Air Cooling and Low Grade Temperature Waste Heat ORC

ASME ORC 2013

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Overview

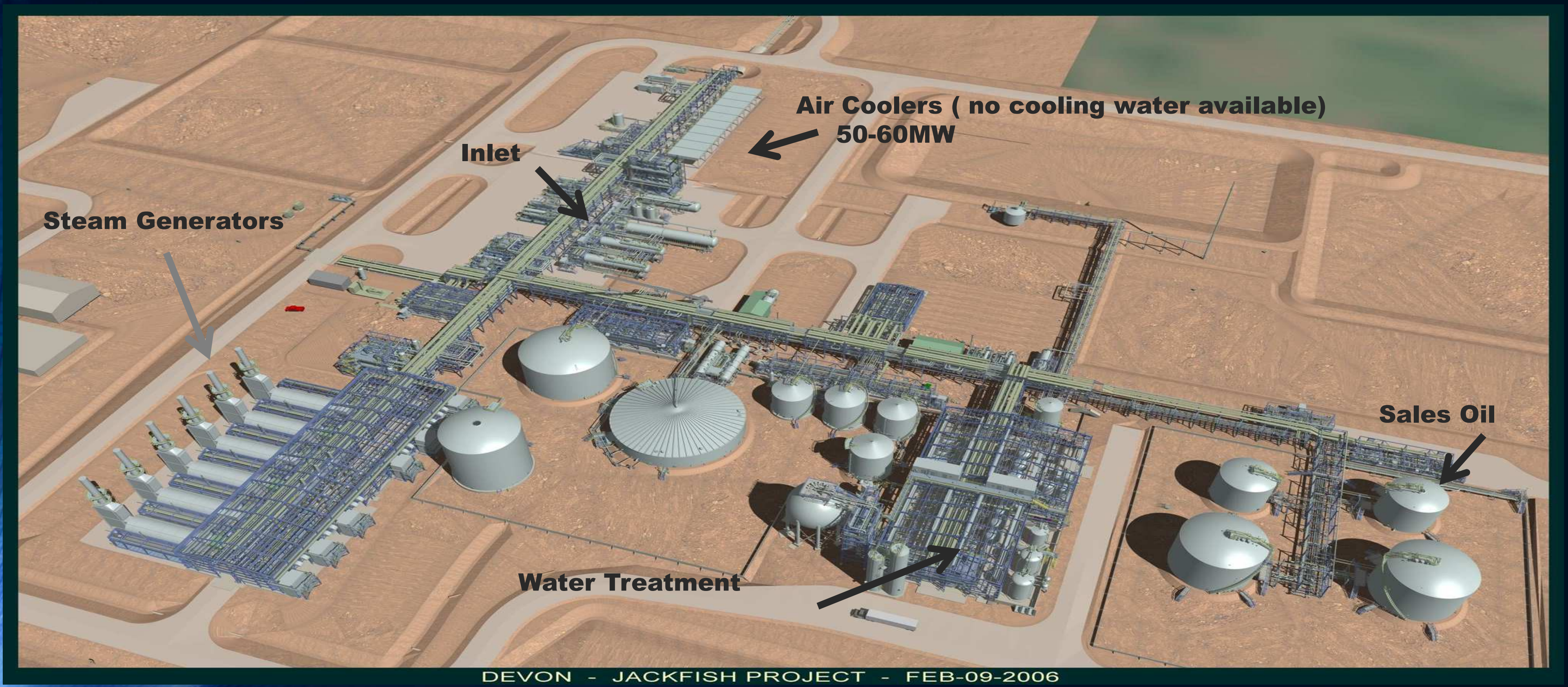
- Problem Statement & Background
- Technology and Challenges
- Condenser controls
- Conclusions / Recommendations

Problem Statement

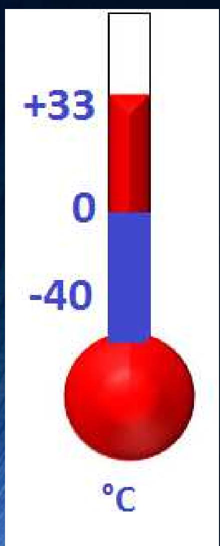
Effective condenser operation & controls with air cooling differ from condensers using cooling water.

Power plant -Rankine cycle

Project Plot Plan – Heavy Oil Production

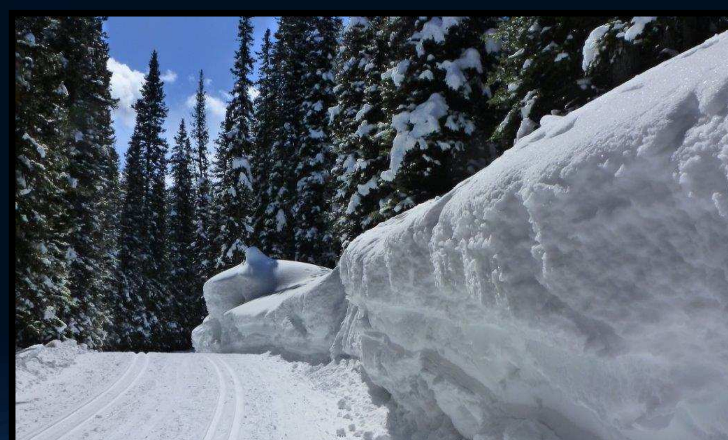


Ambient Temperature Range



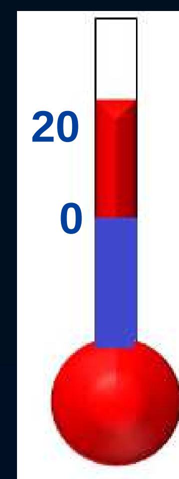
SEASONAL

-40 TO +33 °C



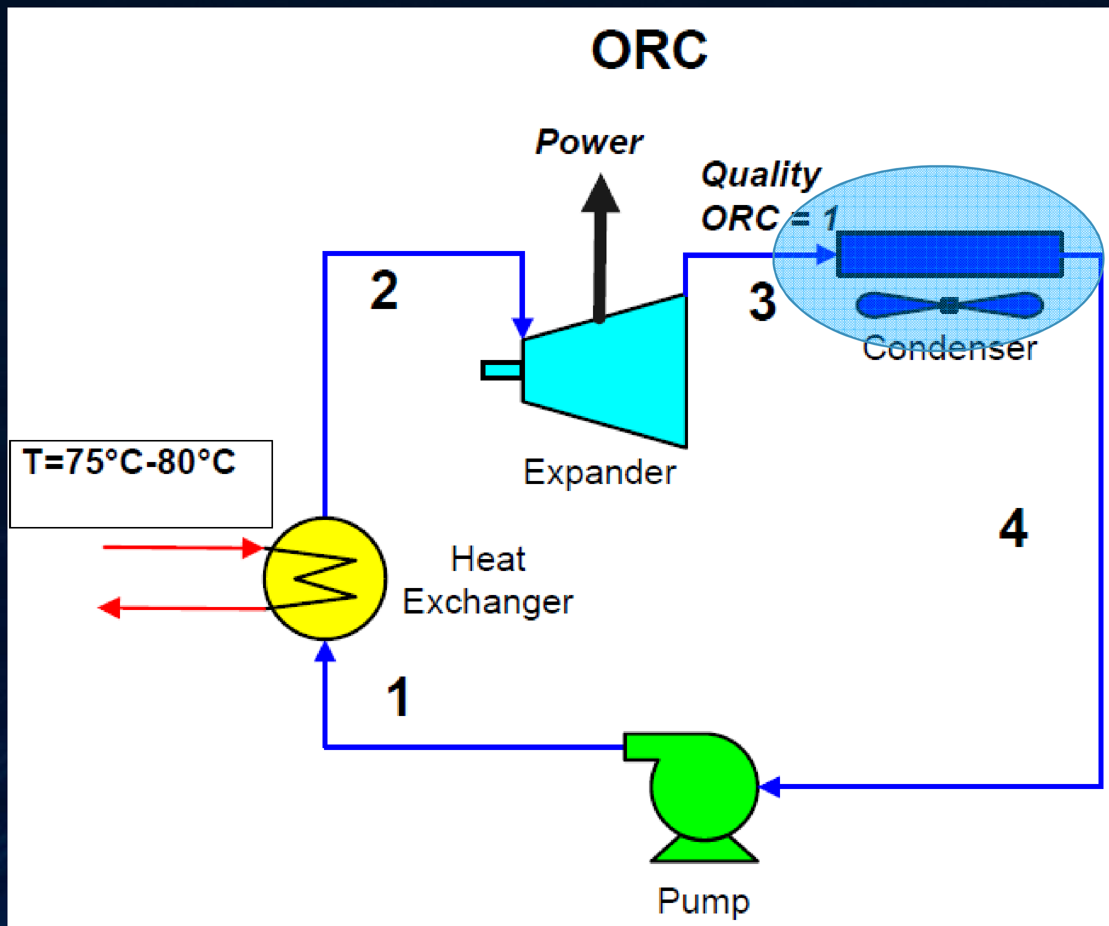
LARGE TEMPERATURE SWINGS

- March – October
- Daily swings of 10-20°C



Air Cooling – ORC Alberta Installation

ORC Process Flow Diagram (PFD)



"Student: Dr. Einstein, Aren't these the same questions as last year's [physics] final exam?

Dr. Einstein: Yes; But this year the answers are different."

— Albert Einstein

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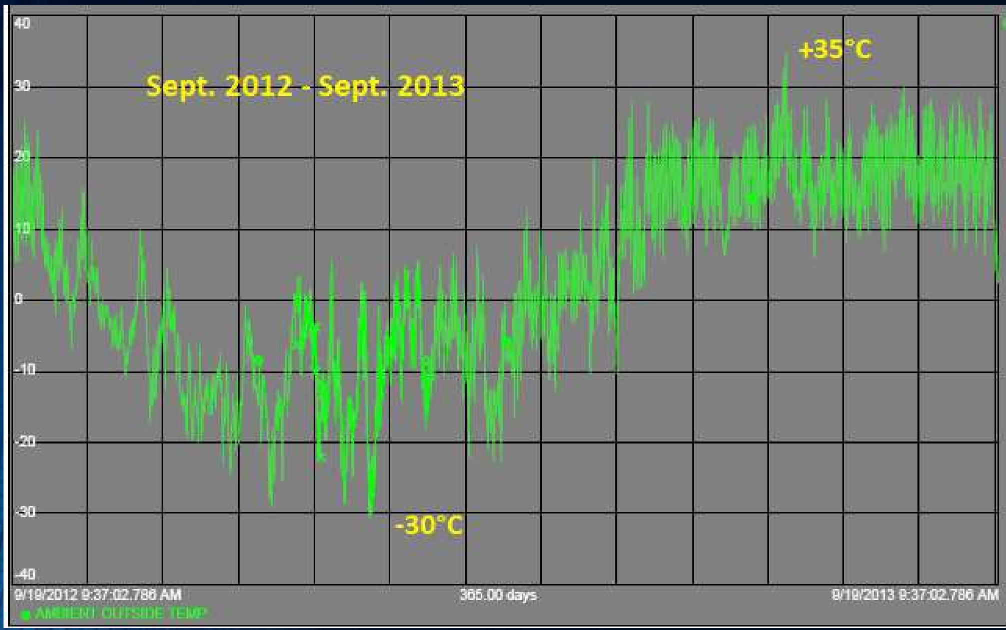
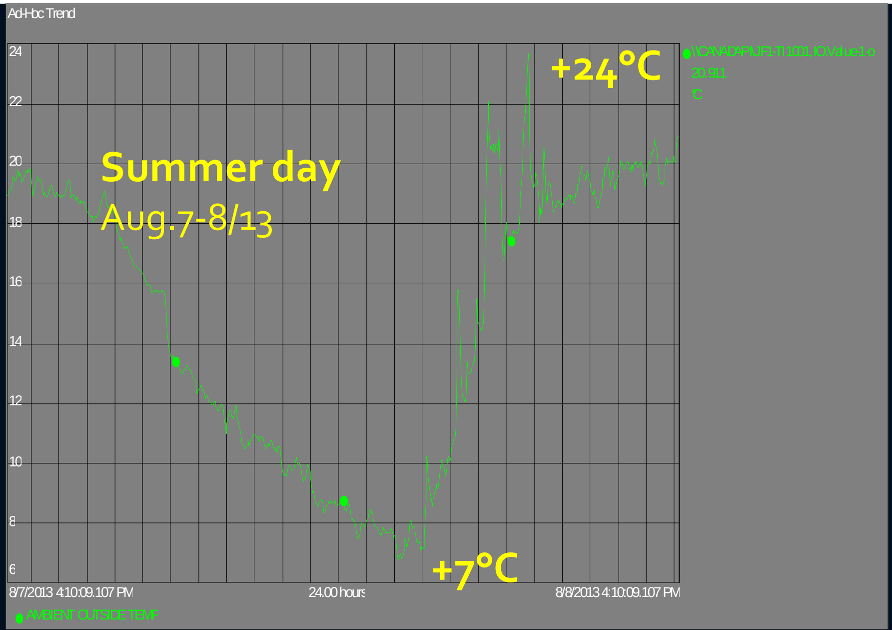
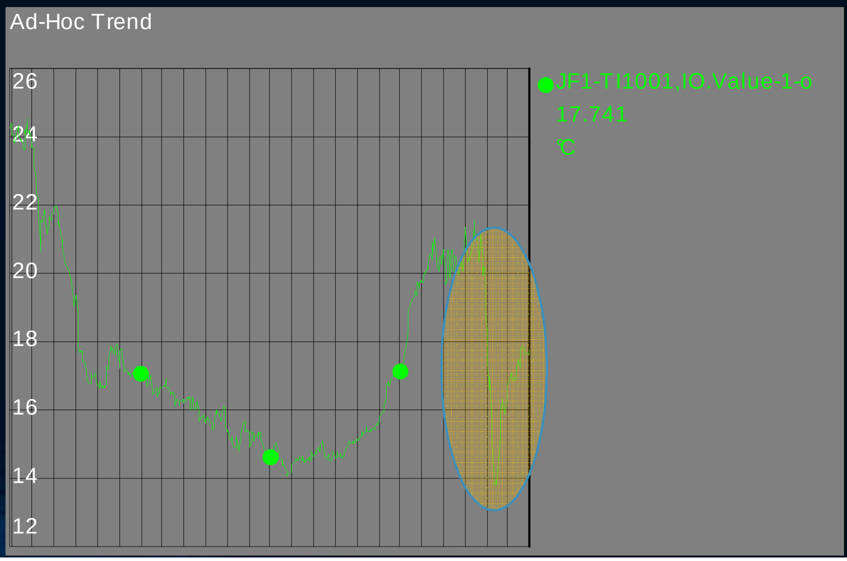
"LEPAGE FINISHED 43RD AT THE RACE BECAUSE OF HIS CAR SUFFERING FROM OVERHEATING FAILURES." REF.AUTORACING.COM

Challenges-
Low grade waste heat & varying ambient

Ambient Temperature Range



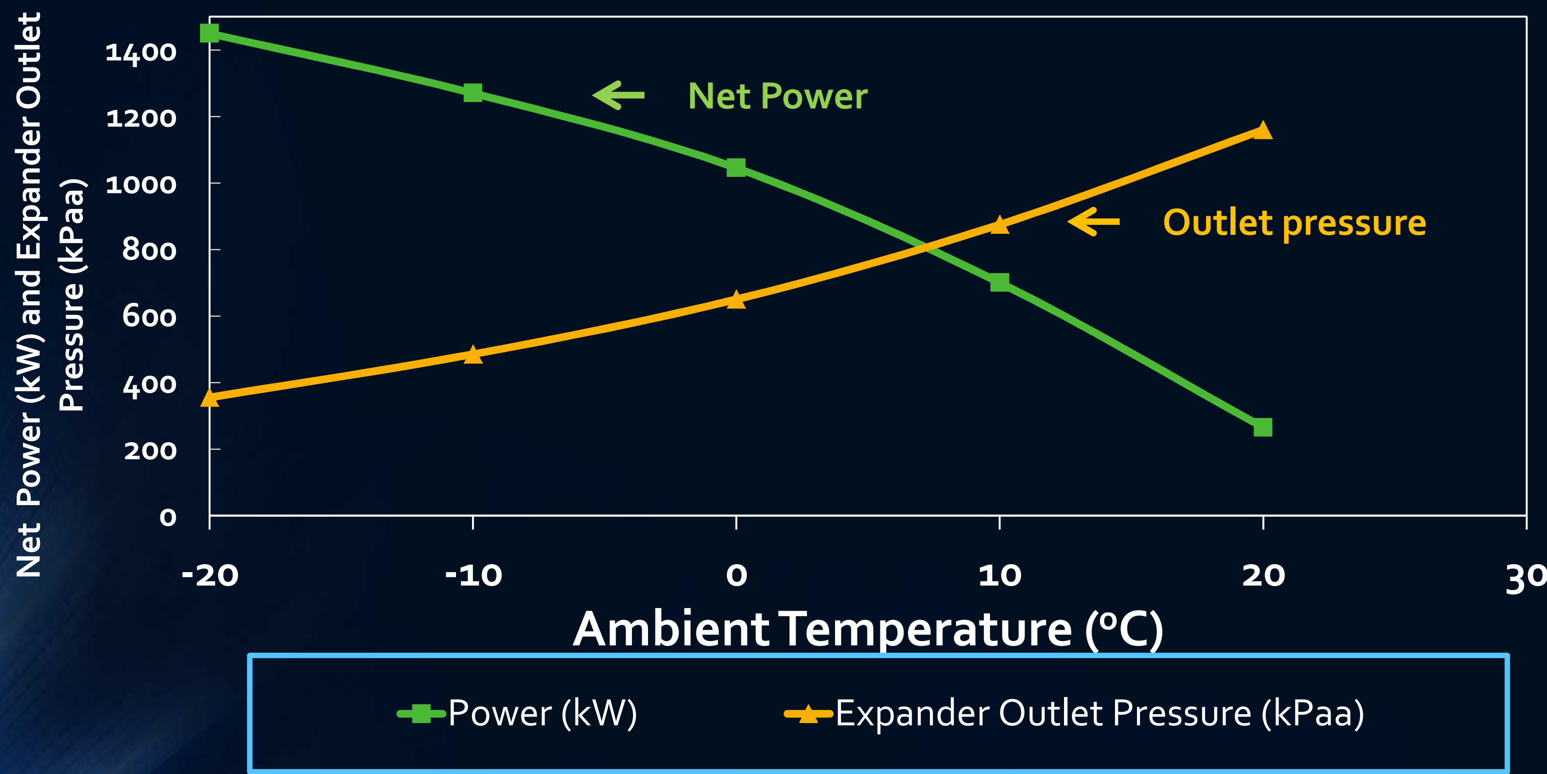




Winter Conditions / other considerations

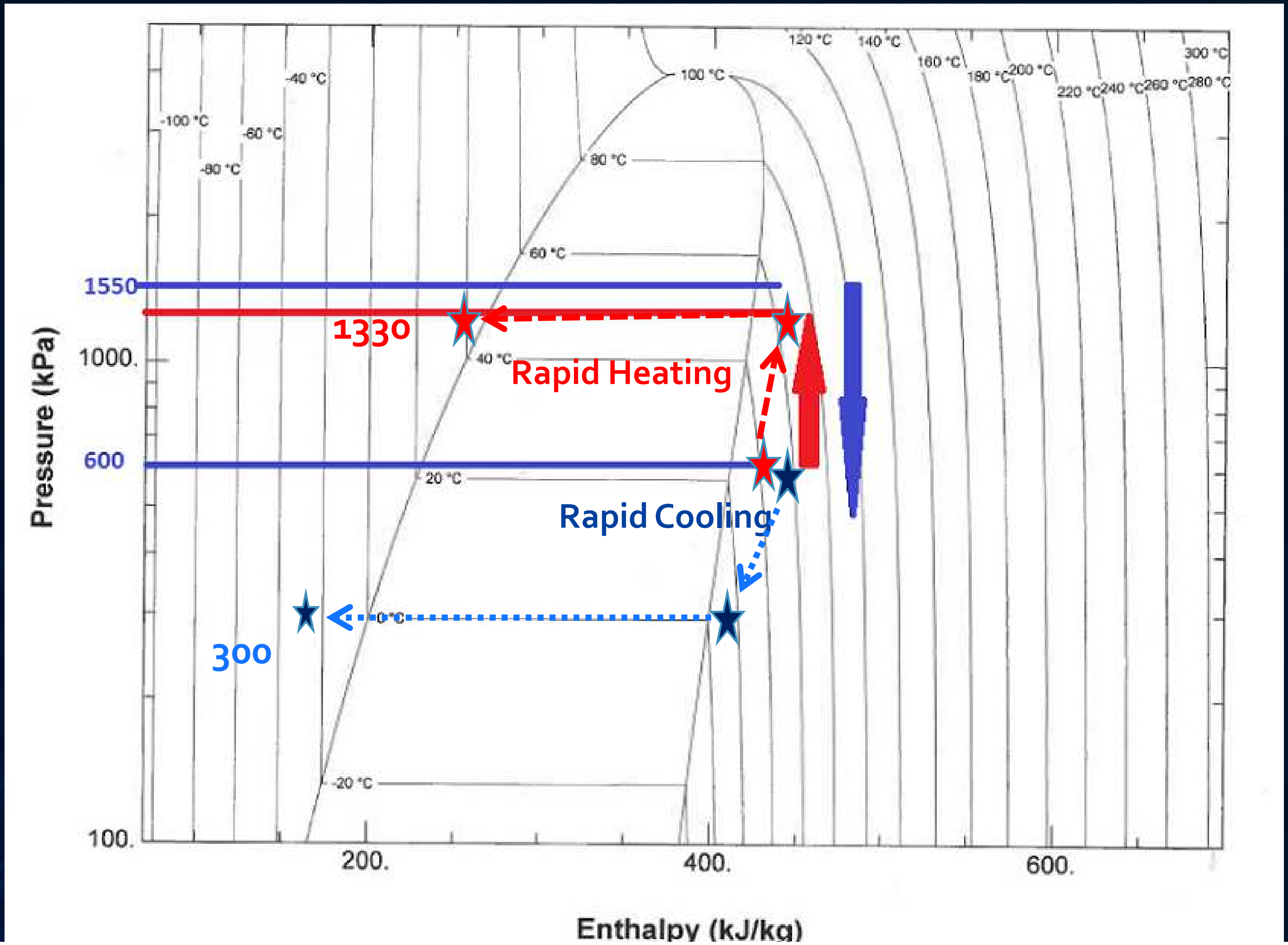
- Expander outlet pressure (or delta P) not 'unlimited'
- Reducing pressure too much can 'choke' expander
- Fouling of air cooler can have significant impact
- Varying conditions affect waste heat exchanger

Parameters Based on 10 °C design

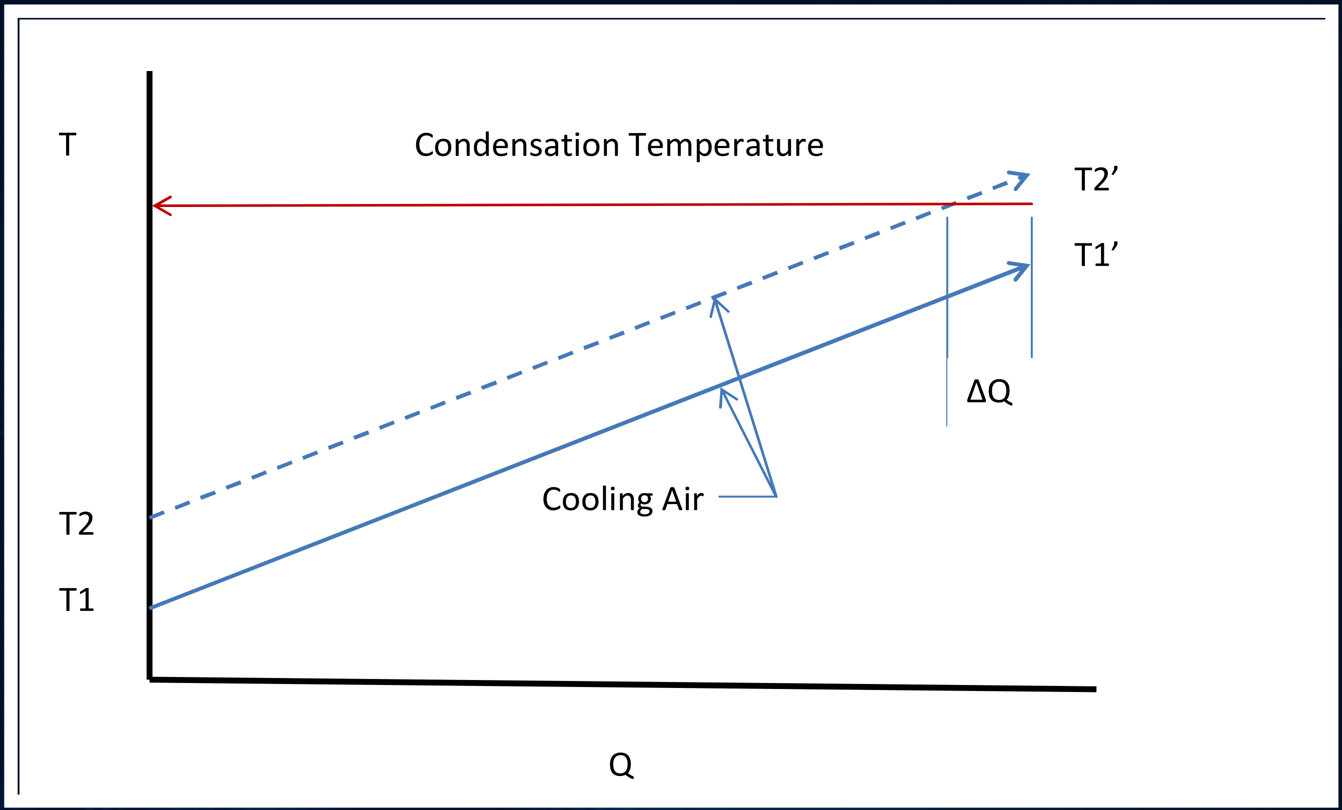


Ref:HYSYS v. 7.3/EDR

Phase Envelope



Rapid Temperature Rise



Economic losses – without controls

- 17 MW h loss per week (estimate)
- $55,000 - $72,000 per year ($64-85/MWh)
- ‘Full time ‘ operator (>$100,000/yr)
- Instrumentation payback < 6 months

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Control Schemes

1.) Float on Pressure

- No automation
- No VFD
- No Surge Tank

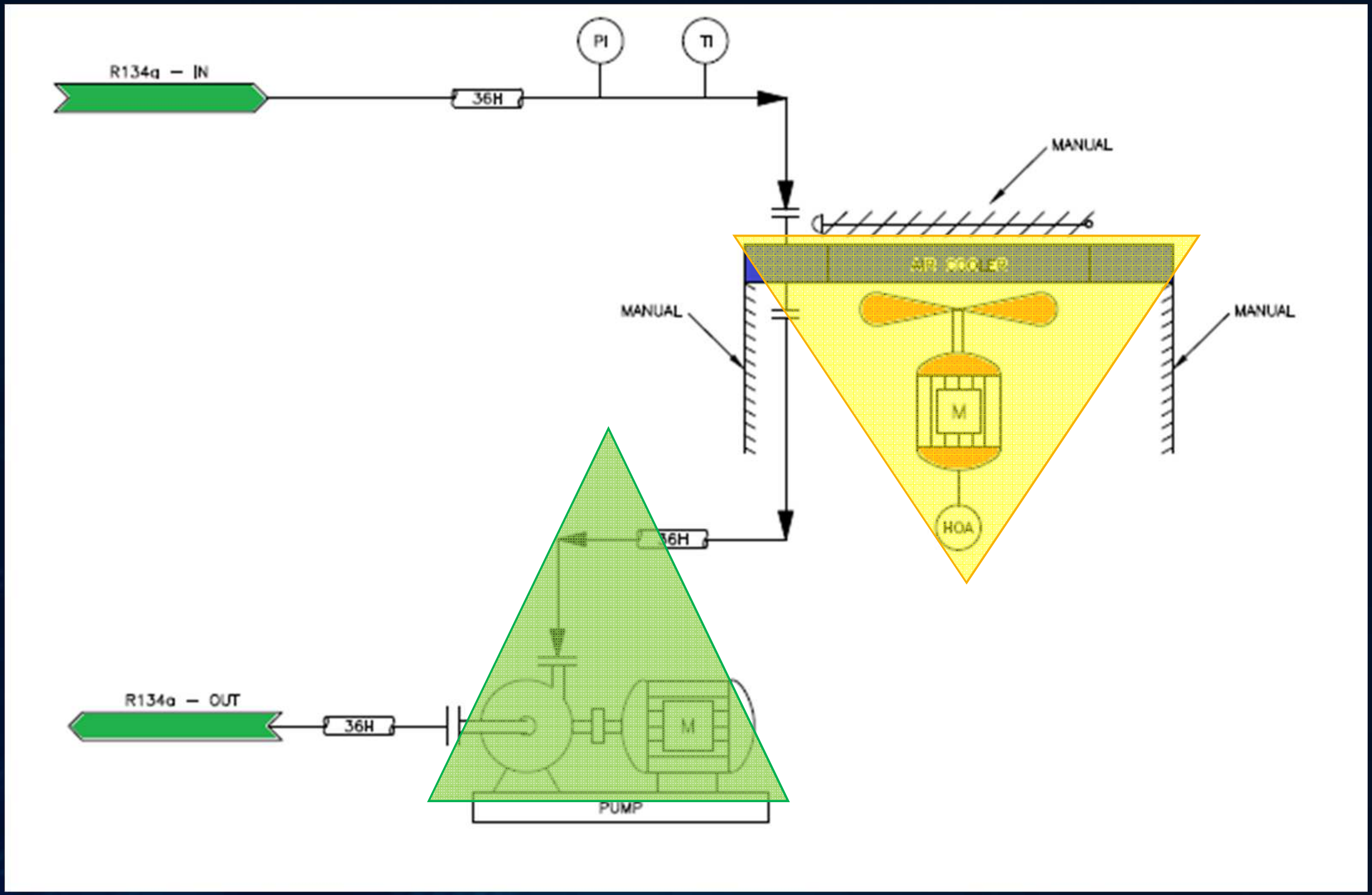
2.) Pressure Control

- Control Valve
- Louvres- side
- Surge Tank

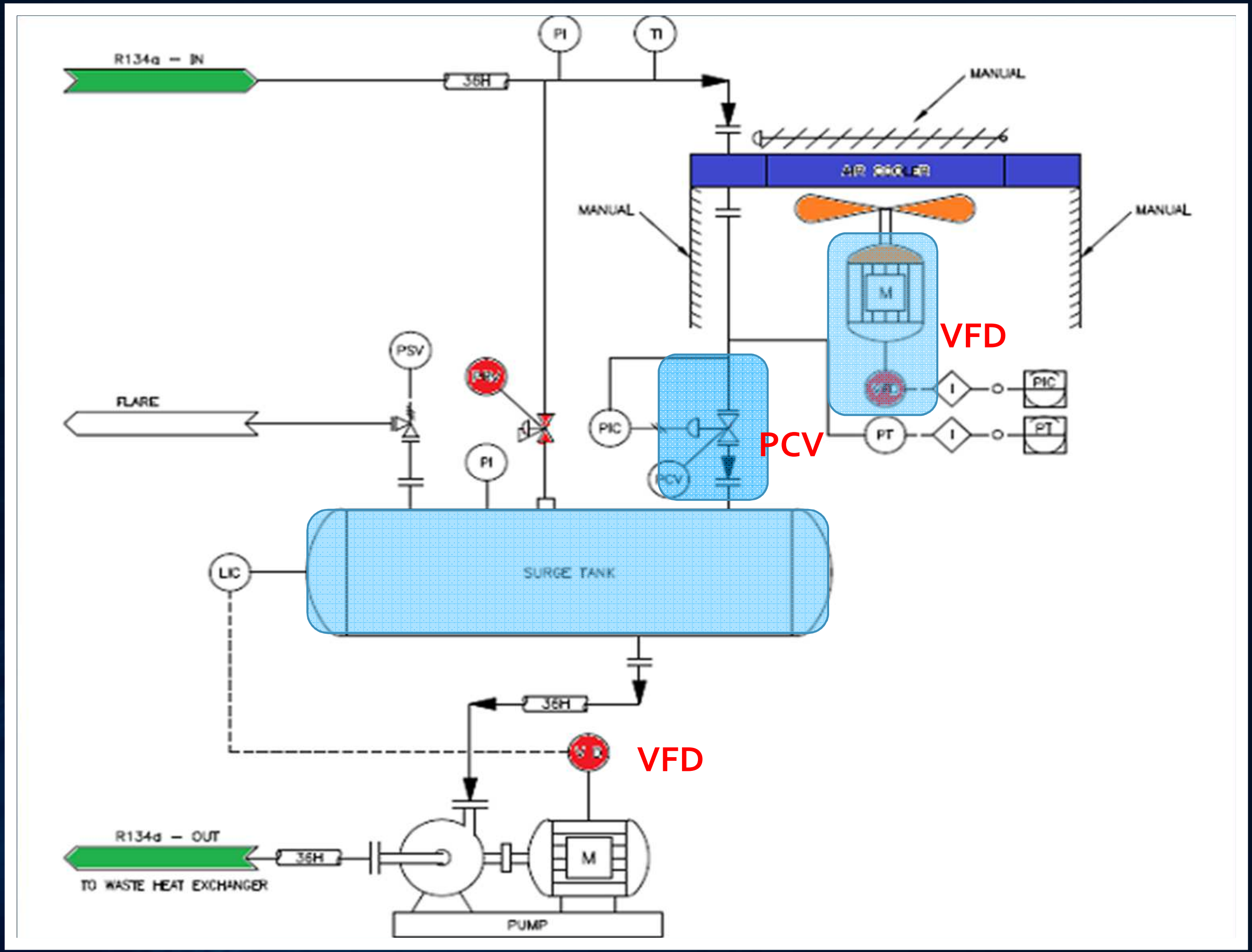
3.)Temperature Control

- Control Valves
- Auto Louvres
- VFD
- Surge Tank

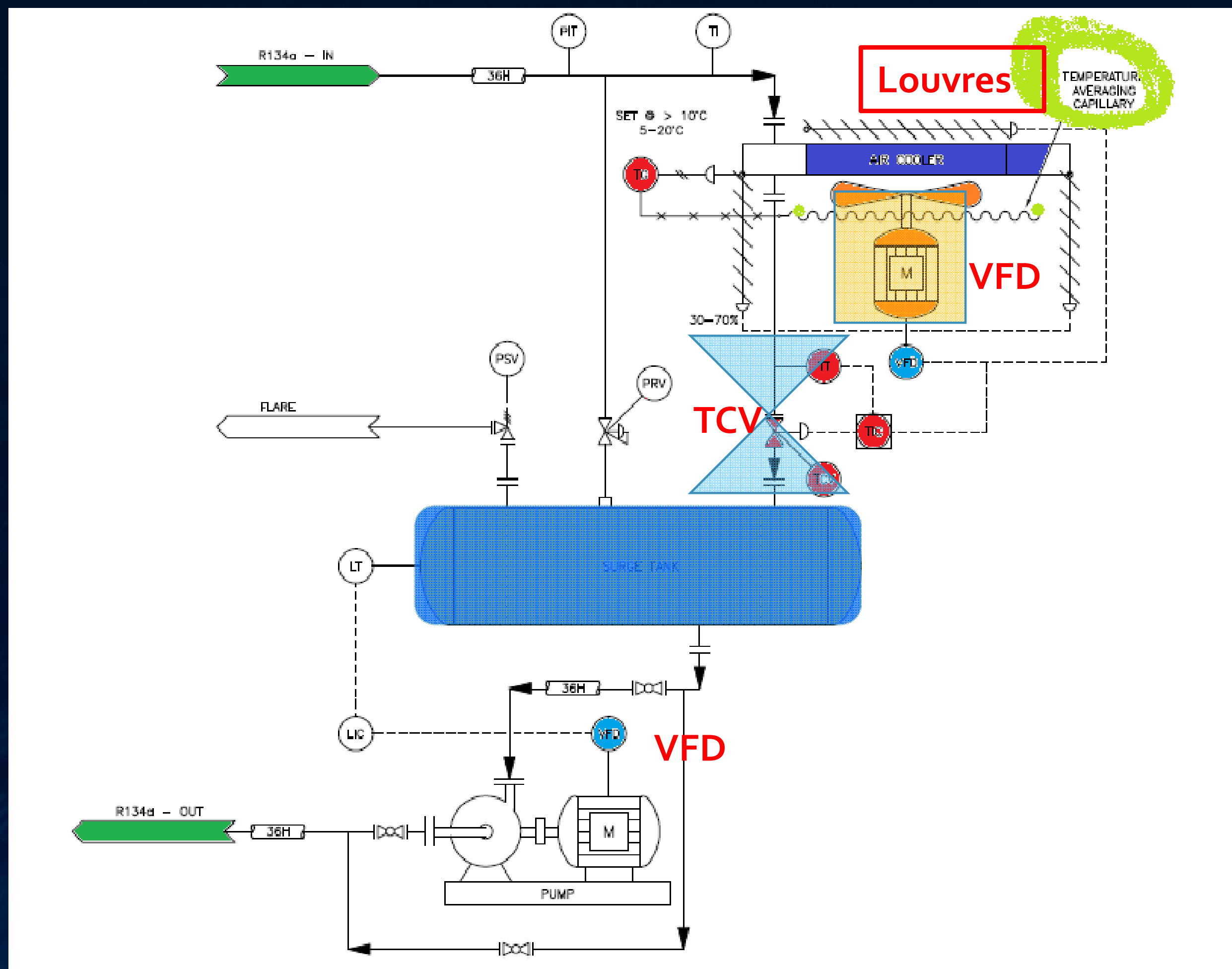
‘No’ Control Float on Pressure



Pressure Control



Temperature control

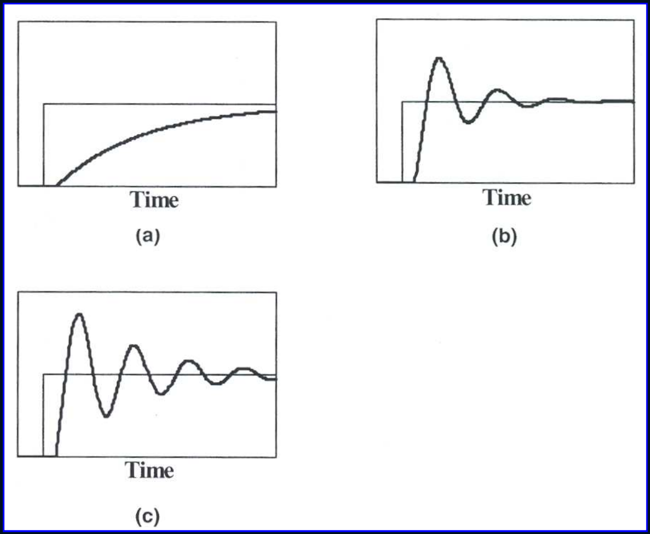


Capillary Tube – Temp sensor

- Enable more stable temperature control – side louvres

Control Philosophy, Narrative etc.

1. Philosophy
2. Narrative (specific to project)
3. PID, APC controls etc.



Fully Automated

Peak time optimization

Seasonal bias

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Recommendations

Step 1
- Evaluate the whole process

Step 2
- Temperature Control scheme

Step 3
- Consider dynamic simulation

Conclusions

1
- Float on pressure inefficient

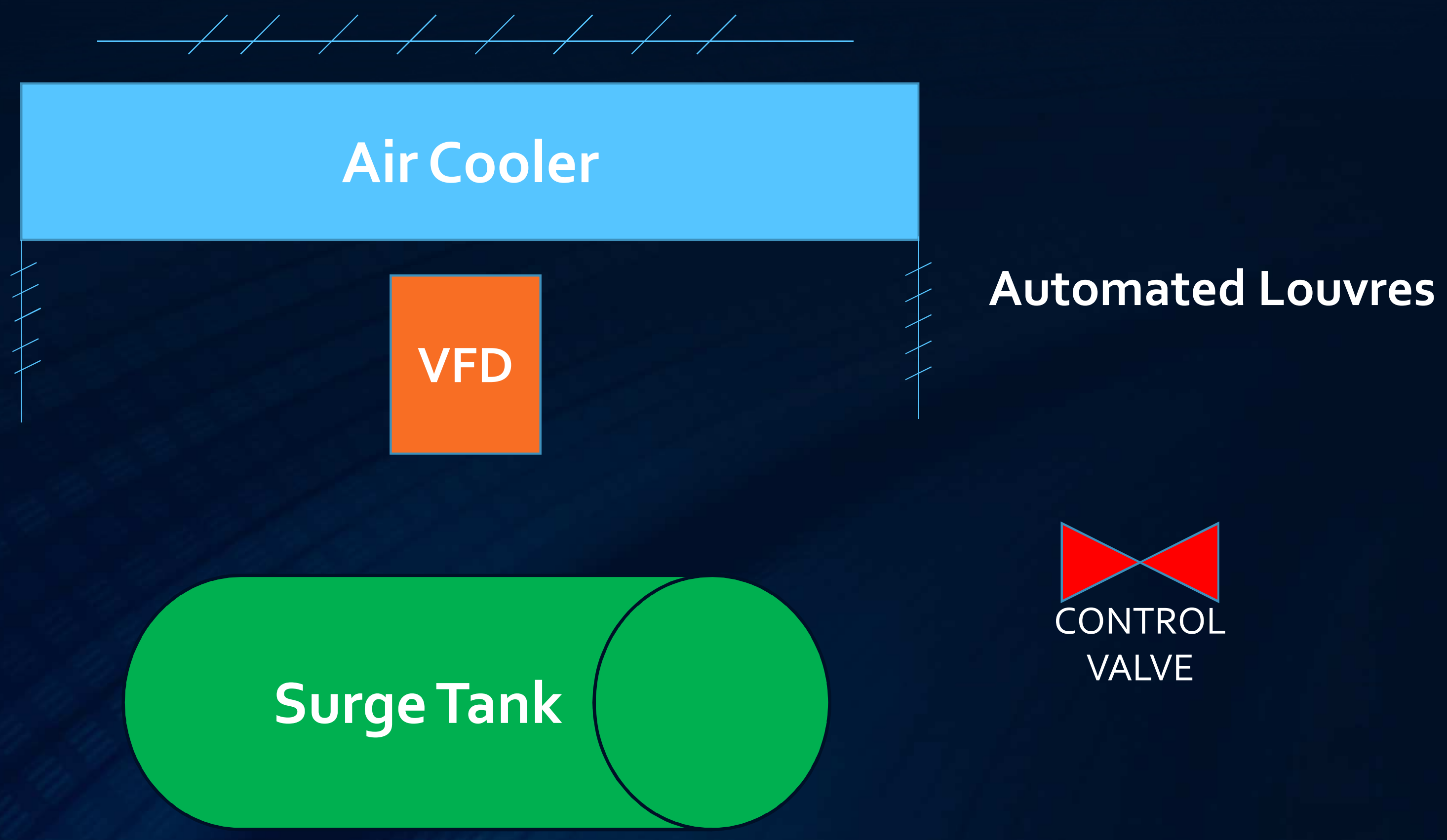
2
- Choose best control logic

3
- VFD's and automation are crucial

Main conclusions?

- **WHAT ARE THE MAIN CONCLUSIONS?**

Main Requirements for smooth control



Appreciation

- Hank Leibowitz (co-author)
- Doug Baird (instrumentation specialist)
- Various Colleagues and industrial contacts
- Devon