

ISOMERIZATION PROCESS USING METAL-MODIFIED SMALL CRYSTALLITE MTT MOLECULAR SIEVE

FIELD OF THE INVENTION

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This invention is directed to a process for isomerizing a feed which includes straight chain and slightly branched paraffins having 10 or more carbon atoms using a catalyst comprising a small crystallite MTT molecular sieve loaded with metals. This invention is also directed to dewaxing methods producing products with improved viscosity indexes at lower pour points.

BACKGROUND OF THE INVENTION

The production of Group II and Group III base oils employing hydroprocessing has become increasingly popular in recent years. Catalysts that demonstrate improved isomerization selectivity and conversion are continually sought. As discussed in U.S. Pat. No. 5,282,958, col. 1-2, the use of intermediate pore molecular sieves such as ZSM-22, ZSM-23, ZSM-35, SSZ-32, SAPO-11, SAPO-31, SM-3, SM-6 in isomerization and shape-selective dewaxing is well-known. Other typical zeolites useful in dewaxing include ZSM-48, ZSM-57, SSZ-20, EU-I, EU-13, ferrierite, SUZ-4, theta-1, NU-10, NU-23, NU-87, ISI-1, ISI-4, KZ-1, and KZ-2.

U.S. Pat. No. 5,252,527 and 5,053,373 disclose a zeolite such as SSZ-32 which is prepared using an N-lower alkyl-N'-isopropyl-imidazolium cation as a template. 5,053,373 discloses a silica to alumina ratio of greater than 20 to less than 40 and a constraint index, after calcination and in the hydrogen form, of 13 or greater. The zeolite of 5,252,527 is not restricted to a constraint index of 13 or greater. 5,252,527 discloses loading zeolites with metals in order to provide a hydrogenation- dehydrogenation function. Typical replacing cations can include hydrogen, ammonium, metal cations, e.g., rare earth, Group IIA and Group VIII metals, as well as their mixtures. A method for

preparation of MTT-type zeolites such as SSZ-32 or ZSM-23 using small neutral amines is disclosed in U.S. Pat. No. 5,707,601.

5 U.S. Pat. No. 5,397,454 discloses hydroconversion processes employing a zeolite such as SSZ-32 which has a small crystallite size and a constraint index of 13 or greater, after calcination and in the hydrogen form. The catalyst possesses a silica to alumina ratio of greater than 20 and less than 40.

U.S. Pat. No. 5,300,210 is also directed to hydrocarbon conversion processes employing SSZ-32. The SSZ-32 of U.S. Pat. No. 5,300,210 is not limited to a
10 small crystallite size.

U.S. Pat. No. 7,141,529 discloses a method of metal-modifying molecular sieves with different metals (a metal or metal selected from the group consisting of Ca, Cr, Mg, La, Ba, Pr, Sr, K and Nd and also with a Group VIII
15 metal) to provide catalysts with improved isomerization selectivity using an nC₁₆ feed. None of the processes produced a molecular sieve with a small crystallite size. None of the isomerization methods gave a slope of the VI of the product boiling at 650°F (343°C) and above versus the pour point of zero or less.

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U.S. Pat. Publication No. 2007/0041898A1 discloses a method of making a small crystallite MTT catalyst. Nothing is disclosed of metal-modifying the molecular sieve.

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SUMMARY OF THE INVENTION

There is provided a process for dewaxing a hydrocarbon feed to produce an isomerized product, the feed including straight chain and slightly branched paraffins having 10 or more carbon atoms, comprising contacting the feed
30 under isomerization conditions in the presence of hydrogen with catalyst comprising a molecular sieve having MTT framework topology and having a crystallite diameter of about 200 to about 400 Angstroms in the longest

direction, the catalyst containing at least one metal selected from the group consisting of Ca, Cr, Mg, La, Na, Pr, Sr, K and Nd and at least one Group VIII metal.

- 5 There is also provided a dewaxing method, comprising isomerization dewaxing a hydrocarbon feed having at least 5 wt% wax over a catalyst to produce two or more isomerized products boiling at 343°C (650°F) or higher, each isomerized product having:
- a. a pour point between 0 and -30°C, and
 - 10 b. a corresponding viscosity index of 95 or higher;
- wherein a line fit to a chart of the pour points on an x-axis and the viscosity indexes on a y-axis has a slope of the line for y of zero or less.

- There is also provided a dewaxing process, comprising isomerization
- 15 dewaxing a hydrocarbon feed having at least 5 wt% wax over a catalyst to produce two or more isomerized products boiling at 343°C (650°F) or higher, each isomerized product having:
- a. a pour point between 0 and -30°C, and
 - b. a corresponding viscosity index of 95 or higher;
- 20 wherein a line fit to a chart of the pour points on an x-axis and the viscosity indexes on a y-axis has a slope of the line for y of zero or less; and wherein the yield of the two or more isomerized products boiling at 343°C (650°F) or higher is 90 wt% or greater based on the feed.

25 BRIEF DESCRIPTION OF THE DRAWINGS

- Figure 1 shows yield versus pour point for isomerization of a heavy neutral (500N) feed using a standard MTT-containing catalyst ("Std SSZ-32"), a metal-modified standard MTT-containing catalyst ("metal-modified SSZ-32")
- 30 and the metal-modified, small crystallite MTT-containing catalyst ("metal-modified SSZ-32X").

Figure 2 shows Viscosity Index (VI) versus pour point for isomerization of a heavy neutral (500N) feed using a standard MTT-containing catalyst ("std SSZ-32"), a metal-modified standard MTT-containing catalyst ("metal-modified SSZ-32") and the metal-modified, small crystallite MTT-containing catalyst ("metal-modified SSZ-32X").

Figure 3 shows gas make (production of C₁-C₄ products) versus pour point for isomerization of a heavy neutral (500N) feed using a standard MTT-containing catalyst ("std SSZ-32"), a metal-modified standard MTT-containing catalyst ("metal-modified SSZ-32") and the metal-modified, small crystallite MTT-containing catalyst ("metal-modified SSZ-32X").

Figure 4 shows yield of C₅ products versus pour point for isomerization of a heavy neutral (500N) feed using a standard MTT-containing catalyst ("std SSZ-32"), a metal-modified standard MTT-containing catalyst ("metal-modified SSZ-32") and the metal-modified, small crystallite MTT-containing catalyst ("metal-modified SSZ-32X").

Figure 5 shows yield versus pour point for isomerization of a 150N feed using a standard MTT-containing catalyst ("std SSZ-32"), a small crystallite MTT-containing catalyst without metal loading ("small crystal SSZ-32"), a metal-modified standard MTT-containing catalyst ("metal-modified SSZ-32") and the metal-modified, small crystallite MTT-containing catalyst ("metal-modified SSZ-32X").

Figure 6 shows Viscosity Index (VI) versus pour point for isomerization of a 150N feed using a standard MTT-containing catalyst ("std SSZ-32"), a metal-modified standard MTT-containing catalyst ("metal-modified SSZ-32") and the metal-modified, small crystallite MTT-containing catalyst ("metal-modified SSZ-32X").

Figure 7 shows gas make versus pour point for isomerization of a 150N feed using a standard MTT-containing catalyst ("std SSZ-32"), a metal-modified standard MTT-containing catalyst ("metal-modified SSZ-32") and the small crystallite MTT-containing catalyst ("metal-modified SSZ-32X").

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Figure 8 shows yield of Light Naphtha (C_5 -250°F) products versus pour point for isomerization of a 150N feed using a standard MTT-containing catalyst ("std SSZ-32"), a metal-modified standard MTT-containing catalyst ("metal-modified SSZ-32") and the metal-modified, small crystallite MTT-containing catalyst ("metal-modified SSZ-32X").

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Figure 9 shows yield versus pour point for isomerization of a Medium Neutral feed using a standard MTT-containing catalyst ("std SSZ-32"), a metal-modified standard MTT-containing catalyst ("metal-modified SSZ-32") and the metal-modified, small crystallite MTT-containing catalyst ("metal-modified SSZ-32X").

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Figure 10 shows Viscosity Index (VI) versus pour point for isomerization of a Medium Neutral feed using a standard MTT-containing catalyst ("std SSZ-32"), a metal-modified standard MTT-containing catalyst ("metal-modified SSZ-32") and the metal-modified, small crystallite MTT-containing catalyst ("metal-modified SSZ-32X").

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Figure 11 shows a comparison of the X-ray diffraction patterns of a standard MTT molecular sieve ("STANDARD SSZ-32") and a small crystallite MTT molecular sieve ("SSZ-32X").

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DETAILED DESCRIPTION OF EMBODIMENTS

In one embodiment the catalyst is comprised of a molecular sieve having the MTT framework topology. The catalyst employed comprises from 5 to 85 wt% molecular sieve. "Molecular sieves" as used herein can include "zeolites". The

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terms "MTT type zeolite", "MTT molecular sieve", or variations thereof refers to the framework structure code for a family of molecular sieve materials. The Structure Commission of the International Zeolite Association (IZA) gives codes consisting of three alphabetical letters to zeolites (a type of molecular sieve) having a structure that has been determined. Zeolites having the same topology are generically called by such three letters. The code MTT is given to the structure of molecular sieves including: ZSM-23, SSZ-32, EU-13, ISI-4, and KZ-1. Thus, zeolites having a framework structure similar to that of ZSM-23 and SSZ-32 are named a MTT-type zeolite.

Other molecular sieves useful for isomerization dewaxing are intermediate pore size molecular sieves having a framework topology of MTT, TON, AEL or FER.

The small crystallite MTT-type zeolites used in one embodiment of the catalyst have a crystallite diameter of about 200 Angstroms to about 400 Angstroms in the longest direction.

Catalyst Preparation

In one embodiment, small crystallite MTT molecular sieves are prepared from an aqueous solution containing sources of an alkali metal oxide or hydroxide, an alkylamine (such as isobutylamine), an organic carbon compound source of quaternary ammonium ion which is subsequently ion-exchanged to the hydroxide form, an oxide of aluminum (e.g., wherein the aluminum oxide source provides aluminum oxide which is covalently dispersed on silica), and an oxide of silicon. In one embodiment the organic carbon compound source of quaternary ammonium ion which is subsequently ion-exchanged to the hydroxide form is N-lower alkyl-N'-isopropyl-imidazolium cation (for-example N, N'-diisopropyl-imidazolium cation or N-methyl-N'-isopropyl-imidazolium cation). The aqueous solution has a composition in terms of mole ratios falling within the following ranges:

Table 1 - Composition of mole ratios

	Embodiment 1	Embodiment 2
$\text{SiO}_2 / \text{Al}_2\text{O}_3$	20-less than 40	30-35
$\text{OH}^- / \text{SiO}_2$	0.10-1.0	0.20-0.40
Q / SiO_2	0.05-0.50	0.10-0.25
$\text{M}^+ / \text{SiO}_2$	0.05-0.30	0.15-0.30
$\text{H}_2\text{O} / \text{SiO}_2$	20-300	25-60
$\text{Q} / \text{Q} + \text{M}^+$	0.25-0.75	0.33-0.67

wherein Q is the sum of Q_a and Q_b ; M is the alkali metal oxide or hydroxide;

- 5 and M^+ is the alkali metal cation derived from the alkali metal oxide or hydroxide. The alkali metals are the series of elements comprising Group 1 (IUPAC style) of the periodic table: lithium (Li), sodium (Na), potassium (K), rubidium (Rb), caesium (Cs), and francium (Fr).
- 10 Q_a is an organic carbon compound source of quaternary ammonium ion and Q_b is an amine. In one embodiment, Q_a is an N-lower alkyl-N'-isopropyl-imidazolium cation (for example an N, N'-diisopropyl-imidazolium cation or N-methyl-N'-isopropyl-imidazolium cation). A number of different Q_b amines are useful. In one embodiment, isobutyl amine, neopentyl amine, monoethyl
- 15 amine, or mixtures thereof are suitable examples of Q_b . The molar concentration of Q_b is greater than the molar concentration of Q_a . Generally, the molar concentration of Q_b is in the range from 2 to about 9 times the molar concentration of Q_a . U.S. Pat No. 5,785,947 (herein incorporated by reference) describes how a zeolite synthesis method employing two organic
- 20 sources of nitrogen, one source being an amine containing from one to eight carbons provides significant cost savings over a method in which the quaternary ammonium ion source (such as imidazolium) is the only source of organic component. The combination of the two organic nitrogen sources allows the possibility of the primary template (used in smaller quantity) to
- 25 nucleate the desired zeolite structure and then the amine to contribute to

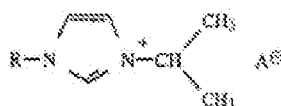
filling the pores in a stabilizing manner, during crystal growth. Empty pores of high silica zeolites are susceptible to re-dissolution under the synthesis conditions. The amine also can contribute to maintaining an elevated alkalinity for the synthesis.

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In one embodiment, the organic carbon compound source of quaternary ammonium ion also provides hydroxide ion.

In one embodiment, the organic carbon compound source of quaternary ammonium ion, Q_{a+} , of the aqueous solution is derived from a compound of the formula:

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wherein R is lower alkyl containing 1 to 5 carbon atoms, for example -CH₃ or isopropyl. An anion (A^-) which is not detrimental to the formation of the MTT molecular sieve is associated with the cation. Examples of an anion include halogens (e.g., fluoride, chloride, bromide and iodide), hydroxide, acetate, sulfate, carboxylate, etc. Hydroxide is a particularly useful anion.

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The reaction mixture is prepared using standard zeolitic preparation techniques. Typical sources of aluminum oxide for the reaction mixture include aluminates, alumina, and aluminum compounds, such as aluminum-coated silica colloids (one example is Nalco 1056 colloid sol), $\text{Al}_2(\text{SO}_4)_3$, and other zeolites.

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In one embodiment the aluminum oxide is in a covalently dispersed form on silica. Aluminum oxide in a covalently dispersed form allows molecular sieve with increased aluminum content to be crystallized. Increased aluminum content in the molecular sieve promotes isomerization. In another approach,

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zeolites of pentasil structure and lower silica/alumina ratios (approximately 10) can be used as aluminum oxide sources or feedstocks for the synthesis of small crystallite MTT molecular sieve. These zeolites are recrystallized to the small crystallite MTT molecular sieve in the presence of the organic sources

5 Q_a and Q_b described above.

Mordenite and ferrierite zeolites constitute two such useful sources of aluminum oxide or feedstocks. These latter zeolites have also been used in the crystallization of ZSM- 5 and ZSM-11 (U.S. Pat. No. 4,503,024).

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Another approach, wherein the aluminum oxide is in a covalently dispersed form on silica, is to use an alumina coated silica sol such as that manufactured by Nalco Chem. Co. under the product name 1056 colloid sol (26% silica, 4% alumina). In addition to providing novel SSZ-32 X with

15 high aluminum content, use of the sol generates crystallites of less than 1000Å (along the principal axis) with surprisingly high isomerization capability.

In one embodiment, the catalytic performance of MTT molecular sieves (in the hydrogen form) for cracking capability is manifested by Constraint Index

20 values (as defined in J. Catalysis 67, page 218) of 13 or greater and in one embodiment the MTT molecular sieve (in the hydrogen form) has a Constraint Index from 13 to 22. Determination of Constraint index is also disclosed in U.S. Pat. No. 4,481,177. In general, lowering the crystallite size of a zeolite leads to decreased shape selectivity. This has been demonstrated for ZSM-5

25 reactions involving aromatics as shown in J. Catalysis 99,327 (1986). In addition, zeolite ZSM-22, (U.S. Pat. No. 4,481,177) has been found to be closely related to ZSM-23 (J. Chem. Soc. Chem. Comm. 1985 page 1117). In the above reference on ZSM-22 it was shown that ball-milling the crystallites produced a catalyst with a constraint index of 2.6. This is a surprisingly low

30 value for this material given other studies which indicate that it is a very selective 10-ring pentasil (Proc. of 7th Intl. Zeolite Conf. Tokyo, 1986, page 23). Presumably the ballmilling leads to a less selective but more active

catalyst, by virtue of producing smaller crystallites. Unlike earlier small crystallite catalysts with low constraint indexes, that smaller crystallite MTT molecular sieve loaded with metals maintains high selectivity.

- 5 Typical sources of silicon oxide include silicates, silica hydrogel, silicic acid, colloidal silica, fumed silicas, tetraalkyl orthosilicates, and silica hydroxides. Salts, particularly alkali metal halides such as sodium chloride, can be added to or form in the reaction mixture. They are disclosed in the literature as aiding the crystallization of zeolites while preventing silica occlusion in the lattice.

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The reaction mixture is maintained at an elevated temperature until the crystals of the molecular sieve are formed. The temperatures during the hydrothermal crystallization step are typically maintained from about 140° C. to about 200° C., for example from about 160° C. to about 180° C. or from
15 about 170° C. to about 180° C. The crystallization period is typically greater than 1 day, and in one embodiment the crystallization period is from about 4 days to about 10 days.

The hydrothermal crystallization is conducted under pressure and usually in
20 an autoclave so that the reaction mixture is subject to autogenous pressure. The reaction mixture can be stirred while components are added as well as during crystallization.

Once the molecular sieve crystals have formed, the solid product is separated
25 from the reaction mixture by standard mechanical separation techniques such as filtration or centrifugation. The crystals are water-washed and then dried, e.g., at 90° C. to 150°C. for from 8 to 24 hours, to obtain the as-synthesized molecular sieve crystals. The drying step can be performed at atmospheric or subatmospheric pressures.

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During the hydrothermal crystallization step, the crystals can be allowed to nucleate spontaneously from the reaction mixture. The reaction mixture can

also be seeded with MTT crystals both to direct, and accelerate the crystallization, as well as to minimize the formation of undesired aluminosilicate contaminants.

- 5 In one embodiment, the small crystallite MTT-type zeolites used in the catalyst have a crystallite diameter of about 200 Angstroms to about 400 Angstroms in the longest direction.

- In one embodiment, the small crystallite MTT molecular sieve can be used as-
10 synthesized or can be thermally treated (calcined). The calcination is advantageously conducted at a temperature of about 750 F. Usually, it is desirable to remove the alkali metal cation by ion exchange and replace it with hydrogen, ammonium, or any desired metal ion. The molecular sieve can be leached with chelating agents, e.g., EDTA or dilute acid solutions, to increase
15 the silica alumina mole ratio. The molecular sieve can also be steamed. Steaming helps stabilize the crystalline lattice to attack from acids.

- The calcined molecular sieve is then loaded with at least one metal selected from the group consisting of Ca, Cr, Mg, La, Na, Pr, Sr, K and Nd. These
20 metals are known for their ability to modify performance of the catalyst by reducing the number of strong acid sites on the catalyst and thereby lowering the selectivity for cracking versus isomerization. In one embodiment, modification also involves increased metal dispersion such that acid or cation sites in the catalysts are blocked. In one embodiment, metal loading is
25 accomplished by a variety of techniques, including impregnation and ion exchange. Typically, the metal is loaded such that the catalyst contains 0.5 to 5 wt.% metal on a dry basis. In one embodiment the catalyst contains 2 to 4 wt% metal on a dry basis.

- 30 Typical ion exchange techniques involve contacting the extrudate or particle with a solution containing a salt of the desired replacing cation or cations. Although a wide variety of salts can be employed, in one embodiment the salt

of the desired replacing cation or cations is selected from the group of chlorides and other halides, nitrates, sulfates, and mixtures thereof. Representative ion exchange techniques are disclosed in a wide variety of patents including U.S. Pat. Nos. 3,140,249; 3,140,251; and 3,140,253, each
5 of which is incorporated herein by reference. Ion exchange can take place either before or after the extrudate or particle is calcined. Calcination is carried out in a temperature range from 400 to 1100 °F.

Following contact with the salt solution of the desired replacing cation, the
10 molecular sieve is dried at temperatures ranging from 149° F. to about 599° F. The molecular sieve is then further loaded using a technique such as impregnation with a Group VIII metal to enhance the hydrogenation function. In some embodiments it is desirable to coimpregnate a modifying metal and Group VIII metal at once, as disclosed in U.S. Pat. No. 4,094,821. In one
15 embodiment the Group VIII metal is platinum, palladium or a mixture of the two. In one embodiment, after metal loading, the material can be calcined in air or inert gas at temperatures from 500 to 900 °F.

Thus, an example of a typical method for preparing the catalyst involves the
20 following steps:

- (a) synthesizing the small crystallite MTT zeolite in an aqueous solution;
- (b) mixing the small crystallite MTT zeolite with a refractory inorganic oxide
25 carrier precursor and an aqueous solution to form a mixture;
- (c) extruding or forming the mixture of step (b) to form an extrudate or formed particle;
- 30 (d) drying the extrudate or formed particle of step (c);
- (e) calcining the dried extrudate or formed particle of step (d);

- (f) impregnating the calcined extrudate or formed particle of step (e) with at least one metal selected from the group consisting of Ca, Cr, Mg, La, Ba, Na, Pr, Sr, K and Nd to prepare a metal-modified extrudate or formed particle;
- 5 (g) drying the metal-modified extrudate or formed particle of step (f);
- (h) further impregnating the metal-modified extrudate or formed particle of step
- 10 (g) with a Group VIII metal to prepare a catalyst precursor;
- (i) drying the catalyst precursor of step (h); and
- 15 (j) calcining the dried catalyst precursor of step (i) to form a finished, bound catalyst.

Use of an active material in conjunction with the synthetic molecular sieve, i.e., combined with it, tends to improve the conversion and selectivity of the catalyst in certain organic conversion processes. Examples of active materials are hydrogenating components and metals added to affect the overall functioning of the catalyst. In one embodiment the overall functioning of the catalyst includes enhancement of isomerization and reduction of

20 cracking activity.

In one embodiment, small crystallite MTT molecular sieve can be used in intimate combination with hydrogenating components for those applications in which a hydrogenation-dehydrogenation function is desired. Typical

30 hydrogenating components can include hydrogen, ammonium, metal cations, e.g. rare earth, Group IIA and Group VII metals, as well as their mixtures. Examples of metal hydrogenating components include tungsten, vanadium,

molybdenum, rhenium, nickel, cobalt, chromium, manganese, platinum, palladium (or other noble metals). In one embodiment the Group VIII metal is a noble metal selected from the group of platinum, palladium, rhenium, and mixtures thereof. In another embodiment the Group VIII metal is a noble metal
5 selected from the group of platinum, palladium, and mixtures thereof. In one embodiment, the metal hydrogenating component is added such that it constitutes about 0.3 to about 5 wt.% of the catalyst on a dry basis.

Metals added to affect the overall functioning of the catalyst (including
10 enhancement of isomerization and reduction of cracking activity) include magnesium, lanthanum (and other rare earth metals), barium, sodium, praseodymium, strontium, potassium and neodymium. Other metals that might also be employed to affect the overall functioning of the catalyst include zinc, cadmium, titanium, aluminum, tin, and iron.

15 Hydrogen, ammonium as well as metal components can be exchanged into the molecular sieve. The zeolite can also be impregnated with the metals, or, the metals can be physically intimately admixed with the molecular sieve using standard methods known to the art. The metals can be occluded in the
20 crystal lattice by having the desired metals present as ions in the reaction mixture from which the zeolite is prepared.

In one embodiment, the molecular sieve zeolite described is converted to its acidic form and then is mixed with a refractory inorganic oxide carrier
25 precursor and an aqueous solution to form a mixture. In one embodiment, the aqueous solution is acidic. The aqueous solution acts as a peptizing agent. In one embodiment, the carrier (also known as a matrix or binder) is chosen for being resistant to the temperatures and other conditions employed in organic conversion processes. Such matrix materials include active and inactive
30 materials and synthetic or naturally occurring zeolites as well as inorganic materials such as clays, silica and metal oxides. In one embodiment the carrier occurs naturally. In another embodiment the carrier is in the form of

gelatinous precipitates, sols, or gels, including mixtures of silica and metal oxides.

In one embodiment the molecular sieve is composited with porous matrix materials and mixtures of matrix materials such as silica, alumina, titania, 5 magnesia, silica-alumina, silica- magnesia, silica-zirconia, silica-thoria, silica-beryllia, silica- titania, titania-zirconia as well as ternary compositions such as silica- alumina-thoria, silica-alumina-zirconia, silica-alumina-magnesia and silica-magnesia-zirconia. The matrix can be in the form of a cogel. In one 10 embodiment, the matrix materials are alumina and silica.

Inactive materials can suitably serve as diluents to control the amount of conversion in a given process so that products can be obtained economically without using other means for controlling the rate of reaction. Frequently, 15 zeolite materials have been incorporated into naturally occurring clays, e.g., bentonite and kaolin. These materials e.g. clays, oxides, etc., function, in part, as binders for the catalyst. It is desirable to provide a catalyst having good crush strength, because in petroleum refining the catalyst is often subjected to rough handling. This tends to break the catalyst down into 20 powders which cause problems in processing.

"Metal-modified" in this disclosure means that the catalyst molecular sieve contains at least one metal selected from the group consisting of Ca, Cr, Mg, La, Na, Pr, Sr, K and Nd; and at least one Group VIII metal. Group VIII 25 metals are Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, and Pt.

In one embodiment, naturally occurring clays are composited with the synthetic small crystallite MTT molecular sieve. Examples of naturally occurring clays include the montmorillonite and kaolin families, which families 30 include the sub-bentonites and the kaolins commonly known as Dixie, McNamee, Georgia and Florida clays or others in which the main mineral constituent is halloysite, kaolinite, dickite, nacrite, or anauxite. Fibrous clays

such as sepiolite and attapulgite can also be used as supports. Such clays can be used in the raw state as originally mined or can be initially subjected to calcination, acid treatment or chemical modification.

5 The mixture of molecular sieve and binder can be formed into a wide variety of physical shapes. Generally speaking, the mixture can be in the form of a powder, a granule, or a molded product, such as an extrudate having a particle size sufficient to pass through a 2.5-mesh (Tyler) screen and be retained on a 48-mesh (Tyler) screen. In cases where the catalyst is molded,
10 such as by extrusion with an organic binder, the mixture can be extruded before drying, or dried or partially dried and then extruded. Small crystallite MTT molecular sieve can also be steamed. Steaming helps stabilize the crystalline lattice to attack from acids. The dried extrudate is then thermally treated, using calcination procedures.

15 Generally it is desirable to minimize the amount of molecular sieve in the finished catalyst for economic reasons. Lower levels of the molecular sieve in the finished catalyst are desirable if good activity and selectivity results are achieved. In one embodiment, the level of molecular sieve is between 5 and
20 85 wt %, or in another embodiment between 5 and 60 wt%. The level of molecular sieve is varied for different molecular sieve types.

In one embodiment, the metal-modified small crystallite MTT catalyst gives superior yields and exceptional Viscosity Index (VI) on a variety of feeds. The
25 byproduct selectivity is significantly changed compared to catalysts containing standard MTT-type zeolite, e.g., the catalyst results in very low gas and naphtha make. For example, on a waxy 500N hydrocrackate feed containing 21% wax, with a waxy VI of 122, the product yield was 97% at a pour point of -15 C and a VI of 120 – 121. Typically, a much larger drop is seen from waxy
30 VI to dewaxed VI. For example, when a catalyst containing a standard MTT-type zeolite was employed, the resultant product VI was about 111. A metal-modified standard MTT-type zeolite catalyst gave a VI of 115. Gas make and

naphtha make were both much reduced by the use of the small crystallite MTT molecular sieve loaded with metals. Such a high yield and product VI very close to the waxy feed VI after dewaxing was very surprising. The yield of 700 F+ dewaxed lube product in this instance was as high as 97%. Also, the slope of the product VI versus pour point is unusual in that it was not lowered at lower pour point.

Data was also obtained on a 150N waxy hydrocrackate which also showed improved product yield and VI compared to previous MTT-type catalysts. Again, lower gas make and naphtha make was observed. An MN feed was also tested and improved yield and VI were again observed.

When a Fischer-Tropsch wax feed was treated using the catalyst comprising a small crystallite MTT Molecular sieve loaded with metals, the resultant 650 F+ product had exceptional VI's of 165-170 at pour points between -25 and -30 °C. When the 750 °F+ boiling product was further split into two fractions, the 750-850 °F fraction had a kinematic viscosity at 100 °C of 3.8 mm²/s and a very high VI of 151 at a pour point of -18°C, and the 850 °F+ fraction had a viscosity of 9.7mm²/s, a pour point of -11°V, and a VI of 168. Kinematic viscosity was measured by ASTM D445-06, pour point was measured by ASTM D5950-02, and VI was measured by ASTM D2270-04.

Feeds

In one embodiment, the process using the catalyst comprising a molecular sieve having a small crystallite MTT topology and loaded with metals is used to dewax a variety of feedstocks ranging from relatively light distillate fractions such as kerosene and jet fuel up to high boiling stocks such as whole crude petroleum, reduced crudes, vacuum tower residua, cycle oils, synthetic crudes (e.g., shale oils, tars and oil, etc.), gas oils, vacuum gas oils, foots oils, Fischer-Tropsch derived waxes and intermediate products, slack waxes, deoiled slack waxes, waxy lubricant raffinates, n-paraffin waxes, NAO waxes,

waxes produced in chemical plant processes, deoiled petroleum derived waxes, microcrystalline waxes, other heavy oils, and mixtures thereof.

- 5 In one embodiment the feedstock is a hydrocarbon having a weight percent wax of at least 5 %.

- Weight percent wax in the feed is measured by heating the waxy sample until it is just above its pour point, pouring 100 grams of the heated waxy sample into a tared 1 liter beaker and recording the weight of the heated waxy sample
10 to two decimal places; adding 400 mL of a 1:1 mixture of toluene:methyl ethyl ketone (MEK) to the beaker and dissolving the waxy sample with gentle stirring over a hot plate until homogeneous. Cover the beaker with a piece of aluminum foil and place it in the freezer which has been preset to the pour point temperature of the feed. Allow the sample to sit undisturbed overnight.
- 15 After cooling in the freezer overnight, filter the mixture using a filter assembly installed in the freezer. Use No. 4 Whatman filter paper (18.5 cm in diameter) in a Buchner funnel and cover the funnel with a piece of aluminum foil to keep ice crystals from collecting in the funnel. Perform the filtration by connecting the funnel to heavy-duty vacuum, prewetting the filter paper with cold MEK,
20 pulling the vacuum, quantitatively transferring the entire mixture in the beaker into the funnel using a spatula, rinsing the beaker with cold MEK, and filtering the rinsate. Close the freezer and wait until the solvent has completely drained through the filter, and the freezer has dropped to its original preset temperature. Wash the wax filter cake thoroughly using cold MEK. Allow the
25 wax cake to dry, disconnect the vacuum, and remove the filter-funnel assembly from the freezer. Using a spatula, transfer as much wax as possible from the filter to a tared jar. Remove the last traces of filtered wax with hot toluene and transfer the rinsate to the tared jar. Evaporate off the toluene and weigh the wax that was collected in the tared jar. Pour the oil
30 filtrate into a tared flask. Strip off the solvent using a rotary evaporator and weigh the flask plus remaining oil and determine the oil weight. The percent

wax is the weight of the wax that was collected in the tared jar divided by the weight of the heated waxy sample, multiplied by 100.

5 Straight chain n-paraffins either alone or with only slightly branched chain paraffins having 16 or more carbon atoms are sometimes referred to herein as waxes. The feedstock will often be a C10+ feedstock generally boiling above about 350°F, since lighter oils will usually be free of significant quantities of waxy components. However, the process is particularly useful with waxy distillate stocks such as middle distillate stocks including gas oils, 10 kerosenes, and jet fuels, lubricating oil stocks, heating oils and other distillate fractions whose pour point and viscosity need to be maintained within certain specification limits. Lubricating oil stocks will generally boil above 230°C. (450°F.), more usually above 315°C. (600°F.). Hydroprocessed stocks are a convenient source of stocks of this kind and also of other distillate fractions 15 since they normally contain significant amounts of waxy n- paraffins. The feedstock of the present process will normally be a C10 + feedstock containing paraffins, olefins, naphthenes, aromatic and heterocyclic compounds and with a substantial proportion of higher molecular weight n-paraffins and slightly branched paraffins which contribute to the waxy nature 20 of the feedstock. During the processing, the n-paraffins and the slightly branched paraffins undergo some cracking or hydrocracking to form liquid range materials which contribute to a low viscosity product. The degree of cracking which occurs is, however, limited so that the yield of products having boiling points below that of the feedstock is reduced, thereby preserving the 25 economic value of the feedstock.

Typical feedstocks include hydrotreated or hydrocracked gas oils, hydrotreated lube oil raffinates, bright stocks, lubricating oil stocks, synthetic oils, foots oils, Fischer-Tropsch synthesis oils, high pour point polyolefins, 30 normal alphaolefin waxes, slack waxes, deoiled waxes, microcrystalline waxes, and mixtures thereof.

Fischer-Tropsch waxes can be obtained by well-known processes such as, for example, the commercial SASOL® Slurry Phase Fischer-Tropsch technology, the commercial SHELL® Middle Distillate Synthesis (SMDS) Process, or by the non-commercial EXXON® Advanced Gas Conversion (AGC-21) process.

5 Details of these processes and others are described in, for example, EP-A-776959, EP-A-668342; U.S. Patent Nos. 4,943,672, 5,059,299, 5,733,839, and RE39073 ; and US Published Application No. 2005/0227866, WO-A-9934917, WO-A-9920720 and WO-A-05107935. The Fischer-Tropsch synthesis product usually comprises hydrocarbons having 1 to 100, or even
10 more than 100 carbon atoms, and typically includes paraffins, olefins and oxygenated products. Fischer Tropsch is a viable process to generate clean alternative hydrocarbon products, including Fischer-Tropsch waxes.

Conditions

15 The conditions under which the isomerization dewaxing process is carried out generally include a temperature which falls within a range from about 392°F to about 800°F, and a pressure from about 15 to about 3000 psig. Typically, the pressure is from about 100 to about 2500 psig. The liquid hourly space
20 velocity during contacting is generally from about 0.1 to about 20, for example from about 0.1 to about 5. In one embodiment the contacting is carried out in the presence of hydrogen. The hydrogen to hydrocarbon ratio can fall within a range from about 2000 to about 10,000 standard cubic feet H₂ per barrel hydrocarbon, for example from about 2500 to about 5000 standard cubic feet
25 H₂ per barrel hydrocarbon.

In one embodiment the isomerization dewaxing product is further treated, for example by hydrofinishing or adsorbent treatment. The hydrofinishing can be conventionally carried out in the presence of a metallic hydrogenation
30 catalyst, for example, platinum on alumina. The hydrofinishing can be carried out at a temperature of from about 374°F to about 644°F and a pressure of from about 400 psig to about 3000 psig. Hydrofinishing in this manner is

described in, for example, U.S. Pat. 3,852,207 which is incorporated herein by reference.

EXAMPLES

5

Another term that may be used to describe the small crystallite MTT molecular sieve loaded with metals is "broadline." The synthesis of a broadline (in reference to the x-ray diffraction pattern) small crystallite molecular sieve is really synonymous with crystallizing a very small crystal example of the zeolite. The x-ray diffraction pattern broadens as the crystallites are reduced in size. In general, for the system of MTT molecular sieves, as the $\text{SiO}_2/\text{Al}_2\text{O}_3$ ratio diminishes (greater wt% Al in the zeolite product) the crystallite size also diminishes.

10

15 Table 2(a) shows the peak listing and relative intensity of peaks of standard SSZ-32, a standard MTT molecular sieve. Table 2(b) shows the peak listing and relative intensity of peaks of small crystallite MTT molecular sieve prior to metal loading. Table 2(b) magnifies peak width so that major peaks of small crystallite MTT molecular sieve and standard SSZ-32 are easily compared.

20

Table 2(a) – Peak listing of standard SSZ-32

2 Theta	d-spacing (Å)	Relative Intensity (%) (I/I₀) x 100
7.9	11.2	19
8.2	10.8	24
8.9	10.0	11
11.4	7.8	20
14.7	6.05	2
15.9	5.59	5
11.4	5.41	4
18.2	4.88	12

19.6	4.52	69
20.1	4.43	11
20.9	4.25	70
21.4	4.15	9
22.8	3.90	100
23.9	3.73	53
24.0	3.70	58
24.7	3.61	50
25.2	3.53	36
26.0	3.43	42
28.2	3.16	11
29.4	3.03	7
31.6	2.83	13

Table 2(b) – Peaks in as-made Small crystallite MTT Molecular Sieve

2 Theta	d-spacing (Å)	Relative Intensity (%) (I/I ₀ x 100)
8.03	11.0	33
8.83	10.0	6
11.30	7.83	20
15.71	5.64	3
16.34	5.42	3
18.09	4.90	7
19.54	4.54	33
19.67	4.51	20
20.81	4.27	31
21.21	4.18	14
22.74	3.91	63
23.91	3.72	100

24.54	3.62	24
25.09	3.55	34
25.87	3.44	31
26.91	3.31	5
28.10	3.17	4
29.34	3.04	5
31.46	2.84	8
31.94	2.80	3
34.02	2.63	1
35.22	2.55	17
36.29	2.47	16

Figure 11 shows the X-ray diffraction patterns of these two types of MTT molecular sieves, and demonstrates clearly the broader x-ray diffraction peaks of the small crystallite MTT molecular sieve.

EXAMPLE 1 SYNTHESIS OF SMALL CRYSTALLITE MTT MOLECULAR SIEVE

Small crystallite MTT molecular sieve was synthesized as follows: A Hastelloy
5 C liner for a 5 gallon autoclave unit was used for the mixing of reagents and
then in the subsequent thermal treatment. At a rate of 1500 RPM and for a
period of ½ hour, the following components were mixed once they had been
added in the order of description, 300 grams of a 1 Molar solution of N, N'
Diisopropyl imidazolium hydroxide was mixed into 4500 grams of water. The
10 salt iodide was prepared as in US 4, 483,835, Example 8, and then
subsequently was ion-exchanged to the hydroxide form using BioRad AG1-X8
exchange resin. 2400 grams of 1 N KOH were added. 1524 grams of Ludox
AS-30 (30wt% SiO_2) were added. 1080 grams of Nalco's 1056 colloid sol
(26wt% SiO_2 and 4 wt% Al_2O_3) were added. Last, 181 grams of isobutylamine
15 were stirred into the mixture. The molar concentration of the amine Q_b
exceeded the molar concentration of the imidazolium compound Q_a .

Once the stirring was finished the autoclave head was closed up and the
reaction was taken up to 170°C with an 8 hour ramp up time. The system was
20 stirred at 150 RPM. The reaction was terminated so that a product was
collected after 106 hours of heating. The solids were collected by filtration
(which goes very slowly; an indication of small crystals). The solids were
subsequently washed several times and then dried. The dried material was
analyzed by x-ray diffraction and the pattern is shown in Table 3. A
25 comparison is made with the more standard SSZ-32 data presented in Table
2(a) and it can be seen that the new product of Example 1 is related to SSZ-
32 but has the x-ray diffraction lines considerably broadened.

Table 3

2 θ	d-spacing (Å)	Intensity	Relative Intensity (%) (I/I ₀ x 100)
8.00	11.05	15	26
8.80	10.05	6	10
11.30	7.83	10	17
14.50	6.11	1	2
15.75	5.63	3	5
16.50	5.37	3	5
18.10	4.901	7	12
19.53	4.545	41	71
20.05	4.428	6 shoulder	10 shoulder
20.77	4.277	41	71
21.30	4.171	7	12
22.71	3.915	58	100
23.88	3.726	57	98
24.57	3.623	30	52
25.08	3.551	25	43
25.88	3.443	27	47
26.88	3.317	5	9
28.11	3.174	6	10

In a concern that the product might be a mix of small crystals and
 5 considerable amorphous material, a TEM (Transmission Electron Microscopy)
 analysis was carried out. The microscopy work demonstrated that the product
 of Example 1 was quite uniformly small crystals of MTT molecular sieve with
 very little evidence of amorphous material. The crystallites were characterized
 by a spread of small, broad lathe-like components having a diameter in the
 10 range of about 200 to about 400 Angstroms in the longest direction. The
 SiO₂/Al₂O₃ ratio of this product was 29.

EXAMPLE 2

The product of Example 1 was calcined to 1100°F in air with a ramp of 1 deg.
5 C/min(1.8F/min) and plateaus of 250°F for 3 hours, 1000 F for 3 hours and
then 1100°F for 3 hours. The calcined material retained its x-ray crystallinity.
The calcined zeolite was subjected to 2 ion-exchanges at 200°F (using NH_4
 NO_3) as has been previously described in US Pat. No. 5,252,527. The ion-
exchanged material was recalcined and then the microporosity measurements
10 were explored, using a test procedure also described in 5,252,527. The new
product, small crystallite MTT molecular sieve, had some unexpected
differences vs. conventional SSZ-32.

The Ar adsorption ratio for small crystallite MTT molecular sieve (Ar
15 adsorption at 87K between the relative pressures of 0.001 and 0.1)/(total Ar
adsorption up to relative pressure of 0.1) is larger than 0.5. In one
embodiment the Ar adsorption ratio is in the range of 0.55 to 0.70. In contrast
for the conventional SSZ-32, the Ar adsorption ratio is less than 0.5, typically
between 0.35 and 0.45. The small crystallite MTT molecular sieve of
20 Examples 1 and 2 demonstrated an Argon absorption ratio of 0.62.

The external surface area of the crystallites jumped from about 50 m^2/g (SSZ-
32) to 150 (small crystallite MTT molecular sieve) m^2/g , indicating the
considerable external surface as a result of very small crystals. At the same
25 time, the micropore volume for small crystallite MTT molecular sieve had
dropped to about 0.035 cc/gm, as compared with about 0.06 cc/gm for
standard SSZ-32.

EXAMPLE 3

30 Small crystallite MTT zeolite was composited with alumina, extruded, dried,
and calcined. The dried and calcined extrudate was impregnated with a

solution containing both platinum and magnesium, and then finally dried and calcined. The overall platinum loading was 0.325 wt.%. This metal-modified catalyst was then tested for isomerization on a waxy 500N hydrocrackate feed having 21% wax, a kinematic viscosity at 100°C of 10.218 mm²/s, and a pour point of +51°C. Isomerization process conditions used were a LHSV of 1.0 hr⁻¹, 4000 scf/bbl gas to oil ratio, and a total pressure of 2300 psig. Following isomerization the products were hydrofinished over a Pt/Pd silica alumina hydrofinishing catalyst at 450 °F. The VI of the waxy 500N hydrocrackate feed was 122, and the VI of the solvent dewaxed waxy 500 hydrocrackate feed was 106 when solvent dewaxed at -18°C. The difference between the waxy VI and the catalytic isomerized product VI was only two (122-120), which was exceptional.

Figures 1 and 2 show the yield and product VI versus pour point achieved with the metal-modified catalyst comprising the small crystallite MTT zeolite catalyst ("metal-modified SSZ-32X"). The data at different product pour points, and corresponding viscosity indexes, was generated by changing the operating temperature of the dewaxing catalyst (for example, a lower pour point is achieved by raising the catalyst temperature). The results are compared with two other catalysts, a standard MTT-containing catalyst ("Std SSZ-32") and a metal-modified standard MTT-containing catalyst ("metal-modified SSZ-32"), tested under the same conditions and using the same feed. The isomerization yield of product boiling at 700°F and above using the metal-modified catalyst comprising the small crystallite MTT zeolite catalyst at the typical product target range of -12 to -15°C pour point was an unprecedented 96 to 97%. The product VI was approximately 120, which is also excellent, and is believed to be attributable to the exceptional amount of isomerized wax retained in the base oil boiling range product. The slope of the VI of the product boiling at 700°F and above versus the pour point was negative, approximately -0.15, such that the VI was actually increased as the pour point was reduced. Example 3 demonstrates where two or more isomerized products boiling at 343°C (650°F) or higher have a corresponding

viscosity index of 104, 110, or higher. Figures 3 and 4 show the low yields of C₁ to C₄ products ("Gas-make") and C₅ to C_{250°F} product (Naphtha) achieved with the metal-modified catalyst comprising the small crystallite MTT zeolite catalyst ("metal-modified SSZ-32X"), compared with two other catalysts.

5

EXAMPLE 4

The same metal-modified catalyst from Example 3 was also tested for isomerization on a waxy 150N hydrocrackate feed containing 10% wax and a pour point of +32°C. Isomerization process conditions used were a LHSV of 1.0 hr⁻¹, 4000 scf/bbl gas to oil ratio, and a total pressure of 2300 psig. Following isomerization the products were hydrofinished over a Pt/Pd silica alumina hydrofinishing catalyst at 450 °F.

15 Figures 5 and 6 show the yield and product VI versus pour point achieved with the metal-modified catalyst comprising the small crystallite MTT zeolite catalyst ("metal-modified SSZ-32X"). The results are compared with three other catalysts: a standard MTT-containing catalyst ("Std SSZ32"), a metal-modified standard MTT-containing catalyst ("metal-modified SSZ-32"), and a
20 standard small crystallite MTT zeolite catalyst that was not metal-modified ("small crystal SSZ-32X"). All four catalysts were tested under the same conditions and using the same 150N feed. The isomerization yield of product boiling at 650°F and above using the metal-modified catalyst comprising the small crystallite MTT zeolite catalyst at the typical product target range of -12
25 to -15°C pour point was 94 to 95%. The product VI was approximately 108. The slope of the VI of the product boiling at 650°F and above versus the pour point was approximately 0.09, which was significantly less than that obtained with the comparison catalysts. The VI was not lowered as much as the pour point was reduced with the metal-modified catalyst comprising the small
30 crystallite MTT zeolite catalyst. Figures 7 and 8 show the low yields of C₁ to C₄ products ("Gas-make") and C₅ to C_{250°F} product (Naphtha) achieved with

the metal-modified catalyst comprising the small crystallite MTT zeolite catalyst ("metal-modified SSZ-32X"), compared with two other catalysts.

EXAMPLE 5

5

The same metal-modified catalyst from Example 3 was also tested for isomerization on a waxy medium neutral (220N, MN) feed containing 12.2% wax, a kinematic viscosity at 100°C of 6.149 mm²/s, and a pour point of +36°C. Isomerization process conditions used were a LHSV of 1.6 hr⁻¹, 4000
10 scf/bbl gas to oil ratio, and a total pressure of 2300 psig. Following isomerization the products were hydrofinished over a Pt/Pd silica alumina hydrofinishing catalyst at 450 °F.

Figures 9 and 10 show the yield and product VI versus pour point achieved
15 with the metal-modified catalyst comprising the small crystallite MTT zeolite catalyst ("metal-modified SSZ-32X"). The results are compared with two other catalysts: a standard MTT-containing catalyst ("standard SSZ-32"), and a metal-modified standard MTT-containing catalyst ("metal-modified SSZ-32"). All three catalysts were tested under the same conditions and using the same
20 220N feed. The isomerization yield of product boiling at 650°F and above using the metal-modified catalyst comprising the small crystallite MTT zeolite catalyst at the typical product target range of -15°C pour point was about 92%. The product VI was 105. The slope of the VI of the product boiling at 650°F and above versus the pour point over a range of pour points from -12°C
25 to -22°C was essentially zero, which again was significantly less than that obtained with the comparison catalysts. The VI was not lowered as the pour point was reduced with the metal-modified catalyst comprising the small crystallite MTT zeolite catalyst.

30 EXAMPLE 6

The same metal-modified catalyst from Example 3 was tested for isomerization on a hydrotreated Fischer-Tropsch wax feed having more than 90% wax made by the SASOL® Slurry Phase Fischer-Tropsch process. Isomerization process conditions used were a LHSV of 1.0 hr^{-1} , 5000 scf/bbl gas to oil ratio, and a total pressure of 300 psig. Following isomerization the products were hydrofinished over a Pt/Pd silica alumina hydrofinishing catalyst at 450 °F. The resultant products boiling at 650°F and above had VIs of 165 to 170 at pour points between -25 and -30°C. The yield of products boiling at 650°F and above were greater than 65 wt.% at a pour point of -20°C. The products boiling at 650°F and above were further split by vacuum distillation into two fractions, one boiling between 750 to 850°F and the other boiling at 850°F and higher. The lighter boiling fraction had a kinematic viscosity at 100°C of $3.8 \text{ mm}^2/\text{s}$, a VI of 151, and a pour point of -18 °C. The heavier boiling fraction had a kinematic viscosity at 100°C of $9.7 \text{ mm}^2/\text{s}$, a VI of 168, and a pour point of -11°C. A comparison run using a metal-modified standard MTT-containing catalyst under the same process conditions and on the same feed gave lower yields but slightly higher VIs. Interestingly, even though the VIs were slightly lower using the metal-modified small crystallite MTT zeolite catalyst the slope of the VI of the product boiling at 650°F and above versus the pour point over a range of pour points from -20°C to -50°C was significantly less, less than 0.56, than the slope obtained with the comparison catalyst, greater than 0.72.

WHAT IS CLAIMED IS:

1. A process for dewaxing a hydrocarbon feed to produce an isomerized product, the feed including straight chain and slightly branched
5 paraffins having 10 or more carbon atoms, comprising contacting the feed under isomerization conditions in the presence of hydrogen with a catalyst comprising a molecular sieve having MTT framework topology and having a crystallite diameter of about 200 to about 400 Angstroms in the longest direction, the catalyst containing at least one metal
10 selected from the group consisting of Ca, Cr, Mg, La, Na, Pr, Sr, K and Nd and at least one Group VIII metal.
2. The process of claim 1 wherein the MTT molecular sieve is selected from the group consisting of SSZ-32, ZSM-23, EU-13, ISI-4, and KZ-1.
15
3. The process of claim 1, wherein said feed is selected from the group consisting of hydrotreated or hydrocracked gas oils, hydrotreated lube oil raffinates, bright stocks, lubricating oil stocks, synthetic oils, foots oils, Fischer-Tropsch synthesis oils, high pour point polyolefins, normal
20 alphaolefin waxes, slack waxes, deoiled waxes, microcrystalline waxes, and mixtures thereof.
4. The process of claim 1, wherein Group VIII metals are selected from the group consisting of platinum and palladium, and mixtures thereof.
25
5. The process of claim 1 wherein said contacting is carried out at a temperature of from 232 – 427 °C (450 - 800°F), and a pressure in the range from about 103.4 kPa gauge (15 psig) to about 20,685 kPa gauge (3000 psig).
30

6. The process of claim 5 wherein said pressure is in the range from about 689.5 kPa gauge (100 psig) to about 17237 kPa gauge (2500 psig).
- 5 7. The process of claim 5, wherein the liquid hourly space velocity during contacting is from about 0.1 to about 20.
8. The process of claim 7, wherein the liquid hourly space velocity is from 0.5 to about 5.
- 10 9. The process of claim 1 wherein the hydrocarbon feed is hydrotreated prior to isomerization at a temperature in the range from 163 to 427 °C (325 to 800° F).
- 15 10. The process of claim 1, further comprising a hydrofinishing step following isomerization.
11. The process of claim 10 wherein hydrofinishing is carried out at a temperature in the range from about 163 to about 310 °C (325 to about
20 590° F) and a pressure in the range from about 2068 kPa gauge (300 psig) to about 20,685 kPa gauge (3000 psig).
12. The process of claim 1 further comprising hydrofinishing of isomerized product.
- 25 13. A dewaxing method, comprising isomerization dewaxing a hydrocarbon feed having at least 5 wt% wax over a catalyst to produce two or more isomerized products boiling at 343°C (650°F) or higher, each isomerized product having:
30 a. a pour point between 0 and -30°C, and
b. a corresponding viscosity index of 95 or higher;

wherein a line fit to a chart of the pour points on an x-axis and the viscosity indexes on a y-axis has a slope of the line for y of zero or less.

14. The dewaxing method of claim 13, wherein the hydrocarbon feed has at
5 least 10 wt% wax.
15. The dewaxing method of claim 13, wherein the hydrocarbon feed has a kinematic viscosity at 100°C of 2.5 mm²/s or greater.
- 10 16. The dewaxing method of claim 13, wherein the catalyst comprises a molecular sieve having MTT framework topology and having a crystallite diameter of about 200 to about 400 Angstroms in the longest direction.
- 15 17. The dewaxing method of claim 16, wherein the catalyst further comprises at least one metal selected from the group consisting of Ca, Cr, Mg, La, Na, Pr, Sr, K and Nd.
18. The dewaxing method of claim 17, wherein the catalyst further
20 comprises at least one Group VIII metal.
19. The dewaxing method of claim 13, wherein the two or more isomerized products boiling at 343°C (650°F) or higher have a corresponding viscosity index of 104 or higher.
- 25 20. The dewaxing method of claim 13, wherein a yield of the two or more isomerized products boiling at 343°C (650°F) or higher is 90 wt% or greater based on the feed.
- 30 21. The dewaxing method of claim 20, wherein the yield is 94 wt% or greater.

22. The dewaxing method of claim 13, wherein the slope of the line is less than -0.05.
23. A dewaxing process, comprising isomerization dewaxing a hydrocarbon
5 feed having at least 5 wt% wax over a catalyst to produce two or more isomerized products boiling at 343°C (650°F) or higher, each isomerized product having:
- a. a pour point between 0 and -30°C, and
 - b. a corresponding viscosity index of 95 or higher;
- 10 wherein a line fit to a chart of the pour points on an x-axis and the viscosity indexes on a y-axis has a slope of the line for y of zero or less; and wherein the yield of the two or more isomerized products boiling at 343°C (650°F) or higher is 90 wt% or greater based on the feed.
- 15 24. The dewaxing process of claim 23, wherein the molecular sieve has MTT framework topology.
25. The dewaxing process of claim 23, wherein the molecular sieve has a crystallite size of about 200-400 Angstroms.