

Solstice™ 1234yf Refrigerant for MAC



The Facts

Honeywell

Editorial



Dear Readers,

The power of human innovation has allowed us to advance our standard of living and protect the environment at the same time. When the EU in 2006 called for a more environmentally friendly refrigerant for cars, they did not specify the technology to be used, but rather the benefit to be delivered. In response, Honeywell's team of world-class scientists launched an accelerated effort to develop the next

generation air conditioning refrigerant for cars. The result: a product that not only exceeded the goals set politically, but one that represents a long-term, global and energy-efficient solution. With more than 90 million light vehicles expected to be built per year by 2019, our new Solstice™ 1234yf mobile refrigerant is destined to become an even greater component in global climate protection.

Once again, Honeywell is proud to introduce another innovation that enables a safe, sustainable and more comfortable future. Thank you for your interest in Solstice™ 1234yf refrigerant and its benefits.

A handwritten signature in black ink that reads "Terrence". The signature is fluid and cursive, with a long, sweeping underline that extends to the left.

Terrence S. Hahn
Vice President and General Manager, Fluorine Products
Honeywell Specialty Materials

The Challenge

Air conditioners in cars have long since moved past the status of a costly option for cars. They are an important contribution to automotive safety. At 95°F/35°C inside a car – not uncommon in summertime even in Central Europe – the driver's response time is reduced by up to 65 percent. In the case of an emergency stop, this can make the crucial difference between a crash and the safe operation of the vehicle. But it does not have to be hot for ACs to add

security to comfort: in cold or moist conditions the AC prevents fogging of the wind screen and ensures an unobstructed view of the road for the driver.



Why a new refrigerant is essential – the political background

Solstice™ 1234yf is the refrigerant to achieve the climate goals set by the EU directive 2006/40, the “Mobile Air Conditioning” Directive (MAC), in a timely, cost effective, energy efficient, and safe way.

Starting with the 1989 Montreal Protocol, which bound the signing parties to phase out ozone depleting substances, the Kyoto Protocol in 1997 set specific goals. The industrialized countries agreed upon defined threshold values for greenhouse gases, which are one of the main causes of global warming.

When the EU Commission implemented the Kyoto Protocol in 2000 it also addressed automotive air conditioning. The objective

was to minimize negative impact on climate through innovative refrigerants. The EU MAC Directive 2006/40 was put in place in 2006. It mandates that all new car types have a refrigerant with a global warming potential (GWP) of less than 150 as of January 2011. From 2017 on, this standard will apply to all new cars.

Honeywell has provided a solution to this challenge: a refrigerant that fulfills all the requirements – environmentally friendly, efficient, safe and globally applicable – and is cost-effective for both the car industry and the individual car owner.

A History of Innovation – the Fourth Generation of Honeywell Refrigerants



The Solution

An innovation to improve the world step by step

Honeywell's Solstice™ 1234yf refrigerant is a key element in achieving the EU's climate goals. With a GWP of only 4, it is 97 percent lower than the mandate of less than 150. It is also 99.7 percent better than the refrigerant currently in use, R134a, which has a GWP of 1430. Solstice™ 1234yf refrigerant is safe and efficient in all climates across the world.

To achieve optimal results, Honeywell has worked closely with the car manufacturers. In 2008, following years of discussions with stakeholders in the automotive industry, Solstice™ 1234yf was identified as the refrigerant that delivered all the requirements – environmental benefits, energy and cost efficiency, global implementation and safety. It has also been subjected to worldwide testing by independent institutes under the supervision of the Society of Automotive Engineers (SAE). They agreed: Solstice™ 1234yf refrigerant is a satisfactory solution.



The Facts

► Climate Protection

Solstice™ 1234yf has a GWP (Global Warming Potential) of 4, exceeding the climate protection goals of the EU (GWP 150) many times over. Compared to alternative refrigerants, Solstice™ 1234yf has the most favorable climate footprint over its entire life cycle.

► Global Solution

Solstice™ 1234yf refrigerant has been established as a worldwide solution for mobile air conditioning.

► Fast Implementation

Solstice™ 1234yf refrigerant is compatible with most current air conditioning systems. Changes will need to be made, but it is not an entirely new technology.

► Energy Efficiency

Solstice™ 1234yf is more efficient in hot regions than competitive LGWP (Low Global Warming Potential) alternatives meeting the GWP 150 requirement of the EU MAC directive. The new refrigerant provides efficient cooling in all global climate zones and has been found suitable for global implementation.

► Safety

Solstice™ 1234yf is safe and can be used as the refrigerant in automotive air conditioning. Extensive, long-running studies have proven that Solstice™ 1234yf is safe for use in motor vehicles.

Ease of implementation

A near-drop-in solution

Implementation of Solstice™ 1234yf will require few changes to existing air conditioning systems. Contrary to that, CO₂ air conditioning system solutions require a complete overhaul of manufacturing technologies that would require significant investment in resources to implement.

Solstice™ 1234yf is an organic fluorinated compound and has performance properties similar to those of the refrigerant R-134a,

currently used in cars in many parts of the world. The operating system pressures of Solstice™ 1234yf are similar to the current refrigerant, R134a. This allows for re-use of the recent manufacturing technology advancements that will continue to make AC systems affordable into the next generation of Solstice™ 1234yf refrigerant systems.

Worldwide, car owners can actively contribute to climate protection without foregoing the safety and convenience of air conditioning.



Innovation

Investment in a more energy efficient, environmentally friendly future

Honeywell is convinced: Innovation is the best path to finding solutions for the challenges of our times. In addition to Solstice™ 1234yf, Honeywell has developed a number of energy efficient, environmentally friendly offerings including various refrigerants – for use in cars, homes, buildings, supermarkets and more, aerosol propellants, blowing agents for insulation applications, and solvents for super-critical electronics.

Innovation means investment. With the development of Solstice™ 1234yf refrigerant, Honeywell is investing in making modern life more comfortable, cost- and energy efficient.

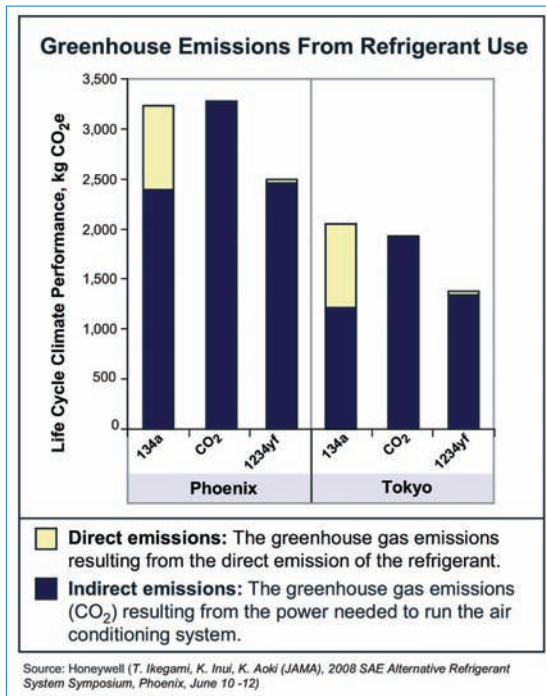


Convincing

The energy efficiency of Solstice™ 1234yf refrigerant

The major part of a refrigerant's global warming potential is due to indirect emissions: CO₂-emissions, caused by increased fuel consumption needed to power the air conditioning system.

Tests by the Japanese Automobile Manufacturers Association JAMA showed that ACs equipped with Solstice™ 1234yf refrigerant produce markedly less CO₂-emissions than those running with CO₂ in hot climate zones. Thus, Solstice™ 1234yf refrigerant provides a global solution to energy efficient vehicle air



Solstice™ 1234yf refrigerant is safe

Worldwide, independent institutes have assessed Solstice™ 1234yf refrigerant in numerous and long-running tests and studies. Risk analysis and laboratory tests as well as toxicological assessments have proven that Solstice™ 1234yf refrigerant is safe. The automotive industry itself has tested the safety of Solstice™ 1234yf refrigerant in use and conducted crash tests with it. These tests showed again that even in the case of a crash, Solstice™ 1234yf did not catch fire or cause any harm.

Third Party Support

“Use of the refrigerant is safe for car passengers and rescue workers.”

German Fire Services Association (DFV), 2011

DFV assessed Solstice™ 1234yf refrigerant in close cooperation with the German Association of the Automotive Industry VDA – including specifically designed tests according to requirements by DFV.

“Used in ACs, this refrigerant shows the least risk potential in comparison to alternative agents and fulfils best all environmental and customer requirements.”

*SAE International, 2010

In 2007-2009, the US Society of Automotive Engineers (SAE) conducted a comprehensive cooperative research program to assess Solstice™ 1234yf refrigerant, involving many independent third party institutes, including German Federal Institute for Materials Research and Testing (BAM), French National Institute for Industrial Environment and Risks (Ineris) and environmental and risk science consulting firm Gradient Corporation.

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Frequently asked questions ...

What is a refrigerant?

The purpose of air conditioning is to regulate the air temperature in spaces intended for human occupancy and provide us with a safe, comfortable condition to go about our daily lives. However, to produce this cooling effect, a refrigerant is needed to transport the energy away from us. The refrigerant works by undergoing a change in its physical state via an increase or decrease of pressure that is regulated by the compressor, expansion device and heat exchangers that make up the AC system hardware. When the refrigerant passes to the low pressure portion of the system, it becomes a very cold liquid and draws the heat away from the interior of the vehicle. Then absorbing enough heat, the refrigerant has boiled away to a gas where it passes through the compressor and it becomes hot because the pressure has been increased. The hot, gaseous refrigerant then transports the energy to the outside air through the condenser, located at

the front of the car. After dumping the energy to the outside air, the now high-pressure, liquid refrigerant flows back to the evaporator where the pressure is reduced and the cycle repeats.

How can such a small thing have such an impact on environmental protection?

To begin with, environmental protection is often the sum of a lot of small changes. With ACs today, two components make a substantial difference in reducing direct emissions. First, new ACs have fewer leaks; second, the most recently used refrigerant had a GWP – a global warming potential – of 1430. The new refrigerant, Solstice™ 1234yf, has a GWP of 4. That means that even if it leaks, there would be practically no impact on the environment. The other major component is indirect emissions that are produced by the burning of extra fuel required to power the AC. Solstice™ 1234yf refrigerant is environmentally friendly here. Its use is energy efficient.

Is it possible for me to put the new, environmentally friendly Solstice™ 1234yf refrigerant in my car as well?

Solstice™ 1234yf refrigerant has the potential to be used as a near retrofit. However, modifications may be necessary and this should take place only after the appropriate studies have been conducted to make sure the vehicle is prepared for Solstice™ 1234yf. In any case, any kind of refill or retrofit should always be conducted by properly trained service mechanics.

How much refrigerant is in an AC?

An average AC is equipped with 500 to 600 grams of refrigerant.

When is the first car equipped with Solstice™ 1234yf refrigerant going to be driven on the streets?

The European directive that prescribes the use of a more environmentally friendly refrigerant in cars went into effect on 1 January 2011 for all new car types. As of 1 January 2017, it will apply to all new cars inside the European Union. The first vehicle with Solstice 1234yf refrigerant will enter into the market in late 2011 or early 2012.

Beyond automotive

Other uses: Buses and Trains

Honeywell developed Solstice™ 1234yf refrigerant especially for the use in passenger vehicles. Its performance properties may also be suitable to replace other refrigerants used in commercial vehicles, buses, or trains.

At the moment, the new refrigerant is undergoing testing in pilot projects for public transport, one of them in Seville, Spain. Suppliers of public transport focus on a solution for ACs that is at the same time environmentally friendly and efficient. Additional fuel consumption should be as

low as possible. First results of the pilot projects suggest that Solstice™ 1234yf may fulfill this key requirement for these other vehicle types.

The evaluation of the pilot project data suggest that Honeywell Solstice™ 1234yf refrigerant could provide comfortable temperatures in buses – from Europe's Mediterranean South to the cool North and beyond.



The company

Facts on Honeywell

Honeywell was founded in 1906 and today is one of the world's leading global technology corporations. The company, with headquarters in Morristown, New Jersey, USA, delivers products and solutions for important markets – aerospace, automati-

on, specialty materials and transportation systems. Fifty per cent of the portfolio is in applications designed to improve energy efficiency.

Globally, more than 130,000 people are employed by Honeywell in 95 countries.

▶ Aerospace

- engines and instruments
- used in the field of aerospace

▶ Automation & Control Solutions

- Automation and control technology, energy management
- use in buildings and industry

▶ Specialty Materials

- High performance materials
- use in electronics, refrigeration, automotive and petrochemicals industries, among others

▶ Transportation Systems

- vehicle technologies and solutions
- turbochargers and brake linings

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