Understanding Flammable Refrigerants in Recirculating Chillers

As global regulations and industry best practices rapidly evolve, manufacturers are transitioning to more environmentally friendly refrigerants with lower Global Warming Potential (GWP). At the forefront this shift, Applied Thermal Control recirculating chillers now incorporate flammable refrigerants – primarily R290 (A3) and R454C (A2L) – in order to comply with future standards while maintaining high performance and a strong safety profile. This approach aligns with international agreements such as the Montreal Protocol and Kigali Amendment, as well as regional legislation like Europe's F-Gas Regulation, all of which seek to phase down high-GWP refrigerants in favour of sustainable alternatives.

Why Flammable Refrigerants?

1. Environmental Regulations and Sustainability

The Montreal Protocol and its Kigali Amendment are international agreements that drive the phase-down of high-GWP refrigerants. Europe's F-Gas Regulation further restricts the use of certain HFCs, thus pushing manufacturers to adopt natural or low-GWP alternatives. Because R290 and R454c have significantly lower GWP than legacy refrigerants such as R404a or R134a, they align closely with global climate goals and sustainability targets.

2. Performance and Efficiency

R290 is recognised for its excellent thermodynamic properties, which translate into efficient heat transfer and reduced energy consumption. Meanwhile, R454c, a mildly flammable (A2L) blend, also offers high energy efficiency, making it a suitable replacement for certain high-GWP refrigerants. Both options help to balance environmental considerations with the performance needs of industrial and research applications.

Safety and Common Applications

Although the term “flammable” raises understandable concerns, these refrigerants are already widely used in everyday contexts. Domestic refrigerators and freezers often rely on small charges of R600a (isobutane, A3). Supermarket display cases frequently utilise R290 in similar charge quantities to those used in many industrial cooling systems. Around the world, air conditioning units and heat pumps are also transitioning to A2L refrigerants like R454C. These established applications demonstrate that the safe use of flammable refrigerants is well supported by industry experience and regulatory guidelines.

Built-In Safety Measures

Our units are designed with robust safety measures to ensure reliable operation in demanding industrial environments. Third-party testing includes overpressure tests to verify the structural integrity of the refrigeration circuit, followed by leak testing to ensure that refrigerant cannot accumulate dangerously inside the unit should a leak occur.

These tests, conducted under controlled conditions, validate the performance of our safety systems and ensure compliance with industry standards.

Because ATC units employ R290 in charges or 100 grams or less, they remain within internationally accepted thresholds for unrestricted indoor use.

Key Standards and Regulations

International safety and design standards govern the use of flammable refrigerants across different industries.

UL 60335-2-40 (USA)

- Addresses safety requirements for air-conditioning and refrigeration systems, including charge limitations and mitigation strategies for flammable refrigerants.

ASHRAE 15 & 34

- Defines refrigerant classifications (A1, A2L, A3, etc) and prescribes safety protocols for installation, maintenance, and operation

IEC 60335-2-89 (International)

- Covers commercial refrigeration equipment using flammable refrigerants, focusing on electrical and mechanical safety design.

EN 378 (Europe)

- Encompasses the full lifecycle of refrigeration systems, stipulating safety, environmental, and operational guidelines for both A2L and A3 refrigerants. .

Key Standards and Regulations

The Lower Flammability Limit (LFL) is the minimum concentration of refrigerant in air at which it can ignite. R290 (A3) typically has an LFL of approximately 2.1% by volume in air, whereas R454c (A2L) generally requires a significantly higher concentration (around 11-12%) to ignite. Consequently, A2L refrigerants present a lower flammability risk compared to A3 refrigerants, although all flammable substances must still be handled with care to avoid reaching unsafe concentrations.

Regulatory standards such as EN 378 and ASHRAE 15 frequently tie permissible refrigerant charges to the volume of the room in which a system is installed. This ensures that if the full refrigerant charge were to escape, the resulting concentration in the air would remain below a safe fraction of the LFL. In smaller rooms, additional safety features like forced ventilation or reduced charge sizes may be required, while larger rooms can accommodate higher volumes of refrigerant without compromising safety. Compliance involves calculating the room volume, verifying the refrigerant charge against established limits, and ensuring that ventilation or other leak mitigation measures are in place where needed.

Additional Considerations

Proper training or certification is essential for technicians who handle flammable refrigerants, as they need to be knowledgeable about leak detection and system evacuation methods. Effective system monitoring is equally important for recognising potential issues before they pose significant risks. Clear labelling and documentation regarding refrigerant type and charge are crucial steps to maintaining regulatory compliance, as local building regulations may impose additional requirements.

By adopting R290 and R454c in its recirculating chillers, ATC demonstrates its commitment to sustainability and energy efficiency. These refrigerants, already commonplace in domestic and commercial applications, are governed by comprehensive safety standards that support reliable performance under industrial conditions. Through careful attention to charge limitations, LFL thresholds, room-size considerations, and stringent third-party testing, ATC ensures that its chillers deliver robust cooling while meeting strict environmental objectives. This balanced approach allows users to benefit from lower-GWP refrigerants without sacrificing the operational safety and efficiency that modern applications demand.