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MARIE CURIE ACTIONS

Energy-SmartOps

Integrated Control and Operation of Process, Rotating Machinery and Electrical Equipment

Control systems for centrifugal compressors with an emphasis on CO_2 compression

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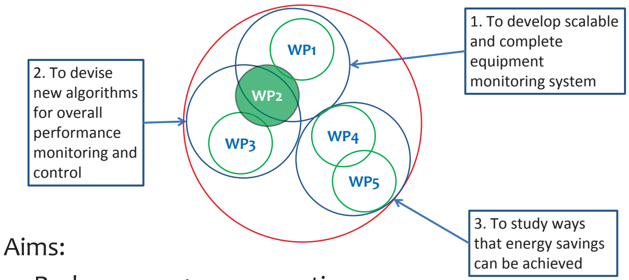
My project in SmartOps

Energy SmartOps: energy savings from smart operation
WP2: integrated automation for energy saving



Aims:

- Reduce energy consumption
- Increase overall stability of the system

Problem statement

In the gas compression industry the control of the compressor has a key role in affecting the performance of the machine and its operative cost. The antisurge controller is the part of the control system that protects the compressor against surge. However the surge phenomenon is not well understood yet and therefore wide safety margin is usually adopted.

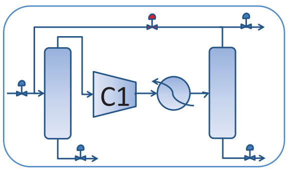
This lack of confidence of the design engineer is due to his difficulty in fully understanding the dynamic behaviour of the machine, especially when it is inserted in the broad and unsteady context of a process plant.

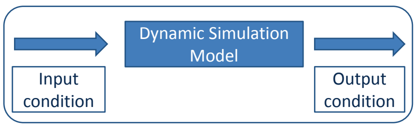
The necessity of further analysis in this area is evident.

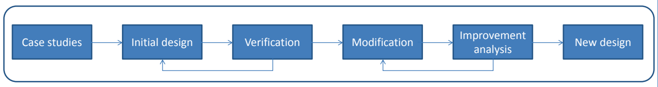
Methodology

Dynamic simulation of the system under different plant loads such as:

- Low P_S (suction pressure)
- High P_D (discharge pressure)
- Low V_{IN} (inlet flow rate)



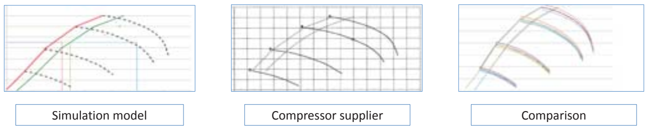




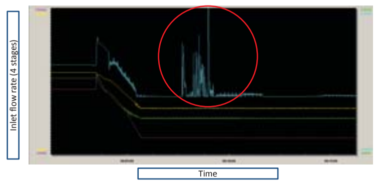
Results

Initial design:

- Input data from case study, courtesy of ESD Simulation Training Ltd.
- Verification



- Shut down: what happens to CO_2?

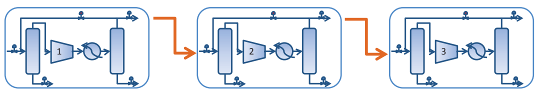


- Normal operation: CO_2 from subcritical to supercritical phase
- Shut down: from supercritical to subcritical phase

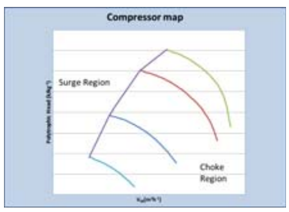
Conclusions

- Compressor: the operating range varies between surge and choke point. However industrial conservative approach places constraints on the lower limit. A better understanding of the problem can widen the operating range
- Process: the presence of a recycle loop protects the machine but affects the overall stability of the system. It is essential to examine this trade-off
- Carbon dioxide: the phase transition (subcritical to supercritical and vice versa) affects the volumetric flow rate and therefore the sizing of the plant.

Future Work



- Sensitivity analysis varying boundary conditions
- Analysis of a multistage system (series of compressors)
- Implementation of multiple speed map
- Modification of the basic layout to reduce the time lag
- Review of start-up and shut-down steps



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