# STATUS OF LEGAL CHALLENGES: PATENTS RELATED TO THE USE OF HFO-1234YF IN AUTO AIR CONDITIONING


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One of the key challenges identified by Parties to the Montreal Protocol as part of the Dubai Pathway on Hydrofluorocarbons (HFCs) relates to concerns raised about intellectual property rights. Because a large number of patents on low global warming potential (GWP) chemical substitutes for HFCs have been filed by a few transnational companies, a number of developing countries (Article 5 Parties) have raised concerns that these could impede their ability to meet HFC reduction goals, significantly increase the costs of doing so, or put their industries at a competitive disadvantage.

Numerous patents have been granted and applications for patents filed both on methods for producing chemical substitutes (i.e., primarily hydrofluoroolefins [HFOs]) and on the compositions and use of these substitutes in a number of industry sectors primarily in developed (non-Article 5) and in several Article 5 Parties. The category of patents on compositions and their uses are generally referred to as application patents. This paper seeks to address what has been described as the primary concern related to patents—*even if chemical companies in Article 5 Parties can develop their own methods of producing HFOs, they would be prevented (absent a license) from selling their products at home and in key markets abroad in countries where application patents have been granted to other companies until the time when these patents expire.*

## I. KEY FINDINGS

This paper focuses on application patents granted on compositions for, and the use of, HFO-1234yf in the automobile air-conditioning sector and examines the current status of legal challenges to a number of patents relevant to this sector. Key findings include:

- Nine patents granted in the United States and Japan and under the European Patent Convention that, in the absence of a license, would prevent the use of HFO-1234yf in automobile air conditioning, are in various stages of challenges, with all patent-holder claims relevant to the use of HFO-1234yf in auto air conditioning canceled or rejected.
- Two of these challenges are final determinations, while the other seven are at various stages of appeals, including re-opening of prosecution.
- Patents granted in India and China on compositions for the use of HFO-1234yf in automobile air conditioning claim the same or very similar subject matter to that recited in the claims contained in the nine patents that have been successfully challenged in the United States, Europe, and Japan.
- Other patent applications (e.g., continuations in part and divisionals[1]) have been filed, and other

patents have recently been granted (some of which are in early stages of being challenged), that are also relevant to the use of HFO-1234yf in automobile air conditioning.

- Any conclusions from this review of legal challenges must be viewed as tentative pending new developments. While a number of early challenges have been successful in revoking relevant patents, in most cases appeals are still pending. In addition, new patents derived from these existing patents are being granted and challenges to them, if successful, will require additional time.
- If any of the legal challenges described below ultimately result in patents being upheld, then restrictions resulting from the patent claims would continue through 2023–25 when they would expire.

## II. APPLICATION PATENTS RELATED TO HFO-1234YF IN AUTO AIR CONDITIONING

This paper focuses on the status of legal challenges to a number of application patents—specifically the use of HFO-1234yf in automobile air conditioning.[2] This sector was targeted because the market for its use is the most advanced. The automobile manufacturing sector is already well along in its transition from HFC-134a to HFO-1234yf in developed nations, many of which have regulations in place setting deadlines for such transitions. While much industry effort has focused on shifting to HFO-1234yf, research is also being conducted on alternative secondary loop systems using HFC-152a[3] and Daimler has announced that it will introduce the first vehicles with carbon dioxide air-conditioning systems in 2017. Nonetheless, automobile manufacturers have developed technical standards (i.e., by the Society of Automotive Engineers) based on converting to HFO-1234yf, and appear to be continuing along this path.

A large number of application patents have been filed by transnational companies that could potentially impact the use of HFO-1234yf in auto air conditioning. Many of these cover the use of a wide range of blends, often involving HFO-1234yf mixed with other compounds. Because the automobile manufacturing sector has focused its efforts on the use of HFO-1234yf alone and not in blends, our analysis focuses only on those patents that would impact the use of HFO-1234yf in this manner in auto air conditioning.

With this limitation in mind, we have focused our analysis on legal challenges on the following nine patents, shown below, that have been granted in the United States, Japan, or by the European Patent Office.[4] These patents appear to be most relevant to the use of pure HFO-1234yf as the refrigerant in auto air conditioning. The patent holder for all nine is Honeywell. These three jurisdictions represent the largest developed country markets for chemical producers seeking to sell substitutes for refrigerants used in automobile air conditioning. Section IV of this paper looks at similar patents granted in India and China that could impact companies' ability to sell HFO-1234yf for use in auto air conditioning in these large developing countries.

Box 1 shows that most of these same patents have also been identified by Honeywell as applicable to use of HFO-1234yf in automobile air conditioning. As described above, while other transnational companies have patents on HFO and other blends for use in auto air conditioning, the blend patents appear to be less relevant and therefore are beyond the scope of this analysis.[5]

### TABLE 1: Patents on the use of HFO-1234yf in Automobile Air Conditioning

| UNITED STATES | EUROPEAN UNION | JAPAN |
|---|---|---|
| US 7,279,451 | EP 1 563 032 | JP 4571183 |
| US 7,534,366 | EP 1 716 216 | JP 4699758 |
| US 8,033,120 | EP 1 725 628 | |
| US 8,065,882 | | |

## BOX 1: Honeywell Web Information on Patents for the Use of HFO-1234yf in Auto Air Conditioning

### SOLSTICE® YF PATENT INFORMATION

Following is a listing of the Honeywell patents under which certain limited rights are granted to purchasers of Honeywell's Solstice yf product. The patents under which rights are granted are limited by application and in accordance with the terms of the purchased product's label license.

For automotive air-conditioning applications:

For the US:

- US 8,065,882
- US 8,033,120
- US 7,279,451
- US 7,534,366
- US 9,157,017

For the EU:

- EP 1 563 032
- EP 1 725 628

For Japan:

- JP 4571183

Honeywell recently updated this web page to include one new patent in the United States (US 9,157,017) and one in Europe (EP 1 563 032). It also eliminated one patent in Europe (EP 1 716 216) and one in Japan (JP 4699758) where legal challenges have successfully revoked the patents with all appeals exhausted. See section III below.

*Source: "Solstice® yf Patent Information | European Refrigerants," Honywell, last accessed July 5, 2016,* https://www.honeywell-refrigerants.com/europe/about-us/solstice-yf-patent-information.

## III. STATUS OF LEGAL CHALLENGES

This analysis focuses on the nine application patents identified in Table 1 that impact the use of HFO-1234yf in automobile air conditioning and that have been the subject of legal challenges. All of the relevant claims[6] included in these nine cases have been rejected by the legal body responsible for hearing the challenges and these rejections have been upheld on the initial appeal. In two of these cases (EP 1 716 216 and JP 4699758), the appeals process has been exhausted and decisions revoking the patents are final. In the remaining seven patents, appeals are at various stages of the legal process and may not be finally resolved for some time. Under the rules governing U.S., European, and Japanese patents, until all avenues of appeal are exhausted, or the time for taking an appeal has expired, patents remain in effect, notwithstanding a determination that all claims are invalid.

The reasoning behind the rejection of specific claims in these patents varies but includes: a lack of novelty or inventiveness due to the existence of prior art.[7] For the European patent challenges, the revocations have been based on failure to describe in the application a basis for the claims added by amendment after filing the application (i.e., an added matter issue).

The following sections briefly describe each patent and the current stage of legal challenges to that patent. Table 2 summarizes this information.

### US 7,534,366 (US '366)

This patent issued from an application filed on October 27, 2003. It covers a heat-transfer composition for use in an air-conditioning system that is comprised of generally at least 50 percent by weight of HFO-1234yf and at least one polyalkylene glycol lubricant. The patent was challenged and a reexamination initiated (#95/002,189) at the U.S. Patent and Trademark Office (USPTO), where all claims were rejected by the examiner. This ruling was appealed to the Patent Trial & Appeals Board (PTAB) and a decision was handed down on March 20, 2016 affirming the examiner's decision to reject all claims. An appeal of the PTAB decision to the U.S. Court of Appeals for the Federal Circuit (CAFC) was filed on May 2, 2016 and is pending.[8]

### US 7,279,451 (US '451)

This patent issued from an application filed on April 29, 2004. It covers a heat-transfer composition comprising at least one fluoroalkene described by a chemical formula contained in the patent (which includes HFO-1234yf as a subset), and that makes up between 5 and 99 percent by weight of the composition. A request to reexamine this patent was granted by the USPTO (#95/000,576) resulting in the initial rejection of all pending claims by the examiner. Upon appeal to the PTAB, the previous decision rejecting all claims was affirmed. A request for rehearing by the PTAB was filed on May 2, 2016 and awaits a decision. If the request is denied, the PTAB decision may be appealed to the CAFC.

### US 8,033,120 (US '120)

This patent issued from an application filed on April 20, 2009. It covers a method of cooling air comprising providing a heat-transfer fluid that includes a lubricant and a fluoroalkene based on a chemical formula contained in the patent (that includes HFO-1234yf as one possible subset). The '120 Patent also was re-examined (#95/001,783) and the examiner's decision to reject all the claims was appealed to the PTAB. The PTAB decision affirmed the rejection of some of the claims by the re-examination examiner and rejected the remaining claims on new grounds, substituting its own modified basis for rejection. Because the PTAB asserted new grounds for rejecting some of the claims, the patent holder requested re-opening prosecution before the examiner for consideration of new evidence and arguments regarding the new grounds of rejection. In addition, on May 2, 2016, the patent holder filed a request for rehearing by the PTAB. If the request for rehearing is denied, and if the examiner again rejects the claims, and the PTAB affirms the rejections, the PTAB decision may be appealed to the CAFC.

### US 8,065,882 (US '882)

This patent issued from an application filed on March 26, 2009. It covers several methods relating to auto air conditioning or cooling air, including a method of transferring heat to or from a fluid or body to provide cooling of air in an automobile with the specifics of the heat-transfer composition described by a chemical formula in the patent. This formula encompasses HFO-1234yf. All claims in the patent were rejected or cancelled during a USPTO reexamination (#95/002,030). On appeal, the PTAB affirmed the rejection of the claims either on the same grounds, or in some cases, on alternative grounds. Because the PTAB asserted new grounds for some of the rejected claims, the patent holder requested re-opening prosecution before the examiner for consideration of new evidence and arguments regarding the new grounds of rejection. In addition, on May 2, 2016, the patent holder filed a request for a rehearing before the PTAB. If the request for rehearing is denied, and if the examiner again finally rejects the claims and the PTAB affirms the rejections, the PTAB decision may be appealed to the CAFC.

### EP 1 563 032 (EP '032)

This patent is derived from the European regional stage of a Patent Cooperation Treaty (PCT) application (published as WO 2004/037913) with an international filing date of October 27, 2003. It covers the use as a heat-transfer composition of a composition comprising at least one HFO-1234 and a polyol ester or polyalkylene glycol lubricant. Opposition to this patent was filed in 2012 and the European Patent Office (EPO) Opposition Division issued a communication revoking the patent on January 15, 2015. An oral hearing is scheduled for January 17, 2017 on an appeal of the revocation to the EPO Boards of Appeal filed by the patent holder.

### EP 1 716 216 (EP '216)

This patent is derived from the European regional stage of a PCT application (published as WO 2005/105947) filed on April 29, 2005. It covers use as a refrigerant of a composition comprising an HFO-1234 in an automobile

air-conditioning system. The EPO Opposition Division revoked this patent following a hearing. Following oral proceedings, this decision was upheld on appeal by the EPO Boards of Appeal and the time period for further appeal has lapsed.

### EP 1 725 628 (EP '628)

This patent is a European regional stage of a PCT application (published as WO 2005/042663) with an international filing date of October 25, 2004. It covers a liquid composition for use in a compression refrigeration, air-conditioning or heat-pump system comprising a general formula including at least HFO-1234yf and a polyol ester or polyalkylene glycol lubricant. Several oppositions to this patent were filed in 2012–2013 and the EPO Opposition Division issued a communication revoking the patent on Jan. 15, 2015. An appeal of the revocation to the Boards of Appeal has been filed by the patent holder.

### JP 4699758 (JP '758)

This patent is a Japanese national stage of a PCT application (published as WO 2004/037913) filed on October 27, 2003, and covers a heat-transfer composition comprising a component described in a chemical formula in the patent along with a polyol ester or polyalkylene glycol lubricant. This patent has been ruled invalid based on a decision by the Japan Patent Office (JPO) Board of Appeals. A further appeal to the high court affirmed the invalidity decision and no further appeals are possible.

### JP 4571183 (JP '183)

This patent is a Japanese national stage of a PCT application (published as WO 2005/105947) filed on April 29, 2005, and covers use as a refrigerant of a constituent containing tetrafluoropropane (HFO-1234) in air-conditioner of an automobile. The patent has been ruled to be invalid based on a decision by the JPO Board of Appeals, but a decision on appeal before the high court is pending.

## SUMMARY OF LEGAL CHALLENGES

Table 2 summarizes the evolution and current status

**TABLE 2: Summary of Legal Challenges**

| PATENT NUMBER | INITIAL APPEAL | FURTHER APPEALS | CURRENT STATUS |
|---|---|---|---|
| US '366 | PTO re-examination—all claims rejected | PTAB affirmed rejections | Appealed to U.S. Court of Appeals |
| US '451 | PTO re-examination—all claims rejected | PTAB affirmed rejections | Rehearing by PTAB requested |
| US '120 | PTO re-examination—all claims rejected | PTAB affirmed rejections; issued new rejections | Rehearing by PTAB requested; prosecution re-opened |
| US '882 | PTO re-examination—all claims rejected | PTAB affirmed rejections; issued new rejections | Rehearing by PTAB requested; prosecution re-opened |
| EP '032 | EPO Opposition Division revoked patent | Under appeal to EPO Boards of Appeal | Appeal of revocation is pending |
| EP '216 | EPO Opposition Division revoked patent | EPO Boards of Appeal upheld revocation | No further appeals possible |
| EP '628 | EPO Opposition Division revoked patent | Under appeal to EPO Boards of Appeal | Appeal of revocation is pending |
| JP '758 | JPO Board of Appeals invalidated patent | Appeals court affirmed invalidation | Revocation is final |
| JP '183 | JPO Board of Appeals invalidated patent | Under appeal to high court pending | Appeal pending |

of legal challenges to the nine key application patents examined in this analysis. It shows that in all nine cases, the entire relevant set of claims contained in these patents has been rejected. In two of these cases, appeals have been exhausted and decisions are final. In the other seven, appeals are pending, requests for rehearing are awaiting a decision, or reconsideration of certain claims by the initial examining authority is in progress.

### ADDITIONAL PATENTS OF RELEVANCE

There are several other patents related to the use of HFO-1234yf in auto air conditioning that recently have been issued and therefore have not yet resulted in legal challenges. In particular, in the United States, US 9,157,017 issued from an application filed on March 26, 2014.[9] It claims a method for cooling air in an automobile using HFO-1234yf and a polyalkylene glycol lubricant. This patent is at the early stages of being challenged by two petitions seeking post grant review and one petition seeking inter parties review. The outcome of these challenges and any subsequent appeals regarding this patent will be relevant to the use of HFO-1234yf in auto air conditioning in the United States.[10]

A communication from the EPO issued recently stating its intention to grant a patent, EP 2314654 (divisional of EP' 032) claiming a refrigerant composition comprising at least 50 percent by weight of a fluoroalkene having a general formula that includes HFO-1234yf and a lubricant which is a polyalkylene glycol.

A communication from the EPO issued in April 2016 stated its intention to grant a patent, EP 2277970 (divisional of EP' 628) claiming, in pertinent part, a liquid composition for use in compression refrigeration, air-conditioning and heat pump systems comprising a fluoroalkene containing from 3 to 4 carbon atoms and at least one but not more than two double bonds and a lubricant, wherein the mixture has one liquid phase with at least one temperature in the range between -40°C and 70°C.[11]

## IV. PATENTS IN INDIA AND CHINA RELEVANT TO USING HFO-1234YF IN AUTO AIR CONDITIONING

Given the potentially substantial markets in India and China for the use of a substitute refrigerant in auto air-conditioning systems, it is not surprising that applications for patents have been filed for this technology in these countries. It is also not surprising that the patents filed in both countries share many common elements with patents filed in the United States, Europe, and Japan given that they arise from the same PCT application. In fact, the PCT was created in part to make it easier to file the same patent application in multiple national or regional jurisdictions. While the applications leading to these patents start off the process virtually the same (i.e., filed under the PCT), as they are reviewed and acted upon by national or regional patent offices, the individual claims can be modified, for example, to address objections raised by specific patent offices and to take into account differences in local or regional legal practices.[12] Nonetheless, it is significant that the relevant patents in India and China contain the same or similar claims to those found in related patents in the United States, Europe, and Japan.

Because claims in specific patents are often modified as they go through national review in a particular country, this section looks at each of the claims contained in two patents granted in India and one in China that appear most relevant to the use of HFO-1234yf in automobile air conditioning. The analysis presented here examines each of the claims in these three patents and compares them to claims included in eight of the nine challenged patents (from the United States, Europe, and Japan) previously discussed. The objective of this analysis is to see if the subject matter of each of the claims in the Indian and Chinese patents can be matched with the same or closely similar subject matter of claims that have been challenged and rejected (pending review) in one or more of the eight relevant patents from the United States, European Patent Convention, or Japan.

It is important to note that decisions rejecting claims by one national patent authority are not in any way binding on another jurisdiction. Each country's patent office makes its own determinations based on national laws. For example, the test applied in Europe to assess whether a claim formally finds basis in the application as originally filed is very strict and this same test is not applied in

any other jurisdiction. Nonetheless, there is considerable commonality across nations in patent laws developed to comply with the Patent Cooperation Treaty and the same information used to challenge the novelty or inventiveness of claimed subject matter in one national jurisdiction may be introduced in proceedings in other national jurisdictions.

## KEY FINDINGS FROM COMPARISONS

For every one of the claims in the two Indian and one Chinese patents, we found the same or substantially similar subject matter in claims that had been rejected in one or more of the eight U.S., European, or Japanese patents examined in this analysis. Attachments 1 and 2 list the claims in the two Indian patents in the first column and identify corresponding claims from eight patents in other jurisdictions (United States, Europe, and Japan) that have been rejected. Since some of the decisions rejecting claims are under appeal, as stated above, the information contained in these tables could change over time. Attachment 3 does the same cross-comparison for the Chinese patent believed to be most relevant.

The two patents granted in India that appear to be most relevant to the use of HFO-1234yf in auto air conditioning have been filed by Honeywell and are: IN 250569 (Compositions Containing Fluorine Substituted Olefins) and IN 239049 (Heat-Transfer Composition for an Air-Conditioning System). The IN 250569 patent focuses on a "method of transferring heat to or from a body to provide cooling of air in an automobile" using a heat-transfer composition defined by a chemical formula which includes HFO-1234yf. The IN 239049 patent focuses on "a heat-transfer composition for use in an air-conditioning system" with specifications that include the use of HFO-1234yf of at least 50 percent by weight.

For IN 239049, we found that its 18 claims closely matched specific claims contained in the US '366 patent. In the case of all 18 claims we found that the exact or similar claim in the US '366 patent has been rejected in the reexamination conducted by the USPTO. On appeal to the PTAB, the rejection of all claims was affirmed and a further appeal to the CAFC is pending. Attachment 1 identifies specific claims in the US '366 patent that match each of the claims in the Indian patent.

Attachment 1 goes on to show that the subject matter of claims in IN 239049 was also contained in exact or similar form in a number of the other seven relevant patents granted in the United States, Europe, and Japan. For example, IN 239049 contains many of the same claims or claims similar subject matter as recited in the claims of the closely related US '120 and US '451 patents. All the claims in both of these U.S. patents have been rejected during reexamination and the decisions affirmed by the PTAB. Requests for a rehearing of the appeal decision by the PTAB or a reopening of the proceeding have been filed by the patent holder. The subject matter of key claims in the Indian patent also tracks closely the subject matter of key claims in the European and Japanese patents that have been rejected with appeals pending in some cases.

The claims in the IN 250569 patent are laid out in Attachment 2 and are also compared to the same eight relevant patents from the United States, Europe, and Japan. In this case, all 48 claims in the Indian patent closely match rejected claims from the US '882 patent. In addition, a large number of the claims in the Indian patent correspond to subject matter recited in claims that have been rejected in other of the patents including those from Europe and Japan presented in the table.

There are pending oppositions against IN 239049 and IN 250569, but the status of that proceeding is undetermined at this time.[13]

The most relevant Chinese patent CN 1732243 (CN '243) is also held by Honeywell and covers the use of a heat-transfer composition in an automobile air-conditioning system and apparatus, said heat-transfer composition comprising a refrigerant comprising HFO-1234yf in an amount of at least 50 percent by weight and a lubricant selected from polyalkylene glycol and/or polyol esters.[14] It is a national stage of the PCT application (published as WO 2004/037913) which claims a priority date of October 25, 2002, to the same two U.S. provisional applications from which the US '366 claims priority. Attachment 3 compares the claims related to the use of HFO-1234yf in auto air conditioning in the Chinese patent to the claims contained in the eight U.S., E.U. and Japanese patents.[15] It shows that for the subset of claims in CN '243 relevant to HFO-1234yf and automobile air conditioning that similar subject matter is recited in the rejected claims of US '366. The attachment also shows that the subject matter or subsets of the subject matter of relevant claims in CN '243 can be found in many of the rejected claims contained in the other seven patents examined in this analysis.

## V. EXPIRATION DATES FOR RELEVANT PATENTS

To the extent patents survive the legal challenges described above, they will continue to restrict the uses of the surviving claimed subject matter in the jurisdictions in which they have been granted until they reach their expiration dates. In general, the patents relevant to this topic expire 20 years after the effective filing date. Determining the "effective filing date", i.e., when the 20-year period begins, is of critical importance. Many of the patents discussed above are related and all claim priority from previously filed applications. In the United States, patents that claim priority from earlier applications expire 20 years from the filing date of the earliest previously claimed priority application (with provisional patents excluded). For patents arising from regional or national stage Patent Cooperation Treaty applications, the effective filing date is the date of the PCT filing. Table 3 provides the relevant priority claims, dates and expiration dates for the patents examined in this analysis relevant to the use of HFO-1234yf in automobiles. It shows that for the patents examined in this analysis, the relevant expiration dates range from 2023–25.

## VI. CONCLUSIONS

This analysis looked at the current status of legal challenges to those application patents that appear most relevant to the use of HFO-1234yf in auto air conditioning. It focused on nine patents in the United States, the European Patent Convention, and Japan; each one has been successfully challenged with all of its relevant claims rejected. However, any conclusions based on these outcomes must be viewed as tentative because appeals are pending in seven of the nine cases, one additional patent in the United States is in the early stages of challenge, and additional patents (i.e., divisionals) are likely to issue from applications currently in the pipeline or could potentially emerge at some future date.

Patents on the use of HFO-1234yf in automobile air conditioning also have been granted in India and China. These patents are part of the same families as those that have been successfully challenged[16] in the U.S., European, and Japanese Patent Offices. While each jurisdictions makes its own legal determinations, our analysis demonstrates that the claims contained in these relevant patents in India and China closely match the subject matter of specific rejected claims in one or more of the eight U.S., European, or Japanese patents we reviewed.

The evidence to date shows a strong record of successful challenges revoking patents restricting the use of HFO-134yf in automobile air conditioning. However, given the time required for appeals to play out and the ability to file new divisional applications, it is difficult to predict a timetable for when it may be possible for chemical producers to sell in key markets unrestricted by patents. Based on the patents reviewed in this analysis, one clear end point is the expiration of relevant application patents that occurs in the 2023–25 timeframe. Whether patent restrictions are lifted before then will be determined by the outcomes of the on-going legal challenges.

## TABLE 3: Relevant Dates for Some Key Patents and Applications Relating to HFO-1234yf

| PATENT OR APPLICATION NO. | EARLIEST CLAIMED PRIORITY DOCUMENT NOS. | EARLIEST CLAIMED PRIORITY DATES | EFFECTIVE FILING DATE | EXPIRATION DATE |
|---|---|---|---|---|
| US 7,279,451 | 60/421,435<br>60/421,263<br>10/694,272<br>10/694,272<br>10/695,212 | 10/25/2002<br>10/25/2002<br>10/27/2003<br>10/27/2003<br>10/27/2003 | 10/27/2003 | 10/27/2023 |
| US 7,534,366 | 60/421,435<br>60/421,263 | 10/25/2002<br>10/25/2002 | 10/27/2003 | 10/27/2023 |
| US 8,033,120 | 60/421,263<br>60/421,435<br>10/694,273 | 10/25/2002<br>10/25/2002<br>10/27/2003 | 10/27/2003 | 10/27/2023 |
| US 8,065,882 | 60/421,263<br>60/421,435<br>10/694,272<br>10/694,272 | 10/25/2002<br>10/25/2002<br>10/27/2003<br>10/27/2003 | 10/27/2003 | 10/27/2023 |
| US 9,157,017 | 60/421,263<br>10/694,272 | 10/25/2002<br>10/27/2003 | 10/27/2003 | 10/27/2023 |
| EP 1 563 032 | US 60/421,262<br>US 60/421,435<br>PCT/US2003/033874 | 10/25/2002<br>10/25/2002<br>10/27/2003 | 10/27/2003 | 10/27/2023 |
| EP 1 716 216 | US 10/837,525<br>PCT/US2005/014873 | 4/29/2004<br>4/29/2005 | 4/29/2005 | 4/29/2025 (N/R, as this patent has been finally revoked) |
| EP 1 725 628 | US 10/695,212<br>PCT/US2004/035132 | 10/27/2003<br>10/25/2004 | 10/25/2004 | 10/25/2024 |
| JP 4571183 | US 10/837,525<br>PCT/US2005/014873 | 4/29/2004<br>4/29/2005 | 4/29/2005 | 4/29/2025 |
| JP 4699758 | US 60/421,262<br>US 60/421,435<br>PCT/US2003/033874 | 10/25/2002<br>10/25/2002<br>10/27/2003 | 10/27/2003 | 10/27/2023 |
| CN Pub. # 1732243<br>App. # 200380107462 | US 60/421,262<br>US 60/421,435<br>PCT/US2003/033874 | 10/25/2002<br>10/25/2002<br>10/27/2003 | 10/27/2003 | 10/27/2023 |
| IN 250569 | US 10/837,525<br>PCT/US2005/014873 | 4/29/2004<br>4/29/2005 | 4/29/2005 | 4/29/2025 |
| IN 239049 | US 60/421,262<br>US 60/421,435<br>PCT/US2003/033874 | 10/25/2002<br>10/25/2002<br>10/27/2003 | 10/27/2003 | 10/27/2023 |

# APPENDIX

## Attachment 1: Indian 239049

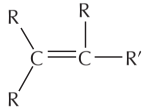
| INDIA 239049: HEAT-TRANSFER COMPOSITION FOR AN AIR-CONDITIONING SYSTEM | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| *Status* | ***Rejected claims from US '366*** ***(PTAB decision appealed to Federal Circuit on May 3, 2016)*** | *Rejected claims from US '451* *(Request for rehearing of PTAB decision filed May 2, 2016)* | *Rejected claims from US '882* *(Request for rehearing of PTAB decision filed May 2, 2016)* | *Rejected claims from US '120* *(Request for rehearing of PTAB decision filed May 2, 2016)* | *Rejected claims from EP 1563032* *(on appeal)* | *Rejected claims from EP 1716216* *(final)* | *Rejected from JP 4699758*[17] *(final)* | *Rejected from JP 4571183* *(on appeal)* |
| 1. A heat-transfer composition for use in an air-conditioning system comprising:<br>(a) at least 50% by weight of 2,3,3,3-tetrafluoropropene (HFO-1234yf) having no substantial acute toxicity; and<br>(b) at least one poly alkylene glycol lubricant. | **Cl. 1** | Cl. 4 regarding HFO-1234yf and cl. 22 regarding 50% by wt. | Claims are to a method of transferring heat that includes a fluoroalkene and a lubricant; cl. 7 is specific to HFO-1234yf, cl. 22 to 50% by wt.; cl. 14 to poly-alkylene glycol. | Cl. 10, in a method for cooling air. | Cls. 1+2+8+ 9, and 12(i)+13+17. | Cls. 1+6+7, but at least 50% by wt. in a range in cl. 2 or 3. | Cls. 1+2+5+8. | Cl.s 1+4+5, but excludes no toxicity and 50% by wt. |
| 2. The composition of claim 1 having a Global Warming Potential (GWP) of not greater than 150. | **Cl. 2** | Cl. 16 | Cl. 16 | NA | NA | NA | NA | NA |

| INDIA 239049: HEAT-TRANSFER COMPOSITION FOR AN AIR-CONDITIONING SYSTEM | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 3. The heat-transfer composition of claim 1 optionally comprising at least one compatablizer. | **Cl. 3** | Cl. 13 | NA | NA | NA | NA | NA | NA |
| 4. The heat-transfer composition of claim 1 wherein said lubricant is present in an amount of at least 30% by weight. | **Cl. 4** | Cl. 8, but in a range of 30–50% | Cl. 12, but in a range of 30–50% | | Cls. 4 and 15, but in a range of 30–50% | Cl. 5, but in a range of 30–50% | Cl. 4, but in a range of 30–50% | Cl. 3, but in a range of 30–50% |
| 5. The composition of claim 1 wherein said lubricant is present in an amount of 50% by weight of the composition. | **Cl. 7** | Cl. 8, but in a range of 30–50% | Cl. 12, but in a range of 30–50% | Cl. 11 | Cls. 4 and 15, but in a range of 30–50% | Cl. 5, but in a range of 30–50% | Cl. 4, but in a range of 30-–0% | Cl. 3, but in a range of 30–50% |
| 6. The composition of claim 1 wherein said composition is non-flammable. | **Cl. 8** | NA | NA | NA | NA | NA | NA | NA |
| 7. The composition of claim 1 having a Global Warming Potential (GWP) of not greater than 100. | **Cl. 9** | NA | NA | NA | NA | NA | NA | NA |
| 8. The composition of claim 1 having a Global Warming Potential (GWP) of not greater than 75. | **Cl. 10** | Cl. 17 | Cl. 17. | Cls. 1 and 13 recite GWP not greater than 75 | NA | NA | NA | NA |
| 9. The composition of claim 1 having an Ozone Depletion Potential (ODP) of not greater than 0.02. | **Cl. 11** | Cl. 19 | Cl. 19 | NA | NA | NA | NA | NA |
| 10. The composition of claim 1 wherein said HFO-1234yf comprises at least 70% by weight of the composition. | **Cl. 12** | Cl. 23 | Cl. 23 | NA | Cls. 3+8 and 12+14 | NA | Cls. 3+8 | NA |
| 11. The composition of claim 10 wherein said compatablizer is selected from the group consisting of propane, butane, pentane, and combinations of these. | **Cl. 13** | NA | NA | NA | NA | NA | NA | NA |

| INDIA 239049: HEAT-TRANSFER COMPOSITION FOR AN AIR-CONDITIONING SYSTEM | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 12. The composition of claim 10 comprising compatablizer in amounts of from 0.5 to 5 percent by weight of the composition. | **Cl. 14** | Cl. 36 | NA | NA | NA | NA | NA | NA |
| 13. The composition of claim 1 having a capacity relative to HFC-134a of 1. | **Cl. 15** | NA | Cls. 35, 44 | Cl. 13 | NA | NA | NA | NA |
| 14. The composition of claim 1 having a Coefficient of Performance (COP) relative to HFC-134a of 1. | **Cl. 16** | NA | Cls. 35, 44 | Cl. 13 | NA | NA | NA | NA |
| 15. The composition of claim 1 further comprising a surfactant and a solubilizing agent. | **Cl. 18** | Cl. 33 | NA | NA | NA | NA | NA | NA |
| 16. The composition of claim 1 wherein said lubricant optionally comprises at least one polyol ester. | **Cl. 19** | Cl. 9 in part | Cls. 13, 41 in part | NA | Cl. 6, 19 | NA | Cl. 1 in part | NA |
| 17. The composition of claim 1 wherein said composition has one liquid phase at at least one temperature between -50°C and +70°C. | **Cl. 21** | Cl. 30 | Cls. 30, 35, 44, 51 | Cls. 1 and 14, but for a broader set of refrigerants of which HFO-1234yf is a subset. | NA | NA | NA | NA |
| 18. The composition of claim 1 wherein said fluorinated propene consists essentially of HFO-1234yf and lubricant. | **Cl. 23** | Cls. 6+7 | Cls. 11, 39 | Cl. 10, but the term "consisting essentially of" is replaced with "comprising." | Cls. 8 and 17, but with the word "comprising" instead of "consisting essentially of." | Cl. 7, but with the word "comprising" instead of "consist-ing essentially of." | Cl. 8, but with the word "contains" instead of "consisting essentially of." | Cl. 5, but with the word "contains" instead of "consisting essentially of." |

## Attachment 2: Indian 250569

| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| *Status* | *Rejected claims from US '366*<br><br>*(PTAB decision appealed to Federal Circuit on May 3, 2016)* | *Rejected claims from US '451*<br><br>*(Request for rehearing of PTAB decision filed May 2, 2016)* | ***Rejected claims from US '882***<br><br>***(Request for rehearing of PTAB decision filed May 2, 2016)*** | *Rejected claims from US '120*<br><br>*(Request for rehearing of PTAB decision filed May 2, 2016)* | *Rejected claims from EP 1563032*<br><br>*(on appeal)* | *Rejected claims from EP 1716216*<br><br>*(final)* | *Rejected claims from JP 4699758*[18]<br><br>*(final)* | *Rejected claims from JP 4571183*<br><br>*(on appeal)* |

| **INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS** | **US '366** | **US '451** | **US '882** | **US '120** | **EP 1563032** | **EP 1716216** | **JP 4699758** | **JP 4571183** |
|---|---|---|---|---|---|---|---|---|
| 1. A method of transferring heat to or from a fluid or body to provide cooling of air in an automobile, said method comprising:<br><br>(a) providing a heat-transfer system comprising an automobile air-conditioning system;<br><br>(b) providing in said system a heat-transfer composition comprising at least one lubricant such as herein described and at least one fluoroalkene having a total of at least four fluorine substituents, said fluoroalkene being of Formula II:<br>  <br>where<br><br>R′ is $(CR_2)_nY$,<br><br>Y is $CF_3$,<br><br>each R is independently F or H,<br><br>and n is 0 or 1,<br><br>provided that there is at least one H on said unsaturated terminal carbon and wherein said fluoroalkene has no substantial toxicity. | Cl. 1 is much narrower than cl. 1 of the '569 Indian Patent but similar in that it recites HFO-1234yf as a heat-transfer composition together with a specific lubricant of a specific viscosity. | Cl. 1 of the '451 Patent is to a heat-transfer composition that is similar to, but broader than, the fluoroalkene recited in the '569 Indian Patent. The '451 claim 1 does not require a lubricant or 4 Fs, and does require a GWP ≤ 1000. However, 4 Fs or a lubricant are required in later claims of the '451. | **Cl. 1 is almost identical except that four halogens are required instead of four Fluorines.** | Cls. 1 and 14 of the '120 are broader as to the method and the recitation of the fluoroalkene; Formula (II) in the Indian Patent is a subset of Formula (I) in the '120. | Cl. 1 is similar in that it recites the use of HFO-1234 (which is a subset of the structure in cl. 1 of the '569 Indian Patent) and select lubricants; cl. 9 recites use in air conditioning. | Cl. 1 is similar in that it recites the use of HFO-1234 (which is a subset of the structure in cl. 1 of the '569 Indian Patent) in an automobile air-conditioning system. | Cl. 1 is similar, in that it recites a heat-transfer constituent having the formula as shown in cl. 1 of the '569 Indian Patent and at least one of a select group of lubricants. | Cl. 1 is similar in that it recites the use of HFO-1234 (which is a subset of the structure in cl. 1 of the '569 Indian Patent) in an automobile air-conditioning system. |

| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 2. The method as claimed in claim 1 wherein said composition has a Global Warming Potential (GWP) of not greater than 500. | NA | Cl. 1 (500 GWP is ≤ 1000, as re-cited in '451's cl. 1) | **Cl. 16 GWP not greater than 150; cl. 17 GWP not greater than 75** | Cl. 1 recites GWP not greater than 75; cl. 14 recites GWP not greater than 150. | NA | Cl. 9 | NA | NA |
| 3. The method as claimed in claim 2 wherein said fluoroalkene of Formula II comprises 1,1,1,2-tetrafluoropro-pene (HFO-1234yf). | Cl. 1 | Cl. 4 | **Cl. 7** | Cl. 10 | Cls. 8 and 17 | Cl. 7 | Cl. 8 | Cl. 5 |
| 4. The method as claimed in claim 1 wherein said providing step com-prises circulating said composition in said automobile air-conditioning system. | NA | NA | **NA** | NA | NA | NA | NA | NA |
| 5. The method as claimed in claim 1 wherein said unsaturated terminal carbon has one F substituent. | NA | This would not be HFO-1234yf. | **Cl. 2** | Cl. 2 | NA | NA | NA | NA |
| 6. The method as claimed in claim 1 wherein n is 0. | Since Cl. 1 is directed to HFO-1234yf, n is inher-ently 0. | Cl. 2 | **Cl. 3** | NA | Inherently in cls. 8 and 17, directed to HFO-1234yf. | Inherently in cl. 7, directed to HFO-1234yf. | Cl. 1 and inherently in cl. 8, directed to HFO-1234yf. | Inherently in cl. 5, directed to HFO-1234yf. |

| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 7. The method as claimed in claim 4 wherein said unsaturated terminal carbon has no F substituent. | Since Cl. 1 is directed to HFO-1234yf, there is inherently no F in unsaturated terminal carbon | Cls. 4, 6; this structure is inherent in HFO-1234yf. | **Cl. 4** | Cl. 5, but stated as both substituents on this carbon being H – hence no F substituents. | Since Cls. 8 and 17 are directed to HFO-1234yf, there is inherently no F in unsaturated terminal carbon | Since Cl. 7 is directed to HFO-1234yf, there is inherently no F in unsaturated terminal carbon. | Since Cl. 8 is directed to HFO-1234yf, there is inherently no F in unsaturated terminal carbon. | Since Cl. 5 is directed to HFO-1234yf, there is inherently no F in unsaturated terminal carbon. |
| 8. The method as claimed in claim 1 wherein each substituent on the unsaturated terminal carbon is H. | Yes, since Cl. 1 is directed to HFO-1234yf. | Cl. 4, 6.<br>This structure is inherent in HFO-1234yf. | **Cl. 5** | Cls. 5, 17 | Yes, since cls. 8 and 17 are directed to HFO-1234yf. | Yes, since cl. 7 is directed to HFO-1234yf. | Yes, since cl. 8 is directed to HFO-1234yf. | Yes, since cl. 5 is directed to HFO-1234yf. |
| 9. The method as claimed in claim 1 wherein n is 1. | NA | Cl. 3, but this would not be a propene. | **Cl. 6** | NA | NA | NA | NA | NA |
| 10. The method as claimed in claim 1 wherein said fluoroalkene of Formula II consists essentially of 1,1,1,2-tetrafluoropropene (HFO-1234yf). | Cl. 1 | Cl. 6 | **Cl. 7, except for the words "comprising" in cl. 7 instead of "consisting essentially of" in cl. 10 of the Indian Patent; and the same in cls. 11 and 39.** | Cl. 10 | Cls. 8 and 17, except for the words "comprising." | Cl. 7, except for the words "comprising." | Cl. 8, except for the words "contains." | Cl. 5, except for the words "contains." |

| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 11. The method as claimed in claim 1 wherein said fluoroalkene of Formula II comprises 1,1,1,3-tetrafluoropropene (HFO-1234ze). | NA | NA | **Cl. 8** | Cls. 8, 20 | Cls. 7, 12, 16. | NA | Cl. 7 | NA |
| 12. The method as claimed in claim 1 wherein said fluoroalkene of Formula II comprises trans 1,1,1,3-tetrafluoropropene (HFO-1234ze). | NA | NA | **Cl. 9** | Cls. 8, 20 | NA | NA | NA | NA |
| 13. The method as claimed in claim 1 comprising conditioning the air in an automobile comprising:<br><br>(a) providing a vapor compression air-conditioning system having at least one compressor, at least one condenser and a heat-transfer fluid in said system, said heat-transfer fluid comprising 1,1,1,2-tetrafluoropropene (HFO-1234yf) in an amount of from 5 % by weight to 99 % by weight of the heat-transfer fluid; and<br><br>(b) operating said condenser in a temperature range that includes 150°F. | NA | The heat-transfer fluid recited in cl. 13 is similar to the heat-transfer composition of cl. 4 of the '451 Patent. The '451 has no component or temp. requirements. | **Cl. 10 (identical), and cls. 33, 47, and 50 with regard to the wt.% HFO-1234yf.** | Cls. 7 and 19 for compressor and condenser and temperature, but not HFO-1234yf or wt.% | NA | Cl. 2, but for use of HFO-1234 | NA | NA |
| 14. The method as claimed in claim 11 wherein said heat-transfer composition comprises from 5% by weight to 95% by weight of 1,1,1.2-tetrafluoropropene (HFO-1234yf). | NA | Cl. 14 of the Indian patent recites a blend (Read with claim 11), but the stated % if yf is recited in cl. 21 of the '451 Patent. | **Cl. 21 as cl. 1 relates to cl. 8 (HFO-1234ze)** | Cl. 10 for HFO-1234yf but no wt. % limitation. | NA | Cl. 3, but for use of HFO-1234. | NA | NA |

| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 15. The method as claimed in claim 13 wherein said lubricant is present in the composition in an amount of from 30% to 50% by weight of the heat-transfer composition based on the total weight of said lubricant and said compound(s) of Formula II. | Cl. 17 | Cls. 7 and 8 | **Cl. 12** | Cls. 9, 11, 21 | Cl. 4 | Cl. 5 | Cl. 4 | Cl. 3 |
| 16. The method as claimed in claim 1 wherein said lubricant is selected from the group consisting of polyol esters, polyalkylene glycols, polyalkylene silicon oils, mineral oils, alkyl benzenes, poly(alpha-olefins) and combinations of these. | Cl. 1 recites polyalkylene glycol lubricant | Cl. 9 | **Was the same as original cl. 13, which was canceled in re-exam** | NA | Cls. 1 and 12 recite polyol ester and polyalkylene glycol lubricants; cls. 5 and 18 recites polyalkylene glycol and cls. 6 and 19 recites polyol ester lubricants. | Cl. 6 recites polyalkylene glycol lubricants. | Cl. 1 recites polyol ester and polyalkylene glycol lubricants; cl. 5 recites polyalkylene glycol and cl. 6 recites polyol ester lubricants. | Cl. 4 recites polyalkylene glycol lubricants. |
| 17. The method as claimed in claim 11 wherein said lubricant comprises at least one polyalkylene glycol. | Cl. 1 | Recites a blend (read with claim 11), but this lubricant is in cl. 10 of the '451 Patent. | **Cl. 14, as cl. 1 relates to cl. 8, HFO-1234ze** | Cls. 10, 12 | Cls. 1, 5, 12, and 18 except for the "at least one" language. | Cl. 6 except for the "at least one" language. | Cls. 1, 5 | Cl. 4 |
| 18. The method as claimed in claim 1 wherein said lubricant comprises polyalkylene glycol ester. | Cl. 1 | Cl. 11 | **Cl. 14** | NA | Cls. 1, 5, 12, and 18 except for the "at least one" language. | Cl. 6 except for the "at least one" language. | Cls. 1, 5 | Cl. 4 |

| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 19. The method as claimed in claim 1 wherein said heat-transfer composition has a Global Warming Potential (GWP) of not greater than 150. | Cl. 2 | Cl. 16 | **Cl. 16** | Cl. 14 | NA | NA | NA | NA |
| 20. The method as claimed in claim 1 wherein said heat-transfer composition has a Global Warming Potential (GWP) of not greater than 75. | Cl. 10 | Cl. 17 | **Cl. 17, 52** | Cl. 1 | NA | NA | NA | NA |
| 21. The method as claimed in claim 1 wherein said heat-transfer composition has an ozone depletion potential (ODP) of not greater than 0.05. | NA | Cl. 18 | **Was the same as original cl. 18, which was canceled during re-exam.** | NA | NA | NA | NA | NA |
| 22. The method as claimed in claim 1 wherein said heat-transfer composition has an ozone depletion potential (ODP) of not greater than 0.02. | Cl. 11 | Cl. 19 | **Was the same as original cl. 19, which was canceled during re-exam.** | NA | NA | NA | NA | NA |
| 23. The method as claimed in claim 1 wherein said heat-transfer composition has an ozone depletion potential (ODP) of not greater than zero. | NA | Cl. 20 | **Was the same as original cl. 20, which was canceled during re-exam.** | NA | NA | NA | NA | NA |
| 24. The method as claimed in claim 1 wherein said compound of Formula II is present in the composition in an amount of from 5 % by weight to 95 % by weight. | NA | Cl. 21 | **Cls. 21, 38** | NA | NA | Cl. 3 for HFO-1234 | NA | NA |

| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 25. The method as claimed in claim 1 wherein said compound of Formula II is present in the composition in an amount of at least 50 % by weight. | Cl. 1 | Cl. 22 | **Cl. 22** | NA | Cls. 2, 13 | NA | Cl. 2 | NA |
| 26. The method as claimed in claim 1 wherein said compound of Formula II is present in the composition in an amount of at least 70 % by weight. | NA | Cl. 23 | **Cls. 23, 45** | NA | Cls. 3, 14 | NA | Cl. 3 | NA |
| 27. The method as claimed in claim 1 wherein said heat-transfer composition comprises one or more of the following: difluoromethane (HFC-32); pentafluoroethane (HFC-125); 1,1,2,2-tetrafluoroethane (HFC-134); 1,1,1,2-tetrafluoroethane (HFC-134a); difluoroethane (HFC-152a); 1,1,1,2,3,3,3-heptafluoropropane (HFC-227ea); 1,1,1,3,3,3-hexafluoropropane (HFC-236fa); 1,1,1,3,3-pentafluoropropane (HFC-245fa); 1,1,1,3,3-pentafluorobutane (HFC-365mfc); water; and $CO_2$. | NA | Cl. 24 | **Cls. 24, 46** | NA | NA | NA | NA | NA |
| 28. The method as claimed in claim 1 wherein said heat-transfer composition comprises a flammability suppressant. | NA | Cl. 25 | **Cl. 25** | NA | NA | NA | NA | NA |

| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 29. The method as claimed in claim 28 wherein said flammability suppressant comprises $CF_3I$. | NA | Cl. 26 | **Was the same as original cl. 26, which was canceled during re-exam.** | NA | NA | NA | NA | NA |
| 30. The method as claimed in claim 1 wherein said lubricant comprises an alkyl benzene. | NA | Cl. 27 | **Was the same as original cl. 27, which was canceled during re-exam, and is the same as part of cls. 41, 49, and 51.** | NA | NA | NA | NA | NA |
| 31. The method as claimed in claim 1 wherein said lubricant comprises an ester oil. | NA | Cl. 28 | **Cl. 28** | NA | NA | NA | NA | NA |
| 32. The method as claimed in claim 1 wherein said lubricant comprises a poly(alpha-olefin) oil. | NA | Cl. 29 | **Was the same as original cl. 29, which was canceled during re-exam; and is the same as part of cls. 41, 49, and 51.** | NA | NA | NA | NA | NA |

| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 33. The method as claimed in claim 1 wherein said heat-transfer composition has one liquid phase at at least one temperature between -50°C and +70°C. | Cl. 21 | Cl. 30 | **Cl. 30, and part of cls. 35, 44, and new re-exam cl. 81.** | Temp. range concept is in cl. 1 | NA | NA | NA | NA |
| 34. The method as claimed in claim 1 wherein said heat-transfer composition is stable when in contact with aluminum, steel and copper under the conditions of use in said air-conditioning systems. | NA | Cl. 31 | **Cl. 31** | NA | NA | NA | NA | NA |
| 35. The method as claimed in claim 1 wherein said automobile air-conditioning system comprises a vapor compression air-conditioning system having at least one compressor and at least one condenser operable in a temperature range that includes 150°F. | NA | NA | **Cl. 33 except for temp. requirement, but also in cl. 47 with temp. requirement; and in new re-exam cl. 86.** | Cls. 7 and 19 in part | NA | NA | NA | NA |

| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 36. The method as claimed in claim 1 wherein said automobile air-conditioning system includes at least one compressor and at least one evaporator, said method comprising:<br><br>(a) utilizing in said system a heat-transfer fluid comprising 1,1,1,2-tetrafluoro-propene (HFO-1234yf) in an amount of from 5% by weight to 99% by weight of the heat-transfer fluid; and<br><br>(b) using said heat-transfer fluid to absorb heat from the air in the automobile by evaporating in said evaporator said heat-transfer fluid to produce a vapor comprising said HFO-1234yf;<br><br>(c) compressing at least a portion of said vapor from said step (b) in said at least one compressor to produce a relatively elevated pressure vapor comprising HFO-1234yf; and<br><br>(d) removing heat from said relatively elevated pressure vapor by condensing said vapor. | NA | The heat-transfer fluid of cl. 36 of the Indian Patent is similar to the heat-transfer composition of cls. 4 and 6 of the '451 Patent. The method of cl. 36 of the Indian Patent is not recited in the claims of the '451 Patent. | **Cl. 50** | NA | NA | NA | NA | NA |

| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 37. The method as claimed in claim 5 wherein said lubricant is selected from the group consisting of polyol esters, polyalklene glycols, polyalkylene silicon oils, mineral oils, alkyl benzenes, poly(alpha-olefins) and combinations of these. | NA | See cl. 5 above. This would not be HFO-1234yf. However, the list of lubricants is in cl. 9 of the '451 Patent. | **Was the same as original cl. 13, which was canceled during re-exam; and is the same cls. 41 and 51.** | NA | NA | NA | NA | NA |
| 38. The method as claimed in claim 5 wherein said at least one lubricant comprises at least one polyalkylene glycol. | Cl. 1 | See cl. 5 above. This would not be HFO-1234yf. However, the lubricant is in cl. 10 of the '451 Patent. | **Cls. 14, 34** | Cls. 8, 10 and 12. | Cl. 1 in part, and cls. 5 and 18 | Cl. 6 | Cl. 1 in part, and cl. 5 | Cl. 4 |
| 39. The method as claimed in claim 5 wherein said at least one lubricant comprises polyalkylene glycol ester. | NA | See cl. 5 above. This would not be HFO-1234yf. However, the lubricant is in cl. 11 of the '451 Patent. | **Cl. 15, 43** | NA | NA | NA | NA | NA |
| 40. The method as claimed in claim 5 wherein said heat-transfer fluid has a capacity relative to HFC-134a of 1 and a Coefficient of Performance (COP) relative to HFC-134a of 1. | Cl. 20; cl. 16 regarding (COP) relative to HFC-134a of 1 only. | NA | **Cl. 35, 44, 48** | Cl. 13, without GWP limitation. | NA | NA | NA | NA |

| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 41. The method as claimed in claim 39 wherein said heat-transfer composition has one liquid phase at at least one temperature between -50°C and +70°C and wherein said heat-transfer composition has a capacity relative to HFC-134a of 1 and a Coefficient of Performance (COP) relative to HFC-134a of 1. | Cl. 20 regarding heat-transfer composition having a capacity relative to HFC-134a of 1 and a COP relative to HFC-134a of 1; cl. 16 regarding (COP) relative to HFC-134a of 1 only. | NA | **Cls. 35, 44, and 48 regarding heat-transfer composition having a capacity relative to HFC-134a of 1 and a COP relative to HFC-134a of 1 only.** | Cls. 1 and 14 regarding temp. range and cl. 13 regarding COP. | NA | NA | NA | NA |
| 42. The method as claimed in claim 41 wherein said fluoroalkene of Formula II comprises 1,1,1,2-tetrafluoropropene (HFO-1234yf) present in the composition in an amount of at least 70 % by weight. | Cl. 12 | See cl. 5 above. This HFO-1234yf would be in a blend with a different fluoroalkene. However, the concept of 70% of yf is in cls. 4 and 23 of the '451 Patent. | **Cl. 45** | Cl. 10 regarding HFO-1234yf, without wt. % limitation. | NA | NA | NA | NA |

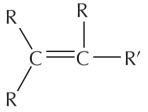
| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 43. The method as claimed in claim 40 wherein said heat-transfer composition comprises one or more of the following: difluoromethane (HFC-32);<br><br>pentafluoroethane (HFC-125); 1,1,2,2-tetrafluoroethane (HFC-134); 1,1,1,2-<br><br>tetrafluoroethane (HFC-134a); difluoroethane (HFC-152a); 1,1,1,2,3,3,3-<br><br>heptafluoropropane (HFC-227ea); 1,1,1,3,3,3-hexafluoropropane (HFC-236fa); 1,1,1,3,3-pentafluoropropane (HFC-245fa); 1,1,1,3,3-pentafluorobutane (HFC-365mfc); water; and $CO_2$. | NA | Cl. 24 | **Cls. 24 and 46, but adds that the composition "further comprises" the listed members.** | NA | NA | NA | NA | NA |
| 44. The method as claimed in claim 36 wherein said heat-transfer fluid comprises at least one lubricant selected from the group consisting of polyol esters, polyalkylene glycols, polyalkylene silicon oils, mineral oils, alkybenzenes, poly(alpha-olefins) and combinations of these. | NA | Cl. 7 | **Cl. 51** | NA | NA | NA | NA | NA |

| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 45. The method as claimed in claim 44 wherein said system comprises a condenser operated in a temperature range that includes 150°F. | NA | NA | **Cl. 47 recites the condenser operating temperature range in connection with a cooling method more general than that in cl. 36.** | Cls. 7 and 19 | NA | NA | NA | NA |
| 46. The method as claimed in claim 45 wherein said heat-transfer fluid has a Global Warming Potential (GWP) of not greater than 75. | Cl. 10 with regard to the lubricant-HFO-1234yf composition. | Cl. 47 | **Cl. 52** | Cl. 1 | NA | NA | NA | NA |
| 47. The method as claimed in claim 14 wherein said at least one lubricant comprises a poly alkylene glycol. | NA | Cl. 47 depends from cl. 14 and cl. 14 recites a blend as read with cl. 11, but the lubricant is recited in cl. 10 of the '451 Patent. | **Cl. 14, as it relates to cl. 1 and cl. 8, HFO-1234ze.** | Cl. 12 | Cl. 18 | NA | Cl. 7 when read with cl. 5 | NA |

| INDIA 250569: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 48. The method as claimed in claim 47 wherein said heat-transfer composition has one liquid phase at at least one temperature between -50°C and +70°C and wherein said heat-transfer composition has a capacity relative to HFC-134a of 1, a Coefficient of Performance (COP) relative to HFC-134a of 1 and a Global Warming Potential (GWP) of not greater than 75. | NA | NA | **Cl. 30, as it relates to cls. 1 and 8, HFO-1234ze.** | Cls. 1, 13 | NA | NA | NA | NA |

## ATTACHMENT 3: Chinese Patent 1732243

| CHINA 1732243: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| *Status* | *Rejected claims from US '366*<br><br>*(PTAB decision appealed to Federal Circuit on May 3, 2016)* | *Rejected claims from US '451*<br><br>*(Request for rehearing of PTAB decision filed May 2, 2016)* | *Rejected claims from US '882*<br><br>*(Request for rehearing of PTAB decision filed May 2, 2016)* | *Rejected claims from US '120*<br><br>*(Request for rehearing of PTAB decision filed May 2, 2016)* | *Rejected claims from EP 1563032*<br><br>*(on appeal)* | *Rejected claims from EP 1716216*<br><br>*(final)* | *Rejected claims from JP 4699758*[19]<br><br>*(final)* | *Rejected claims from JP 4571183*<br><br>*(on appeal)* |
| 1. A heat-transfer composition, including:<br><br>(A) at least one fluoro-olefin with formula I:<br><br>$XCF_zR_{3-z}$ (I)<br><br>wherein X is unsaturated, which is replaced or and replaces without $C_2$ or $C_3$ –alkyl,<br><br>R is independently Cl, F, Br, I or H, and z is 1 to 3;<br><br>the heat-transfer compound having less than about 150 global warming potential (GWP). | Cl. 1 is to the HFO-1234yf subset of the fluoro-olefins of Formula (I), with a lubricant. The GWP limitation is in cl. 2. | Cl. 1 is to the HFO-1234yf subset of the fluoro-olefins of Formula (II), with a GWP limitation not greater than 1000. | Although to a method, the fluoro-alkene of Cl. 1 is to the Formula (II) subset of Formula (I). | Although directed to a method, Cl. 1 includes, in part, the fluoro-olefin of cl. 1 of the Chinese patent, but the GWP is not greater than 75. | Cl. 1 is to the HFO-1234 subset of the fluoro-olefins of Formula (I), with a lubricant. | Cl. 1 is to the HFO-1234 subset of the fluoro-olefins of Formula (I). | The heat-transfer constituent of Cl. 1 is to the Formula (II) subset of Formula (I). | Cl. 1 is to the HFO-1234 subset of a fluoro-olefin of Formula (I). |

| CHINA 1732243: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 2. such as a heat-transfer composition described in claim 1, wherein at least one fluorine compound of the olefin is a type II:<br>  <br>each one of those R is independently Cl, F, Br, I or H,<br>R′ is $(CR_2)_nY$, and<br>N is 0 or 1. | Cl. 1 is to the HFO-1234yf subset of the fluoro-olefins of Formula (II). | Cl. 1, but GWP in '451 Patent is "not greater than 1000" and there is a 5–99% by weight range. | Although directed to a method, cl. 1 includes, in part, the compound of cl. 2 of the Chinese patent. | NA | Cl. 1 is to the HFO-1234 subset of the fluoro-olefins of Formula (II). | Cl. 1 is to the HFO-1234 subset of the fluoro-olefins of Formula (II). | Cl. 1, in part except R is F or H and at least one R on end unsaturated C is H. | Cl. 1 is to the HFO-1234 subset of the fluoro-olefins of Formula (II). |
| 3. such as heat-transfer composition described in claim 2, where Y is the $CF_3$. | The HFO-1234yf subset of cl. 1 meets this limitation. | Cl. 1 | Cl. 1 | Cls. 4, 6 result in the composition of cl. 3. | The HFO-1234 subset of cl. 1 meets this limitation. | The HFO-1234 subset of cl. 1 meets this limitation. | Cl. 1 | The HFO-1234 subset of cl. 1 meets this limitation. |
| 4. heat-transfer compositions described in claim 3, wherein [in] the unsaturated carbon at least an R at the end was not F. | The HFO-1234yf subset of cl. 1 meets this limitation. | Cl. 1 | Cls. 1, 36 for subset of Formula (II); cl. 2 in part. | Cl. 1 in part regarding Formula (I). | The HFO-1234 subset of cls. 1, 12, 16, 17 (yf) meet this limitation. | The HFO-1234 subset of cls. 1 and 7 (yf) meet this limitation | Cl. 1 | The HFO-1234 subset of cls. 1 and 5 (yf) meet this limitation. |
| 5. such as heat-transfer compositions described in claim 4, wherein [on] the carbon at the unsaturated end at least one R is H. | The HFO-1234yf subset meets this limitation. | Cl. 1 | Cl. 1 in part | Cls. 1 and 14 in part regarding Formula (I). | The HFO-1234 subset of cls. 1, 12, 16, 17 (yf) meet this limitation. | The HFO-1234 subset of cls. 1 and 7 (yf) meet this limitation. | Cl. 1 | The HFO-1234 subset of cls. 1 and 5(yf) meet this limitation. |

| CHINA 1732243: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 6. such as heat-transfer compositions described in claim 2, in which n is 0. | The HFO-1234yf subset of cl. 1 meets this limitation. | Cl. 2 | Cl. 3 | The Formula (II) subset of cls. 4 and 14 achieve same result. | The HFO-1234 subset of cls. 1, 12, 16, 17 (yf) meet this limitation. | The HFO-1234 subset of cls. 1 and 7 (yf) meet this limitation. | Cl. 1 | The HFO-1234 subset of cls. 1 and 5(yf) meet this limitation. |
| 7. such as heat-transfer compositions described in claim 2, where Y is the $CF_3$, and n is 0. | The HFO-1234yf subset of cl. 1 meets this limitation. | Cl. 2 | Cls. 1, 3 | The Formula (II) subset of Cls. 1 and 4 achieve the same result. | The HFO-1234 subset of cls. 1, 12, 16, 17(yf) meet this limitation. | The HFO-1234 subset of cls. 1 and 7 (yf) meet this limitation. | Cl. 1 | The HFO-1234 subset of cls. 1 and 5 (yf) meet this limitation. |
| 8. such as heat-transfer compositions described in claim 1, wherein at least one fluorine alkene comprising at least one allyl PTFE (HFO-1234). | The HFO-1234yf subset of cl. 1 meets this limitation. | The yf subset of HFO-1234 is in cls. 4 and 6. | The yf subset of HFO-1234 is in cls. 7, 11, 32, 37, 39, 47, 50. | The yf subset of HFO-1234 is in cl. 10. | Cl. 1 includes HFO-1234, but not the rest of the claim in the Chinese Patent. | Cl. 1 includes HFO-1234, but not the rest of the claim in the Chinese Patent. | The yf subset of HFO-1234 is in cl. 8. | Cl. 1 includes HFO-1234, but not the rest of the claim in the Chinese Patent. |
| 9.–10. Directed to non HFO-1234yf. | -- | -- | -- | -- | -- | -- | -- | -- |
| 11. such as heat-transfer compositions described in claim 8, wherein at least one allyl PTFE (HFO-1234) including at least one where the unsaturated end have at most one F substituent on the carbon compounds. | NA | NA | NA | NA | Cl. 1 includes HFO-1234, but not the rest of the claim in the Chinese Patent. | Cl. 1 includes HFO-1234, but not the rest of the claim in the Chinese Patent. | NA | Cl. 1 includes HFO-1234, but not the rest of the claim in the Chinese Patent. |

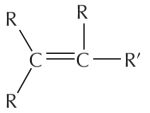
| CHINA 1732243: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 12. such as heat-transfer compositions described in claim 11, wherein at least one allyl PTFE (HFO-1234) basically consists of unsaturated end referred to therein have at most one F substituent on the carbon compounds. | NA | NA | NA | NA | Cl. 1 includes HFO-1234, but not the rest of the claim in the Chinese Patent. | Cl. 1 includes HFO-1234, but not the rest of the claim in the Chinese Patent. | NA | Cl. 1 includes HFO-1234, but not the rest of the claim in the Chinese Patent. |
| 13.–14. Directed to non HFO-1234yf. | -- | -- | -- | -- | -- | -- | -- | -- |
| 15. a thermal conduction to a fluid or fluid or subject or from a main method of heat conduction, which include fluoro-olefin-I under a phase change occurs: $XCF_z R_{3-z}$ (I) where X is an unsaturated, which replaced or replaced without $C_2$ or $C_3$ – alkyl group and independent for each R[is] Cl, F, Br, I, or H and z=1-3. | The HFO-1234yf subset meets the Formula (I) description. | Cl. 1 is the Formula (II) subset of Formula(I), but does not recite the method. | Cl. 1 recites a similar method but with the formula of cl. 2 of the Chinese Patent. | Cl. 1 recites a similar formula for a method of cooling, but R is F or H. | Cl. 1 is to the HFO-1234 subset of the fluoro-olefins that meet this limitation. | Cl. 1 is to the HFO-1234 subset of the fluoro-olefins that meet this limitation. | The heat-transfer constituent of Cls. 1 and 5 are subsets of a fluoro-olefin that meets this limitation. | Cl. 1 is to the HFO-1234 subset of a fluoro-olefin that meets this limitation. |
| 16. such as the method of claim 15, wherein the fluoro-olefin includes a have at most one unsaturated carbon at the end of the F substituent. | NA | NA | NA | NA | NA | NA | NA | NA |
| 17. such as a method referred to in claim 16, z=3. | The HFO-1234yf subset of cl. 1 meets this limitation. | Cl. 2 recites n=0, resulting in a similar structure. | Cl. 3 recites n=0, resulting in a similar structure. | Cl. 4, but for a method of cooling. | Cl. 1 is to the HFO-1234 subset of the fluoro-olefins that meet this limitation. | Cls. 1 and 7 are to the HFO-1234 subset of the fluoro-olefins that meet this limitation. | The heat-transfer constituent of Cls. 1 and 8 are subsets of a fluoro-olefin that meet this limitation. | Cl. 1 is to the HFO-1234 subset of a fluoro-olefin that meets this limitation. |

| CHINA 1732243: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 18. such as the method of claim 17, wherein [on] the unsaturated end at least one substituent on the carbon is not F. | The HFO-1234yf subset of cl. 1 meets this limitation. | Cl. 1 meets this limitation for the composition of Formula (II). | Cls. 1, 36 for subset of Formula (II). | Cl. 1 for subset of Formula (II); cl. 2 in part. | Cl. 1 in part regarding Formula (I). | The HFO-1234 subset of cls. 1, 12, 16, 17 (yf) meet this limitation | The HFO-1234 subset of cls. 1 and 8 meet this limitation. | Cl. 1 |
| 19. such as a method referred to in claim 18, wherein [on] the unsaturated end at least one substituent on the carbon is H. | The HFO-1234yf subset of cl. 1 meets this limitation. | Cl. 1, in part, meets this limitation for the composition of Formula (II). | Cl. 1 meets this limitation for the composition of Formula (II). | Cls. 1, 14 | Cls. 1 and 7 are to HFO-1234 subsets of the fluoro-olefins that meet this limitation. | Cl. 1 is to the HFO-1234 subset of the fluoro-olefins that meet this limitation. | Cls. 1 and 8 are subsets of the fluoro-olefin that meet this limitation. | Cls. 1 and 5 are subsets of the fluoro-olefin that meet this limitation. |
| 20. such as a method referred to in claim 16, where X is a $C_2$ alkyl group. | NA | Cl. 1 embodies a subset that could meet this limitation. | Cls. 1, 8, 9, 36 meet the limitations of this claim. | Cl. 6, but for a method of cooling. | Cl. 7, 12, 16 | The HFO-1234 subset of cl. 1 meets this limitation. | Cl. 7 | The HFO-1234 subset of cl. 1 meets this limitation. |
| 21. such as a method referred to in claim 16, where Y is the $CF_3$ and X [is] a $C_2$ n. | The HFO-1234yf subset of cl. 1 meets this limitation. | Cl. 1 embodies a subset that could meet this limitation. | Cl. 1+3, 36 recites subsets that meet this limitation, with the formula of cl. 2 of the Chinese Patent. | Cls. 4+6, but for a method of cooling. | Cl. 7, 12, 16 recite compositions that meet this limitation. | The HFO-1234 subset of cl. 1 meets this limitation. | Cl. 1, Y is $CF_3$, but with the compound of Formula (II) and there is no n value, cl.7 may meet this limitation. | The HFO-1234 subset of cl. 1 meets this limitation. |
| 22–44. directed to non HFO-1234yf and/or other applications. | NA | NA | NA | NA | NA | NA | NA | NA |

| CHINA 1732243: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 45. a compatibility composition, which is used for improved heat-transfer fluids and lubricants for compatibility, the compatibility composition including at least a fluoro-olefin with type I:<br>$XCF_zR_{3-z}$ (I)<br>where X is an unsaturated, which replaced or replaced without $C_2$ or $C_3$ –alkyl, R [is] independent[ly] Cl, F, Br, I, or H and z [is] 1 to 3, the compatibility composition having a less than about 150 of the global warming potentials (GWP). | Cl. 1 is to the HFO-1234yf subset of the fluoro-olefins of Formula (I). The GWP limitation is in cl. 2; cl. 3 recites a compatibilizer. | Cl. 1 recites a subset of the fluoro-olefin of cl. 45. The GWP limitation is in cl. 16; cl. 13 adds a compatibilizer. | Cls. 1 and 36 recite a composition that meets the fluoro-olefin limitation. | Cls. 1 and 14 recite methods using a similar fluoro-alkene, in part. | The HFO-1234 subset of cl. 1 meets the fluoro-olefin limitation with a lubricant, but not the rest of the claim. | The HFO-1234 subset of cl. 1 meets the fluoro-olefin limitation but not the rest of the claim. | Cl. 1 recites a compound that is a subset of the fluoro-olefin, but not the rest of the claim. | Cl. 1 recites the HFO-1234 subset of the fluoro-olefin of this claim, but not the rest. |
| 46. claim 45 the compatibility composition, wherein the GWP is not greater than 100 percent. | Cl. 9 | Cls. 16 and 45 recites GWP not greater than 150. | Cl. 16 recites a GWP not greater than 150. | Cl. 14 recites a GWP not greater than 150. | NA | NA | NA | NA |
| 47. such as increasing capacity referred to in claim 45 compositions, having not more than 0.05 percent of ozone-depletion potential (ODP). | Cl. 11 has ODP not greater than 0.02. | Concept appears in Cls. 18 and 45, but for a composition similar to an embodiment of cl. 2 of the Chinese patent. | Concept was in Cl. 18, but with the formula of cl. 2 of the Chinese Patent, but canceled during re-exam. | NA | NA | NA | NA | NA |

| CHINA 1732243: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 48. as described in the claim 45 the capacity increase of composition wherein fluorine alkene includes a have at most one unsaturated carbon at the end of the F substituent. | NA | NA | NA | NA | NA | NA | NA | NA |
| 49. as described in the claim 45 the capacity increase of composition wherein fluorine alkene, including end of an unsaturated carbon and unsaturated end mentioned at least one substituent on the carbon is H. | The HFO-1234yf subset of cl. 1 meets this limitation. | Cl. 1, in part, meets this limitation for the composition of Formula (II). | Cl. 1 meets this limitation for the composition of Formula (II). | Cls. 1, 14 | Cls. 1 and 7 are to HFO-1234 subsets of the fluoro-olefins that meet this limitation. | Cl. 1 is to the HFO-1234 subset of the fluoro-olefins that meet this limitation. | Cls. 1 and 8 are subsets of the fluoro-olefin that meet this limitation. | Cls. 1 and 5 are subsets of the fluoro-olefin that meet this limitation. |
| 50–53 directed to a disinfectant | NA | NA | NA | NA | NA | NA | NA | NA |

| CHINA 1732243: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 54. a composition which includes:<br><br>(A) at least a fluoro-olefin with type I:<br><br>$XCF_zR_{3-z}$ (I)<br><br>where X is an unsaturated, which replaced or replaced without $C_2$ or $C_3$- alkyl group and independent for each R [is] Cl, F, Br, I, or H and z for 1 to 3;<br><br>(B) at least a junior agent, by said junior agent is selected free following material composition of group: lubricant, and increased capacity agent, and surfactant, and increased solvent, and dispersed agent, and bubble hole stable agent, and appearance modified agent (cosmetics), and polishing agent, and pharmacy, and clean agent, and flame retardant agent, and coloring agent, and chemical disinfectant, and stable agent, and multiple alcohol, and multiple alcohol pre mixed component and the these material in the of two species or two species above material of combination. | Cl. 1 is to the HFO-1234yf subset of the fluoro-olefins of Formula (I), with a lubricant.<br><br>Cl. 18 recites surfactant. | Cl. 1 recites a subset of the fluoro-olefin of cl. 54. Cl. 7 adds a lubricant. | Cl. 1 recites a subset of the fluoro-olefin of cl. 54 with a lubricant. | Cls. 1 and 14 recite methods that include a composition of Formula (I), in part, with a lubricant. | Cls. 1 and 12 recites a subset of the fluoro-olefin and lubricant. | Cl. 1 recites a subset of the fluoro-olefin of cl. 54; cl. 4 adds a lubricant. | Cl. 1 recites a subset of the fluoro-olefin of cl. 54 with a lubricant. | Cl. 1 recites the HFO-1234 subset of the fluoro-olefin of cl. 54; cl. 2 adds a lubricant. |

| CHINA 1732243: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 55. as described in the claim 54 composition not more than about 150 of their global warming potentials (GWP). | Cl. 2 if the structure of cl. 54 is limited to constituents of HFO-1234yf. | Cl. 16 in part, if the structure of cl. 54 is limited to the structure of cl. 2 of the Chinese Patent. | Cl. 16 but with the composition of cl. 2 of the Chinese Patent. | Cl. 14 | NA | NA | NA | NA |
| 56. as described in claim 55 compositions, wherein at least one fluorine compound of the type II:<br>  <br>each one of those R is independently Cl, F, Br, I or H,<br>R′ is $(CR_2)_nY$<br>Y is $CRF_2$,<br>and n is 0 or 1. | Cl. 1 is to the HFO-1234yf subset of the fluoro-olefins of Formula (II). | Cl. 1 in part, except Y is $CF_3$. | Formula (II) recited in methods of cls. 1 and 36. | Cls. 8, 10, 20 recites HFO-1234 subsets of Formula (II) of cl. 56. | Cl. 1 recites the HFO-1234 subset of cl. 56. | Cl. 1 recites the HFO-1234 subset of cl. 56. | Cl. 1 in part, but Y is $CF_3$ with no reference to GWP. | Cls. 1 and 5 recite the HFO-1234 subsets of cl. 56, but with no reference to GWP. |
| 57. the compositions described in claim 56, where Y is the $CF_3$. | The HFO-1234yf subset of cl. 1 meets this limitation. | Cl. 1, in part. | Formula (II) recited in methods of cls. 1 and 36. | Cls. 1 and 14 recite comparable compositions; cl. 14 recites the same. GWP (see cl. 55). | Cl. 1 recites the HFO-1234 subset of cl. 56. | Cl. 1 recites the HFO-1234 subset of cl. 56. | Cl. 1, but with no reference to GWP. | Cl. 1 recites the HFO-1234 subset of cl. 56. |

| CHINA 1732243: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 58. if the compositions described in claim 56, wherein [on] the unsaturated carbon at least an R at the end was not F. | The HFO-1234yf subset of cl. 1 meets this limitation. | Cl. 1 meets this limitation. | Cls. 1, 36 for subset of Formula (II). | Cl. 1 for subset of Formula (II); cl. 2 in part. | Cl. 1 in part regarding Formula (I). | The HFO-1234 subset of cls. 1, 12, 16, 17 (yf) meet this limitation. | The HFO-1234 subset of cls. 1 and 8 meet this limitation. | Cl. 1 recites HFO-1234 subset of cl. 58. |
| 59. the compositions described in claim 56, wherein [on the] carbon unsaturated end at least one R is H. | The HFO-1234yf subset of cl. 1 meets this limitation | Cl 1 | Formula (II) recited in methods of cls. 1 and 36. | Cl. 1 for subset of Formula (II); cl. 2 in part. | Cl. 1 in part regarding Formula (I). | The HFO-1234 subset of cls. 1, 12, 16, 17 (yf) meet this limitation. | Cl. 1 | Cl. 1 recites HFO-1234 subset of cl. 59. |
| 60. including such as heat-transfer compositions described in claim 54 compositions wherein the adjuvant includes at least one lubricant. | Cl. 1 | Cl. 7 in part | Cl. 1 | The heat-transfer fluids used in the methods include a lubricant and the composition of Formula (I). | Cl. 1 includes a lubricant with HFO-1234. | Cl. 4 includes a lubricant with HFO-1234. | Cl. 1 | Cl. 2 with HFO-1234. |
| 61. includes such as heat-transfer compositions described in claim 54 composition, increasing capacity of the adjuvant includes at least one agent. | NA | NA | NA | NA | NA | NA | NA | NA |

| CHINA 1732243: COMPOSITION CONTAINING FLUORINE SUBSTITUTED OLEFINS | US '366 | US '451 | US '882 | US '120 | EP 1563032 | EP 1716216 | JP 4699758 | JP 4571183 |
|---|---|---|---|---|---|---|---|---|
| 62. such as heat-transfer compositions described in claim 61, wherein the compounds of formula I is at least about 50% the weight, and the weight of the lubricant quantity is at least about 30%. | Cls. 1 + 4 for the HFO-1234yf subset of cl. 1. | NA | NA | NA | NA | NA | NA | NA |
| 63.-65. Directed to foaming agent applications. | NA | NA | NA | NA | NA | NA | NA | NA |
| 66. as described in the claim 54 compositions, which generally do not have acute toxicity. | Cl. 1 in part if cl. 1 of Chinese patent is limited to HFO-1234yf. | NA | Cl. 1 in part, with the Formula (ii) compound. | Cl. 3 | NA | NA | NA | NA |
| 67. the compositions described in claim 54, which has low acute toxicity, wherein the compounds of formula I composed essentially of one or more compounds, wherein the fluoro-olefin includes a have at most one unsaturated carbon at the end of the F substituent. | NA | NA | NA | Cl. 2 | NA | NA | NA | NA |
| 68. as described in the claim 54 compositions, it has low acute toxicity, wherein the compounds of formula I composed essentially of one or more compounds, wherein the fluoro-olefin including end of an unsaturated carbon and unsaturated end mentioned at least one substituent on the carbon is H. | The HFO-1234yf subset of cl. 1 meets this limitation, but states "no substantial acute toxicity." | Cl. 1, in part, meets this limitation for the composition of Formula (II), excluding the low toxicity requirement. | Cl. 1 meets this limitation for the composition of Formula (II), excluding the low toxicity requirement. | Cl. 1, in part, meets this limitation for the composition of Formula (II). | Cl. 1 meets this limitation for the composition of Formula (II). | Cl. 1 is to the HFO-1234 subset of the fluoro-olefins that meet this limitation, excluding the low toxicity requirement. | Cls. 1 and 8 are subsets of the fluoro-olefin that meet this limitation, excluding the low toxicity requirement. | Cls. 1 and 5 are subsets of the fluoro-olefin that meet this limitation, excluding the low toxicity requirement. |

## ENDNOTES

1 Divisional, continuation, and continuation-in-part (CIP) applications (collectively, continuing applications), may be filed during the pendency of a prior filed application based on the same text as the prior filed application, or in the case of CIPs, based on a modified text, but have claims that differ from the claims of any patent granted on the prior filed application. Continuing applications claim priority to at least the immediately prior filed application and are treated for purposes of determining dates of expiration and what constitutes prior art, as having been filed on the same day as the earliest claimed priority application. CIPs are not authorized in most countries, but are in the United States.

2 A large number of production process patents have been filed by transnational chemical companies (e.g., Arkema, Mexichem, Chemours, and Honeywell) in many of the larger developed and developing countries. In addition, a number of Chinese entities have also filed production process patents and SRF (India) has also recently announced plans to begin a pilot plant to produce HFO-1234yf using its own unique process. Issues concerning production process patents are not addressed in this paper.

3 A demonstration project on this technology is being conducted by TATA Motors Limited, MAHLE, and the Institute for Governance and Sustainable Development under a grant from the Climate and Clean Air Coalition.

4 The European Commission has issued a Statement of Objections (Oct. 21, 2014) to Honeywell and DuPont (now Chemours) raising antitrust issues concerning their 2010 cooperation agreement on the development of HFO-1234yf for use in auto air conditioning. While potentially significant, this paper focuses solely on legal challenges to patents and does not address this antitrust action.

5 Honeywell has signed purchase agreements with a number of other chemical producers for supplying HFO-1234yf. It has an agreement with Chemours and has recently announced agreements with Navin (India) and Juhua (China) to supply HFO-1234yf to Honeywell.

6 Patents contain lists of the specific "claims" made by the patent holder that define the extent or scope of the protection conferred by a patent and what it is that the patent holder can prohibit others, without a license, from making, using, selling or importing into the country that granted the patent.

7 We report on the status of the challenges only and offer no opinion as to the correctness of the outcomes of the challenges to any of the patents discussed herein.

8 In addition to direct challenges to a number of patents, Arkema is pursuing a case in the U.S. District Court for the Eastern District of Pennsylvania seeking a declaratory judgment of invalidity of four Honeywell patents in the United States on the use of HFO-12234yf in auto air conditioning that are discussed in this section. The case was stayed pending the final outcome of the *inter partes* reexamination proceedings on these patents. See Arkema Inc. et al. v. Honeywell International Inc., No. 10-CV-02886.

9 While US '017 was filed in October 2014, it claims priority based on previously filed patents that date back to 2003. As a result, despite being filed in 2014, this patent would expire in October 2023. See section V below.

10 In addition, US 9,005,467 was recently issued, but appears to be specific to the use of HFO-1234yf as a drop-in substitute in existing HFC-134a systems.

11 In addition to EP '654 and EP '970, there are other European applications pending that are relevant to the use of HFO-1234yf in automobile air conditioning. By way of example: EP 2277971 and EP 2277972 (both are divisionals of EP '032); EP 2258802 and EP 2277977 (both divisionals of EP 1716216).

12 Within limits provided the claims are based on subject matter disclosed in the application as filed.

13 In documents submitted to the PTAB in connection with a challenge to US Patent No. 9,157,017, Honeywell listed, as required, related proceedings including an opposition against Indian Patents 239049 and 250569, which are identified as foreign counterparts, respectively, to the US '366 and US '451 and '017 patents.

14 Moreover, two other pending patent applications are at an advanced stage in the examination proceedings. CN 103642461 (divisional of the Chinese counterpart of WO 2005/042663) and CN 103215013, a divisional of the Chinese counterpart of WO 2005/042663.

15 In addition to claims related to auto air conditioning, CN 1732243 contains claims that are specific to the use of HFOs in foam, as a solvent, and fire suppressant agent. This analysis focuses only on those claims related to auto air conditioning.

16 Subject to the outcome of pending appeals, re-opened prosecution, and rehearing requests.

17 The comparison for both Japanese patents is based on machine translations of the Japanese claims.

18 Ibid.

19 Ibid.

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