

明 細 書

冷凍機油およびそれを用いた冷凍機

技術分野

この発明は、合成油からなる冷凍機油およびそれを用いた冷凍機に関する。

背景技術

従来、冷凍機の冷媒としてH C F C (ハイドロクロロフルオロカーボン) 系冷媒が主に使用されてきた。しかしながら、上記H C F C 系冷媒が地球を取り巻く大気中のオゾン層を破壊するため、オゾン破壊係数の小さいH F C (ハイドロフルオロカーボン) 系冷媒がH C F C 系冷媒の代替として考えられている。上記H F C 系冷媒は、冷凍機油として従来より使用されている鉱物油がほとんど溶けず、圧縮機の潤滑性能が著しく低下するため、H F C 系冷媒に対して相溶性を有する合成油を冷凍機油として使用することが提案されている。

ところで、上記H F C 系冷媒は、水素原子とフッ素原子の組み合わせを有するために極性が強いのにに対して、冷媒回路内に残存する切削油、錆止め油、作動油および洗浄油等や冷凍機油の劣化物のコンタミネーション(汚物)は非極性で、エーテル系油等の合成油は、極性基と非極性基の両方を有している。このため、上記合成油は、極性を有するH F C 系冷媒に対して相溶性を有し、また、非極性のコンタミネーションとも親和力が強く、これら両方を溶解させる。そして、上記冷凍機の圧縮機内では、コンタミネーションを溶解した合成油は、圧縮機から冷媒と共に吐出されて、冷媒回路内を循環し、凝縮器でH F C 系冷媒が凝縮されると、合成油は液冷媒に対する溶解性が強いため、液冷媒に溶け込んで、合成油が冷媒と共に冷

媒回路を循環する。この場合、コンタミネーションと合成油との親和力に比べて、HFC系冷媒と合成油との親和力の方が強く、また、非極性のコンタミネーションは極性の強いHFC系冷媒に溶けないため、合成油が液冷媒に溶解する際、それまで、合成油中に溶け込んでいたコンタミネーションは合成油と分離して、液冷媒中に析出する。そして、析出されたコンタミネーションは粘度が高いため、キャピラリーや膨張弁の狭い流路に付着し、堆積して詰まらせる。

上記キャピラリーや膨張弁の詰まりは、冷媒流量の制御を不能にし、異常な温度上昇や圧縮機への液バック(戻り)を引き起こして、冷媒回路の信頼性を著しく損なわせる。特に、上記冷凍機油にエステル系油を用いた場合、水分があると加水分解を起こすと共に、スラッジが発生しやすい。また、上記冷媒回路の減圧器としてキャピラリーを用いた冷凍機では、キャピラリーチューブが細径になる程、キャピラリー詰まりが生じやすくなり、冷凍機として機能しなくなるという問題がある。

このようなキャピラリーや膨張弁の詰まりを防ぐ方法としては、生産工程や据え付け時に不純物が混入しないように、厳しい基準に基づく部品洗浄や据え付け時の徹底した管理および冷媒系部品や加工工程の見直し等が考えられる。しかしながら、これらの方法は時間を要すると共に、従来に比べて多大な工数を必要とし、さらに、部品洗浄時に多くの洗浄剤を使用し、多くのエネルギー消費を招くので、大幅なコストアップとなる。

これに対して、キャピラリー詰まりが生じにくいアルキルベンゼン系油のみを冷凍機油として用いたHFC系冷媒対応の冷蔵庫が実用化されているが、アルキルベンゼン系油は、HFC系冷媒とは非相溶であるため、冷媒ガスを溶かし難い性質を有している。さらに、温度範囲や冷媒/冷凍機油の比率によっては二層分離を生じる場合があるという問題がある。したがっ

て、セパレート型空気調和機では、全てが一体型のユニットに内蔵された冷蔵庫とは異なり、長い連絡配管で室内ユニットと室外ユニットが接続されるので、HFC系冷媒と非相溶のアルキルベンゼン系油を冷凍機油に用いた場合、冷媒回路内で冷凍機油の粘度が高く、圧縮機から吐出された冷凍機油が圧縮機に戻りにくいので、連絡配管が長い空気調和機では、圧縮機内の冷凍機油が不足して、焼き付きや磨耗による異常が発生するという問題がある。

また、上記圧縮機の周囲温度が低く、液冷媒が多量に圧縮機内に寝込んだ場合や、除霜時に液冷媒が多量に圧縮機に戻ってきた場合には、圧縮機のドーム内で冷凍機油とHFC系冷媒が二層分離を起こし、比重の大きい冷媒リッチ層がドーム下部に溜まる。そうすると、上記圧縮機のドーム内の最下部に設けられた油ポンプの吸込口から粘度が極端に低下した冷媒リッチ液が吸い込まれることになる。通常、圧縮機の軸受の設計は、冷凍機油の粘度が比較的高い状態であることを想定して、軸受のサイズや軸受での摩擦動力を考慮しているので、粘度が極端に低下した冷媒リッチ液が吸い込まれると、油膜の厚さが薄くなって金属接触が生じて、軸受が損傷し、圧縮機の信頼性が著しく損なわれるという問題がある。

発明の開示

そこで、この発明の目的は、冷媒系部品や加工工程を見直すことなく、冷媒回路内に生じたスラッジを容易に除去でき、圧縮機に油戻りしやすい冷凍機油およびそれを用いた冷凍機を提供することにある。

また、この発明のもう一つの目的は、圧縮機内で冷媒との二層分離を防止できる冷凍機油およびそれを用いた冷凍機を提供することにある。

上記目的を達成するため、この発明は、アルキルベンゼン系油からなる第1の合成油とそのアルキルベンゼン系油以外の第2の合成油とが混合さ

れていることを特徴とする冷凍機油を提供する。

この構成の冷凍機油に関して、本願出願人は、種々の実験および考察を行った結果、アルキルベンゼン系油からなる第1の合成油とそれ以外の第2の合成油(エーテル系油, エステル系油, フッ素系油およびカーボネイト系油等)とが混合された混合油が、冷媒に溶けだした切削油, 錆止め油, 作動油および洗浄油等のコンタミネーション(汚物)によって冷媒系部品の内面に生じたスラッジを剥離することを発見した。したがって、上記冷凍機油によれば、アルキルベンゼン系油によって、キャピラリや膨張弁の細径部の内面に付着したスラッジを剥がして除去するので、冷媒系部品や加工工程の見直しを行うことなく、スラッジを除去してキャピラリや膨張弁が詰まるのを防ぐことができる。なお、例えばHFC系冷媒を使用する冷凍機において、HFC系冷媒によく溶ける合成油を用いることによって、圧縮機から冷媒と共に吐出された合成油は冷媒回路内を循環して圧縮機に戻るため、合成油が戻りにくく潤滑不良となるという問題がなく、圧縮機に対する潤滑性能を維持できる。

一実施例に係る冷凍機油では、上記第2の合成油をエーテル系油とする。これにより、例えばHFC系冷媒を用いた場合、上記エーテル系油は、HFC系冷媒によく溶けて、冷媒回路内を循環するので、圧縮機から冷媒と共に吐出されたエーテル系油が戻りにくいという問題がなく、圧縮機に対する潤滑性能を維持しつつ、アルキルベンゼン系油によって、キャピラリや膨張弁の細径部の内面に付着したスラッジを剥がして除去できる。また、上記HFC系冷媒と非相溶なアルキルベンゼン系油は、エーテル系油によく溶けるので、アルキルベンゼン系油がエーテル系油に溶けた状態でも冷媒回路内に運ばれて、スラッジを効果的に除去することができる。

一実施例に係る冷凍機油では、上記第2の合成油をエステル系油とする。

これにより、例えばH F C系冷媒を用いた場合、上記エステル系油は、H F C系冷媒によく溶けて、冷媒回路内を循環するので、圧縮機から冷媒と共に吐出されたエステル系油が戻りにくいという問題がなく、圧縮機に対する潤滑性能を維持しつつ、アルキルベンゼン系油によって、キャピラリーや膨張弁の細径部の内面に付着したスラッジを剥がして除去できる。また、上記H F C系冷媒と非相溶なアルキルベンゼン系油は、エステル系油によく溶けるので、アルキルベンゼン系油がエステル系油に溶けた状態でも冷媒回路内に運ばれて、スラッジを効果的に除去することができる。

一実施例に係る冷凍機油では、上記第2の合成油をエーテル系油とエステル系油とからなる。

これにより、例えばH F C系冷媒を用いた場合、上記エーテル系油とエステル系油は、H F C系冷媒によく溶けて、冷媒回路内を循環するので、圧縮機から冷媒と共に吐出されたエーテル系油とエステル系油が戻りにくいという問題がなく、圧縮機に対する潤滑性能を維持しつつ、アルキルベンゼン系油によって、キャピラリーや膨張弁の細径部の内面に付着したスラッジを剥がして除去できる。また、上記H F C系冷媒と非相溶なアルキルベンゼン系油は、エーテル系油とエステル系油によく溶けるので、アルキルベンゼン系油がエーテル系油とエステル系油に溶けた状態でも冷媒回路内に運ばれて、スラッジを効果的に除去することができる。また、上記エステル系油は、水により加水分解するが、酸化による劣化が起きにくく、反対にエーテル系油は、酸化により劣化するが、水に強く加水分解しにくいので、エーテル系油とエステル系油の比率を例えば1 : 1とすることによって、酸化による劣化の度合いと水によって加水分解される度合いを夫々半減させた冷凍機油を得ることができる。

一実施例に係る冷凍機油では、上記第2の合成油をフッ素系油にする。

これにより、例えばH F C系冷媒を用いた場合、上記フッ素系油は、H F C系冷媒によく溶けて、冷媒回路内を循環するので、圧縮機から冷媒と共に吐出されたフッ素系油が戻りにくいという問題がなく、圧縮機に対する潤滑性能を維持しつつ、上記アルキルベンゼン系油によって、キャピラリーや膨張弁の細径部の内面に付着したスラッジを剥がして除去することができる。

一実施例に係る冷凍機油では、上記第2の合成油をカーボネイト系油にする。

これにより、例えばH F C系冷媒を用いた場合、上記カーボネイト系油は、H F C系冷媒によく溶けて、冷媒回路内を循環するので、圧縮機から冷媒と共に吐出されたカーボネイト系油が戻りにくいという問題がなく、圧縮機に対する潤滑性能を維持しつつ、上記アルキルベンゼン系油によって、キャピラリーや膨張弁の細径部の内面に付着したスラッジを剥がして除去することができる。

一実施例に係る冷凍機油では、上記冷凍機油に対して上記アルキルベンゼン系油の比率を1 wt%～50 wt%にする。

このようにすると、圧縮機から冷媒と共に吐出された合成油が冷媒回路を循環して再び圧縮機に戻るには、アルキルベンゼン系油の比率が小さい程よいが、スラッジ除去にはアルキルベンゼン系油の比率が大きい程よいので、冷媒回路等に応じて合成油の油戻りを維持しつつ、できるだけアルキルベンゼン系油の比率を大きくすることによって、効果的なスラッジ除去が行われる。なお、上記冷凍機油に対してアルキルベンゼン系油の比率が50 wt%を越える場合、アルキルベンゼン系油が溶けない例えばH F C系冷媒に対して、アルキルベンゼン系油の比率が増えすぎたことになって、圧縮機から冷媒と共に吐出された冷凍機油が冷媒回路を循環して戻りにく

くなるが、冷凍機油に対してアルキルベンゼン系油の比率が50wt%以下では、圧縮機から冷媒と共に吐出された合成油が冷媒回路を循環して確実に戻る。一方、上記冷凍機油に対してアルキルベンゼン系油の比率が1wt%未満では、スラッジの除去が十分でないが、1wt%以上であれば、スラッジ除去効果が発揮される。

一実施例に係る冷凍機油において、上記冷凍機油に対して上記アルキルベンゼン系油の比率を5wt%以上で、かつ、粘度を100℃において2.5cst以上にする。

本願出願人により行った試験と考察によって、冷凍機油に対してアルキルベンゼン系油の比率が5wt%以上であれば、冷媒(実験ではHFC系冷媒)に溶けだした切削油、錆止め油、作動油および洗浄油等のコンタミネーションによりキャピラリの内面に生じたスラッジを剥離して確実に除去し、キャピラリの詰まりがなくなることが判明した。また、上記冷凍機油に対してアルキルベンゼン系油の比率が5wt%未満なら、キャピラリの内面に生じたスラッジを十分に除去できないことが判明した。また、この冷凍機油の粘度を100℃において2.5cst以上にするによって、金属接触率がほぼ0%となり軸受等の油膜が保たれることが試験により判明した。また、冷凍機油の粘度を100℃において2.5cst未満にすると、金属接触率が高くなり軸受等の油膜が十分に確保されないことが判明した。したがって、上記冷凍機油に対してアルキルベンゼン系油の比率が5wt%以上で、かつ、冷凍機油の粘度が100℃において2.5cst以上とすることによって、キャピラリや膨張弁のスラッジによる詰まりを防止すると共に、運転範囲の全領域で軸受等の油膜が正常に保たれて、圧縮機の信頼性を維持できる。

一実施例に係る冷凍機油において、上記冷凍機油とHFC系冷媒とが0

℃において二層分離したときの冷媒リッチ層の油濃度を2.5wt%以上にする。

こうすると、圧縮機内でHFC系冷媒と冷凍機油が二層分離した場合、二層分離した冷媒リッチ層の油濃度が2.5wt%以上であれば、圧縮機の軸受等の油膜が適正に保たれ、信頼性に問題ないことが耐久試験により判明した。また、二層分離した冷媒リッチ層の油濃度が2.5wt%未満であれば、圧縮機の軸受等の油膜が薄くなって、軸受等が損傷することが判明した。したがって、運転停止状態でHFC系冷媒が圧縮機内に寝込んで、HFC系冷媒と冷凍機油が二層分離しても、冷媒リッチ層の油濃度を2.5wt%以上になるように、HFC系冷媒/基油の二層分離温度や冷凍機油に対するアルキルベンゼン系油の比率を調整するので、油膜が保たれて、軸受等が損傷するということがなく、圧縮機の信頼性を維持できる。また、上記第2の合成油がエーテル系油の場合、エーテル系油は、HFC系冷媒/エーテル系油の二層分離温度を容易に調整することができ、エステル系油に比べて、アルキルベンゼン系油をより多く混合しても、冷媒/混合油(アルキルベンゼン系油とエーテル系油)の二層分離温度を低くできる。

一実施例に係る冷凍機油において、上記冷凍機油に対して上記アルキルベンゼン系油の比率を5wt%以上で、かつ、HFC系冷媒と上記冷凍機油との二層分離温度を10℃以下にする。

このようにすると、上記冷凍機油に対してアルキルベンゼン系油の比率が5wt%以上であれば、HFC系冷媒に溶けだした切削油、錆止め油、作動油および洗浄油等のコンタミネーションによってキャピラリーや膨張弁の内面に生じたスラッジを剥離して確実に除去し、キャピラリーの詰まりがなくなる。また、本願出願人が行った耐久試験の結果、HFC系冷媒/冷凍機油の二層分離温度を10℃以下にすることによって、油温10℃以上の運

転状態では、圧縮機のドーム内に液冷媒が戻ってきた場合でも、冷凍機油と液冷媒が均一に溶解することが判明した。また、HFC系冷媒／冷凍機油の二層分離温度が10℃を越えると、冷凍機油と液冷媒が均一に溶解しない場合があることが判明した。したがって、上記冷凍機油に対してアルキルベンゼン系油の比率が5wt%以上で、かつ、HFC系冷媒／冷凍機油の二層分離温度を10℃以下にすることによって、適当な粘度を有する冷媒／混合油の混合体が油ポンプに吸い込まれるので、圧縮機の信頼性を維持できる。また、上記第2の合成油がエーテル系油の場合、エーテル系油は、HFC系冷媒／エーテル系油の二層分離温度を容易に調整することができ、エステル系油に比べて、アルキルベンゼン系油をより多く混合しても、冷媒／混合油(アルキルベンゼン系油とエーテル系油)の二層分離温度を低くできる。

また、この発明は、上述のいずれか1つの冷凍機油を用いた冷凍機を提供する。

上記構成の冷凍機によれば、上記アルキルベンゼン系油によって、キャピラリや膨張弁の細径部の内面に付着したスラッジを剥がして除去するので、キャピラリや膨張弁が詰まるのを防止できる。また、上記スラッジの原因となる切削油、錆止め油および作動油等を除去するための冷媒系部品の洗浄工程が不要となるため、工数とコストを低減できる。

一実施例に係る冷凍機では、HFC(ハイドロフルオロカーボン)系冷媒を用いる。

これにより、HFC系冷媒に対して相溶性を有する合成油を冷凍機油として用いた場合、特にキャピラリや膨張弁の細径部の内面にスラッジが生じやすいが、上記アルキルベンゼン系油によって、キャピラリや膨張弁の細径部の内面に付着したスラッジを剥がして除去することができる。

一実施例に係る冷凍機では、減圧器にキャピラリを用いる。

こうすると、上記アルキルベンゼン系油によって、キャピラリの細径部の内面に付着したスラッジを剥がして除去するので、安価なキャピラリを使用することができ、冷凍機のコストを低減できる。

一実施例に係る冷凍機では、H F C系冷媒を用いると共に、高圧ドーム型の圧縮機を備えて、上記冷凍機油に対して上記アルキルベンゼン系油の比率を5 wt%以上で、かつ、上記冷凍機油の粘度を100℃において2.5 cst以上にする。

上述の試験と考察の結果から、上記冷凍機油に対してアルキルベンゼン系油の比率が5 wt%以上で、かつ、冷凍機油の粘度が100℃において2.5 cst以上とすることによって、キャピラリや膨張弁のスラッジによる詰まりを防止すると共に、運転範囲の全領域で軸受等の油膜が正常に保たれて、油温が高い高圧ドーム型の圧縮機の信頼性を維持できる。なお、高圧ドーム型の圧縮機とは、冷媒が吸入管、圧縮部分および圧縮機の容器(高圧ドーム)を経て吐出管に流れるもので、冷凍機油が高圧ドーム内の高温高圧部に貯留されるものである。

一実施例に係る冷凍機では、上記冷凍機油と上記H F C系冷媒とが0℃において二層分離したときの冷媒リッチ層の油濃度を2.5 wt%以上にする。

こうすると、上記圧縮機内でH F C系冷媒と冷凍機油が二層分離した場合、二層分離した冷媒リッチ層の油濃度が2.5 wt%以上であれば、圧縮機の軸受等の油膜が適正に保たれ、信頼性に問題ない。したがって、H F C系冷媒と冷凍機油の二層分離が問題となる高圧ドーム型の圧縮機の場合、運転停止状態でH F C系冷媒が圧縮機内に寝込んで、H F C系冷媒と冷凍機油が二層分離しても、冷媒リッチ層の油濃度を2.5 wt%以上になるよ

うに、H F C系冷媒／基油の二層分離温度や冷凍機油に対するアルキルベンゼン系油の比率を調整するので、油膜が保たれて、軸受等が損傷するということがなく、圧縮機の信頼性を維持できる。また、上記第2の合成油がエーテル系油の場合、エーテル系油は、H F C系冷媒／エーテル系油の二層分離温度を容易に調整することができ、エステル系油に比べて、アルキルベンゼン系油をより多く混合しても、冷媒／混合油(アルキルベンゼン系油とエーテル系油)の二層分離温度を低くできる。

一実施例に係る冷凍機では、H F C系冷媒を用いると共に、低圧ドーム型の圧縮機を備えて、上記冷凍機油に対して上記アルキルベンゼン系油の比率を5 wt%以上で、かつ、上記H F C系冷媒と上記冷凍機油との二層分離温度を10℃以下にする。

このようにすると、上述の試験と考察の結果から、上記冷凍機油に対してアルキルベンゼン系油の比率が5 wt%以上であれば、H F C系冷媒に溶けだした切削油、錆止め油、作動油および洗浄油等のコンタミネーションによってキャピラリの内面に生じたスラッジを剥離して確実に除去し、キャピラリーや膨張弁の詰まりがなくなる。また、上記H F C系冷媒と冷凍機油の二層分離が生じやすい低圧ドーム型の圧縮機の場合、高圧ドーム型に比べてアルキルベンゼン系油の比率を小さくする必要があるが、H F C系冷媒／冷凍機油の二層分離温度を10℃以下にすることによって、油温10℃以上の運転状態では、圧縮機のドーム内に液冷媒が戻ってきた場合でも、冷凍機油と液冷媒が均一に溶解する。したがって、上記冷凍機油に対してアルキルベンゼン系油の比率が5 wt%以上で、かつ、H F C系冷媒／冷凍機油の二層分離温度を10℃以下にすることによって、適当な粘度を有する冷媒／混合油の混合体が油ポンプに吸い込まれるので、低圧ドーム型の圧縮機の信頼性を維持できる。なお、低圧ドーム型の圧縮機とは、冷媒が

吸入管、圧縮機の容器(低圧ドーム)および圧縮部分を経て吐出管に流れるもので、冷凍機油が低圧ドーム内の低温低圧部に貯留されるものである。また、上記第2の合成油がエーテル系油の場合、エーテル系油は、HFC系冷媒／エーテル系油の二層分離温度を容易に調整することができ、エステル系油に比べて、アルキルベンゼン系油をより多く混合しても、冷媒／混合油(アルキルベンゼン系油とエーテル系油)の二層分離温度を低くできる。

一実施例に係る冷凍機では、HFC系冷媒を用いる。

これにより、合成油を冷凍機油として用いた場合、特にキャピラリや膨張弁の細径部の内面にスラッジが生じやすいが、上記アルキルベンゼン系油によって、キャピラリや膨張弁の細径部の内面に付着したスラッジを剥がして除去することができる。

一実施例に係る冷凍機では、HFC系冷媒を用いると共に、減圧器にキャピラリを用いる。

これにより、上記冷凍機油はHFC系冷媒に対しても相溶性を有し、冷凍機油に混合された上記アルキルベンゼン系油によって、キャピラリの細径部の内面に付着したスラッジを剥がして除去することができる。また、上記アルキルベンゼン系油によって、キャピラリの細径部の内面に付着したスラッジを剥がして除去するので、安価なキャピラリを使用することができ、コストを低減できる。また、上記冷凍機油を充填した冷凍機は、冷凍機油を交換することなく、HFC系冷媒を代替冷媒のHFC系冷媒に置き換えること(レトロフィット)が容易にできる。

一実施例に係る冷凍機では、HFC系冷媒を用いると共に、高圧ドーム型の圧縮機を備えて、上記冷凍機油に対して上記アルキルベンゼン系油の比率を5wt%以上で、かつ、上記冷凍機油の粘度を100℃において2.

5 cst以上にする。

このようにすると、上述の試験と考察の結果から、上記冷凍機油に対してアルキルベンゼン系油の比率が5 wt%以上で、かつ、冷凍機油の粘度が100℃において2.5 cst以上とすることによって、キャピラリや膨張弁のスラッジによる詰まりを確実に防止すると共に、運転範囲の全領域で軸受等の油膜が正常に保たれて、油温が高い高圧ドーム型の圧縮機の信頼性を維持できる。また、上記冷凍機油を充填した冷凍機は、冷凍機油を交換することなく、H C F C系冷媒を代替冷媒のH F C系冷媒に置き換えることが容易にできる。

一実施例に係る冷凍機では、上記冷凍機油と上記H C F C系冷媒とが0℃において二層分離したときの冷媒リッチ層の油濃度を2.5 wt%以上にする。

こうすると、上記圧縮機内でH C F C系冷媒と冷凍機油が二層分離した場合、二層分離した冷媒リッチ層の油濃度が2.5 wt%以上であれば、圧縮機の軸受等の油膜が適正に保たれ、信頼性に問題ない。したがって、H C F C系冷媒と冷凍機油の二層分離が問題となる高圧ドーム型の圧縮機の場合、運転停止状態でH C F C系冷媒が圧縮機内に寝込んでH C F C系冷媒と冷凍機油が二層分離しても、冷媒リッチ層の油濃度を2.5 wt%以上になるように、H F C系冷媒／基油の二層分離温度や冷凍機油に対するアルキルベンゼン系油の比率を調整するので、油膜が保たれて、軸受等が損傷するということがなく、圧縮機の信頼性を維持できる。また、上記冷凍機油を充填した冷凍機は、冷凍機油を交換することなく、H C F C系冷媒を代替冷媒のH F C系冷媒に置き換えることが容易にできる。また、上記第2の合成油がエーテル系油の場合、エーテル系油は、H F C系冷媒／エーテル系油の二層分離温度を容易に調整することができ、エステル系油に

比べて、アルキルベンゼン系油をより多く混合しても、冷媒／混合油(アルキルベンゼン系油とエーテル系油)の二層分離温度を低くできる。

一実施例に係る冷凍機では、H C F C系冷媒を用いると共に、低圧ドーム型の圧縮機を備えて、上記冷凍機油に対して上記アルキルベンゼン系油の比率を5 wt%以上で、かつ、上記冷凍機油と上記H C F C系冷媒との二層分離温度を10℃以下にする。

このようにすると、上述の試験と考察の結果から、冷凍機油に対してアルキルベンゼン系油の比率が5 wt%以上であれば、H C F C系冷媒に溶けだした切削油、錆止め油、作動油および洗浄油等のコンタミネーションによってキャピラリの内面に生じたスラッジを剥離して確実に除去し、キャピラリの詰まりがなくなる。また、上記H C F C系冷媒と冷凍機油の二層分離が生じやすい低圧ドーム型の圧縮機の場合、その二層分離温度を10℃以下にすることによって、油温が10℃以上の運転状態では、圧縮機のドーム内に液冷媒が戻ってきた場合でも、冷凍機油と液冷媒が均一に溶解する。したがって、適当な粘度を有する冷媒／冷凍機油の混合体が油ポンプに吸い込まれるので、低圧ドーム型の圧縮機の信頼性を維持できる。また、上記冷凍機油を充填した冷凍機は、冷凍機油を交換することなく、H C F C系冷媒を代替冷媒のH F C系冷媒に置き換えることが容易にできる。また、上記第2の合成油がエーテル系油の場合、エーテル系油は、H F C系冷媒／エーテル系油の二層分離温度を容易に調整することができ、エステル系油に比べて、アルキルベンゼン系油をより多く混合しても、冷媒／混合油(アルキルベンゼン系油とエーテル系油)の二層分離温度を低くできる。

一実施例に係る冷凍機では、駆動軸の偏心部に回転自在に嵌合するローラと、このローラの外周に一体に固定されると共に、上記ローラの径方向の外方に延びて、シリンダ内のシリンダ室を圧縮室と吸入室とに区画する

ブレードと、上記シリンダに回転自在に支持されており、上記ブレードの突出側先端部を受け入れて案内する受入溝が形成されている支持体とを有するスイング式圧縮機を用いる。

上記構成の冷凍機では、上記スイング式圧縮機において、ブレードをローラに固定し、回転自在な支持体の受入溝でブレードの先端部を案内するようにしたから、ブレードの面は支持体に面接触してシールを行って境界潤滑状態が発生しない。したがって、環境安全性を考慮した代替フロン冷媒を使用しても、上記アルキルベンゼン系油によって、キャピラリや膨張弁の細径部の内面に付着したスラッジを剥がして除去でき、しかも、圧縮機のブレードを支持体に面接触させて摺動させるから、潤滑油の劣化を防止でき、焼き付きを防止できる。

図面の簡単な説明

図1はこの発明の第1、第2実施形態の冷凍機油を用いた冷凍機の回路図である。

図2はHFC系冷媒R-407C/混合油(アルキルベンゼンとポリエーテルA)における二層分離線図である。

図3はHFC系冷媒R-407C/混合油(アルキルベンゼンとポリエーテルB)における二層分離線図である。

図4はHFC系冷媒/基油の二層分離温度とアルキルベンゼン系油の比率との関係を示す図である。

図5は油の粘度に対する金属接触率を示す図である。

図6はこの発明の第3実施形態の冷凍機が備えるスイング式圧縮機の要部を示す平断面図である。

発明を実施するための最良の形態

以下、この発明の冷凍機油に関する実験と考察について説明すると共に、

その冷凍機油を用いた冷凍機を図示の実施の形態により詳細に説明する。

まず、本願出願人は、実験にあたって、冷凍機油として合成油(例えばエステル系油)を用いた冷凍機を長期間運転し、冷媒に溶けだした切削油、錆止め油、作動油および洗浄油等のコンタミネーション(汚物)によりキャピラリ内面に生じたスラッジによってキャピラリを詰まらせ、そのキャピラリを切断して、複数のサンプルを用意した。そして、内面にスラッジが生じて詰まった複数のサンプルを、第2の合成油としてのエーテル系油、エステル系油およびフッ素系油に第1の合成油としてのアルキルベンゼン系油を夫々添加した混合油に長期間浸けて、各サンプルのスラッジの状態変化を観察した。その結果、上記エーテル系油、エステル系油およびフッ素系油をベース油にアルキルベンゼン系油を夫々添加することによって、冷媒に溶けだした切削油、錆止め油、作動油および洗浄油等のコンタミネーション(汚物)により冷媒系部品の内面に生じたスラッジを剥離する効果があることを発見した。

また、上記サンプルをアルキルベンゼン系油のみに長期間浸けた実験を行った結果、アルキルベンゼン系油だけで、キャピラリ詰まりの原因であるスラッジを剥がして、キャピラリの内面を洗浄する効果があることが判った。上記実験後のサンプルは、エーテル系油、エステル系油およびスニソ油を用いた場合と異なり、新品同様の光沢のある内面状態となった。しかしながら、上記アルキルベンゼン系油を冷凍機油として使用すると、アルキルベンゼン系油がHFC系冷媒に対して非相溶であるため、長い配管や高低差が大きい冷凍機では、圧縮機から冷媒と共に吐出された冷凍機油が冷媒回路を循環して圧縮機に戻らず、潤滑不良により信頼性が低下する。

そこで、本願出願人は、上記実験結果に基づいて、HFC系冷媒に対して相溶性を有する合成油(エーテル系油、エステル系油、フッ素系油および

カーボネイト系油等)とアルキルベンゼン系油を併用することにした。すなわち、上記HFC系冷媒によく溶ける合成油によって、圧縮機に対する潤滑性能を維持するための油戻りを良好にすると共に、その合成油にアルキルベンゼン系油を添加することによって、キャピラリ詰まりを引き起こすスラッジを除去するのである。こうして、上述の潤滑不良とキャピラリ詰まりの問題を一気に解決することができる。

(第1実施形態)

以下、上記冷凍機油を冷凍機に用いた場合について説明する。

図1は上記冷凍機油を用いた冷凍機の回路図であり、1は圧縮機、2は上記圧縮機1の吐出側に接続された四路弁、3は上記四路弁2に一端が接続された室外熱交換器、4は上記室外熱交換器3の他端に一端が接続された膨張手段としてのキャピラリ、5は上記キャピラリ4の他端に閉鎖弁11を介して一端が接続された室内熱交換器、6は上記室内熱交換器5の他端に閉鎖弁12と四路弁2を介して一端が接続され、他端が上記圧縮機1の吸入側に接続されたアキュムレータである。

上記構成の冷凍機において、HCFC系冷媒の代替冷媒としてHFC系冷媒(R-134a, R-407系, R-410系およびHFC-32/134a等)を用いると共に、エーテル系油, エステル系油, フッ素系油およびカーボネイト系油等の合成油のうちのいずれか1つとアルキルベンゼン系油との混合油を冷凍機油として用いる。なお、上記アルキルベンゼン系油の比率は、冷媒回路等に応じて冷凍機油全体に対して1wt%~50wt%の範囲内で設定する。

上記冷凍機油に混合されたアルキルベンゼン系油によって、キャピラリ4の細径部の内面に付着したスラッジを剥がして除去するので、冷媒系部品や加工工程の見直しを行うことなく、キャピラリ詰まりを防止すること

ができる。また、上記スラッジの原因となる切削油、錆止め油および作動油等を除去するための冷媒系部品の洗浄工程が不要となるため、工数とコストを低減することができる。

また、H F C系冷媒を用いた冷媒回路に、H F C系冷媒に対して相溶性を有する合成油(エーテル系油、エステル系油、フッ素系油およびカーボネイト系油等)を冷凍機油として用いた場合、上記合成油がH F C系冷媒によく溶けて、冷媒回路内を循環するので、圧縮機1から吐出された合成油が戻りにくいという問題がなく、圧縮機1の潤滑性能を維持することができる。そして、上記合成油を用いた場合は、特にスラッジが生じやすいが、冷凍機油に混合されているアルキルベンゼン系油によって、キャピラリ4等の冷媒系部品の細径部の内面に付着したスラッジを剥がして除去することができる。また、上記アルキルベンゼン系油はエーテル系油、エステル系油によく溶け、アルキルベンゼン系油がエーテル系油、エステル系油に溶けた状態で冷媒回路内に運ばれて、上記スラッジを効果的に除去することができる。

また、上記アルキルベンゼン系油と他の合成油とが混合された冷凍機油によって、キャピラリ4の細径部の内面に付着したスラッジを剥がして除去するので、キャピラリ詰まりの心配がなく、安価なキャピラリを使用することができる。したがって、上記冷凍機のコストを低減することができる。また、上記キャピラリを使用することで、冷凍機の信頼性を向上することができる。

さらに、本願出願人は、キャピラリ詰まりが生じにくく、かつ、圧縮機の信頼性を損なうことのない冷凍機油について様々な条件で試験を重ねた結果、エーテル系油またはエステル系油の第2の合成油にアルキルベンゼン系油からなる第1の合成油を適正な比率で混ぜた混合油がこれらの問題

を解決できることを発見した。以下にその詳細を説明した後、その混合油を冷凍機油として用いた冷凍機の第2実施形態について説明する。

表1は、エーテル系油とエステル系油の合成油を基油としてアルキルベンゼン系油の比率を変えて、浸漬試験と実機耐久試験を行った結果を示している。

【表1】

	アルキルベンゼン系油の比率 [wt%]					
	0	3	5	10	30	50
浸漬試験 I	×	×	○	○	○	○
浸漬試験 II	×	×	○	○	○	○
実機耐久試験	×	—	○	—	—	○

なお、表1において、浸漬試験 I、浸漬試験 II および実機耐久試験の夫々の試験条件等は次のとおりである。

浸漬試験 I 基油：エーテル系油

内面にスラッジが付着したキャピラリを常温で2週間

浸漬

○：スラッジが剥がれる

×：スラッジが剥がれない

浸漬試験 II 基油：エステル系油

内面にスラッジが付着したキャピラリを常温で2週間

浸漬

○：スラッジが剥がれる

×：スラッジが剥がれない

実機耐久試験 試験機：ルームエアコン(1馬力)

冷媒：R-407C

基油：エーテル系油

4000時間運転後にスラッジの有無を判断

○：キャピラリが詰まらない

×：キャピラリが詰まる

上記浸漬試験 I, II では、エステル系油の実機耐久試験で詰まったキャピラリ片を混合油に浸漬し、一定時間後にスラッジの変化を見て、キャピラリ内面に付着したスラッジが剥がれているかどうかを観察した。また、実機耐久試験では、キャピラリを備えたルームエアコンの実機を用いて、混合油を充填すると共に、コンタミネーションを一定量混入させて耐久試験を行い、一定時間毎にキャピラリを外して、一定差圧条件で窒素ガスを流し、その流量を測定して、流量低下の有無によりキャピラリ詰まりを評価した。つまり、窒素流量が低下した場合は、キャピラリ内面にスラッジが付着しており、窒素流量が低下しない場合は、キャピラリ内面にスラッジが付着していないと判断するのである。

上記浸漬試験 I, II の結果と実機耐久試験の結果とはよく一致し、アルキルベンゼン系油からなる第1の合成油とそれ以外の第2の合成油(エーテル系油, エステル系油)冷凍機油に対するアルキルベンゼン系油の比率が5 wt%以上であれば、キャピラリ内面のスラッジを剥離して確実に除去できると共に、冷凍機油のコンタミネーションとの親和力が維持され、液冷媒中にコンタミネーションを析出させないことが判った。なお、上記第2の合成油としてエーテル系油とエステル系油とからなる混合油, フッ素系油およびカーボネイト系油を用いた場合も同様となる。

また、HFC系冷媒に対して相溶性を有する合成油(エステル系油, エーテル系油)にアルキルベンゼン系油を混合した混合油において、HFC系冷媒/混合油の二層分離温度は、アルキルベンゼン系油の比率に大きく影

響される。

この点に着目して、本願出願人は、H F C系冷媒R-407Cと混合油との二層分離特性について試験を行った。その結果を図2、図3に示す。この図2の試験では、冷凍機油としてアルキルベンゼン系油とポリエーテルA(エーテル系油)との混合油を用い、図3の試験では、冷凍機油としてアルキルベンゼン系油とポリエーテルB(エーテル系油)との混合油を用いた。なお、図2におけるH F C系冷媒R-407C/ポリエーテルAの単体の二層分離温度を約 -20°C とし、図3におけるH F C系冷媒R-407C/ポリエーテルBの単体の二層分離温度を約 -35°C とした。図2、図3において、H F C系冷媒R-407Cとアルキルベンゼン系油の単体とはいかなる温度範囲においても二層分離を生じ、いわゆる下部臨界溶解温度は出現しない。

上記ポリエーテルA、Bの基油にアルキルベンゼン系油を混合して、アルキルベンゼン系油の比率を大きくするほど、H F C系冷媒/混合油の二層分離温度は著しく上昇する。例えば、図2において、アルキルベンゼン系油を約11wt%混合すると、二層分離温度は約 -20°C から約 10°C となり、ポリエーテルA単体に比べて約 30°C 上昇する。一方、図3において、アルキルベンゼン系油を約21wt%混合すると、二層分離温度は約 -35°C から約 10°C となり、図1の場合に比べてアルキルベンゼン系油の比率が同一の場合は、二層分離温度は全体に低くなっている。

このように、H F C系冷媒/基油単体の二層分離温度が低くなるほど、H F C系冷媒/混合油の二層分離温度もそれに応じて低くすることができる。そして、H F C系冷媒/混合油の二層分離温度を低くすることによって、圧縮機内の油温が上昇した運転状態では、圧縮機のドーム内に液冷媒が戻ってきた場合でも、冷凍機油と液冷媒は均一に溶解し、適当な粘度を持つ冷凍機油/冷媒の混合物が油ポンプに吸い込まれて、圧縮機の軸受等

の潤滑を正常に維持することができる。特に、低圧ドーム型の圧縮機では、高圧ドーム型に比べて油温が低く、液冷媒が直接冷凍機油と混合されることになるため、HFC系冷媒／混合油の二層分離温度がさらに低い冷凍機油が要求される。

また、上記エーテル系油は、HFC系冷媒／エーテル系油の二層分離温度を調整することができる特徴を有している。したがって、低い二層分離温度を持つ混合油を提供しようとする場合は、エステル系油よりも二層分離温度を低くすることが可能なエーテル系油を基油として用いるのが好ましい。

上述の試験と考察の結果から従来の問題点を解決するアルキルベンゼン系油の適正な比率を探索した。すなわち、

i) キャピラリや膨張弁が詰まらない

ii) 液冷媒が圧縮機に戻る状態または冷凍機油が高温になる状態でも圧縮機の信頼性が損なわれない

という要求条件を満たすように、冷凍機油に対するアルキルベンゼン系油の比率を探索した。

図4はその探索の結果を示しており、横軸はHFC系冷媒／基油の二層分離温度Tであり、縦軸はアルキルベンゼン系油の比率Yである。

まず、表1により、アルキルベンゼン系油の比率Yの条件は、

$$Y \geq 5 \dots \dots \text{[条件1]}$$

となる。

また、低圧ドーム型の圧縮機では、二層分離が起きやすいため、高圧ドーム型に比べてアルキルベンゼン系油の比率を小さくする必要がある。また、圧縮機の耐久試験を行った結果、HFC系冷媒／混合油の二層分離温度が10℃以下であれば、圧縮機の信頼性が確保させることが判明した。

また、HFC系冷媒／混合油の二層分離温度が10℃を越えると、圧縮機の信頼性が十分に確保できないことが判明した。従来のHCFC系冷媒R-22と鉱油(スニソ4GS)の組み合わせでも、二層分離温度が約10℃であり、その実績からも、HFC系冷媒／混合油の二層分離温度10℃は妥当な数値である。そこで、図2、図3のデータから二層分離温度10℃のときのアルキルベンゼン系油の比率を求めて、図4の○印で示した。したがって、図4に示すように、HFC系冷媒／混合油の二層分離温度が10℃以下となるHFC系冷媒／基油の二層分離温度Tに対するアルキルベンゼン系油の比率Yの条件は、

$$Y \leq -0.67T - 3 \dots \dots \dots \text{[条件2]}$$

となる。

また、高圧ドーム型の圧縮機では、通常の運転状態では、油温が高いため、アルキルベンゼン系油の比率を増加しても、二層分離はほとんど発生しないが、停止状態では、油温が周囲温度まで下がり、冷媒がドーム内に移動してくるいわゆる寝込みが生じる。この状態では、HFC系冷媒と混合油の二層分離が生じる。この寝込みを想定した耐久試験を行った結果、二層分離した冷媒リッチ層の油濃度が2.5wt%以上(0℃において)であれば、圧縮機の軸受等の油膜が保たれて、信頼性上問題のないことが判明した。また、二層分離した冷媒リッチ層の油濃度が2.5wt%未満(0℃において)であれば、圧縮機の軸受等の油膜が薄くなって、軸受等が損傷することが判明した。そこで、図2、図3のデータから0℃のときの油分率が2.5wt%における冷凍機油に対するアルキルベンゼン系油の比率を求めて、図4の△印で示した。したがって、図4に示すように、HFC系冷媒／基油の二層分離温度Tに対するアルキルベンゼン系油の比率Yの条件は、

$$Y \leq -T + 15 \dots \dots \dots [\text{条件3}]$$

となる。

なお、上記〔条件3〕は、二層分離が問題となるような高圧ドーム型の場合であり、冷房専用機やヒートポンプではあっても冷媒量が少ない場合や、圧縮機に二層分離防止機能が備わっている場合には、この〔条件3〕を満たす必要はない。

また、高圧ドーム型の圧縮機の運転時の油温90～110℃において油の粘度に対する金属接触率の関係を調べた試験結果を図5に示す。図5に示すように、運転条件によって多少異なるが、油の粘度が2.5cst以上であれば、金属接触率がほぼ0%となって、圧縮機の軸受等の油膜が保持されることが判る。また、油の粘度が2.5cst未満であれば、金属接触率が大きくなって、圧縮機の軸受等の油膜が薄くなって、軸受等が損傷し信頼性が損なわれることが判る。したがって、油温が高い運転条件を考慮した場合、冷凍機油の粘度が油温100℃において2.5cst以上であれば、製品運転範囲の全領域で軸受の油膜が正常に保たれる。上記冷凍機油の粘度が2.5cst以上という条件と粘度の混合則により求められたアルキルベンゼン系油の比率Yの条件は、

$$Y \leq (\log \log(2.5+0.6) - \log \log(U+0.6))$$

$$/ (\log \log(V+0.6) - \log \log(U+0.6)) \times 100 \dots \dots [\text{条件4}]$$

となる。上記〔条件4〕において、Uは基油の100℃における粘度[cst]、Vはアルキルベンゼン系油の100℃における粘度[cst]である。なお、上記混合則は体積比を規定するものであるから、重量比に置き換える際に、基油とアルキルベンゼン系油の密度は同一とみなして算出している。したがって、基油とアルキルベンゼン系油の密度が異なる場合は、その補正を行う。なお、図4に示した〔条件4〕の境界線は、基油の粘度グレードが

V G 6 8 (40℃における粘度 6 8 [cst])、アルキルベンゼン系油の粘度グレードが V G 8 (40℃における粘度 8 [cst]) の場合である。

(第2実施形態)

以下、上述の [条件 1] ~ [条件 4] を満たす冷凍機油を冷凍機に用いた場合について説明する。

第1実施形態の図1に示す冷凍機と同一の構成の冷凍機において、H F C系冷媒を用いると共に、高圧ドーム型の圧縮機1を備えて、上記 [条件 1] , [条件 4] を満たす比率(図4に示す領域 A, B および C) のアルキルベンゼン系油を基油(エーテル系油)に混合した冷凍機油を用いる。この場合、キャピラリ4の詰まりがなく、かつ、運転範囲の全領域で軸受等の油膜が正常に保たれて、油温が高い高圧ドーム型の圧縮機1の信頼性を維持することができる。

また、上記圧縮機1が二層分離が問題となる高圧ドーム型の場合は、上記 [条件 1] , [条件 4] に加えて [条件 3] を満たす比率(図4に示す領域 A, B) のアルキルベンゼン系油を基油(エーテル系油)に混合した冷凍機油を用いる。この場合、キャピラリ4の詰まりを防止すると共に、運転停止状態で冷媒が圧縮機内に寝込み等によって二層分離しても、冷媒リッチ層の油濃度を 2. 5 wt% 以上にするので、油膜が保たれて、軸受等が損傷するということがなく、高圧ドーム型の圧縮機1の信頼性を向上することができる。

また、上記圧縮機1が二層分離が生じやすい低圧ドーム型の場合、上記 [条件 1] と [条件 2] を満たす比率(図3に示す領域 A) のアルキルベンゼン系油を基油(エーテル系油)に混合した冷凍機油を用いる。すなわち、高圧ドームに比べてアルキルベンゼン系油の比率を小さくして、H F C系冷媒/混合油の二層分離温度が 1 0℃以下にすることによって、油温が 1

0℃以上の運転状態では、圧縮機1のドーム内に液冷媒が戻ってきた場合でも、混合油と液冷媒が均一に溶解し、適当な粘度を有する冷媒／混合油の混合体が油ポンプに吸い込まれるので、低圧ドーム型の圧縮機1の信頼性を維持することができる。

また、上記第2実施形態において、アルキルベンゼン系油はエーテル系油によく溶けると共に、エーテル系油は、HFC系冷媒／エーテル系油の二層分離温度を容易に調整できるので、エステル系油等に比べて、アルキルベンゼン系油をより多く混合しても、HFC系冷媒／混合油(エーテル系油とアルキルベンゼン系油)の二層分離温度を低くすることができる。したがって、上記冷凍機油に対するアルキルベンゼン系油の比率を大きくでき、キャピラリや膨張弁の内面に付着したスラッジを特によく除去することができる。なお、上記第2実施形態において、第1の合成油としてのアルキルベンゼン系油に、第2の合成油としてエステル系油、エーテル系油とエステル系油からなる混合油、フッ素系油およびカーボネイト系油を混合した冷凍機油を用いてもよい。

(第3実施形態)

図6はこの発明の第3実施形態の冷凍機が備えるスイング式圧縮機を示している。

このスイング式圧縮機は圧縮要素30を備える。上記圧縮要素30は、内部にシリンダ室41をもつシリンダ40と、上記シリンダ室41内に公転可能に配置されたローラ7とを備えている。そして、駆動軸(図示せず)の偏心部20に、上記ローラ7を相対回転自在に嵌合している。一方、上記シリンダ40の側壁には、シリンダ室41に開口する吸入口30aと吐出口30bとが形成されている。また、上記ローラ7の外周部には、ローラ

7の径方向外方に向けて突出しているブレード8が一体形成されている。一方、上記シリンダ40の吸入口30aと吐出口30bとの中間部に、円筒形の筒状保持孔42が形成されている。そして、この保持孔42には、横断面が半円形状の2つの半円柱状部材22、22で構成する支持体21が回転自在に嵌合している。上記半円柱状部材22の相対向する平坦面が受入溝21aを構成している。この受入溝21aは、一端が上記シリンダ室41内に連通しており、この受入溝21aに上記ブレード8の先端部8aが面接触可能に摺動自在に挿入されている。このブレード8は、上記シリンダ室41内を圧縮室31と吸入室32とに区画する。また、上記吐出口30bを開閉する板状の弁体9が、上記吐出口30bの出口周りに形成されている弁座面44に密着するように配設されている。この弁体9には受板10が貼り合わされている。

そして、上記スイング式圧縮機は、上記シリンダ室41内で圧縮される作動流体として、代替フロン冷媒であるHFC系のR410Aを使用している。また、潤滑油として、HFC系冷媒に対して相溶性を有するエーテル系油とアルキルベンゼン系油を併用している。このR410Aは、HFC32とHFC125との混合冷媒の1つである。

また、この冷凍機は、減圧手段としてキャピラリーチューブを用いている。

上記構成の冷凍機において、駆動軸が駆動されると、ローラ7に一体に設けたブレード8の突出先端部8aが支持体21の受入溝21aに沿って出入すると同時に、支持体21が旋回する。つまり、上記ブレード8は、ローラ7の公転にしたがって揺動しながら径方向へ進退動することによって、シリンダ室41の内部を常に圧縮室31と吸入室32とに区画する。

この冷凍機によれば、ローラ7を、偏心部20に対し自転することなく

公転させているときに、つまり、ブレード8を中心にスイング（揺動）させているときに、従来と異なり、ブレード8の先端部がローラ7の外周面に線接触して移動することがなく、ブレード8とローラ7とが相対移動しない。したがって、ブレード8とローラ7との線接触による摺動摩擦が発生しない。そして、ブレード8の面は支持体21に面接触してシールを行うので、境界潤滑状態が発生しない。

したがって、上記スイング式圧縮機を用いた冷凍機によれば、環境安全性を考慮した代替フロン冷媒を使用しても、上記アルキルベンゼン系油によって、キャピラリや膨張弁の細径部の内面に付着したスラッジを剥がして除去でき、しかも、圧縮機のブレード8を支持体21に面接触させて摺動させるから、潤滑油の劣化を防止することができ、焼き付きを防止することができる。

上記第1実施形態では、アルキルベンゼン系油からなる第1の合成油と、エーテル系油、エステル系油、フッ素系油およびカーボネイト系油の第2の合成油とが混合された冷凍機油を用いたが、アルキルベンゼン系油からなる第1の合成油と、エーテル系油、エステル系油、フッ素系油およびカーボネイト系油以外の第2の合成油とが混合された冷凍機油を用いてもよいのは勿論である。

また、上記第1実施形態では、第2の合成油としてエーテル系油、エステル系油、フッ素系油およびカーボネイト系油のいずれか1つにアルキルベンゼン系油からなる第1の合成油を添加したが、エーテル系油とエステル系油の混合油にアルキルベンゼン系油を添加してもよい。この場合、上記エステル系油は、水により加水分解するが、酸化による劣化が起きにくく、反対にエーテル系油は、酸化により劣化するが、水に強く加水分解しにくいので、エーテル系油とエステル系油の比率を例えば1：1とするこ

とによって、酸化による劣化の度合いと水によって加水分解される度合いを夫々半減させた冷凍機油を得ることができる。

また、上記第1、第2実施形態では、HFC系冷媒を用いた冷凍機について説明したが、冷媒はHFC系冷媒に限らず、HCFC系冷媒等でもよいのは勿論である。この場合、この発明の冷凍機油は鉱油などのHCFC系冷媒用の冷凍機油が混入しても問題が起きず、また、HCFC系冷媒R-22等との相溶性もあるため、HCFC系冷媒を用いた冷凍機にこの発明の冷凍機油を充填しておくことによって、冷凍機油を交換することなく、その冷凍機のHCFC系冷媒を代替冷媒のHFC系冷媒に置き換える(いわゆるレトロフィット)ことが容易にできる。

また、上記第3実施形態では、この発明の冷凍機油をスイング式圧縮機に用いたが、ベンとロータが別体でベンの先端がロータの外周面に接触するロータリタイプの圧縮機や二つのスクロールの間でガスを圧縮するスクロール圧縮機にこの発明の冷凍機油を用いてもよい。

産業上の利用可能性

この発明の冷凍機油およびそれを用いた冷凍機は、食品等を冷凍冷蔵する冷蔵庫に用いられる他、室内の冷暖房を行う空気調和機に用いられる。

請求の範囲

1. アルキルベンゼン系油からなる第1の合成油とそのアルキルベンゼン系油以外の第2の合成油とが混合されていることを特徴とする冷凍機油。
2. 請求項1に記載の冷凍機油において、上記第2の合成油はエーテル系油であることを特徴とする冷凍機油。
3. 請求項1に記載の冷凍機油において、上記第2の合成油はエステル系油であることを特徴とする冷凍機油。
4. 請求項1に記載の冷凍機油において、上記第2の合成油はエーテル系油とエステル系油とからなることを特徴とする冷凍機油。
5. 請求項1に記載の冷凍機油において、上記第2の合成油はフッ素系油であることを特徴とする冷凍機油。
6. 請求項1に記載の冷凍機油において、上記第2の合成油はカーボネイト系油であることを特徴とする冷凍機油。
7. 請求項1に記載の冷凍機油において、上記冷凍機油に対して上記アルキルベンゼン系油の比率が1wt%～50wt%であることを特徴とする冷凍機油。



8. 請求項1に記載の冷凍機油において、上記冷凍機油に対して上記アルキルベンゼン系油の比率が5 wt%以上で、かつ、粘度が100℃において2.5 cst以上であることを特徴とする冷凍機油。
9. 請求項8に記載の冷凍機油において、上記冷凍機油とHFC系冷媒とが0℃において二層分離したときの冷媒リッチ層の油濃度が2.5 wt%以上であることを特徴とする冷凍機油。
10. 請求項1に記載の冷凍機油において、上記冷凍機油に対して上記アルキルベンゼン系油の比率が5 wt%以上で、かつ、HFC系冷媒と上記冷凍機油との二層分離温度が10℃以下であることを特徴とする冷凍機油。
11. 請求項1に記載の冷凍機油を用いたことを特徴とする冷凍機。
12. 請求項11に記載の冷凍機において、HFC(ハイドロフルオロカーボン)系冷媒を用いたことを特徴とする冷凍機。
13. 請求項11に記載の冷凍機において、減圧器にキャピラリを用いたことを特徴とする冷凍機。
14. 請求項11に記載の冷凍機において、HFC系冷媒を用いると共に、高圧ドーム型の圧縮機を備えて、上記冷凍機油に対して上記アルキルベンゼン系油の比率が5 wt%以上で、かつ、上記冷凍機油の粘度が100℃において2.5 cst以上であることを特徴とする冷凍機。



15. 請求項14に記載の冷凍機において、上記冷凍機油と上記HFC系冷媒とが0℃において二層分離したときの冷媒リッチ層の油濃度が2.5wt%以上であることを特徴とする冷凍機。

16. 請求項11に記載の冷凍機において、HFC系冷媒を用いると共に、低圧ドーム型の圧縮機を備えて、上記冷凍機油に対して上記アルキルベンゼン系油の比率が5wt%以上で、かつ、上記HFC系冷媒と上記冷凍機油との二層分離温度が10℃以下であることを特徴とする冷凍機。

17. 請求項11に記載の冷凍機において、HCFC(ハイドロクロロフルオロカーボン)系冷媒を用いたことを特徴とする冷凍機。

18. 請求項11に記載の冷凍機において、HCFC系冷媒を用いると共に、減圧器にキャピラリを用いたことを特徴とする冷凍機。

19. 請求項11に記載の冷凍機において、HCFC系冷媒を用いると共に、高圧ドーム型の圧縮機を備えて、上記冷凍機油に対して上記アルキルベンゼン系油の比率が5wt%以上で、かつ、上記冷凍機油の粘度が100℃において2.5cst以上であることを特徴とする冷凍機。

20. 請求項19に記載の冷凍機において、上記冷凍機油と上記HCFC系冷媒とが0℃において二層分離したときの冷媒リッチ層の油濃度が2.5wt%以上であることを特徴とする冷凍機。

21. 請求項11に記載の冷凍機において、HCFC系冷媒を用いると



共に、低圧ドーム型の圧縮機を備えて、上記冷凍機油に対して上記アルキルベンゼン系油の比率が5 wt%以上で、かつ、上記冷凍機油と上記H C F C系冷媒との二層分離温度が10℃以下であることを特徴とする冷凍機。

22. 請求項12に記載の冷凍機において、駆動軸の偏心部(20)に回転自在に嵌合するローラ(7)と、このローラ(7)の外周に一体に固定されると共に、上記ローラ(7)の径方向の外方に延びて、シリンダ(4)内のシリンダ室(41)を圧縮室(31)と吸入室(32)とに区画するブレード(8)と、上記シリンダ(40)に回転自在に支持されており、上記ブレード(8)の突出側先端部(8a)を受け入れて案内する受入溝(21a)が形成されている支持体(21)とを有するスイング式圧縮機を用いたことを特徴とする冷凍機。



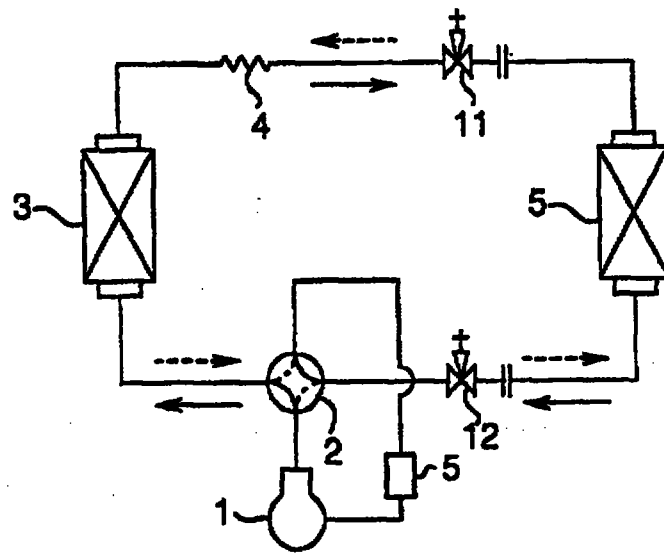
Fig. 1

Fig.2

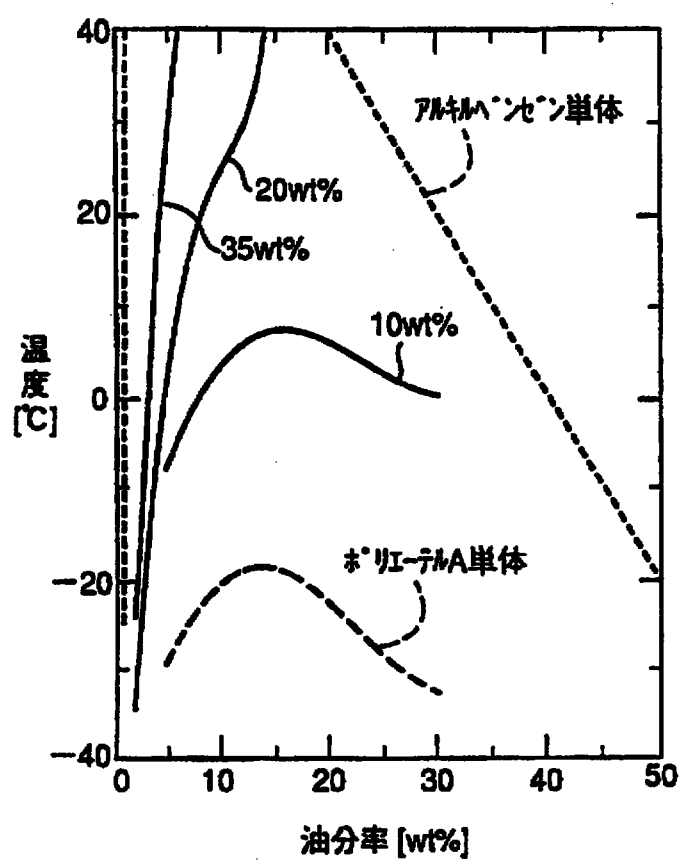


Fig.3

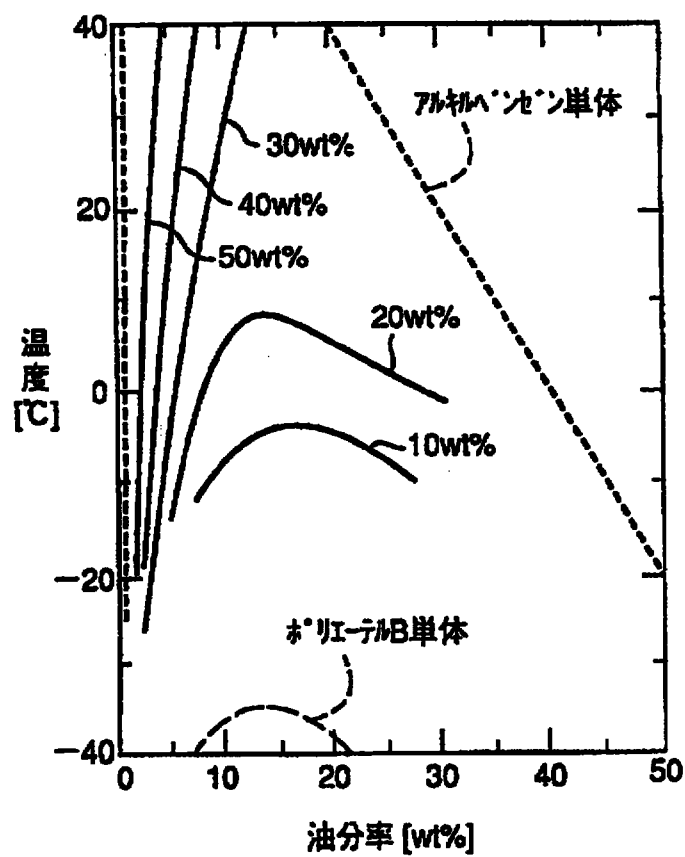


Fig.4

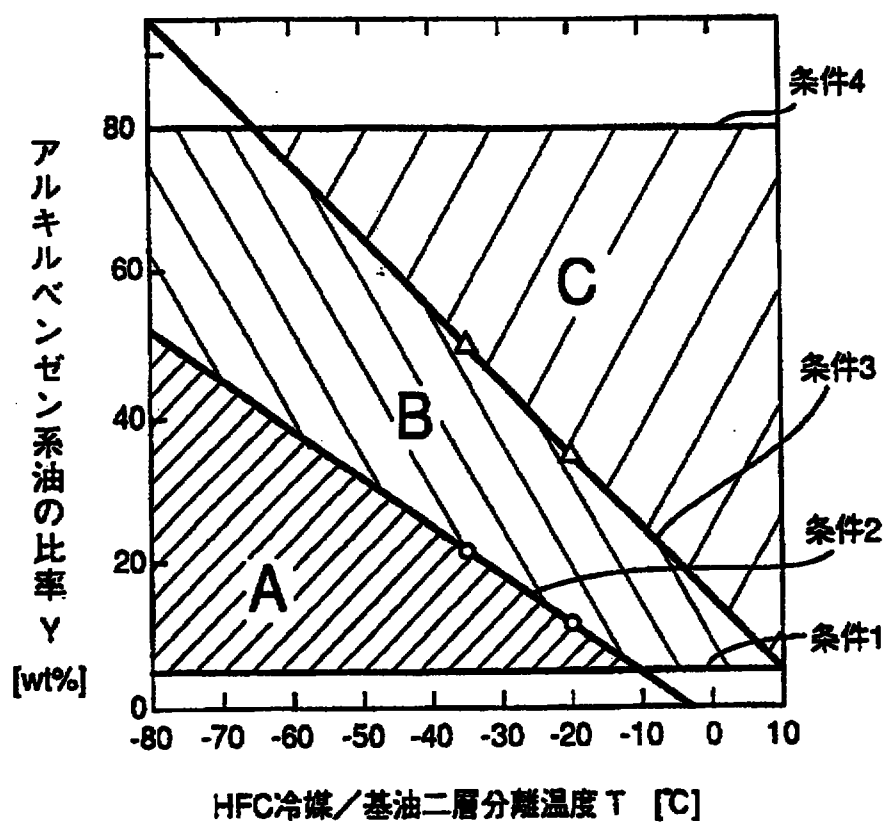


Fig.5

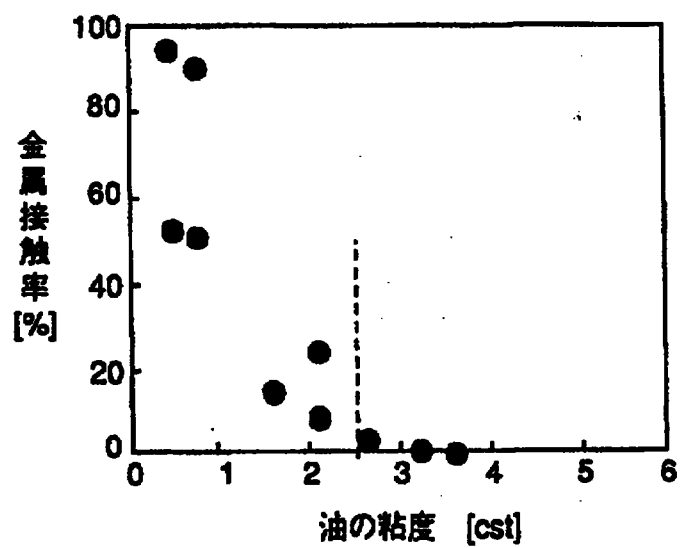
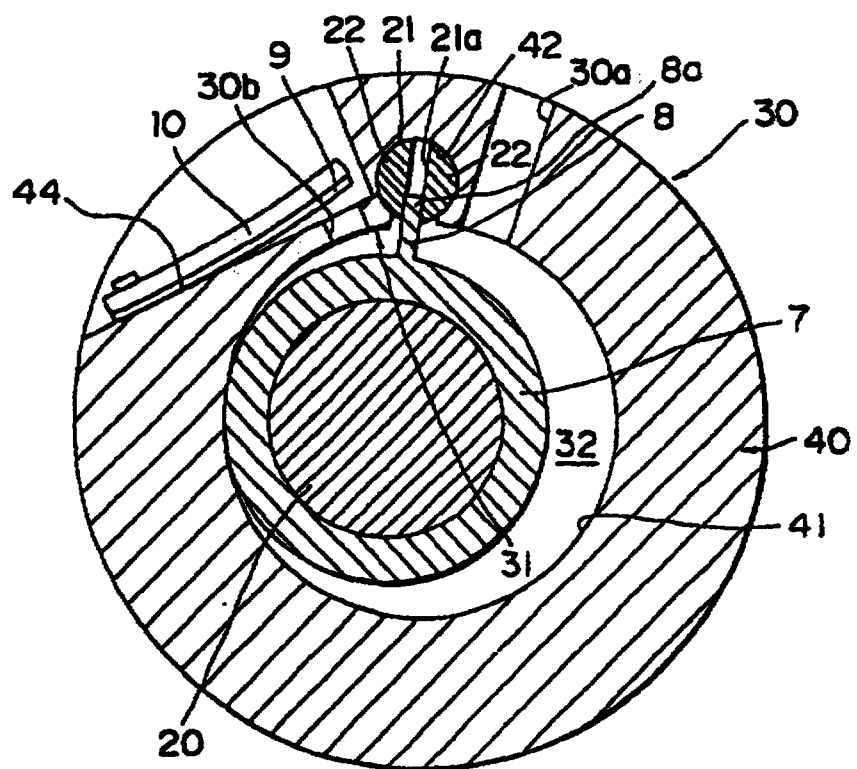


Fig. 6



SPECIFICATION

REFRIGERATING MACHINE OIL AND REFRIGERATOR EMPLOYING THE SAME

5

TECHNICAL FIELD

The present invention relates to a refrigerating machine oil comprised of a synthetic oil and a refrigerator employing the same.

10

BACKGROUND ART

Conventionally, an HCFC (hydrochloro-
fluorocarbon) refrigerant has been mainly employed as
a refrigerant of a refrigerator. However, since the
15 HCFC refrigerant destroys the ozone layer in the
atmosphere that surrounds the earth, an HFC
(hydrofluorocarbon) refrigerant having a small ozone
destruction factor is considered as a substitute for
the HCFC refrigerant. The HFC refrigerant scarcely
20 dissolves therein a mineral oil that has
conventionally been employed as a refrigerating
machine oil, so that lubricating performance of a
compressor is significantly reduced. Therefore, it is
proposed to employ a synthetic oil having a

compatibility with the HFC refrigerant as a refrigerating machine oil.

The HFC refrigerant has an intense polarity since it has a combination of a hydrogen atom and a
5 fluorine atom. In contrast to this, contaminations (soiled things) of deteriorated objects of cutting oil, rust preventive oil, hydraulic oil, wash oil, refrigerating machine oil and so on are nonpolar, while synthetic oil of an ether oil or the like has
10 both a polar group and a nonpolar group. Therefore, the synthetic oil has a compatibility with the HFC refrigerant having a polarity and an affinity with nonpolar contaminations, therefore dissolving both of them. Then, in a compressor of the above
15 refrigerator, the synthetic oil dissolving therein the contaminations is discharged together with the refrigerant from the compressor and made to circulate through a refrigerant circuit. When the HFC refrigerant is condensed in a condenser, the synthetic
20 oil, which has an intense solubility to a liquid refrigerant, is dissolved in the liquid refrigerant, as a consequence of which the synthetic oil circulates through the refrigerant circuit together with the refrigerant. In this case, the affinity of the HFC
25 refrigerant with the synthetic oil is stronger than

the affinity of the contaminations with the synthetic oil, while the nonpolar contaminations are not dissolved in the HFC refrigerant having an intense polarity. Therefore, when the synthetic oil is dissolved into the liquid refrigerant, the contaminations that have been dissolved in the synthetic oil are separated from the synthetic oil and deposited in the liquid refrigerant. Then, the deposited contaminations, which have a high viscosity, adhere to narrow fluid passages of a capillary and an expansion valve, and they are eventually deposited to clog up passages.

The clogging of the capillary and the expansion valve disables the control of the refrigerant flow and causes an abnormal increase in temperature and a backward flow (return) of the fluid to the compressor, significantly impairing the reliability of the refrigerant circuit. Particularly when the ester oil is employed as the refrigerating machine oil, it causes a hydrolysis with water and tends to generate a sludge. In a refrigerator employing a capillary as a decompressor of the refrigerant circuit, the capillary tends to develop more clogging as the capillary tube has a smaller

diameter, leading to a problem that it becomes inoperable as a refrigerator.

As a method for preventing the clogging of the capillary and expansion valve, it can be considered to clean the components on a strict standard, thoroughly control the setting and review components of a refrigerating system and the processing steps so that impurities do not enter during a manufacturing process and a setting process. However, these methods require much time as well as an increased number of processes as compared with the conventional cases. Furthermore, they employ an increased amount of detergent in the component cleaning stage and cause much energy consumption, consequently leading to a significant cost increase.

In contrast to this, a refrigerator which can cope with the HFC refrigerant employing only the refrigerating machine oil of the alkylbenzene oil that causes less capillary clogging has been put into practical use. However, the alkylbenzene oil, which is incompatible with the HFC refrigerant, has a property that it scarcely dissolves therein the refrigerant gas. Furthermore, it is sometimes the case where a two-layer separation may be caused depending on the temperature range and the ratio of

the refrigerant to the refrigerating machine oil. Accordingly, in a separate type air conditioner, an indoor unit and an outdoor unit are connected to each other by way of a long communicating pipe differently
5 from the refrigerator in which all the components are integrated in a unit. Therefore, if the alkylbenzene oil incompatible with the HFC refrigerant is employed as the refrigerating machine oil, then the refrigerating machine oil discharged from the
10 compressor is hard to return to the compressor since the viscosity of the refrigerating machine oil in the refrigerant circuit is high. Therefore, an air conditioner having a long communicating pipe has a problem that an abnormality occurs due to a seizure
15 and abrasion caused by a shortage of refrigerating machine oil in the compressor.

Furthermore, when a large amount of liquid refrigerant lies in the compressor at a low environmental temperature of the compressor or when a
20 large amount of liquid refrigerant returns to the compressor during defrosting, the refrigerating machine oil and the HFC refrigerant separate into two layers inside a dome of the compressor, as a consequence of which a refrigerant rich layer having a
25 greater specific gravity stays in a lower portion of

the dome. Then, the refrigerant rich fluid whose viscosity has been significantly reduced is consequently sucked from the inlet port of an oil pump provided in the lowermost portion of the dome of the compressor. A bearing of the compressor is normally designed on the supposition that the viscosity of the refrigerating machine oil is relatively high, according to which the size of the bearing and a frictional motive force at the bearing are considered. Therefore, if the refrigerant rich fluid whose viscosity is significantly reduced is sucked, then a thickness of oil film is reduced to cause a metal contact, and this leads to a problem that the bearing is damaged and the reliability of the compressor is significantly impaired.

DISCLOSURE OF THE INVENTION

Accordingly, it is an object of the present invention to provide a refrigerating machine oil which can easily remove a sludge generated in a refrigerant circuit without reviewing refrigerant system components nor processing steps and is easy to return to a compressor and refrigerator employing the same.

Another object of the present invention is to provide a refrigerating machine oil which can

prevent a two-layer separation of oil and refrigerant into two layers inside a compressor and refrigerator employing the same.

In order to achieve the aforementioned
5 objects, the present invention provides a refrigerating machine oil obtained by mixing a first synthetic oil comprised of an alkylbenzene oil with a second synthetic oil other than the alkylbenzene oil.

In regard to the refrigerating machine oil
10 having the above construction, the present applicant has conducted various experiments and study and discovered that the mixed oil obtained by mixing the first synthetic oil comprised of an alkylbenzene oil and the second synthetic oil (ether oil, ester oil,
15 fluorine oil, carbonate oil or the like) other than the alkylbenzene oil exfoliated sludge generated on inner surfaces of refrigerant system components due to the contaminations (soiled objects) of cutting oil, rust preventive oil, hydraulic oil, wash oil and so on
20 dissolved into a refrigerant. Therefore, according to the above refrigerating machine oil, the sludge adhered to the inner surfaces of a capillary and an expansion valve is exfoliated and removed by the alkylbenzene oil. Therefore, the sludge can be
25 removed to prevent the capillary and the expansion

valve from being clogged without reviewing the refrigerant system components nor their processing steps. By employing a synthetic oil that is easy to dissolve into an HFC refrigerant in, for example, a refrigerator employing the HFC refrigerant, the synthetic oil discharged together with the refrigerant from a compressor circulates through a refrigerant circuit and returns to the compressor. Accordingly, there is no such problem that the synthetic oil is hard to return and causes a poor lubrication, so that the lubricating performance of the compressor can be maintained.

According to the refrigerating machine oil of one embodiment, the second synthetic oil is provided by an ether oil.

With this arrangement, for example, when an HFC refrigerant is employed, the ether oil is well dissolved in the HFC refrigerant and circulates through the refrigerant circuit. Accordingly, there is no such problem that the ether oil discharged together with the refrigerant from the compressor is hard to return, so that the sludge adhered to the inner surfaces of small-diameter portions of the capillary and the expansion valve can be exfoliated and removed by the alkylbenzene oil while maintaining

the lubricating performance of the compressor. The alkylbenzene oil incompatible with the HFC refrigerant is well dissolved in the ether oil, and therefore, the alkylbenzene oil is transferred to the inside of the refrigerant circuit even in a state in which the alkylbenzene oil is dissolved in the ether oil, so that the sludge can effectively be removed.

According to the refrigerating machine oil of one embodiment, the second synthetic oil is provided by an ester oil.

With this arrangement, for example, when an HFC refrigerant is employed, the ester oil is well dissolved in the HFC refrigerant and circulates through the refrigerant circuit. Accordingly, there is no such problem that the ester oil discharged together with the refrigerant from the compressor is hard to return, so that the sludge adhered to the inner surfaces of small-diameter portions of the capillary or the expansion valve can be exfoliated and removed by the alkylbenzene oil while maintaining the lubricating performance of the compressor. The alkylbenzene oil incompatible with the HFC refrigerant is well dissolved in the ester oil, and therefore, the alkylbenzene oil is transferred to the inside of the refrigerant circuit even in a state in which the

alkylbenzene oil is dissolved in the ester oil, so that the sludge can effectively be removed.

According to the refrigerating machine oil of one embodiment, the second synthetic oil is
5 comprised of an ether oil and an ester oil.

With this arrangement, for example, when an HFC refrigerant is employed, the ether oil and the ester oil are well dissolved in the HFC refrigerant and circulate through the refrigerant circuit.
10 Accordingly, there is no such problem that the ether oil and the ester oil discharged together with the refrigerant from the compressor are hard to return, so that the sludge adhered to the inner surfaces of small-diameter portions of the capillary and the
15 expansion valve can be exfoliated and removed by the alkylbenzene oil while maintaining the lubricating performance of the compressor. The alkylbenzene oil incompatible with the HFC refrigerant is well dissolved in the ether oil and the ester oil, and
20 therefore, the alkylbenzene oil is transferred to the inside of the refrigerant circuit even in a state in which the alkylbenzene oil is dissolved in the ether oil and the ester oil, so that the sludge can effectively be removed. The ester oil is hydrolyzed
25 by water but deterioration by oxidation scarcely

occurs. On the contrary, the ether oil is deteriorated by oxidation but scarcely hydrolyzed by water since it withstands water. Therefore, by setting the ratio of the ether oil to the ester oil to 1 : 1, there can be obtained a refrigerating machine oil of which the degree of deterioration by oxidation and the degree of hydrolysis by water are each reduced half.

According to the refrigerating machine oil of one embodiment, the second synthetic oil is a fluorine oil.

With this arrangement, for example, when an HFC refrigerant is employed, the fluorine oil is well dissolved in the HFC refrigerant and circulates through the refrigerant circuit. Accordingly, there is no such problem that the fluorine oil discharged together with the refrigerant from the compressor is hard to return, so that the sludge adhered to the inner surfaces of small-diameter portions of the capillary and the expansion valve can be exfoliated and removed by the alkylbenzene oil while maintaining the lubricating performance of the compressor.

According to the refrigerating machine oil of one embodiment, the second synthetic oil is a carbonate oil.

With this arrangement, for example, when an HFC refrigerant is employed, the carbonate oil is well dissolved in the HFC refrigerant and circulates through the refrigerant circuit. Accordingly, there
5 is no such problem that the carbonate oil discharged together with the refrigerant from the compressor is hard to return, so that, while maintaining the lubricating performance of the compressor, the sludge adhered to the inner surfaces of small-diameter
10 portions of the capillary and the expansion valve can be exfoliated and removed by the alkylbenzene oil.

According to the refrigerating machine oil of one embodiment, the ratio of the alkylbenzene oil relative to the refrigerating machine oil is set to 1
15 to 50 percent by weight.

With this arrangement, the ratio of the alkylbenzene oil is preferably smaller for the synthetic oil discharged together with the refrigerant from the compressor to circulate through the
20 refrigerant circuit and return to the compressor, whereas the ratio of the alkylbenzene oil is preferably greater for the removal of the sludge. Therefore, by making the ratio of the alkylbenzene oil as great as possible while maintaining the oil return
25 of the synthetic oil according to the refrigerant

circuit, effective sludge removal is executed. When the ratio of the alkylbenzene oil relative to the refrigerating machine oil exceeds 50 percent by weight, the ratio of the alkylbenzene oil is consequently increased too much with respect to, for example, the HFC refrigerant in which the alkylbenzene oil does not dissolve, for which the refrigerating machine oil discharged together with the refrigerant from the compressor is hard to circulate the refrigerant circuit and return. When the ratio of the alkylbenzene oil relative to the refrigerating machine oil is not greater than 50 percent by weight, the synthetic oil discharged together with the refrigerant from the compressor circulates through the refrigerant circuit and surely returns. The removal of the sludge is insufficient when the ratio of the alkylbenzene oil relative to the refrigerating machine oil is smaller than 1 percent by weight, whereas the sludge removal effect is produced when the ratio is not smaller than 1 percent by weight.

According to the refrigerating machine oil of one embodiment, the ratio of the alkylbenzene oil relative to the refrigerating machine oil is made not smaller than five percent by weight and the viscosity

of the refrigerating machine oil is made not smaller than 2.5 cst at a temperature of 100°C.

According to the experiments and study conducted by the present applicant, it was discovered
5 that the sludge generated on the inner surface of the capillary due to the contaminations of cutting oil, rust preventive oil, hydraulic oil, wash oil and so on dissolved into the refrigerant (HFC refrigerant according to the experiment) was exfoliated and surely
10 removed when the ratio of the alkylbenzene oil relative to the refrigerating machine oil is not smaller than five percent by weight, so that the clogging of the capillary was eliminated. It was also discovered that the sludge generated on the inner
15 surface of the capillary was not able to be removed when the ratio of the alkylbenzene oil relative to the refrigerating machine oil was smaller than five percent by weight. It was further discovered through an experiment that the ratio of metal contact becomes
20 almost zero percent by making the viscosity of the refrigerating machine oil not smaller than 2.5 cst, so that the oil films of the bearing and so on were maintained. It was further discovered that the ratio of metal contact increases and the oil films of the
25 bearing and so on were not sufficiently secured when

the viscosity of the refrigerating machine oil was made smaller than 2.5 cst. Therefore, by making the ratio of the alkylbenzene oil relative to the refrigerating machine oil not smaller than five
5 percent by weight and making the viscosity of the refrigerating machine oil not smaller than 2.5 cst, the clogging of the capillary and the expansion valve by the sludge can be prevented and the oil films of the bearing and so on are maintained normal throughout
10 the entire region of the operating range, so that the reliability of the compressor can be maintained.

According to the refrigerating machine oil of one embodiment, the oil concentration of the refrigerant rich layer is made not smaller than 2.5
15 percent by weight when the refrigerating machine oil and the HFC refrigerant are separated into two layers at a temperature of 0°C.

With this arrangement, it was discovered through an endurance test that, when the HFC
20 refrigerant and the refrigerating machine oil were separated into two layers inside the compressor, the oil films of the bearing and so on of the compressor were maintained appropriate and no problem has occurred when the oil concentration of the refrigerant
25 rich layer of the layers that had separated into two

layers was not smaller than 2.5 percent by weight. It was also discovered that the oil films of the bearing and so on of the compressor were reduced and the bearing and so on were damaged when the oil concentration of the refrigerant rich layer of the layers that had separated into two layers was smaller than 2.5 percent by weight. Therefore, even when the HFC refrigerant lies in the compressor in an operation stop state and the HFC refrigerant and the refrigerating machine oil are separated into two layers, the two-layer separation temperature of the HFC refrigerant and the base oil and the ratio of the alkylbenzene oil relative to the refrigerating machine oil are adjusted so that the oil concentration of the refrigerant rich layer becomes not smaller than 2.5 percent by weight. Therefore, the oil films are maintained and the bearing and so on are not damaged, so that the reliability of the compressor can be maintained. When the second synthetic oil is the ether oil, the ether oil can easily adjust the two-layer separation temperature of the HFC refrigerant and the ether oil, so that the two-layer separation temperature of the refrigerant and the mixed oil (alkylbenzene oil and ether oil) can be reduced even

when an increased amount of alkylbenzene oil is incorporated therein as compared with the ester oil.

According to the refrigerating machine oil of one embodiment, the ratio of the alkylbenzene oil relative to the refrigerating machine oil is made not smaller than five percent by weight and the two-layer separation temperature of the HFC refrigerant and the refrigerating machine oil is made not higher than 10°C.

With this arrangement, when the ratio of the alkylbenzene oil relative to the refrigerating machine oil is not smaller than five percent by weight, the sludge generated on the inner surfaces of the capillary and the expansion valve due to the contaminations of cutting oil, rust preventive oil, hydraulic oil, wash oil and so on dissolved into the HFC refrigerant is exfoliated and surely removed, so that the clogging of the capillary is eliminated. According to the results of an endurance test conducted by the present applicant, it was discovered that the refrigerating machine oil and the liquid refrigerant were uniformly dissolved in an operating state at a temperature of not lower than 10°C by making the two-layer separation temperature of the HFC refrigerant and the refrigerating machine oil not

higher than 10 °C even when the liquid refrigerant returned into the dome of the compressor. It was also discovered that the refrigerating machine oil and the liquid refrigerant were sometimes not uniformly dissolved when the two-layer separation temperature of the HFC refrigerant and the refrigerating machine oil exceeded the temperature of 10 °C . Therefore, by making the ratio of the alkylbenzene oil relative to the refrigerating machine oil not smaller than five percent by weight and making the two-layer separation temperature of the HFC refrigerant and the refrigerating machine oil not higher than 10 °C , a mixture of the refrigerant and the mixed oil having an appropriate viscosity is sucked into an oil pump, so that the reliability of the compressor can be maintained. When the second synthetic oil is the ether oil, the ether oil can easily adjust the two-layer separation temperature of the HFC refrigerant and the ether oil, so that the two-layer separation temperature of the refrigerant and the mixed oil (alkylbenzene oil and ether oil) can be reduced even when an increased amount of alkylbenzene oil is incorporated.

The present invention also provides a refrigerator employing one of the aforementioned refrigerating machine oils.

According to the refrigerator constructed as
5 above, the sludge adhered to the inner surfaces of the small-diameter portions of the capillary and the expansion valve is exfoliated and removed by the alkylbenzene oil, and therefore, the capillary and the expansion valve can be prevented from being clogged.
10 Furthermore, the above arrangement can obviate the need for a refrigerant system component cleaning process for removing the cutting oil, rust preventive oil and the hydraulic oil that cause the sludge, so that the number of processes and cost can be reduced.

15 According to the refrigerator of one embodiment, an HFC (hydrofluorocarbon) refrigerant is employed.

With this arrangement, the sludge adhered to the inner surfaces of the small-diameter portions of
20 the capillary and the expansion valve can be exfoliated and removed by the alkylbenzene oil although the sludge is easily generated on, in particular, the inner surfaces of the small-diameter portions of the capillary and the expansion valve when
25 a synthetic oil having a compatibility with the HFC

refrigerant is employed as a refrigerating machine oil.

According to the refrigerator of one embodiment, a capillary is employed as a decompressor.

5 With this arrangement, the sludge adhered to the inner surface of the small-diameter portion of the capillary is exfoliated and removed by the alkylbenzene oil. Therefore, an inexpensive capillary can be employed, so that the cost of the refrigerator
10 can be reduced.

 According to the refrigerator of one embodiment, an HFC refrigerant and a high-pressure dome type compressor are employed and the ratio of the alkylbenzene oil relative to the refrigerating machine
15 oil is made not smaller than five percent by weight and the viscosity of the refrigerating machine oil is made not smaller than 2.5 cst at a temperature of 100°C.

 According to the results of the
20 aforementioned test and study, by making the ratio of the alkylbenzene oil relative to the refrigerating machine oil not smaller than five percent by weight and making the viscosity of the refrigerating machine oil not smaller than 2.5 cst at a temperature of
25 100°C, the clogging of the capillary and the expansion.

valve due to the sludge can be prevented and the oil films of the bearing and so on are maintained normal throughout the entire region of the operating range, so that the reliability of the high-pressure dome type compressor having a high oil temperature can be maintained. It is to be noted that the high-pressure dome type compressor has a construction in which the refrigerant flows to a discharge pipe via an inlet pipe, a compressing portion and the container (high-pressure dome) of the compressor and the refrigerating machine oil is reserved in a high-temperature high-pressure portion inside the high-pressure dome.

According to the refrigerator of one embodiment, the oil concentration of the refrigerant rich layer when the refrigerating machine oil and the HFC refrigerant are separated into two layers at a temperature of 0 °C is made not smaller than 2.5 percent by weight.

With this arrangement, in the case where the HFC refrigerant and the refrigerating machine oil are separated into two layers inside the compressor, the oil films of the bearing and so on of the compressor are maintained appropriate when the oil concentration of the refrigerant rich layer of the layers that have separated into two layers is not smaller than 2.5

percent by weight, causing no problem in terms of the reliability. Therefore, in the case of the high-pressure dome type compressor in which the two-layer separation of the HFC refrigerant and the refrigerating machine oil is a problem, the two-layer separation temperature of the HFC refrigerant and the base oil and the ratio of the alkylbenzene oil relative to the refrigerating machine oil are adjusted so that the oil concentration of the refrigerant rich layer becomes not smaller than 2.5 percent by weight even when the HFC refrigerant lies in the compressor in the operation stop state and the HFC refrigerant and the refrigerating machine oil are separated into two layers. Therefore, the oil films are maintained to cause no damage of the bearing and so on, so that the reliability of the compressor can be maintained. When the second synthetic oil is the ether oil, the ether oil can easily adjust the two-layer separation temperature of the HFC refrigerant and the ether oil, so that the two-layer separation temperature of the refrigerant and the mixed oil (alkylbenzene oil and ether oil) can be reduced even when an increased amount of alkylbenzene oil is incorporated therein as compared with the ester oil.

According to the refrigerator of one embodiment, an HFC refrigerant and a low-pressure dome type compressor are employed, the ratio of the alkylbenzene oil relative to the refrigerating machine oil is made not smaller than five percent by weight and the two-layer separation temperature of the HFC refrigerant and the refrigerating machine oil is made not higher than 10°C.

With this arrangement, according to the results of the aforementioned test and study, when the ratio of the alkylbenzene oil relative to the refrigerating machine oil is not smaller than five percent by weight, the sludge generated on the inner surface of the capillary due to the contaminations of cutting oil, rust preventive oil, hydraulic oil, wash oil and so on dissolved into the HFC refrigerant is exfoliated and surely removed, so that the clogging of the capillary and the expansion valve is eliminated. In the case of the low-pressure dome type compressor in which the two-layer separation of the HFC refrigerant and the refrigerating machine oil tends to occur, the ratio of the alkylbenzene oil must be reduced as compared with the high-pressure dome type. By making the two-layer separation temperature of the HFC refrigerant and the refrigerating machine oil not

higher than 10°C, the refrigerating machine oil and the liquid refrigerant are uniformly dissolved in an operating state at a temperature of not lower than 10°C by making the two-layer separation temperature of the HFC refrigerant and the refrigerating machine oil not higher than 10°C even when the liquid refrigerant returned into the dome of the compressor. Therefore, by making the ratio of the alkylbenzene oil relative to the refrigerating machine oil not smaller than five percent by weight and making the two-layer separation temperature of the HFC refrigerant and the refrigerating machine oil not higher than 10°C, a mixture of the refrigerant and the mixed oil having an appropriate viscosity is sucked into the oil pump, so that the reliability of the low-pressure dome type compressor can be maintained. It is to be noted that the low-pressure dome type compressor has a construction in which the refrigerant flows to a discharge pipe via an inlet pipe, the container (low-pressure dome) of the compressor and a compressing portion and the refrigerating machine oil is reserved in a low-temperature low-pressure portion inside the low-pressure dome. When the second synthetic oil is the ether oil, the ether oil can easily adjust the two-layer separation temperature of the HFC

refrigerant and the ether oil, so that the two-layer separation temperature of the refrigerant and the mixed oil (alkylbenzene oil and ether oil) can be reduced even when an increased amount of alkylbenzene oil is incorporated therein as compared with the ester oil.

According to the refrigerator of one embodiment, an HCFC refrigerant is employed.

With this arrangement, the sludge adhered to the inner surfaces of the small-diameter portions of the capillary and the expansion valve can be exfoliated and removed by the alkylbenzene oil although the sludge is easily generated on, in particular, the inner surfaces of the small-diameter portions of the capillary and the expansion valve when a synthetic oil is employed as a refrigerating machine oil.

According to the refrigerator of one embodiment, an HCFC refrigerant is employed and a capillary is employed for its decompressor.

With this arrangement, the refrigerating machine oil also has a compatibility with the HCFC refrigerant, and the sludge adhered to the inner surface of the small-diameter portion of the capillary can be exfoliated and removed by the alkylbenzene oil

mixed in the refrigerating machine oil. Since the
sludge adhered to the inner surface of the small-
diameter portion of the capillary is exfoliated and
removed by the alkylbenzene oil, an inexpensive
5 capillary can be employed, so that the cost of the
refrigerator can be reduced. The refrigerator filled
with the above refrigerating machine oil can easily
replace the HCFC refrigerant with the alternative
refrigerant of the HFC refrigerant (so-called the
10 retrofit can easily be achieved) without changing the
refrigerating machine oil.

According to the refrigerator of one
embodiment, an HCFC refrigerant and a high-pressure
dome type compressor are employed, the ratio of the
15 alkylbenzene oil relative to the refrigerating machine
oil is made not smaller than five percent by weight
and the viscosity of the refrigerating machine oil is
made not smaller than 2.5 cst at a temperature of
100°C.

20 With this arrangement, according to the
results of the aforementioned test and study, by
making the ratio of the alkylbenzene oil relative to
the refrigerating machine oil not smaller than five
percent by weight and making the viscosity of the
25 refrigerating machine oil not smaller than 2.5 cst at

a temperature of 100°C, the clogging of the capillary and the expansion valve by the sludge can surely be prevented and the oil films of the bearing and so on are maintained normal throughout the entire region of the operating range, so that the reliability of the high-pressure dome type compressor having a high oil temperature can be maintained. The refrigerator filled with the above refrigerating machine oil can easily replace the HCFC refrigerant with the alternative refrigerant of the HFC refrigerant without changing the refrigerating machine oil.

According to the refrigerator of one embodiment, the oil concentration of the refrigerant rich layer is made not smaller than 2.5 percent by weight when the refrigerating machine oil and the HCFC refrigerant are separated into two layers at a temperature of 0°C.

With this arrangement, in the case where the HFC refrigerant and the refrigerating machine oil are separated into two layers inside the compressor, the oil films of the bearing and so on of the compressor are maintained appropriate when the oil concentration of the refrigerant rich layer of the layers that have separated into two layers is not smaller than 2.5 percent by weight, causing no problem in terms of the

reliability. Therefore, in the case of the high-pressure dome type compressor in which the two-layer separation of the HCFC refrigerant and the refrigerating machine oil is a problem, the two-layer
5 separation temperature of the HCFC refrigerant and the base oil and the ratio of the alkylbenzene oil relative to the refrigerating machine oil are adjusted so that the oil concentration of the refrigerant rich layer becomes not smaller than 2.5 percent by weight
10 even when the HCFC refrigerant lies in the compressor in the operation stop state and the HCFC refrigerant and the refrigerating machine oil are separated into two layers. Therefore, the oil films are maintained to cause no damage of the bearing and so on, so that
15 the reliability of the compressor can be maintained. The refrigerator filled with the above refrigerating machine oil can easily replace the HCFC refrigerant with the alternative refrigerant of the HFC refrigerant without changing the refrigerating machine
20 oil. When the second synthetic oil is the ether oil, the ether oil can easily adjust the two-layer separation temperature of the HFC refrigerant and the ether oil, so that the two-layer separation temperature of the refrigerant and the mixed oil
25 (alkylbenzene oil and ether oil) can be reduced even

when an increased amount of alkylbenzene oil is incorporated as compared with the ester oil.

According to the refrigerator of one embodiment, an HCFC refrigerant and a low-pressure dome type compressor are employed, the ratio of the alkylbenzene oil relative to the refrigerating machine oil is made not smaller than five percent by weight and the two-layer separation temperature of the refrigerating machine oil and the HCFC refrigerant is made not higher than 10°C.

With this arrangement, according to the results of the aforementioned test and study, when the ratio of the alkylbenzene oil relative to the refrigerating machine oil is not smaller than five percent by weight, the sludge generated on the inner surface of the capillary due to the contaminations of cutting oil, rust preventive oil, hydraulic oil, wash oil and so on dissolved into the HCFC refrigerant is exfoliated and surely removed, so that the clogging of the capillary is eliminated. In the case of the low-pressure dome type compressor in which the two-layer separation of the HCFC refrigerant and the refrigerating machine oil tends to occur, by making the two-layer separation temperature not higher than 10°C, the refrigerating machine oil and the liquid

refrigerant are uniformly dissolved in an operating state at a temperature not lower than 10°C even when the liquid refrigerant returns to the inside of the dome of the compressor. Therefore, a mixture of the refrigerant and the refrigerating machine oil having an appropriate viscosity is sucked into the oil pump, so that the reliability of the low-pressure dome type compressor can be maintained. The refrigerator filled with the above refrigerating machine oil can easily replace the HCFC refrigerant with the alternative refrigerant of the HFC refrigerant without changing the refrigerating machine oil. When the second synthetic oil is the ether oil, the ether oil can easily adjust the two-layer separation temperature of the HFC refrigerant and the ether oil, so that the two-layer separation temperature of the refrigerant and the mixed oil (alkylbenzene oil and ether oil) can be reduced even when an increased amount of alkylbenzene oil is incorporated as compared with the ester oil.

According to the refrigerator of one embodiment, there are employed a swing type compressor comprising: a roller which is rotatably fitted on an eccentric section of a driving shaft; a blade which is integrally fixed to an outer peripheral surface of the

roller and extends outwardly of a radius of the roller, thereby separating a cylinder chamber inside a cylinder into a compression chamber and an inhalation chamber; and a support member which is rotatably
5 supported in the cylinder and in which is formed a reception groove that receives and guides a protruding side tip portion of the blade.

According to the refrigerator constructed as above, in the swing type compressor, the blade is
10 fixed to the roller and the tip portion of the blade is guided by the reception groove of the rotatable support member. Therefore, the surface of the blade comes in surface contact with the support member to achieve sealing, generating no boundary lubrication
15 state. Therefore, even when the alternative freon refrigerant is employed taking the environmental safety into consideration, the sludge adhered to the inner surfaces of the small-diameter portions of the capillary and the expansion valve can be exfoliated
20 and removed by the alkylbenzene oil. Furthermore, the blade of the compressor is made to slide in surface contact with the support member, and therefore, the deterioration of the lubricating oil can be prevented, so that the seizure can be prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a circuit diagram of a refrigerator employing a refrigerating machine oil according to first and second embodiments of the present invention;

Fig. 2 is a graph showing two-layer separation of an HFC refrigerant R-407C and a mixed oil (alkylbenzene and polyether A);

Fig. 3 is a graph showing two-layer separation of an HFC refrigerant R-407C and a mixed oil (alkylbenzene and polyether B);

Fig. 4 is a graph showing a relation between a two-layer separation temperature of an HFC refrigerant and a base oil and a ratio of an alkylbenzene oil;

Fig. 5 is a graph showing a ratio of metal contact relative to an oil viscosity; and

Fig. 6 is a cross section view showing essential part of a swing type compressor provided for a refrigerator according to a third embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

The following will describe in detail experiments and study concerning refrigerating machine oil of the present invention as well as a refrigerator
5 employing the refrigerating machine oil on the embodiments shown in the drawings.

First, the present applicant prepared for experiments by operating a refrigerator which employs a synthetic oil (ester oil, for example) as a
10 refrigerating machine oil for a long term, clogging a capillary with a sludge generated on an inner surface of the capillary with contaminations (soiled objects) of cutting oil, rust preventive oil, hydraulic oil, wash oil and so on dissolved into a refrigerant and
15 cutting the capillary for the preparation of a plurality of samples. Then, by immersing for a long term the plurality of samples clogged with the sludge generated on the inner surface into mixed oils obtained by incorporating an alkylbenzene oil which
20 serves as a first synthetic oil into each of an ether oil, an ester oil and a fluorine oil which serve as a second synthetic oil, the change in state of the sludge of each sample was observed. As a result, by incorporating the alkylbenzene oil into the base oils
25 of the ether oil, ester oil and the fluorine oil, it

was discovered that there was the effect of exfoliating the sludge generated on the inner surfaces of refrigerant system components due to the contaminations (soiled objects) of cutting oil, rust preventive oil, hydraulic oil, wash oil and so on dissolved into the refrigerant.

Furthermore, as a result of conducting the experiment of immersing for a long term the samples into only the alkylbenzene oil, it was discovered that the alkylbenzene oil singly had the effect of exfoliating the sludge, or the cause of the clogging of the capillary and cleaning the inner surface of the capillary. The samples of the above experiment had come to have a lustered inner surface state similar to a new one differently from the case where the ether oil, ester oil or a mineral oil was used. However, if the alkylbenzene oil is employed as a refrigerating machine oil, then the alkylbenzene oil is incompatible with the HFC refrigerant, and therefore, the refrigerating machine oil discharged together with the refrigerant from the compressor does not return to the compressor without circulating through the refrigerant circuit in a refrigerator having a long piping or a great difference of elevation, and this leads to a reduction in reliability due to a poor lubrication.

Accordingly, based on the results of the above experiment, the present applicant decided to concurrently employ an alkylbenzene oil and a synthetic oil (ether oil, ester oil, fluorine oil, carbonate oil and so on) having a compatibility with the HFC refrigerant. That is, lubricating performance of the compressor is maintained by making satisfactory oil return with the synthetic oil that is well dissolved in the HFC refrigerant and the sludge causing the clogging of the capillary is removed by incorporating the alkylbenzene oil into the synthetic oil. Thus, the aforementioned problems of the poor lubrication and the clogging of the capillary can be resolved at once.

15 (First Embodiment)

The following will describe the case where the above refrigerating machine oil is employed in the refrigerator.

Fig. 1 is a circuit diagram of a refrigerator employing the above refrigerating machine oil, the refrigerator including a compressor 1, a four-way valve 2 connected to the outlet side of the compressor 1, an outdoor heat exchanger 3 whose one end is connected to the four-way valve 2, a capillary 4 which serves as an expanding means whose one end is

connected to the other end of the outdoor heat
exchanger 3, an indoor heat exchanger 5 whose one end
is connected to the other end of the capillary 4 via a
shutoff valve 11 and an accumulator 6 of which the one
5 end is connected to the other end of the indoor heat
exchanger 5 via a shutoff valve 12 and the four-way
valve 2 and the other end is connected to the inlet
side of the compressor 1.

In the refrigerator constructed as above, an
10 HFC refrigerant (R-134a, R-407, R-410, HFC-32/134a or
the like) is employed as a substitute refrigerant for
the HCFC refrigerant, while a mixed oil obtained by
mixing any one of the ether oil, ester oil, fluorine
oil and carbonate oil with an alkylbenzene oil is
15 employed as a refrigerating machine oil. The ratio of
the alkylbenzene oil is set within a range of 1 to 50
percent by weight relative to the whole refrigerating
machine oil according to the refrigerant circuit and
so on.

20 The sludge adhered to the inner surface of
the small-diameter portion of the capillary 4 is
exfoliated and removed by the alkylbenzene oil mixed
in the refrigerating machine oil, and therefore, the
clogging of the capillary can be prevented without
25 reviewing the refrigerant system components nor the

processing steps. Furthermore, the above arrangement can obviate the need for a refrigerant system component cleaning process for removing the cutting oil, rust preventive oil, the hydraulic oil and the like which cause the sludge, and therefore, the number of processes and cost can be reduced.

When a synthetic oil (ether oil, ester oil, fluorine oil, carbonate oil or the like) incompatible with an HFC refrigerant is employed in a refrigerant circuit employing the HFC refrigerant, the synthetic oil is well dissolved in the HFC refrigerant to circulate through the refrigerant circuit. Accordingly, there is no such problem that the synthetic oil discharged from the compressor 1 is hard to return, so that the lubricating performance of the compressor 1 can be maintained. When the synthetic oil is employed, particularly a sludge tends to be generated. However, the sludge adhered to the inner surfaces of the small-diameter portions of the refrigerant system components such as the capillary 4 can be exfoliated and removed by the alkylbenzene oil mixed in the refrigerating machine oil. Furthermore, the alkylbenzene oil is well dissolved in the ether oil and the ester oil, so that the alkylbenzene oil is transferred into the refrigerant circuit in a state in

which the alkylbenzene oil is dissolved in the ether oil and the ester oil, thereby allowing the sludge to be effectively removed.

Furthermore, the sludge adhered to the inner
5 surface of the small-diameter portion of the capillary
4 is exfoliated and removed by the refrigerating
machine oil obtained by mixing the alkylbenzene oil
with another synthetic oil. Accordingly, there is no
concern about the clogging of the capillary, so that
10 an inexpensive capillary can be employed. Therefore,
the cost of the refrigerator can be reduced.
Furthermore, by employing the above capillary, the
reliability of the refrigerator can be improved.

Furthermore, the present applicant carried
15 out experiments on various conditions about the
refrigerating machine oil scarcely causing capillary
clogging and causing no impairment of the reliability
of the compressor, and consequently discovered that a
mixed oil obtained by mixing a first synthetic oil
20 comprised of an alkylbenzene oil into a second
synthetic oil comprised of an ether oil or ester oil
at an appropriate ratio was able to solve these
problems. The following will describe the detail of
the above as well as a second embodiment of the

refrigerator which employs the mixed oil as a refrigerating machine oil.

Table 1 shows the results of immersion experiments and real machine endurance test conducted with synthetic oils of an ether oil and an ester oil employed as a base oil and with the ratio of the alkylbenzene oil changed.

Table 1:

	Ratio of alkylbenzene oil (wt%)					
	0	3	5	10	30	50
Immersion experiment I	x	x	○	○	○	○
Immersion experiment II	x	x	○	○	○	○
Real machine endurance test	x	-	○	-	-	○

10

In Table 1, the test conditions and so on of the immersion experiment I, the immersion experiment II and the real machine endurance test are as follows.

Immersion Experiment I

Base oil: Ether oil

5 The capillary to the inner surface of which
sludge is adhered is immersed at normal
temperature for two weeks.

O: The sludge is exfoliated.

x: The sludge is not exfoliated.

Immersion Experiment II

Base oil: Ester oil

10 The capillary to the inner surface of which
sludge is adhered is immersed at normal
temperature for two weeks.

O: The sludge is exfoliated.

x: The sludge is not exfoliated.

15 Real Machine Endurance Test

Test machine: Room air conditioner (1 hp)

Refrigerant: R-407C

Base oil: Ester oil

20 The presence or absence of sludge is decided
after an elapse of 4000 hours of operation.

O: The capillary is not clogged.

x: The capillary is clogged.

25 According to the above immersion experiments
I and II, a clogged capillary piece through the real
machine endurance test of an ester oil was immersed in

a mixed oil, and a change of sludge was visually observed to check whether or not the sludge adhered to the inner surface of the capillary was exfoliated. According to the real machine endurance test, the
5 endurance test was executed by filling the real machine having a capillary with the mixed oil and mixing a specified amount of contamination. Then, nitrogen gas was flowed under a specified pressure difference condition with the capillary removed every
10 specified time, and the flow rate was measured for the evaluation of the capillary clogging depending on the presence or absence of a reduction in flow rate. That is, it is determined that the sludge is adhered to the inner surface of the capillary when the nitrogen flow
15 rate is reduced and no sludge is adhered to the inner surface of the capillary when the nitrogen flow rate is not reduced.

The results of the immersion experiments I and II and the result of the real machine endurance
20 test well conformed to each other, consequently discovering that the sludge on the inner surface of the capillary was able to be exfoliated and securely removed and the affinity of the refrigerating machine oil with the contamination was maintained,
25 consequently depositing no contamination in the liquid

refrigerant when the ratio of the alkylbenzene oil relative to the refrigerating machine oil comprised of the first synthetic oil of the alkylbenzene oil and the second synthetic oil (ether oil or ester oil) other than it was not smaller than five percent by weight. It is to be noted that the same result is also obtained when a mixed oil comprised of the ether oil and the ester oil, the fluorine oil or the carbonate oil is employed as the second synthetic oil.

Furthermore, in a mixed oil obtained by mixing an alkylbenzene oil into a synthetic oil (ether oil or ester oil) having a compatibility with the HFC refrigerant, a two-layer separation temperature at which the HFC refrigerant and the mixed oil are separated into two layers is significantly influenced by the ratio of the alkylbenzene oil.

Paying attention to this point, the present applicant carried out a test of the characteristic of the two-layer separation of the HFC refrigerant R-407C and the mixed oil. The results are shown in Fig. 2 and Fig. 3. A mixed oil of an alkylbenzene oil and a polyether A (ether oil) was employed as the refrigerating machine oil in the test of Fig. 2, while a mixed oil of an alkylbenzene oil and a polyether B (ether oil) was employed as the refrigerating machine

oil in the test of Fig. 3. The two-layer separation temperature of the HFC refrigerant R-407C and a single substance of the polyether A was set to about -20°C in the case of Fig. 2, while the two-layer separation
5 temperature of the HFC refrigerant R-407C and a single-element substance of the polyether B was set to about -35°C in the case of Fig. 3. In Fig. 2 and Fig. 3, the HFC refrigerant R-407C and the single substance of the alkylbenzene oil were separated into two layers
10 in any temperature range, and the so-called lower critical solution temperature does not appear.

As the ratio of the alkylbenzene oil is increased by incorporating an increased amount of alkylbenzene oil into the base oil of the polyether A
15 and B, the two-layer separation temperature of the HFC refrigerant and the mixed oil rises more significantly. For example, when about 11 percent by weight of alkylbenzene oil is incorporated in the case of Fig. 2, the two-layer separation temperature
20 changes from about -20°C to about 10°C , which is increased by about 30°C as compared with the polyether A. On the other hand, when about 21 percent by weight of alkylbenzene oil is incorporated in the case of Fig. 3, the two-layer separation temperature changes
25 from about -35°C to about 10°C , meaning that the two-

layer separation temperature becomes totally low in the case where the ratio of the alkylbenzene oil is identical as compared with the case of Fig. 2.

As described above, as the two-layer
5 separation temperature of the HFC refrigerant and the single substance of the base oil becomes lower, the two-layer separation temperature of the HFC refrigerant and the mixed oil can be made lower according to it. Then, by lowering the two-layer
10 separation temperature of the HFC refrigerant and the mixed oil, the refrigerating machine oil and the liquid refrigerant are uniformly incorporated in an operating state in which the oil temperature inside the compressor has risen even when the liquid
15 refrigerant returns to the inside of the dome of the compressor, and a mixture of the refrigerating machine oil and the refrigerant having an appropriate viscosity is sucked into an oil pump, so that the lubrication of the bearing and so on of the compressor
20 can be maintained normal. Particularly in the low-pressure dome type compressor having an oil temperature lower than that of the high-pressure dome type, the liquid refrigerant is to be directly mixed with the refrigerating machine oil, and therefore, a
25 refrigerating machine oil having a lower two-layer

separation temperature of the HFC refrigerant and the mixed oil is needed.

The ether oil has a feature that it can adjust the two-layer separation temperature of the HFC refrigerant and the ether oil. Therefore, when
5 intending to provide a mixed oil having a low two-layer separation temperature, it is preferable to employ as a base oil an ether oil capable of making the two-layer separation temperature lower than that
10 of the ester oil.

From the results of aforementioned test and study, the proper ratio of the alkylbenzene oil for resolving the conventional problems was searched. That is, the ratio of the alkylbenzene oil relative to
15 the refrigerating machine oil was searched so as to satisfy the required conditions that:

i) neither a capillary nor an expansion valve is clogged; and

ii) the reliability of the compressor is not
20 impaired even in a state in which the liquid refrigerant returns to the compressor or the refrigerating machine oil comes to have a high temperature.

Fig. 4 shows the results of the search,
25 where the axis of abscissas represents the two-layer

separation temperature T of the HFC refrigerant and the base oil and the axis of ordinates represents the ratio Y of the alkylbenzene oil.

First, from Table 1, the condition of the
5 ratio Y of the alkylbenzene oil is:

$$Y \geq 5 \quad \dots [\text{Condition 1}]$$

The two-layer separation easily occurs in the low-pressure dome type compressor, and therefore, it is required to make the ratio of the alkylbenzene
10 oil lower than in the high-pressure dome type. As a result of carrying out an endurance test of the compressor, it was discovered that the reliability of the compressor was able to be secured when the two-layer separation temperature of the HFC refrigerant
15 and the mixed oil is not higher than 10°C. It was also discovered that the reliability of the compressor was not able to be sufficiently secured when the two-layer separation temperature of the HFC refrigerant and the mixed oil exceeded 10°C. The two-layer
20 separation temperature is about 10°C in the case of the conventional combination of the HCFC refrigerant and the mineral oil (Suniso 4GS: tradename), and according to this achievement, the two-layer separation temperature of 10°C of the HFC refrigerant
25 and the mixed oil is the proper value. Accordingly,

the ratio of the alkylbenzene oil at the two-layer separation temperature of 10°C was obtained from the data shown in Fig. 2 and Fig. 3, and the ratio was indicated by o marks in Fig. 4. Therefore, as shown
5 in Fig. 4, the condition of the ratio Y of the alkylbenzene oil relative to the two-layer separation temperature T of the HFC refrigerant and the base oil at which the two-layer separation temperature of the HFC refrigerant and the mixed oil becomes not higher
10 than 10°C is:

$$Y \leq -0.67T - 3 \quad \dots [\text{Condition 2}]$$

Furthermore, in the high-pressure dome type compressor having a high oil temperature in the normal operating state, the two-layer separation scarcely
15 occurs even when the ratio of the alkylbenzene oil is increased. However, in a stop state, the oil temperature is reduced to the environmental temperature, and the refrigerant moves into the dome, causing so-called the lie-up. In this state, the two-
20 layer separation of the HFC refrigerant and the mixed oil occurs. As a result of carrying out an endurance test supposing this lie-up, it was discovered that the oil films of the bearing and so on of the compressor were maintained and no problem occurs in terms of the
25 reliability when the oil concentration of the

refrigerant rich layer of the layers that are separated into two layers was not smaller than 2.5 percent by weight (at a temperature of 0°C). It was also discovered that the oil films of the bearing and so on of the compressor became thin to cause damage of the bearing and so on when the oil concentration of the refrigerant rich layer of the layers that are separated into two layers was smaller than 2.5 percent by weight (at a temperature of 0°C). Accordingly, the ratio of the alkylbenzene oil relative to the refrigerating machine oil when the oil content at the temperature of 0°C was 2.5 percent by weight was obtained from the data of Fig. 2 and Fig. 3, and the ratio was indicated by o marks in Fig. 4. Therefore, as shown in Fig. 4, the condition of the ratio Y of the alkylbenzene oil relative to the two-layer separation temperature T of the HFC refrigerant and the base oil is:

$$Y \leq -T + 15 \quad \dots [\text{Condition 3}]$$

It is to be noted that the above [Condition 3] is in the case of the high-pressure dome type in which the two-layer separation becomes a problem, and this [Condition 3] is not required to be satisfied in the case where the amount of refrigerant is small although the machine is specially designed for both

cooling and heating or cooling only or in the case where the compressor is provided with a two-layer separation preventing function.

Fig. 5 shows the result of the test of
5 examining a relation of the ratio of metal contact relative to the oil viscosity at an oil temperature of 90 to 110°C during operation of the high-pressure dome type compressor. As shown in Fig. 5, although there is a variation depending on the operating conditions,
10 the ratio of metal contact becomes approximately zero percent when the oil viscosity is not smaller than 2.5 cst, and this discovers that the oil films of the bearing and so on of the compressor are maintained. If the oil viscosity is smaller than 2.5 cst, the
15 ratio of metal contact increases and the oil films of the bearing and so on of the compressor become thin, and this discovers that the bearing and so on are damaged to impair the reliability. Therefore, when the operating condition of a high oil temperature is
20 taken into consideration, the oil films of the bearing are maintained normal throughout the entire region of the operating range of the product when the viscosity of the refrigerating machine oil is not smaller than 2.5 cst at an oil temperature of 100°C. The condition
25 of the ratio Y of the alkylbenzene oil obtained on the

basis of a rule of mixture and the condition that the viscosity of the refrigerating machine oil is not smaller than 2.5 cst and the viscosity is:

$$Y \leq (\log\log(2.5+0.6) - \log\log(U+0.6)) \\ 5 \quad \quad \quad / (\log\log(V+0.6) - \log\log(U+0.6)) \times 100 \\ \quad \quad \quad \dots [\text{Condition 4}]$$

In the above [Condition 4], U represents the viscosity [cst] of the base oil at a temperature of 100°C, while V represents the viscosity [cst] of the alkylbenzene oil at a temperature of 100 °C. The above rule of mixture prescribes the volume ratio, and therefore, it is to be calculated on the assumption that the concentrations of the base oil and the alkylbenzene oil are identical in converting it into the weight ratio. Therefore, when the densities of the base oil and the alkylbenzene oil differ from each other, they are to be corrected. The boundary line of the [Condition 4] shown in Fig. 4 is in the case where the grade of viscosity of the base oil is VG68 (viscosity is 68 [cst] at a temperature of 40°C) and the grade of viscosity of the alkylbenzene oil is VG8 (viscosity is 8 [cst] at a temperature of 40°C).

(Second Embodiment)

The following will describe the case where a refrigerating machine oil satisfying the

aforementioned [Condition 1] through [Condition 4] is employed in a refrigerator.

5 In a refrigerator having the same construction as that of the refrigerator of the first embodiment shown in Fig. 1, an HFC refrigerant and a high-pressure dome type compressor 1 are employed, and a refrigerating machine oil obtained by mixing the alkylbenzene oil of ratios satisfying the
10 aforementioned [Condition 1] and [Condition 4] (indicated in the regions A, B and C in Fig. 4) into a base oil (ether oil) is employed. In this case, no clogging occurs in the capillary 4 and the oil films of the bearing and so on are maintained normal throughout the entire region of the operating range,
15 so that the reliability of the high-pressure dome type compressor 1 having a high oil temperature can be maintained.

In the case where the compressor 1 is the high-pressure dome type in which the two-layer
20 separation is a problem, a refrigerating machine oil obtained by mixing the alkylbenzene oil of ratios satisfying the [Condition 3] in addition to the [Condition 1] and [Condition 4] (indicated in the regions A and B in Fig. 4) into a base oil (ether oil)
25 is employed. In this case, the clogging of the

capillary 4 is prevented and the oil concentration of the refrigerant rich layer is made not smaller than 2.5 percent by weight even when the refrigerant is separated into two layers in an operation stop state
5 due to the lie-in or the like. Therefore, the oil films are maintained to prevent the bearing and so on from being damaged, so that the reliability of the high-pressure dome type compressor 1 can be improved.

In the case where the compressor 1 is the
10 low-pressure dome type in which the two-layer separation easily occurs, a refrigerating machine oil obtained by mixing the alkylbenzene oil of ratios satisfying the [Condition 1] and [Condition 2] (indicated in the region A in Fig. 4) into a base oil
15 (ether oil) is employed. That is, by reducing the ratio of the alkylbenzene oil as compared with the high-pressure dome type to thereby make the two-layer separation temperature of the HFC refrigerant and the mixed oil not higher than 10°C, the mixed oil and the
20 liquid refrigerant are uniformly dissolved even when the liquid refrigerant returns to the inside of the dome of the compressor 1 in an operating state in which the oil temperature is not lower than 10°C, so that the mixture of the refrigerant and the mixed oil
25 having an appropriate viscosity is sucked into the oil

pump. Therefore, the reliability of the low-pressure dome type compressor 1 can be maintained.

In the aforementioned second embodiment, the alkylbenzene oil is well dissolved in the ether oil, and the ether oil can easily adjust the two-layer separation temperature of the HFC refrigerant and the ether oil. Therefore, even when an increased amount of alkylbenzene oil is incorporated in the ether oil as compared with the ester oil or the like, the two-layer separation temperature of the HFC refrigerant and the mixed oil (ether oil and the alkylbenzene oil) can be reduced. Therefore, the ratio of the alkylbenzene oil relative to the refrigerating machine oil can be increased, and the sludge adhered to the inner surfaces of the capillary and the expansion valve can be more effectively removed. It is to be noted that a refrigerating machine oil obtained by mixing a second synthetic oil of an ester oil, a mixed oil comprised of an ether oil and an ester oil, a fluorine oil or a carbonate oil with the first synthetic oil of the alkylbenzene oil may be employed in the second embodiment.

(Third Embodiment)

Fig. 6 shows a swing type compressor provided for a refrigerator according to a third embodiment of the present invention.

5 This swing type compressor includes a compressor element 30. The compressor element 30 includes a cylinder 40 internally having a cylinder chamber 41 and a roller 7 arranged revolvably inside the cylinder chamber 41. Then, the roller 7 is
10 relatively rotatably fitted on an eccentric section 20 of a driving shaft (not shown). On the other hand, an inlet port 30a and an outlet port 30b opened at the cylinder chamber 41 are formed at the wall of the cylinder 40. On the outer peripheral surface of the
15 roller 7 is integrally formed a blade 8 that is projecting radially outwardly of the roller 7. On the other hand, a cylindrical retainer hole 42 is formed in a portion between the inlet port 30a and the outlet port 30b of the cylinder 40. Then, a support member
20 21 comprised of two semicylindrical members 22 and 22 having a semicircular cross-section shape is rotatably fitted in this retainer hole 42. Opposite flat surfaces of the semicylindrical members 22 constitute a reception groove 21a. This reception groove 21a has
25 one end communicated with the inside of the cylinder

chamber 41, while a tip portion 8a of the blade 8 is slidably inserted in this reception groove 21a while being able to come in surface contact with it. This blade 8 divides the inside of the cylinder chamber 41 into a compression chamber 31 and an inhalation chamber 32. A plate-shaped valve 9 for opening and closing the outlet port 30b is provided so as to fit on a valve seat surface 44 formed around the exit of the outlet port 30b. A backing plate 10 is stuck to this valve 9.

Then, the swing type compressor employs HFC R410A that is an substitute freon refrigerant as a working fluid to be compressed inside the cylinder chamber 41. As a lubricating oil, an ether oil and an alkylbenzene oil having a compatibility with the HFC refrigerant are concurrently employed. This R410A is one mixed refrigerant of HFC32 and HFC125.

This refrigerator employs a capillary tube as a decompressing means.

In the refrigerator constructed as above, when the driving shaft is driven, the protruding tip portion 8a of the blade 8 integrated with the roller 7 moves inward and outward along the reception groove 21a of the support member 21, while the support member 21 rotates simultaneously with the movement. That is,

the blade 8 consistently comparts the inside of the cylinder chamber 41 into the compression chamber 31 and the inhalation chamber 32 by advancing and retreating while swaying in accordance with the revolution of the roller 7.

According to this refrigerator, while the roller 7 is revolved without rotating relative to the eccentric section 20, i.e., while it is made to swing (rock) about the blade 8, the tip portion of the blade 8 does not move in line contact with the peripheral surface of the roller 7, meaning that the blade 8 and the roller 7 do not relatively move differently from the prior art. Therefore, no slide friction occurs due to the line contact between the blade 8 and the roller 7. Then, the surface of the blade 8 seals the support member 21 while being put in surface contact with the support member 21, and therefore, no boundary lubricating state occurs.

Therefore, according to the refrigerator employing the above swing type compressor, the sludge adhered to the inner surfaces of the small-diameter portions of the capillary and the expansion valve can be exfoliated and removed by the alkylbenzene oil even when an alternative freon refrigerant that takes the environmental safety into consideration is employed.

Furthermore, the blade 8 is made to slide in surface contact with the support member 21, and therefore, the deterioration of the lubricating oil can be prevented, so that the seizure can be prevented.

5 In the first embodiment, the refrigerating machine oil obtained by mixing the first synthetic oil comprised of the alkylbenzene oil with the second synthetic oil comprised of the ether oil, ester oil, fluorine oil and the carbonate oil is employed.
10 However, it is of course acceptable to employ a refrigerating machine oil obtained by mixing the first synthetic oil comprised of the alkylbenzene oil with the second synthetic oil comprised of other than the ether oil, ester oil, fluorine oil and the carbonate
15 oil.

 In the first embodiment, the first synthetic oil comprised of the alkylbenzene oil is incorporated into the second synthetic oil comprised of one of the ether oil, ester oil, fluorine oil and the carbonate
20 oil. However, it is acceptable to incorporate the alkylbenzene oil into the mixed oil comprised of the ether oil and the ester oil. In this case, the ester oil is hydrolyzed by water but deterioration by oxidation scarcely occurs. On the contrary, the ether
25 oil is deteriorated by oxidation but scarcely

hydrolyzed by water since it withstands water. Therefore, by setting the ratio of the ether oil to the ester oil to 1 : 1, a refrigerating machine oil of which the degree of deterioration by oxidation and the
5 degree of hydrolysis by water are each reduced half can be obtained.

Furthermore, the first and second embodiments have been described with reference to a refrigerator employing an HFC refrigerant. However,
10 the refrigerant is not limited to the HFC refrigerant, and it may also be the HCFC refrigerant or the like. In this case, the refrigerating machine oil of the present invention causes no trouble even if a refrigerating machine oil such as the mineral oil for
15 HCFC refrigerant enters. Furthermore, also by virtue of the compatibility with the HCFC refrigerant R-22 or the like, the HCFC refrigerant of the refrigerator can easily be replaced by the HFC refrigerant (so-called the retrofit can be easily achieved) without changing
20 the refrigerating machine oil by filling the refrigerator employing the HCFC refrigerant with the refrigerating machine oil of the present invention.

In the third embodiment, the refrigerating machine oil of the present invention is employed in
25 the swing type compressor. However, it is acceptable

to employ the refrigerating machine oil of the present invention in a rotary type compressor in which a vane and a rotor are separated and the tip of the vane comes in contact with the outer peripheral surface of the rotor or a scroll compressor in which gas is compressed between two scrolls.

INDUSTRIAL APPLICABILITY

The refrigerating machine oil of the present invention and refrigerator employing the same is applied to a refrigerator for freezing and refrigerating foods and so on and to an air conditioner for executing cooling and heating inside a room.

WHAT IS CLAIMED IS:

1. A refrigerating machine oil obtained by mixing a first synthetic oil comprised of an alkylbenzene oil with a second synthetic oil other
5 than the alkylbenzene oil.
2. A refrigerating machine oil as claimed in claim 1, wherein the second synthetic oil is an ether oil.
10
3. A refrigerating machine oil as claimed in claim 1, wherein the second synthetic oil is an ester oil.
- 15 4. A refrigerating machine oil as claimed in claim 1, wherein the second synthetic oil is comprised of an ether oil and an ester oil.
- 20 5. A refrigerating machine oil as claimed in claim 1, wherein the second synthetic oil is a fluorine oil.
- 25 6. A refrigerating machine oil as claimed in claim 1, wherein the second synthetic oil is a carbonate oil.



7. A refrigerating machine oil as claimed in claim 1, wherein a ratio of the alkylbenzene oil relative to the refrigerating machine oil is 1 to 50 percent by weight.

8. A refrigerating machine oil as claimed in claim 1, wherein a ratio of the alkylbenzene oil relative to the refrigerating machine oil is not smaller than five percent by weight and the refrigerating machine oil has a viscosity of not smaller than 2.5 cst at a temperature of 100°C.

9. A refrigerating machine oil as claimed in claim 8, wherein a refrigerant rich layer has an oil concentration of not smaller than 2.5 percent by weight when the refrigerating machine oil and an HFC refrigerant are separated into two layers at a temperature of 0°C.

10. A refrigerating machine oil as claimed in claim 1, wherein a ratio of the alkylbenzene oil relative to the refrigerating machine oil is not smaller than five percent by weight and a temperature at which an HFC refrigerant and the refrigerating



machine oil separate into two layers is not higher than 10°C.

11. A refrigerator employing the refrigerating machine oil claimed in claim 1.

12. A refrigerator as claimed in claim 11, wherein an HFC (hydrofluorocarbon) refrigerant is employed.

10

13. A refrigerator as claimed in claim 11, wherein a capillary is employed as a decompressor.

14. A refrigerator as claimed in claim 11, wherein an HFC refrigerant and a high-pressure dome type compressor are employed, a ratio of the alkylbenzene oil relative to the refrigerating machine oil is not smaller than five percent by weight and the refrigerating machine oil has a viscosity of not smaller than 2.5 cst at a temperature of 100°C.

20

15. A refrigerator as claimed in claim 14, wherein a refrigerant rich layer has an oil concentration of not smaller than 2.5 percent by weight when the refrigerating machine oil and the HFC

25



refrigerant are separated into two layers at a temperature of 0°C.

16. A refrigerator as claimed in claim 11,
5 wherein an HFC refrigerant and a low-pressure dome
type compressor are employed, a ratio of the
alkylbenzene oil relative to the refrigerating machine
oil is not smaller than five percent by weight and a
temperature at which the HFC refrigerant and the
10 refrigerating machine oil separate into two layers is
not higher than 10°C.

17. A refrigerator as claimed in claim 11,
wherein an HCFC (hydrochlorofluorocarbon) refrigerant
15 is employed.

18. A refrigerator as claimed in claim 11,
wherein an HCFC refrigerant is employed and a
capillary is employed in as a decompressor.
20

19. A refrigerator as claimed in claim 11,
wherein an HCFC refrigerant and a high-pressure dome
type compressor are employed, a ratio of the
alkylbenzene oil relative to the refrigerating machine
25 oil is not smaller than five percent by weight and the



refrigerating machine oil has a viscosity of not smaller than 2.5 cst at a temperature of 100°C.

20. A refrigerator as claimed in claim 19,
5 wherein a refrigerant rich layer has an oil concentration of not smaller than 2.5 percent by weight when the refrigerating machine oil and the HCFC refrigerant are separated into two layers at a temperature of 0°C.

10

21. A refrigerator as claimed in claim 11,
wherein an HCFC refrigerant and a low-pressure dome type compressor are employed, a ratio of the alkylbenzene oil relative to the refrigerating machine
15 oil is not smaller than five percent by weight and a temperature at which the refrigerating machine oil and the HCFC refrigerant separate into two layers is not higher than 10°C.

20 22. A refrigerator as claimed in claim 12, employing a swing type compressor comprising: a roller (7) which is rotatably fitted on an eccentric section (20) of a driving shaft; a blade (8) which is integrally fixed to an outer peripheral surface of the
25 roller (7) and extends outwardly of a radius of the



roller (7), thereby separating a cylinder chamber (41)
inside a cylinder (40) into a compression chamber (31)
and an inhalation chamber (32); and a support member
(21) which is rotatably supported in the cylinder (40)
5 and in which is formed a reception groove (21a) that
receives and guides a protruding side tip portion (8a)
of the blade (8).



ABSTRACT OF THE DISCLOSURE

There are provided a refrigerating machine oil which can easily remove a sludge generated in a refrigerant circuit and is easy to return to a compressor and a refrigerator employing the same. A refrigerating machine oil obtained by mixing an alkylbenzene oil and an ether oil is employed in a refrigerant circuit. A sludge generated on an inner surface of a small-diameter portion of a capillary (4) is exfoliated and removed by the alkylbenzene oil while maintaining lubricating performance of a compressor (1) with the ether oil that is well dissolved in an HFC refrigerant, thereby preventing capillary clogging.

Fig. 1

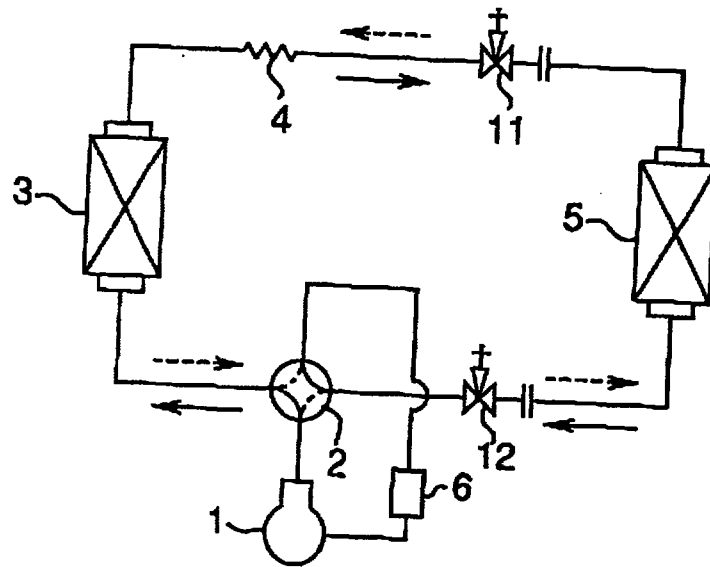


Fig.2

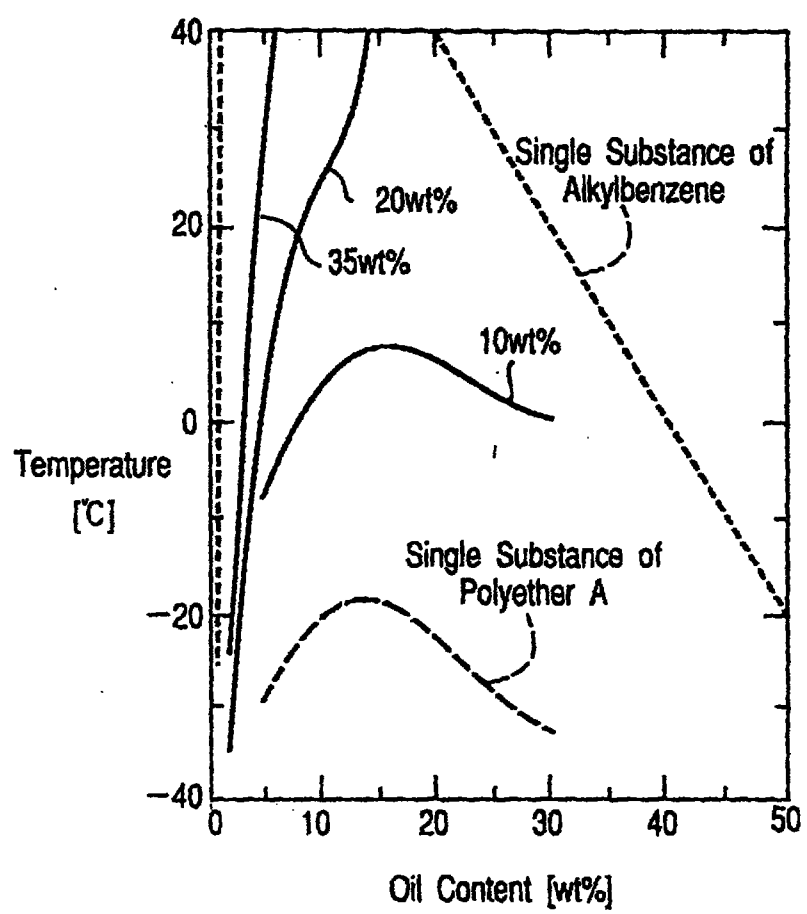


Fig.3

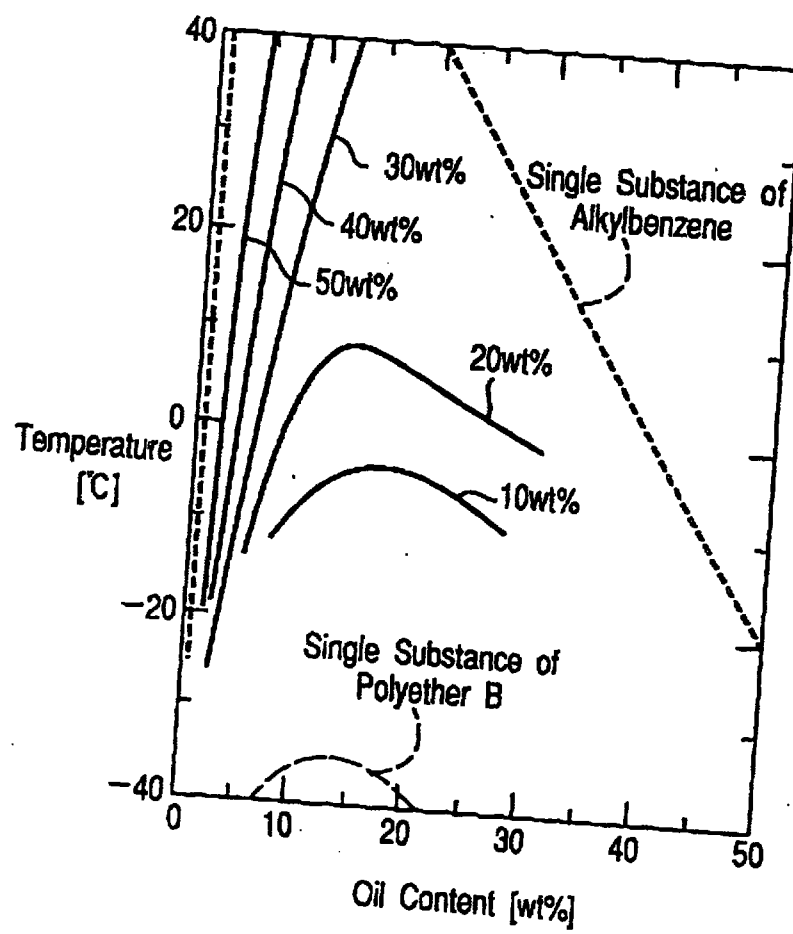


Fig.4

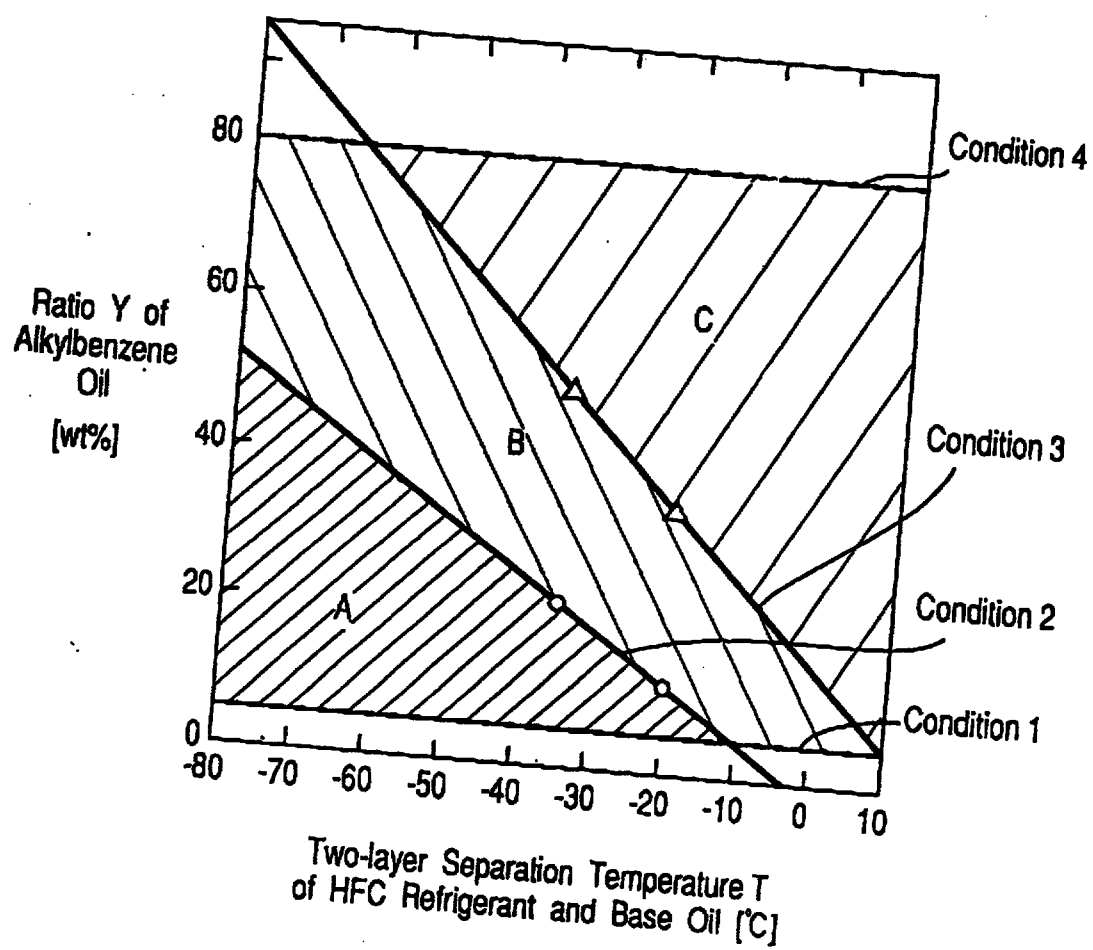


Fig.5

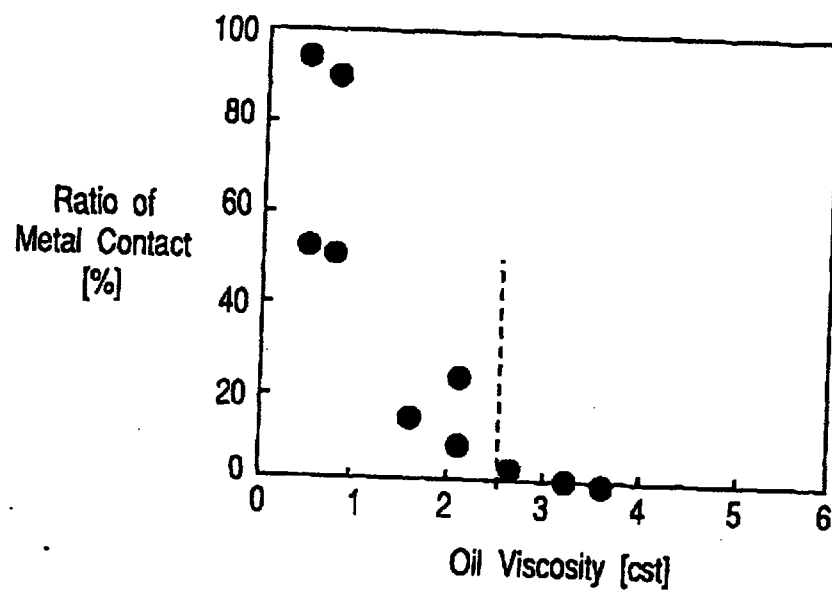
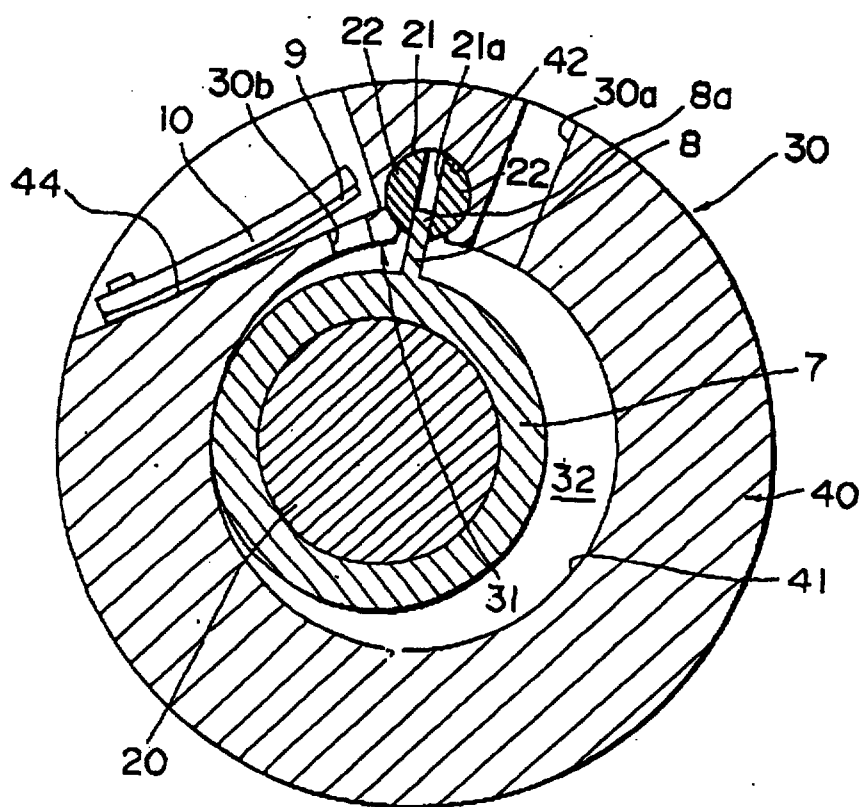


Fig. 6





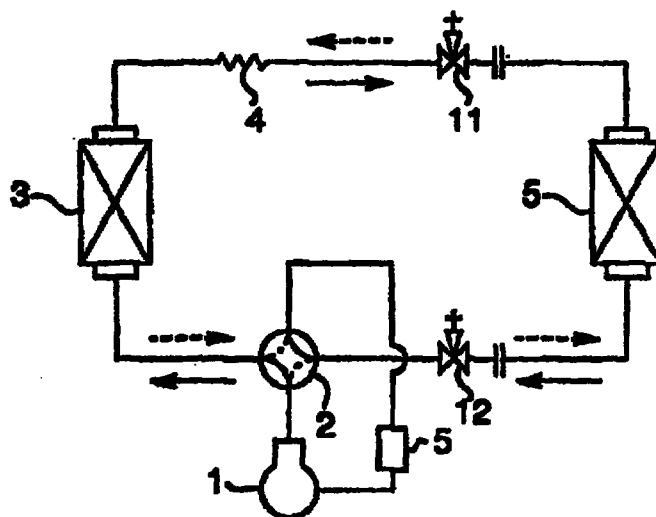
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(21) 国際出願番号 PCT/JP96/03792 (22) 国際出願日 1996年12月25日(25.12.96) (30) 優先権データ 特願平7/342651 1995年12月28日(28.12.95) ✓ JP 特願平8/43221 1996年2月29日(29.02.96) JP (71) 出願人 (米国を除くすべての指定国について) ダイキン工業株式会社(DAIKIN INDUSTRIES, LTD.)(JP/JP) ✓ 〒530 大阪府大阪市北区中崎西2丁目4番12号 梅田センタービル Osaka, (JP) (72) 発明者：および (75) 発明者／出願人 (米国についてのみ) 矢嶋龍三郎(YAJIMA, Ryuzaburo)(JP/JP) 北 宏一(KITA, Koichi)(JP/JP) 〒591 大阪府堺市金岡町1304番地 ダイキン工業株式会社 堺製作所 金岡工場内 Osaka, (JP) 平良繁治(TAIRA, Shigeharu)(JP/JP) 大沼洋一(OONUMA, Youichi)(JP/JP) 〒525 滋賀県草津市岡本町字大谷1000番地の2 ダイキン工業株式会社 滋賀製作所内 Shiga, (JP)	(74) 代理人 弁理士 青山 葆, 外(AOYAMA, Tamotsu et al.) 〒540 大阪府大阪市中央区城見1丁目3番7号 IMPビル 青山特許事務所 Osaka, (JP) (81) 指定国 AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO特許 (KE, LS, MW, SD, SZ, UG), ユーラシア特許 (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), 欧州特許 (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI特許 (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). 添付公開書類 国際調査報告書	

(54)Title: REFRIGERATING MACHINE OIL AND REFRIGERATOR USING SAME

(54)発明の名称 冷凍機油およびそれを用いた冷凍機



(57) Abstract

The present invention provides a refrigerating machine oil which permits ready removal of sludge generated in a refrigerant circuit and is easy to return to a compressor, and a refrigerator using the oil. A refrigerating machine oil composed of a mixture of alkylbenzene based oil and ether based oil is used in a refrigerant circuit whereby the ether based oil well soluble in a HFC based refrigerant maintains a lubricating performance of a compressor (1) and the alkylbenzene based oil peels off and removes sludge generated on an inner surface of a small diameter portion of a capillary tube (4) to prevent clogging of the capillary tube.

(57) 要約

冷媒回路内に生じたスラッジを容易に除去でき、圧縮機に油戻りしやすい冷凍機油およびそれを用いた冷凍機を提供する。アルキルベンゼン系油とエーテル系油とが混合された冷凍機油を冷媒回路に用いることによって、HFC系冷媒によく溶けるエーテル系油によって、圧縮機(1)の潤滑性能を維持しつつ、アルキルベンゼン系油によって、キャピラリ(4)の細径部の内面に生じたスラッジを剥がして除去し、キャピラリ詰まりを防止する。

情報としての用途のみ

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