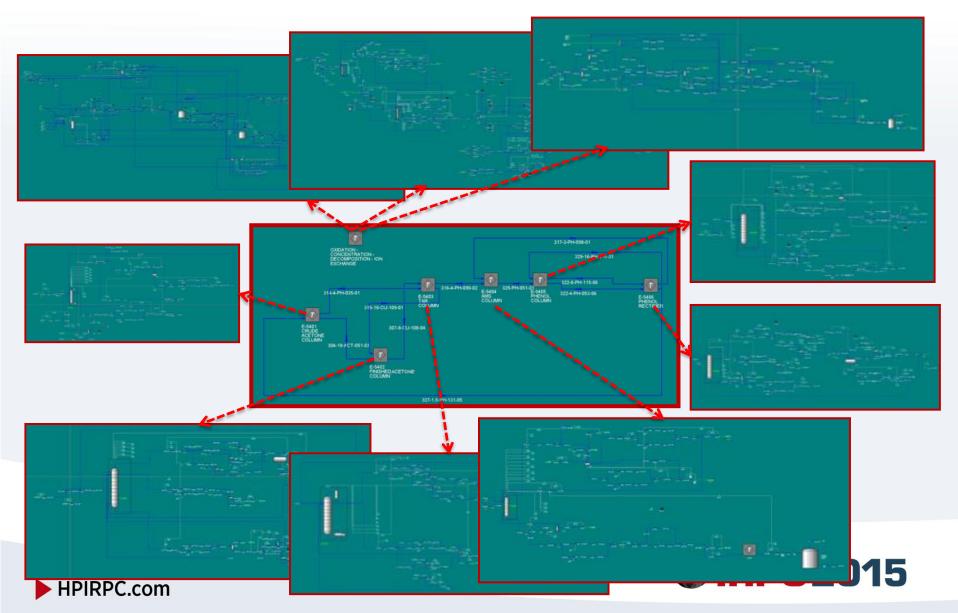




Cumene HYSYS Dynamics model



Phenol HYSYS Dynamics model



The OTS: modeling highlights

Reactor Dynamics

The HYSYS CSTR reactor was used with rigorous kinetics. Reactors parameters and kinetics constants were adjusted to obtain accurate dynamics.

Hydraulics Effects in Reactor Dynamics

Compressors push air to the bottom of the Oxidizers and the liquid mass is in suspension, but HYSYS CSTR is an ideal homogenous reactor. These dynamics were modelled, therefore when compressor trips the Oxidizers levels are affected.

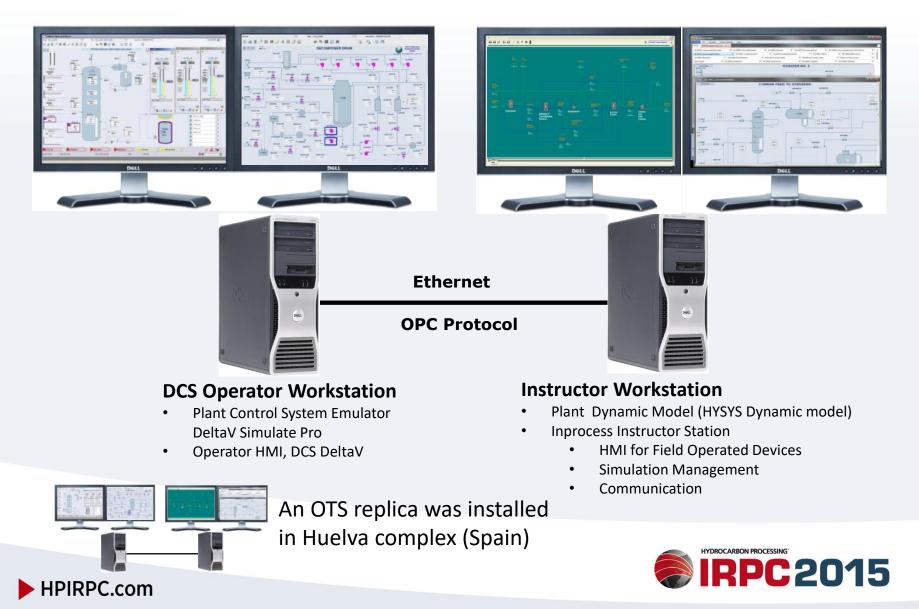
Calorimeters DeltaT

They are the sensors of the reaction. They were calibrated with the same dynamics that the existing Huelva (Spain) plant was providing.

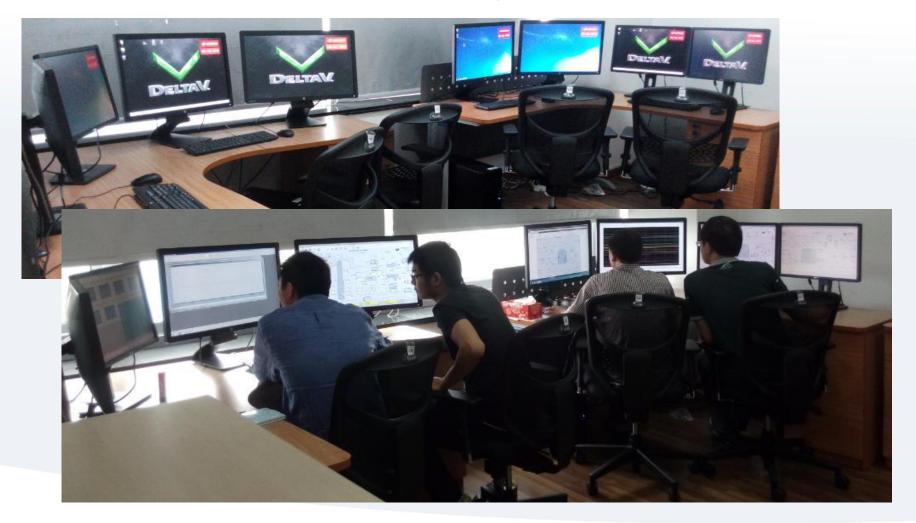




The OTS: Architecture



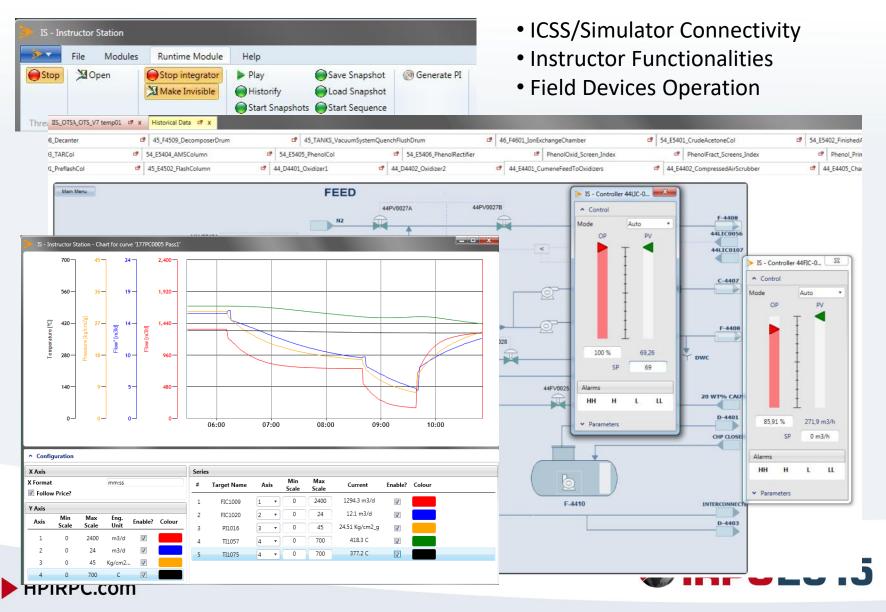
The OTS: DeltaV Operate







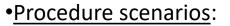
The OTS: Instructor Station



The OTS: Scenarios

50 scenarios were developed:

- Operational scenarios:
 - change utilities conditions
 - change in raw material quality
 - throughput changes



Start-up

Shutdown

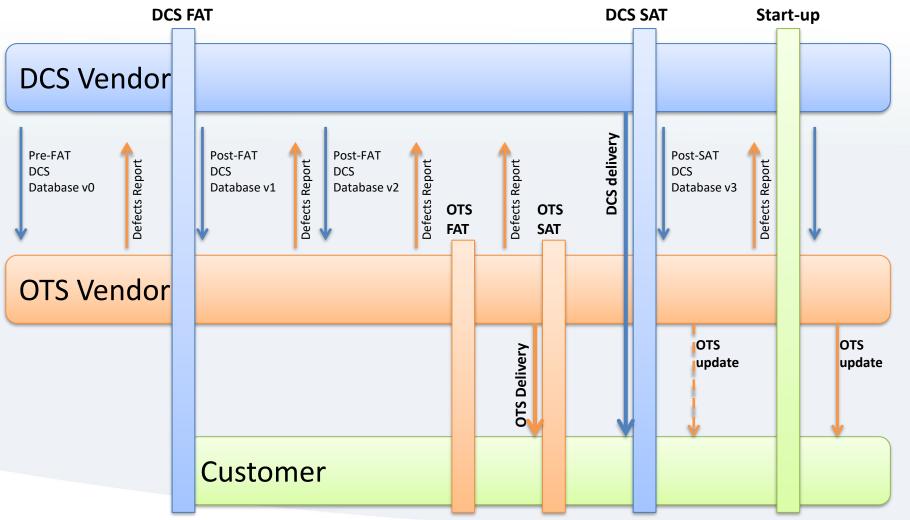
- Safety Scenarios:
 - Equipment power loss
 - Instrument air failure
 - Critical utilities loss

- Equipment failures and malfunctions:
 - Column steam failure
 - Exchangers fouling
 - Instrument failure





OTS value: Debug ICSS code



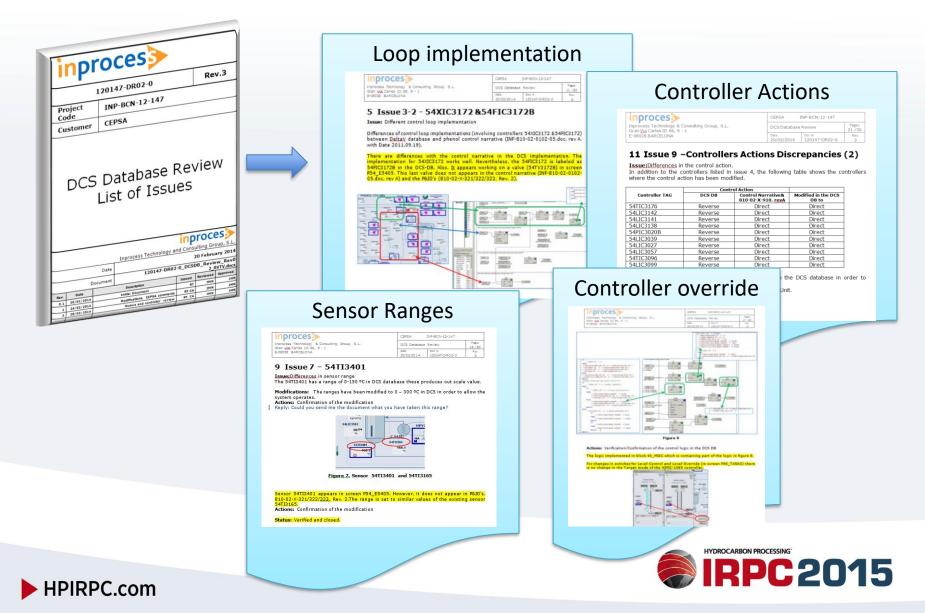
HYDROCARBON PROCESSING

RPC2015

Important: OTS Vendor acts as a truly independent auditor of the ICSS functionality



Examples ICSS database review



OTS value: Operator Training

 46 operators has been trained: 1998 hours in total, training table sample

1. GET FAMILIAR:

With the process With the procedures With HMI navigation and controls

2. IMPROVE:

Operation and safety procedures Uniform skills levels in all operators Rational thinking Time to react

3. RESULTS:

Increased Safety Reduce Start-up time Off-spec reduction

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OTS value: Operating range

In the Shanghai petrochemical area, there were several alternative providers of feed propylene, each with different grades and other distributions of Lights and Heavies components.



CEPSA Operations requested to investigate the process operating constraints (valve saturation, duty limits, impurities accumulations) with different streams compositions of propylene feed.

The model proved that, making certain SetPoint adjust, other propylene grades were able to be handled by the plant.





OTS ownership

There is one important aspect when Operating Companies decide to invest in OTS:

The OTS itself does not do the training and knowledge transfer

The Operating Company needs to design the operator competency program making use of the OTS as an integral tool of the training programs.



Like NASA does with astronauts



Like Airlines do with pilots



Like Mercedes does with Hamilton

Inprocess helps to design and complement those training programs with the use of the OTS. Resources and workflows need to be defined and **<u>budgeted</u>**.



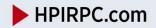


HYSYS as OTS engine

Using HYSYS Dynamics as OTS simulation engine has some advantages:

- 1.- It is a known software inside CEPSA and most of the engineers are familiar with it
- 2.- It can increase the rigor as needed, depending on training objectives
- 3.- It is flexible enough to develop custom items (spreadsheet, UserVar, Extensions)
- 4.- It is powerful enough to handle >5000 I/O tags/sec in realtime in one PC.
- 5.- Models can be taken from the OTS to run other operations/eng. studies
- 6.- It is easy to maintain for typical changes (new instrument, new valves, loop changes, etc)





Conclusions

OTS improves the ICSS testing and debugging

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OTS could reduce the major operational incidents

> OTS is a good platform to evaluate operation skills of operators and to uniforms the operators skills

> OTS is a suitable tool to validate raw material planning decisions

> HYSYS-based OTS secures reusability of the process model

> OTS was executed within time and budget; OTS team was adaptive to the EPC and ICSS schedules.

➢ This was the first high fidelity HYSYS OTS in CEPSA; as a result CEPSA is considering OTS for new and existing plants. CEPSA is executing the 3rd training simulator with Inprocess.



Q&A, contact

Thank you

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