DYNAMIC SIMULATION:
A TOOL FOR ADVANCED PROCESS CONTROL STRATEGIES AND DESIGN

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TECHINT GROUP OF COMPANIES

- Revenues of the six main companies in 2016: 15.2 billion USD
- 48,500 permanent employees in 2016
• We carry out **EPC projects** and engineering services, construction and EPCM
• We understand the needs of our industrial customers in the **oil & gas, power, mining, infrastructure and steel markets**, providing them with best-fit solutions
• Our organization adds value to our undertakings by drawing on both a **global vision** and a **local presence**
• We have a strong **commitment to the safety** of our people and to the **quality of the delivery**
DElivering Results

+450 pipelines, totaling +70,000 km installed
450 O&G plants and units
+1,000 petrochemical and chemical plants and units
+12,000 MW in combined cycle power plants
+7 million kVA in electrical substations
+23,000 km of power transmission lines

70 years in the oil & gas, energy and mining
1.8 million engineering man-hours per year
67 million construction man-hours per year
3,500 projects successfully completed worldwide
Dynamic Process Simulation is available in common commercial softwares for more than 10 years.

Dynamic simulation is the best tool when time-transient conditions/operations directly impact on a process system design and configuration.

Main use in consolidated and specific applications:

- Flare systems verification.
- Fast depressuring
- Emergency depressuring system
- Compressor’s anti-surge systems
- Flow assurance studies
Synergy between Process and Instrumentation and Control:

- Instant validation of Control Philosophy and Interlocks Logics
- Test and Set-up of sequence events
- Selection of the right PID parameters

Thus leads to:

- Reducing overdesign resulting in optimized CAPEX and OPEX.
- Reducing operating risks related to unexpected system behaviour.
- Allowing control system offline tuning thus reducing risks of damage during start-up.
- Reducing duration of commissioning and start-up.

Different approach; working with dynamic process data instead of classic static ones (max, min, normal).
CASE-HISTORY 1 - KEEP PUMP OPERATIONS UNDER CONTROL

HIGH PRESSURE PUMP OPERATING SCHEME IN LNG PLANT

Spherical Tank

BOG Compressor

Recondenser

In-Tank Low Pressure Pumps

Booster Pumps

High Pressure Pump
CASE-HISTORY 1 - KEEP PUMP OPERATIONS UNDER CONTROL

OPERATING PROBLEMS

Existing control system lacked of flexibility and control capability when dealing with sharp flow variations.

Sharp Variation of flowrate at:
- Pressurization line opening
- Rotational speed increase steps

Causing partial emptying of pump pot and near-dry operation with bearings damage.

From 30 barg to 105 barg

Reduced bore (till 30 barg)
CASE-HISTORY 1 - KEEP PUMP OPERATIONS UNDER CONTROL

STUDIED SOLUTION

Control system was improved by:

- Addition of an RO to limit flow rate during pressurization phase
- Addition of a new control valve (CV2) to limit pump flow rate during rotational sped increase steps
- Proper tuning of Control Valves for fast response

Dynamic Simulation was used for:

- Sizing the RO
- Selecting the best CV and the characteristic curve of the maximum flow valve CV2
- Selecting the right sequence timing
- Proper tuning of Control Valves before commissioning phase
Dynamic model of HP Pump and relevant control system was used to verify:

- Behaviour of the system during the transient conditions
- Define proper tuning for Control Valves
- Reproduce the pressurization procedure and verify the real expected behavior of pump and control system
CASE-HISTORY 2 — IDENTIFICATION OF CONTROL VALVES SIZING

GENERAL SCHEME

Refinery
Reformer Catalytic section

Main Products:
- GASOLINE
- LPG
Butterfly Valve (manual now fully open)

Butterfly Valve (max closure 40%)
due to surge of compressor
But we increase the delta P with the surge problem at the compressor.
CASE-HISTORY 2 — IDENTIFICATION OF CONTROL VALVES SIZING

SIMULATION

Solutions:
1. Adding another small bypass
2. Changing the type of valve from Equal Percentage to Butterfly and updating of PID parameters
3. Changing compressor
4. Adding an antisurge valve to the compressor

ΔP circuit (till 1100 mbar)
CASE-HISTORY 2 — IDENTIFICATION OF CONTROL VALVES SIZING SIMULATION

**New ΔP circuit (till 150 mbar)**

<table>
<thead>
<tr>
<th>Manual Balancing Valve</th>
<th>New Control Valve</th>
<th>Gas Control Valve Flow (kg/h)</th>
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<tr>
<td>Gas Flow to Reboiler (kg/h)</td>
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<tr>
<td>Manual Balancing Valve 1</td>
<td>100</td>
<td>11</td>
</tr>
<tr>
<td>FV</td>
<td>60</td>
<td>101</td>
</tr>
<tr>
<td>TV</td>
<td>75</td>
<td>110</td>
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**ΔP ~170 mbar**

New butterfly Valve

Manual Butterfly Valve
Unit belongs to the lube oils cycle. Its purpose is to remove paraffins from lube oils by extraction with MEK.

Paraffines dissolved in MEK are recovered through refrigeration of the mixture of feed and solvent, crystallization and final filtration in a vacuum rotating filter.

The large compressor (3.5 Mw) of the refrigeration cycle is currently operated by a steam turbine allowing very smooth start-up. Replacement of the steam turbine with an electric motor has been planned.

Dynamic simulation was used to check the impact of the sharp start-up transient (8 seconds) on compressor and refrigeration cycle operations.
CASE-HISTORY 3 - REPLACE A STEAM TURBINE WITH AN ELECTRIC MOTOR

STUDIED SOLUTIONS

FIRST STEP: build the dynamic model and reproduce the steady state operating data (model tuning phase)

FIRST SCENARIO

START-UP FOLLOWING GENERIC SHUTDOWN

- Developed for both steam-turbine and electric-motor case
- Detected Accumulator Level falling down fast when electric motor is considered
- Suggested use of VFD with FLOW controller (new set of PID parameters)

Liquid entrainment during SU – Electric motor

- Flow rate: m³/h
- Accum. Volume: m³

Liquid entrainment during SU – Steam Turbine

- Flow rate: m³/h
- Accum. Volume: m³
CASE-HISTORY 3 - REPLACE A STEAM TURBINE WITH AN ELECTRIC MOTOR

STUDIED SOLUTIONS

SECOND SCENARIO

**INTRODUCTION OF 3 THROTTLING VALVES ON THE SUCTION LINES**

- Developed for electric-motor case
- Start-up current reduced by presence of throttling valves. Smaller driver.
- Detected a reduction of liquid entrainment during restart following generic shutdown
- No impact on liquid entrainment during restart following shutdown due to HH liquid level in First KOD
- Compressor operating trail during start-up moved very close to surge line if throttling valves are closed
CASE-HISTORY 3 - REPLACE A STEAM TURBINE WITH AN ELECTRIC MOTOR

STUDIED SOLUTIONS

SCENARIO REVEALED DURING DYNAMIC SIMULATION

SHUTDOWN PREVENTION BASED ON VAPOUR LINE TEMPERATURE

- Developed for electric motor case
- Detected sudden temperature drop in vapour line to First KOD well in advance to level shutdown
- Use the Vapour line temperature as a preventive alarm (20 minutes)
- Setting the right PID parameters for flow regulation

VFD

ALARM

Reboot from HH liquid level in First KOD

Vapour line temperature °C

HH level shutdown

Preventive temperature drop

Liquid accumulation start
Q&A

Thank You!