saliqo

STAR REFRIGERATION

Adaptive Control Stabilises Coupled Tank Levels in Industrial Freezer Systems

4-6 weeks
reduction in commissioning time

15%
Energy saving through optimised economiser

150+ hrs/yr
in ongoing maintenance eliminated

Saliqo adaptive control helped Star Refrigeration achieve stable freezer operation while eliminating control commissioning time and reducing valve wear.

May 2026

KEY OUTCOMES

METRIC	OUTCOME
Commissioning time	4-6 week reduction
Energy efficiency	~15% improvement
Control system tuning	Eliminated – 150hrs/yr saved
System wear & tear	Reduced valve wear with smoother valve operation
Deployment scale	Currently operating in 16 systems across UK sites

SUMMARY

Industrial refrigeration systems often contain multiple interconnected vessels such as economisers and condensers. Maintaining stable liquid levels in these tanks is essential for efficient freezer operation, but these systems are notoriously difficult to control due to nonlinear process dynamics and strong interactions between vessels.

Working with **Star Refrigeration**, Saliqo adaptive control technology was deployed to stabilise interacting tank levels within Star Refrigeration's **Azanefreezer systems.**

The deployment demonstrated that model-free adaptive control can stabilise highly nonlinear interacting processes while eliminating manual controller tuning and control commissioning effort. The technology has now been deployed on **16 industrial refrigeration systems across multiple sites in the UK** and will be integrated into **all future Star Refrigeration Azanefreezer installations.**

STAR REFRIGERATION AND AZANE SYSTEMS

Star Refrigeration is a global engineering company specialising in industrial refrigeration systems. Their **Azanefreezer and Azanechiller platforms** are widely deployed across cold storage, food processing, and logistics facilities. These systems incorporate multiple liquid vessels that regulate refrigerant flow and optimise refrigeration cycle efficiency.

Typical vessels include:

- Economisers
- Liquid receivers
- Condensers
- Surge drums

These vessels are hydraulically coupled through compressors and control valves, meaning the behaviour of one tank directly influences the others.

MAIN CONTROL OBJECTIVES

Star Refrigeration defined three primary objectives for the control system:

01. Stable and efficient freezer operation

Maintaining stable refrigerant levels ensures efficient refrigeration cycle performance and prevents disturbances propagating through the system.

02. Reduced commissioning and re-tuning time

Refrigeration plants operate under changing conditions due to seasonal variations, changing cooling loads, and equipment ageing. Reducing both initial commissioning effort and ongoing controller re-tuning was a major operational goal.

03. Smooth valve operation

Aggressive valve movement leads to mechanical wear and premature actuator failure. The control system therefore aimed to prioritise **smooth valve operation**, even if this occasionally meant sacrificing small amounts of level control precision.

All three objectives were successfully achieved with the adaptive control deployment.

TANK LEVEL CONTROL ACROSS INDUSTRY

Liquid level control is one of the most common control challenges across industrial processes including:

- Chemical plants
- Petrochemical facilities
- Water treatment plants
- Food processing
- Refrigeration systems

Tank systems exhibit **nonlinear dynamics**, with outlet flow typically proportional to the square root of liquid height. These nonlinearities make control challenging, especially when multiple tanks interact.

CONTROL CHALLENGES IN AZANE SYSTEMS

Azanefreezer refrigeration plants experience many sources of variability that make conventional control difficult.

Variations Within a Single System

- Coupled tank level control with nonlinear interacting dynamics
- Ambient temperature variations (winter vs summer)
- System disturbances
- Changes in mass flow rate and condensing pressure
- Valve condition and sensor drift
- Operation in different modes (chill mode vs freezer mode)
- Setpoint changes

Variations Between Systems

- Different valve dynamics
- Different pipework lengths and diameters
- Vessel size differences
- Different compressor characteristics
- Variations in cooling capacity and flow rates

These factors mean that controllers tuned for one operating condition or one plant often perform poorly when conditions change, or when used on a different system.

ADAPTIVE CONTROL SOLUTION

To address these challenges, **Saliqo adaptive control** was deployed as an intelligent control layer integrated directly into the plants existing PLC system.

Unlike traditional advanced control approaches, Saliqo does not require detailed mathematical models of the process. Instead, the controller adapts directly to the observed behaviour of the system in real time.

This allows the control system to continuously compensate for disturbances and changing operating conditions.

Key characteristics include:

Model- free operation
The controller learns directly from process measurements without requiring system modelling or manual tuning.

Continuous adaptation
Internal parameters automatically adjust as system dynamics change due to load variations, seasonal conditions, or equipment ageing.

Deterministic control behaviour
A robust control architecture ensures predictable system behaviour while the adaptive layer continuously improves performance.

SIMPLE INTEGRATION

A key advantage of the system is its **ease of integration**. The adaptive controller was integrated directly into the customer's **existing PLC control software** in Mitsubishi GX Works 2 without requiring:

- Additional hardware
- New sensors or data
- Modifications to the plant automation architecture.

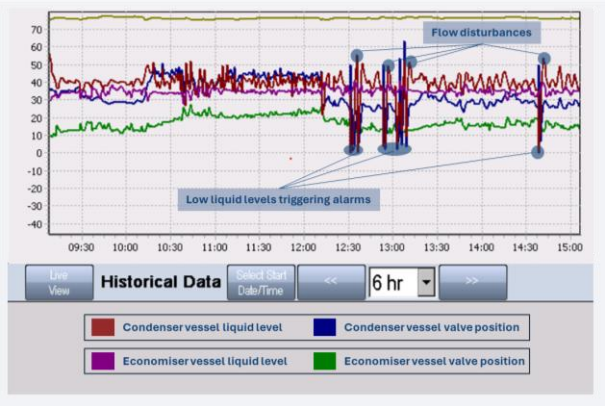
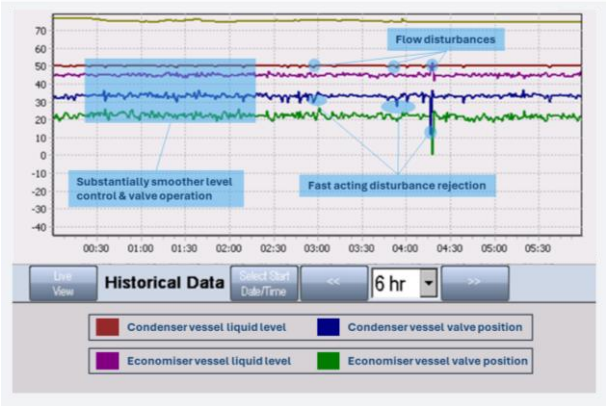
As a result, deployment across multiple refrigeration systems was straightforward and scalable.

OPERATIONAL IMPROVEMENTS

Deployment of Saliqo adaptive control stabilised the interacting tank levels across the refrigeration systems while meeting Star Refrigeration's operational objectives. Most importantly, **control system commissioning time and re-tuning was eliminated entirely.**

PERFORMANCE IMPROVEMENTS

IMPROVEMENT	RESULT
Commissioning time	4-6 week reduction
Energy consumption	~15% reduction
PID tuning	No manual control tuning required
Valve wear	Significantly reduced due to smoother control

PID	saliqo
	

OPERATIONAL BENEFITS

Operators reported several improvements:

- Stable tank levels across interacting vessels
- Fewer system alarms
- Smoother valve movements
- Improved refrigeration cycle efficiency
- Reduced maintenance requirements.

DEPLOYMENT ACROSS THE UK

Following successful deployment, the adaptive control system has now been rolled out to **16 Azanefreezer and Azanechiller refrigeration systems across multiple industrial sites in the UK, increasing to 23 systems in 2026.** Due to the operational benefits achieved, the technology will now be incorporated into **all future Star Refrigeration Azanefreezer installations.**

BROADER INDUSTRIAL RELEVANCE

While this deployment focused on industrial refrigeration, the results demonstrate the broader applicability of adaptive control to nonlinear interacting processes across many industries. By removing the modelling and tuning barriers that traditionally limit advanced control deployment, Saliqo's adaptive control technology makes advanced control practical for a much wider range of industrial systems.