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CSIR-IICT Develops India's First Indigenous HFO-1234yf Refrigerant Process

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10 July 2026 · 3 min read ·

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WHY IN NEWS

In July 2026, the CSIR-Indian Institute of Chemical Technology (CSIR-IICT), Hyderabad, announced India's first indigenous process technology to manufacture Hydrofluoroolefin-1234yf (HFO-1234yf), a fourth-generation refrigerant that replaces high-GWP hydrofluorocarbons such as R-134a, with the technology now ready for transfer to industry.

WHAT IS HFO-1234YF

HFO-1234yf is a **fourth-generation refrigerant** used in air-conditioning and refrigeration, most prominently in automobile air-conditioners. Its significance lies in its environmental profile. It has **near-zero Ozone Depletion Potential (ODP)** and a **very low Global Warming Potential (GWP) of about 4**, against roughly **1,430 for the widely used R-134a** it is designed to replace.

Refrigerant chemistry has moved through generations: from ozone-destroying CFCs and HCFCs, to the ozone-safe but climate-warming HFCs (such as R-134a), and now to **HFOs**, which are both ozone-safe and climate-friendly. HFO-1234yf sits at the leading edge of this transition.

PROPERTY	HFO-1234YF	R-134A (HFC)
Generation	Fourth (HFO)	Third (HFC)
Ozone Depletion Potential	Near zero	Zero
Global Warming Potential	About 4	About 1,430
Typical use	Auto AC, refrigeration	Auto AC, refrigeration

THE INDIGENOUS BREAKTHROUGH

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Until now, HFO-1234yf has been produced by a small set of global manufacturers, and India has depended on imports. The **CSIR-Indian Institute of Chemical Technology (CSIR-IICT), Hyderabad, Telangana**, has developed a homegrown **process technology** to make the molecule, and the process is **ready for transfer to industry**.

This is a textbook **Atmanirbhar Bharat** outcome in green chemistry. Domestic production promises **import substitution**, lower costs for Indian air-conditioning and automobile manufacturers, and a secure supply of a strategically important chemical as the country phases out older refrigerants. CSIR-IICT functions under the **Council of Scientific and Industrial Research (CSIR)**, which is under the **Ministry of Science and Technology**.

THE CLIMATE-TREATY CONTEXT

The achievement maps directly onto India's international obligations. The **Montreal Protocol (1987)** is the landmark treaty that protects the ozone layer by phasing out ozone-depleting substances. Its **Kigali Amendment (2016)** extended the treaty's reach to the **phase-down of HFCs**, which, though ozone-safe, are potent greenhouse gases.

India ratified the Kigali Amendment in 2021, and under its agreed schedule the **phase-down of HFCs begins in 2032**. Building indigenous capacity to make low-GWP alternatives like HFO-1234yf is precisely how a country meets such a phase-down without becoming dependent on foreign suppliers. Domestic R&D thus becomes an instrument of climate diplomacy.

ANALYSIS AND WAY FORWARD

The development shows how laboratory science can serve national strategy at once, cutting an import bill, advancing green chemistry and helping meet a treaty commitment. The real test now is **scale-up**: moving from a validated process to reliable, cost-competitive industrial production, and ensuring safe handling, since HFO-1234yf is mildly flammable. If Indian industry adopts the process ahead of the 2032 phase-down window, the country can enter the transition from a position of manufacturing strength rather than dependence.

UPSC RELEVANCE

GS Paper 3: Science and technology developments and their applications; **indigenisation** (<https://ujiyari.com/vocab/indigenisation/>) of technology; environment and climate-change agreements.

Prelims pointers:

- HFO-1234yf is a fourth-generation refrigerant with near-zero ODP and a GWP of about 4, versus about 1,430 for R-134a.
- The Montreal Protocol (1987) protects the ozone layer; the Kigali Amendment (2016) targets the phase-down of HFCs.
- India ratified the Kigali Amendment in 2021, with its HFC phase-down beginning in 2032.
- CSIR-IICT is located in Hyderabad and functions under CSIR, Ministry of Science and Technology.
- HFOs are both ozone-safe and low in global-warming impact.

Mains question: “Indigenous development of low-GWP refrigerants illustrates how domestic R&D can advance both self-reliance and climate-treaty compliance. Discuss with reference to the Kigali Amendment and India’s phase-down obligations.” (15 marks, 250 words)

FACTS CORNER

★ FACTS CORNER, KNOWLEDGEPEDIA

HFO-1234yf: Fourth-generation refrigerant, near-zero ODP, GWP about 4; replaces R-134a (GWP about 1,430).

CSIR-IICT: Indian Institute of Chemical Technology, Hyderabad, under CSIR, Ministry of Science and Technology.

Montreal Protocol (1987): Treaty protecting the ozone layer.

Kigali Amendment (2016): Amendment to the Montreal Protocol targeting the phase-down of HFCs.

India and Kigali: Ratified in 2021; HFC phase-down begins in 2032.

Significance: Atmanirbhar Bharat in green chemistry, import substitution and climate-treaty compliance.

Sources: *CSIR-IICT* (<https://www.iict.res.in/>), *Council of Scientific and Industrial Research* (<https://www.csir.res.in/>), *Press Information Bureau* (<https://pib.gov.in/>)

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