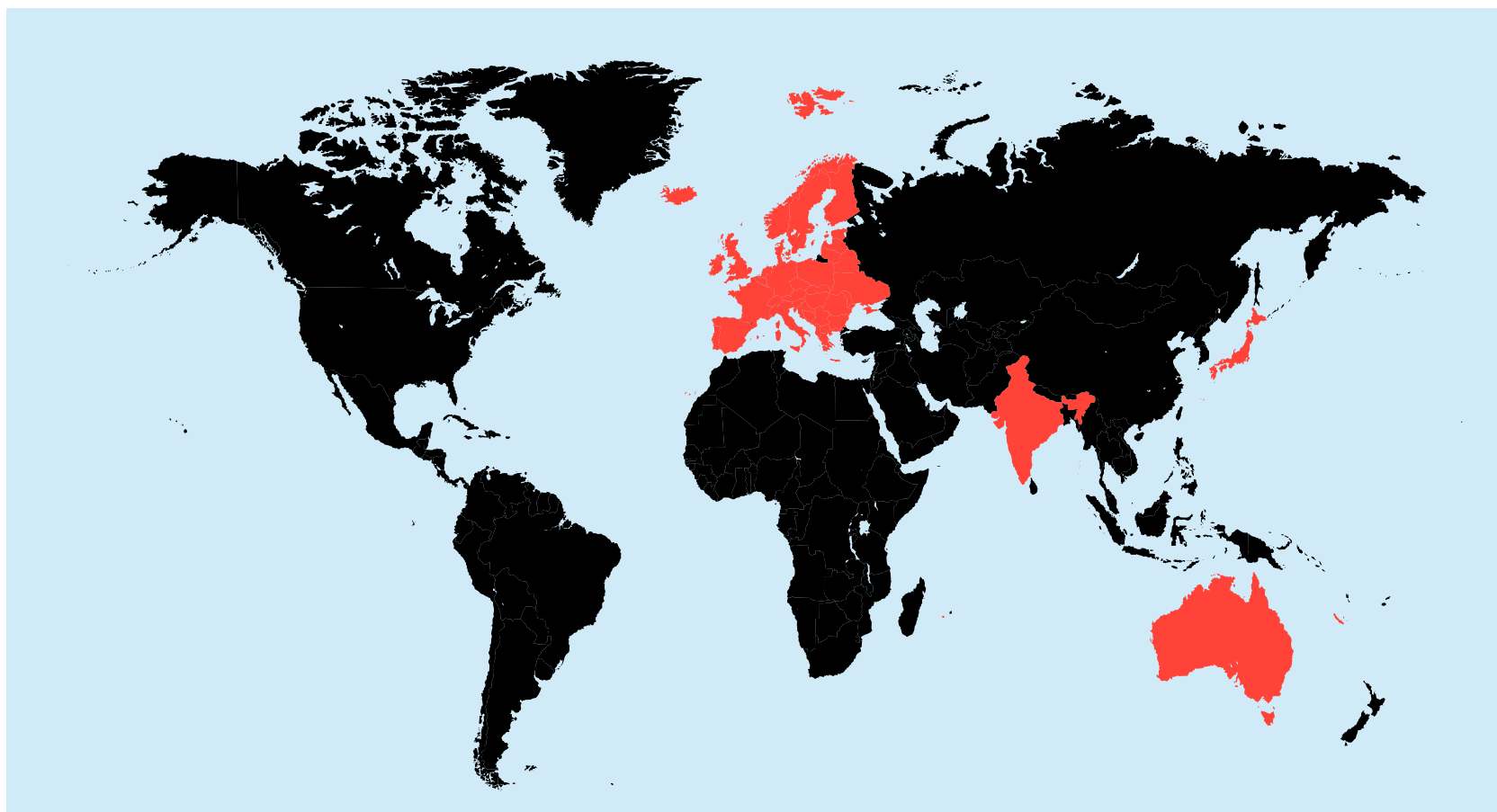


# THE LOWDOWN ON R32

An increased demand for air conditioning in developing countries, coupled with the push for low global warming potential refrigerants worldwide has hastened the move towards mildly flammable refrigerants. Sean McGowan reports on the introduction of R32.



*A global push for low-GWP refrigerants has fostered R32's worldwide spread.*

In 1987, the Montreal Protocol saw developed countries in Europe, as well as the United States of America, Japan and Australia, commit to phasing out ozone-depleting substances, including CFCs and HCFCs.

Twenty-six years on, these signatory nations are just two years away from a 90 per cent phase-out, and only six years away from total phase-out.

However, for developing countries like China, India and Brazil, such progress is a long way behind.

Only this year have consumption levels of HCFCs in these countries been frozen, with total phase-out not to be achieved until 2030.

Despite significant progress in developed countries, it is these developing countries that represent a dilemma for governments worldwide. Such is the demand for air conditioning (currently around 60 million residential packaged systems sold annually) in the developing world that the continued use of R22 and R410A presents a major global warming risk should its use continue at such a rate until 2030.

As a result, international collaboration is seeking the next generation of refrigerants that are not only zero-ozone depleting potential (ODP), but also lower in GWP.

Enter R32 (HFC32) – a single component, zero-ODP gas with a GWP of 675.

According to leading manufacturers including Daikin and Fujitsu, R32 will not only be used in emerging markets, but also in developed markets including Australia, signalling the beginning of the end of the use of R410A.

While R32 is not new to Australia (it makes up 50 per cent of the R410A blend with R125), its pure use in air conditioning systems represents a significant step-change – and one that is occurring quickly.

“In Japan, the first systems were introduced in November 2012, and it followed that most residential single split systems were converted to R32 this year,” says Gary Knox, M.AIRAH, engineering manager for Daikin Australia.

“If Australia follows the Japanese example, R32 will become a major refrigerant next year.”

According to Fujitsu General Australia’s national product manager, Peter Cashel, the company is currently releasing three ranges of R32-charged wall-mounted models into the Australian market.

Two reverse-cycle models were released at the end of September, while a cooling-only model will be available by the end of October.

Plans to release more R32 models are yet to be publicly released by Fujitsu, but it appears the development of new wall-mounted models containing R410A is a thing of the past.

“I don’t believe that Fujitsu will be completing any major new development on R410A refrigerants in wall-mounted air conditioners, and will look to use R32 where suitable in future models,” says Cashel.

## A BRIEF HISTORY

Following the freezing of HCFC consumption in developed countries in 1996, a search began for new refrigerants that did not deplete the ozone layer.

Complicating this search were regulations and standards that emphasised a preference for non-flammable refrigerants, by way of limitations on flammable refrigerants.

R32 came under close consideration, however, the benefits of zero ODP and a low GWP compared to other HFCs were outweighed by its flammable properties that placed it in the A2 classification.

The use of pure R32 was therefore not pursued.

Instead, it was blended with the fire suppressant R125 in equal parts to create R410A – currently the most common refrigerant used in packaged split air conditioning systems.

Another refrigerant blend, R407C, also contains 23 per cent R32.

“The relationship between GWP and flammability is a trade-off,” says Knox. “Lowering GWP inevitably raises flammability and vice versa. This is unavoidable due to the physical characteristics of chemicals.”

However, with the demand for packaged residential air conditioning in the developing markets of China, India and Brazil now dwarfing that of the developed markets, the step to R32 is now considered necessary.

Not only is R32's GWP much lower than that of R410A (675 versus 2090), but research has also revealed a host of efficiency benefits.

For instance, R32 has a potential refrigerating effect 1.5 times that of R410A, while the pressure losses are lower for the same capacity. Liquid density is also 10 per cent lower, meaning the pipe diameter can be smaller and as a result, the refrigerant charge could be up to 30 per cent less than that of an equivalent R410A system.

Along with its environmental and operational efficiency benefits, R32 also offers a financial incentive with an equivalent carbon price levy of \$15.70 per kg versus \$41.66 per kg for R410A. (This of course assumes the equivalent carbon price levy on refrigerants remains).

## FLAMMABILITY AND TOXICITY

As the vast majority of air conditioners previously sold in Australia have used non-flammable Category 1 refrigerants, the move to R32 by leading air conditioning manufacturers represents a significant step-change for the local HVAC&R industry.

Naturally, it has met some criticism from those at the industry's coalface, who are concerned about the health and safety implications of working with a flammable refrigerant.

According to Stephen Smith, head teacher for refrigeration and air conditioning trades at TAFE NSW, R32 is a refrigerant that does not lend itself well to medium or low-temperature applications.

He says it will therefore find predominant use in the same equipment that R410A is used in, such as residential and light-commercial split and ducted systems.

“R32 is one of the two components that are mixed to make R410A,” Smith says.

“It has the same high operating pressures as R410A – slightly higher actually – and cannot therefore be used as a drop-in replacement for existing systems. The pressure vessel ratings are higher, meaning that compressor shells, receiver/accumulator vessels and refrigerant cylinders, including recovery cylinders, must be specifically engineered for R32.”

Both Daikin and Fujitsu have engineered compressors specifically designed for use with R32.

Likewise, leading refrigerant distributor Heatcraft has confirmed that while bulk R32 is already available in Australia, a lack of compliant cylinders is currently restricting its decanting and distribution (more on that later).

Classed as flammable, R32 falls under the A2 classification in AS/NZS 1677.1, which means it is non-toxic (A) in its manufactured state, and has flammability properties (2 on a scale of 1 to 3) with a lower explosive limit (LEL) greater or equal to 3.5 per cent volume.

Toxicity within AS/NZS 1677.1 lists the exposure standard of R32 at 1,000ppm – the same as many other refrigerants including R22, R407C and R290 (propane), for example.

This means R32 has charge limitations that will prevent its use in very large air conditioners, or in very small rooms. According to Knox, AS/NZS 60335.2.40 calculates a minimum room size of 0.9m<sup>2</sup> and AS/NZS 1677.2 calculates a minimum room volume of 18.5m<sup>3</sup> for a 1kg R32 charged wall split system.

“These room sizes are generally smaller than the usual installation of a wall split system and should not present undue restriction, however, we advise awareness to avoid any misapplication,” he says.

One concern already expressed by industry members is the potential for the creation of hydrogen fluoride in the event R32 is ignited.

Smith says that when exposed to high temperatures, such as an oxy-acetylene flame, R32 will decompose into three toxic substances – carbon monoxide, carbon dioxide and hydrogen fluoride.

Hydrogen fluoride, on contact with moisture, converts to hydrofluoric acid.

“All three are dangerous and must not be taken lightly, but to put this in proper perspective, all of the HFC

## Your questions answered, with Gary Knox, M.AIRAH, engineering manager for Daikin Australia and Stephen Smith, head teacher for refrigeration and air conditioning trades at TAFE NSW.

### HVAC&R Nation: How is the local industry equipped to handle the move to R32?

**Knox:** Developed countries are well positioned to change-over to R32 because R410A has been used for many years.

R32 is similar in pressure to R410A and therefore suitable copper pipe is already available at trade outlets. There has been much training and experience with higher pressure refrigerants.

### HVAC&R Nation: Can the same tools used on R410A systems be used on R32 systems?

**Knox:** Many tools are common with R410A and this includes gauge manifolds, charging hoses, weighing instruments, pipe benders, pipe cutters, flaring tools, torque wrenches, cylinder caps, vacuum pumps and electronic leak detectors.

All of these tools can be reused.

### HVAC&R Nation: How does R32 stack up against other refrigerants, including naturals?

**Smith:** This new refrigerant carries all of the risks associated with every other HFC we have been using for the past 20 years.

Although flammable, it is more difficult to ignite, burns slower and releases less energy than the A3-category hydrocarbon refrigerants that we, as an industry, are also learning to live with in our daily lives.

### HVAC&R Nation: What are the key differences between R32 and R410A?

**Smith:** Improved thermodynamic performance and lower liquid density results in better electrical efficiency and lower refrigerant charge.

The operating pressures and temperatures are very close to what everyone is used to, so the primary issue is going to be adherence to logical safety precautions that should already be in place – the use of nitrogen while brazing and a check for sources of ignition prior to handling the refrigerant.

### HVAC&R Nation: What protection is needed on tools to prevent venting of the refrigerant and spark ignition?

**Smith:** As with hydrocarbons, the most common possible sources of ignition will be the vacuum pump and the recovery pump. Precautions must be taken when operating these devices.

With regard to the pipe joints necessary on a split system, Fujitsu has developed a “one use” coupling that is supplied with their machines. This device prevents untrained individuals from disconnecting the pipework and eliminates the need to perform any “hot work” on the interconnecting pipe.

### HVAC&R Nation: Is grounding required before working on R32 equipment (i.e. anti-static precautions)?

**Smith:** This is not currently a requirement as such, however, it would be sensible to include this aspect in the risk management plan.

### HVAC&R Nation: What licensing will be required to work on R32 systems?

**Smith:** R32 is a controlled substance and therefore remains under the jurisdiction of the national ARCTick licence.

From a regulation standpoint, individuals handling R32 must possess either a Certificate II in split system installation or the full Certificate III trade together with a current refrigerant handling licence.

R32 must be recovered.

### HVAC&R Nation: Is a licence required for R32 in Queensland, as is the case for hydrocarbons?

**Answer:** No. According to the Department of Natural Resources and Mining, Queensland legislation only applies to pure hydrocarbon refrigerants such as propane, butane, isobutane and blends of these gases. If the chemical formula of the refrigerant has other constituents such as fluorine, it does not fall under the department's jurisdiction.



Kevin Lee, M.AIRAH

refrigerants will decompose to the same three toxic substances as they all contain hydrogen and fluorine," Smith says.

He says while industry members should not be unduly concerned about working with R32, it does serve as a reminder that we work in a dangerous industry.

"Numerous hazards exist in every aspect of our working lives, including electrical, mechanical, physical and chemical. A complacent attitude to any of these will result in injury or worse."

The international push for new generation, lower GWP refrigerants has led ASHRAE to create a new 2L sub-class to the existing Class 2 flammability classification: A2L.

This is intended to take in refrigerants like R32, as it covers Class 2 refrigerants with a burning velocity less than or equal to 10cm/s. Gases with a low burning velocity do not propagate horizontally and are difficult to ignite. However, this change is yet to be recognised or endorsed in Australia (AS/NZS 1677.1) or internationally under ISO 817.

Interestingly, another refrigerant that would also be classified as A2L sub-class is R1234yf, which is finding wide application in the European motor vehicle industry.

## SUPPLY CHAIN

According to Kevin Lee, M.AIRAH, global technical manager for Heatcraft Australia, the speed at which R32 has been adopted by the major Japanese and Chinese based manufacturers has surprised many in the Australian refrigerant supply chain.

"Daikin released R32 on only four models of mini-splits in the Japanese market last November. Today they have more than 50 models released on R32," Lee says.

"China has also geared up very quickly on R32, as it has received government endorsement as the replacement for R22 in the Chinese domestic market."

Locally, a lag can be expected between the introduction of R32 pre-charged equipment in the latter months of 2013, and the supply of R32 to the local industry.

While this is largely due to a lack of compliant cylinders available that meet the pressure requirements of R32, the fact that Australia's refrigerant supply chain is largely geared to the supply of non-flammable, non-toxic refrigerants is also impacting supply.

"R32, due to its flammability, brings additional requirements that must be adhered to," says Lee. "Warehouse facilities, storage requirements and

handling procedures must all be reviewed and/or revised."

For instance, the Australian Dangerous Goods Code (ADG Code) for transport and storage classifies R32 as a dangerous good under Division 2.1 Flammable gases.

In contrast, Lee says that R32 is not classified as flammable for storage and transport in Japan, and therefore presented no challenges to the supply chain there.

He says Heatcraft is currently reviewing its branch refrigerant storage facilities and procedures, and is considering a roll-out of R32 in a limited number of strategically located branches.

"We are working towards having supply of R32 in some form within the next couple of months, but we cannot commit to any detail at this stage due to the uncertainties discussed."

## TRAINING

According to Cashel, one of the reasons Fujitsu has chosen Australia and New Zealand as among the first countries to launch R32-charged systems is because local technicians are considered well-equipped to handle and use A2 class flammable refrigerants.

"There are already many flammable refrigerants used in domestic refrigeration and air conditioning in Australia, and Fujitsu believes that all of our customers are very capable of transitioning to the use of these refrigerants," he says.

Since the release of its R32-charged split systems in September, Fujitsu has trained more than 1700 technicians Australia-wide, with workshops held in major metropolitan centres as well as regional locations.

"These were open product information sessions open to all installers – not just Fujitsu customers," Cashel says. "We intend to continue training customers on R32 refrigerants and our new range of wall-mounted split systems."

Likewise, Knox says Daikin will offer information sessions to its customer-base prior to launching its R32-charged range of air conditioners in Australia in coming months.

"They will contain information on the properties of refrigerants and oils, refrigerant cylinders, service and installation tools, as well as equipment installation and service," he says.

The Australian Refrigeration Equipment Manufacturers Association (AREMA) and National Electrotechnology Industry Skills Council (known as E-Oz) are also in discussions with the Kingswood Refrigeration and Air Conditioning section of Western Sydney Institute. They plan to produce a training manual and national course specifically aimed at the introduction of the new range of A2 refrigerants entering our industry.

According to Smith, while the focus is currently on R32, the course will be designed such that it can be quickly modified to include the latest HFO refrigerants as they enter our market.

"It is anticipated that the course will be ready for implementation by February 2014, with initial training sessions concentrating on bringing TAFE teachers around the country up-to-date, thus enabling a far wider choice of training sites," says Smith.

In the meantime, the industry-endorsed Flammable Refrigerant Safety Guide developed by AIRAH this year outlines the health and safety risks associated with refrigeration and air conditioning equipment and systems that use flammable refrigerants. This includes R32 based systems.

The Flammable Refrigerant Safety Guide is available for download at [www.airah.org.au](http://www.airah.org.au)

HVAC&R Nation will keep you up-to-date with available training and updates on R32 and other A2 flammable refrigerants throughout 2014. ▲

## HOW R32 STACKS UP

Refrigerants			Characteristics				
			P cond (MPa)	Cooling Capacity (%compared to HCFC22)	Theoretical COP (%compared to HCFC22)	ODP	GWP (IPCC 4th report)
	HCFC22	Single	1.73	100	100	0.05	1810
HFC	R407C	Zeotrope	1.86	98	95	0	1770
	R410C	Azeotrope-like	2.73	141	91	0	2090
	HFC32	Single	2.79	160	96	0	675
	HF01234yf	Single	1.15	56	92	0	4
	HF01234ze (E)	Single	0.88	45	98	0	6
	HFO-Mix	Zeotrope	n/a	n/a	n/a	0	n/a
Non-HFC	Ammonia	Single	1.78	115	105	0	0
	Propane	Single	1.53	83	97	0	< 3
	CO <sub>2</sub>	Single	10	256	41	0	1

Green cells indicate appropriate values for refrigerants.

Conditions: T<sub>evap</sub> = 0°C, T<sub>cond</sub> = 45°C, T<sub>sub cool</sub> = 0°C, T<sub>superheat</sub> = 0°C, Compressor efficiency = 70%

CO<sub>2</sub>: Gas cooler outlet temperature = 45°C, high side pressure = 10Mpa

Database: Cycle\_D, Version 5.0, NIST Standard reference database 49

Source: Daikin Australia