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IMPROVED AROMATIC ALKYLATION PROCESS

This invention relates to a process for removing impurities from an alkylation process, and also relates to the improved alkylation process resulting therefrom.

5 In an aromatic alkylation process, alkylated aromatic compounds are prepared by alkylating an aromatic compound with an alkylating agent. The alkylation process is typically carried out in the presence of an acid which can be in the form of either a liquid or a solid. Examples of such acids include AlCl_3 , BF_3 , and zeolites. Zeolites are preferred in many instances because they eliminate problems associated with disposal and reclamation. The
10 particular alkylated aromatic product that is desired is often a monoalkylated aromatic compound such as ethylbenzene or cumene (isopropyl benzene). Polyalkylated aromatic compounds may be formed in the process of manufacturing the monoalkylated product, and must be either removed or converted. Advantageously, transalkylation is employed to convert the polyalkylated aromatic to the desired monoalkylated aromatic compound. For example, in
15 a process scheme to produce ethylbenzene, unwanted diethylbenzene produced in the alkylation step is converted to ethylbenzene in a transalkylation step. Thus, a transalkylation step is often an integrated part of a high yield alkylation process.

The polyalkylated aromatic feedstream to the transalkylation reactor may contain impurities such as aromatic or aliphatic olefins, aromatic or aliphatic diolefins, styrene,
20 oxygenated organic compounds, sulfur containing compounds, nitrogen containing compounds such as collidine, oligomeric compounds such as polystyrene, and combinations thereof. Whereas vapor phase transalkylation processes are typically resistant to the presence of such impurities, liquid phase transalkylation processes are very susceptible to catalyst contamination, deactivation, plugging and the like by virtue of contact with any or all of these
25 transalkylation feed contaminants. Many other factors favor liquid phase transalkylation units in an overall alkylation process scheme, and therefore a method and apparatus to effectively remove such contamination would be desirable.

Many methods and materials have been proposed for the removal of contaminants from hydrocarbon streams. U.S. Patent No. 2,778,863 describes a multi-step clay treatment
30 process for aromatics containing streams to overcome the clay fouling problems caused by diolefins in other clay treatment processes. Clays such as bentonite or synthetic alumina

and/or silica-containing material are disclosed in U.S. Patent No. 3,835,037 for use in a low temperature process for oligomerization/polymerization of color forming olefinic impurities in an aromatics stream such as a naphtha fraction. A process utilizing a silica alumina cracking catalyst in slurry form to contact and polymerize olefins and diolefins in a steam cracked naphtha stream is proposed in U.S. Patent No. 3,400,169. The proponents of the process disclosed in U.S. Patent No. 4,795,550 surveyed the aforementioned hydrocarbon purification processes and proposed the use a liquid phase process with a solid medium comprising a crystalline aluminosilicate zeolite such as faujasite and a refractory oxide to remove bromine-reactive olefinic impurities from aromatics containing streams. WO99/38936 discloses a process wherein an aromatics stream is pre-treated to remove di-olefins prior to contact with an acid active catalyst material which removes mono-olefinic bromine reactive hydrocarbon contaminants.

Hydrocarbon separation processes utilizing the selective sorption properties of certain zeolite materials, including specially treated zeolite materials, have been proposed in U.S. Patent Nos. 3,888,939 and 4,309,281. The removal of nitrogen containing compounds from a hydrocarbon stream by using a selective adsorbent, such as ZSM-5, having an average pore size less than 5.5 Angstroms is disclosed in U.S. Patent No. 5,744,686. U.S. Patent No. 5,330,946 discloses a bentonite clay-based catalyst, suitable for removing olefins from aromatics streams, manufactured by adhering together a plurality of smaller acid-activated bentonite clay particles using a strong mineral acid as a binder. The use of spent catalysts for purification of aromatic streams by diolefin saturation and CCR removal at temperature low enough to reduce olefin polymerization reactions is proposed in U.S. Patent No. 4,501,652.

It would be desirable to have a simple, single step process suitable for removing and/or converting most or all of the various different types of organic and inorganic contaminants which may be present in an alkylation/transalkylation process unit such that the valuable liquid phase transalkylation catalyst material will not be deactivated and/or plugged by these contaminants, thus reducing downtime and capital costs, while improving yields and material costs.

According to the invention, there is provided an alkylation process comprising the steps of:

- (a) contacting at least one alkylatable aromatic compound with at least one alkylating agent in the presence of a catalyst to provide an alkylation product comprising at least one monoalkylated aromatic compound and at least one polyalkylated aromatic compound;
- 5 (b) contacting at least a portion of the alkylation product with a purification medium in a liquid phase pre-reaction step to remove impurities and form a purified stream comprising at least one polyalkylated aromatic compound; and
- (c) contacting the purified stream with at least one alkylatable aromatic compound under liquid phase conditions in a transalkylation section in the presence of a catalyst to
- 10 convert at least a portion of said at least one polyalkylated aromatic compound into a monoalkylated aromatic compound.

The purification medium is preferably a molecular sieve catalyst selected from the group consisting of MCM-22, MCM-36, MCM-49, MCM-56, MCM-58, zeolite beta, faujasite, mordenite, and combinations thereof, although MCM-22, MCM-36, MCM-49, and

15 MCM-56 are preferred. The purification medium may purify the alkylation stream, prior to transalkylation, by a combination of sorption and catalytic conversion.

The accompanying drawing is a simplified flow diagram of a process for producing ethylbenzene in accordance with an embodiment of the invention.

In the improved alkylation process of the invention, at least one alkylatable aromatic

20 compound is contacted with at least one alkylating agent under sufficient reaction conditions and in the presence of a catalyst to provide an alkylated product comprising at least one monoalkylated aromatic compound and at least one polyalkylated aromatic compound. Then at least a portion of the product is contacted with a purification medium in a liquid phase pre-reaction step to remove impurities and form a purified stream comprising at least one

25 polyalkylated aromatic compound. The purified stream and at least one alkylatable aromatic compound are then contacted under liquid phase conditions in a transalkylation section in the presence of a catalyst to convert at least a portion of said at least one polyalkylated aromatic compound into a monoalkylated aromatic compound.

The term "aromatic" in reference to the alkylatable compounds which are useful herein

30 is to be understood in accordance with its art-recognized scope which includes alkyl substituted and unsubstituted mono- and polynuclear compounds. Compounds of an aromatic

character which possess a heteroatom (e.g., N or S) are also useful provided they do not act as catalyst poisons under the reaction conditions selected.

Substituted aromatic compounds which can be alkylated herein must possess at least one hydrogen atom directly bonded to the aromatic nucleus. The aromatic rings can be substituted with one or more alkyl, aryl, alkaryl, alkoxy, aryloxy, cycloalkyl, halide, and/or other groups which do not interfere with the alkylation reaction.

Suitable aromatic hydrocarbons include benzene, naphthalene, anthracene, naphthacene, perylene, coronene, and phenanthrene.

Generally the alkyl groups which can be present as substituents on the aromatic compound contain from 1 to 22 carbon atoms and usually from 1 to 8 carbon atoms, and most usually from 1 to 4 carbon atoms.

Suitable alkyl substituted aromatic compounds include toluene, xylene, isopropylbenzene, normal propylbenzene, alpha-methylnaphthalene, ethylbenzene, cumene, mesitylene, durene, p-cymene, butylbenzene, pseudocumene, o-diethylbenzene, m-diethylbenzene, p-diethylbenzene, isoamylbenzene, isohexylbenzene, pentaethylbenzene, pentamethylbenzene; 1,2,3,4-tetraethylbenzene; 1,2,3,5-tetramethylbenzene; 1,2,4-triethylbenzene; 1,2,3-trimethylbenzene, m-butyltoluene; p-butyltoluene; 3,5-diethyltoluene; o-ethyltoluene; p-ethyltoluene; m-propyltoluene; 4-ethyl-m-xylene; dimethylnaphthalenes; ethylnaphthalene; 2,3-dimethylantracene; 9-ethylantracene; 2-methylantracene; o-methylantracene; 9,10-dimethylphenanthrene; and 3-methyl-phenanthrene. Higher molecular weight alkylaromatic hydrocarbons can also be used as starting materials and include aromatic hydrocarbons such as are produced by the alkylation of aromatic hydrocarbons with olefin oligomers. Such products are frequently referred to in the art as alkylate and include hexylbenzene, nonylbenzene, dodecylbenzene, pentadecylbenzene, hexyltoluene, nonyltoluene, dodecyltoluene, pentadecyltoluene, etc. Very often alkylate is obtained as a high boiling fraction in which the alkyl group attached to the aromatic nucleus varies in size from C₆ to C₁₂.

The alkylating agents which are useful in the process of this invention generally include any organic compound having at least one available alkylating group capable of reaction with the alkylatable aromatic compound. Preferably, the alkylating group possesses from 1 to 5 carbon atoms. Examples of suitable alkylating agents are olefins such as ethylene, propylene,

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the butenes and the pentenes; alcohols (inclusive of monoalcohols, dialcohols, trialcohols, etc.) such as methanol, ethanol, the propanols, the butanols and the pentanols; aldehydes such as formaldehyde, acetaldehyde, propionaldehyde, butyraldehyde and n-valeraldehyde; and, alkyl halides such as methyl chloride, ethyl chloride, the propyl chlorides, the butyl chlorides and the pentyl chlorides.

Mixtures of light olefins are especially useful as alkylating agents in the alkylation process of this invention. Accordingly, mixtures of ethylene, propylene, butenes and/or pentenes which are major constituents of a variety of refinery streams, e.g., fuel gas, gas plant off-gas containing ethylene, propylene, etc., naphtha cracker off-gas containing light olefins, refinery FCC propane/propylene streams, etc., are useful alkylating agents herein. For example, a typical FCC light olefin stream possesses the following composition:

	<u>Wt.%</u>	<u>Mole.%</u>
Ethane	3.3	5.1
Ethylene	0.7	1.2
Propane	14.5	15.3
Propylene	42.5	46.8
Isobutane	12.9	10.3
n-Butane	3.3	2.6
Butenes	22.1	18.32
Pentanes	0.7	0.4

Preferably, the alkylatable aromatic compound is benzene, the alkylating agent is ethylene or propylene and the desired monoalkylated reaction product is ethylbenzene or cumene respectively.

The alkylation catalyst used in the process of the invention is a molecular sieve which is selective to the production of monoalkylated species, such as ethylbenzene and cumene. Suitable molecular sieves include MCM-22 (described in U.S. Patent No. 4,954,325), PSH-3 (described in U.S. Patent No. 4,439,409), SSZ-25 (described in U.S. Patent No. 4,826,667), MCM-49 (described in U.S. Patent No. 5,236,575), MCM-56 (described in U.S. Patent No. 5,362,697), and zeolite beta (described in U.S. Patent No. 3,308,069).

The alkylation step of this invention is conveniently conducted under conditions including a temperature of 0° to 500°C, and preferably 50° to 250°C, a pressure of 0.2 to 250 atmospheres, and preferably 5 to 100 atmospheres, a molar ratio of alkylatable aromatic

compound to alkylating agent of 0.1:1 to 50:1, and preferably 0.5:1 to 10:1, and a feed weight hourly space velocity (WHSV) of 0.1 to 500 hr⁻¹, preferably 0.5 to 100 hr⁻¹.

When benzene is alkylated with ethylene to produce ethylbenzene, the alkylation reaction is preferably carried out in the liquid phase. Suitable liquid phase conditions include a temperature between 300° and 600°F (150° and 316°C), preferably between 400° and 500°F (205° and 260°C), a pressure up to 3000 psig (20875 kPa), preferably between 400 and 800 psig (2860 and 5600 kPa), a space velocity between 0.1 and 20 WHSV, preferably between 1 and 6 WHSV, based on the ethylene feed, and a ratio of the benzene to the ethylene in the alkylation reactor from 1:1 to 30:1 molar, preferably from 1:1 to 10:1 molar.

When benzene is alkylated with propylene to produce cumene, the reaction is preferably carried out under liquid phase conditions including a temperature of up to 250°C, e.g., up to 150°C, e.g., from 10° to 125°C; a pressure of 250 atmospheres or less, e.g., from 1 to 30 atmospheres; and an aromatic hydrocarbon weight hourly space velocity (WHSV) of from 5 hr⁻¹ to 250 hr⁻¹, preferably from 5 hr⁻¹ to 50 hr⁻¹.

In addition to the desired monoalkylated aromatic compound, the alkylation product stream will contain polyalkylated species which are separated and fed to the transalkylation section for reaction with additional alkylatable aromatic compound, such as benzene. However, the alkylation product stream may also contain impurities such as, for example, olefins, diolefins, styrene, oxygenated organic compounds, sulfur containing compounds, nitrogen containing compounds, oligomeric compounds, and combinations thereof. These impurities may originate from external feed streams or may be produced in either liquid or vapor phase alkylation reactors, or they may come from both of these sources.

These impurities or contaminants can deactivate or plug the transalkylation catalyst. and in the process of the present invention, these impurities are removed through adsorption and reaction in a treatment step carried out in a 'pre-reactor' which contains a purification medium. The removal of these impurities extends the cycle length of the transalkylation reactor by preventing poisoning and potential plugging of the valuable transalkylation catalyst. The operating conditions of the pre-reactor are such that the feed is in the liquid phase and at sufficient temperature to react the olefins, diolefins, and styrene and other highly reactive molecules to form heavy alkylaromatics.

In embodiments of the invention, the aromatic stream to be purified, i.e., containing some or all of the above-referenced impurities, is brought into contact with the purification medium in a suitable pre-reaction zone such as, for example, in a flow reactor containing a fixed bed comprising the purification medium composition, under effective liquid phase conditions to effect the removal of the impurities by reaction and/or adsorption. In the case of the oxygenates and sulfur compounds as well as in the case of heavier, oligomeric compounds such as polystyrene, in addition to converting some of these molecules to less reactive heavier molecules, the purification medium also acts as a sorbent bed. The conditions employed in the purification step include a temperature of 100° to 600°F (38° to 315°C), and preferably 150° to 500°F (65° to 260°C), a weight hourly space velocity (WHSV) of 0.1 to 200 hr⁻¹ and preferably 0.5 to 100 hr⁻¹ and a pressure of ambient to 400 psig (2860kPa).

The purification medium may be a molecular sieve catalyst, such as beta, MCM-22, MCM-36, MCM-49, MCM-56, MCM-58, faujasite, or mordenite. MCM-22, MCM-36, MCM-49, and MCM-56 are especially preferred.

MCM-22, MCM-36, MCM-49, and MCM-56 are especially effective in removing both olefins and styrenes from heavy reformat and UDEX extract streams by reacting them to produce heavy alkylaromatics. Liquid phase operating conditions using MCM-22, MCM-36, MCM-49, and MCM-56 which are preferred for obtaining these results are 10 to 40 WHSV, 270° to 410°F (130° to 210°C) and 100 to 300 psig (790 to 2170 kPa). MCM-22, MCM-36, MCM-49, and MCM-56 can also tenaciously adsorb nitrogen species such as collidine at the contemplated liquid phase conditions. Finally, alkylation studies have shown that olefins have little propensity to oligomerize over MCM-22, MCM-36, MCM-49, and MCM-56 under the contemplated liquid phase conditions. These three attributes of the molecular sieve purification medium of the invention: (1) high reactivity for alkylation, (2) strong retention of poisons such as basic nitrogen compounds, and (3) low reactivity for oligomerization, make MCM-22, MCM-36, MCM-49, or MCM-56 particularly preferred as a purification medium component for the improved alkylation process of the invention.

In embodiments of the invention where the purification medium is a molecular sieve catalyst, it may be desired to incorporate the purification medium with another material resistant to the temperatures and other conditions employed in the purification step. Such materials include active and inactive materials and synthetic or naturally occurring zeolites as

well as inorganic materials such as clays, silica and/or metal oxides such as alumina. The latter may be either naturally occurring or in the form of gelatinous precipitates or gels including mixtures of silica and metal oxides. Use of a material in conjunction with the new crystal, i.e., combined therewith or present during synthesis of the new crystal, which is active, tends to
5 change the conversion and/or selectivity of the catalyst in certain organic conversion processes. Inactive materials suitably serve as diluents to control the amount of conversion in a given process so that products can be obtained economically and orderly without employing other means for controlling the rate of reaction. These materials may be incorporated into naturally occurring clays, e.g., bentonite and kaolin, to improve the crush strength of the
10 catalyst under commercial operating conditions. The materials, i.e., clays, oxides, etc., function as binders for the catalyst. It is desirable to provide a catalyst having good crush strength because in commercial use it is desirable to prevent the catalyst from breaking down into powder-like materials. These clay and/or oxide binders have been employed normally only for the purpose of improving the crush strength of the catalyst, however, in the present
15 context of the invention active clay binders and the like may be used to improve the purification properties of the purification medium. Alternately, binders may be selected such that they do not participate in the removal of impurities, i.e., they are passive in the process of the invention.

Naturally occurring clays which can be composited with the new crystal include the
20 montmorillonite and kaolin family, which families include the subbentonites, 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. Such clays can be used in the raw state as originally mined or initially subjected to calcination, acid treatment or chemical modification. Binders useful for compositing with the molecular sieve catalyst also
25 include porous high surface area oxides such as silica, alumina, zirconia, titania or another include porous high surface area inorganic oxide.

In addition to the foregoing materials, the molecular sieve catalyst serving as a purification medium can be composited with a porous matrix material such as silica-alumina, silica-magnesia, silica-zirconia, silica-thoria, silica-beryllia, silica-titania as well as ternary
30 compositions such as silica-alumina-thoria, silica-alumina-zirconia silica-alumina-magnesia, and silica-magnesia-zirconia.

The relative proportions of finely divided purification medium and inorganic oxide matrix vary widely, with the purification medium content ranging from 1 to 100 percent by weight and more usually, particularly when the composite is prepared in the form of beads, in the range of from 2 to 90 wt.% of the composite.

5 Optionally, the molecular sieve purification medium may be tabletted or pelleted or otherwise produced in a shaped form so that no binder is present.

10 The molecular sieve purification medium can also contain a metal function such that unsaturated compounds are converted to saturated compounds in the presence of a hydrogen co-feed. For example, a hydrogenating component such as tungsten, vanadium, molybdenum, rhenium, nickel, cobalt, chromium, manganese, or a noble metal such as platinum or palladium may be used where a hydrogenation-dehydrogenation function is to be performed. Such component can be in the purification medium composition by way of co-crystallization, exchanged into the composition to the extent a Group IIIA element, e.g., aluminum, is in the structure, impregnated therein or intimately physically admixed therewith. Such component
15 can be impregnated in or on to it such as, for example, by, in the case of platinum, treating the silicate with a solution containing a platinum metal-containing ion. Thus, suitable platinum compounds for this purpose include chloroplatinic acid, platinous chloride and various compounds containing the platinum amine complex.

20 The improved alkylation process described herein, specifically the pre-reaction step carried out in the presence of a purification medium, can be carried out as a batch-type, semi-continuous or continuous operation utilizing a fixed or moving bed catalyst system. In embodiments of the invention, two pre-reactors may be situated in parallel, so that they can be operated in a swing mode. The location of the pre-reactor can be located directly upstream of the transalkylator or in the distillation section used to separate the monoalkylated product and
25 the unreacted alkylatable aromatic compound from the alkylation effluent. The latter arrangement is employed in the ethylbenzene process illustrated in the accompanying drawing.

30 Referring to the drawing, ethylene and recycle benzene flow through line 11 into an alkylation reactor 12 and alkylation effluent (including unreacted benzene, ethylbenzene and polyethylated benzenes) are fed from the reactor through line 13 to a benzene column 14. Unreacted benzene is removed from the alkylation effluent in column 14 and is fed, together with fresh benzene, through recycle line 15 to the feed line 11. The residue from the column

14 then passes to an ethylbenzene column 16 from which the desired ethylbenzene product is removed as overhead. The residue from the column 16 then passes to a polyethylbenzene column 17 from which the polyethylbenzenes are removed as overhead and fed to a transalkylator 18. The effluent from the transalkylator 18 is fed to line 13 for combination
5 with the alkylation effluent and passage to the benzene column 14.

According to the invention, the process shown in the drawing includes a pre-reactor 19 which is located downstream of the ethylbenzene column 16 and upstream of the polyethylbenzene column 17. The pre-reactor as shown in the drawing is designed to be bypassed when the catalyst is spent or if polymer formation causes excess pressure drop. The
10 location of the pre-reactor in the distillation section of the improved alkylation process of the invention can be changed depending on the impurity to be removed. If the major impurities to be removed are reactive olefins such as styrene, the pre-reactor can be located upstream of the ethylbenzene column 16 with hydrogen co-feed to convert the unsaturated molecules to the saturated version thereof. For example, styrene would be converted to ethylbenzene.

15 In order to preclude plugging of the catalyst bed, the pre-reactor bed optionally may be 'graded' by structuring the bed so that larger catalyst particles are placed at the entrance to the bed. In this manner, the interstitial volume between the particles is larger at the entrance, for example the top of the bed, thereby allowing a greater amount of contaminant residue to build up on the catalyst before the bed begins to constrict flow. This will have the effect of
20 extending the life of the bed.

In the process of the invention, the purified stream is contacted under liquid phase conditions in a transalkylation section in the presence of a catalyst to convert at least a portion of the at least one polyalkylated aromatic compound to a monoalkylated aromatic compound. It is generally known to improve the yield of monoalkylated product by producing additional
25 monoalkylated product by transalkylation. The polyalkylated products may be recycled to the alkylation reactor to undergo transalkylation or they may be reacted with additional aromatic feed in a separate reactor. It may be preferred to blend the bottoms from the distillation of monoalkylated product with a stoichiometric excess of the aromatic feed, and react the mixture in a separate reactor over a suitable transalkylation catalyst. The transalkylation
30 catalyst may be a catalyst comprising a zeolite such as MCM-49, MCM-22, MCM-56, PSH-3, SSZ-25, zeolite X, zeolite Y, zeolite beta, or mordenite. Such transalkylation reactions over

zeolite beta are disclosed in the U.S. Patent No. 4,891,458; and further such transalkylations using an acid dealuminized mordenite are disclosed in U.S. Patent No. 5,243,116. The effluent from the transalkylation reactor is blended with alkylation reactor effluent and the combined stream distilled. A bleed may be taken from the polyalkylated product stream to
5 remove unreactive heavies from the loop or the polyalkylated product stream may be distilled to remove heavies prior to transalkylation.

The pre-reactor of the invention is of particular value where the alkylation step is effected in the vapor phase using "dirty" feedstocks such as dilute ethylene sourced from FCC offgas. Polyethylbenzene (PEB) from such alkylation units is likely to be contaminated with
10 impurities, such as those cited above which may cause deactivation and/or plugging of the liquid phase transalkylation reactor.

The process of the invention allows a revamp of older alkylation process units with a liquid phase transalkylator at a significantly lower capital cost. Use of liquid phase transalkylator instead of a vapor phase transalkylator will also produce significantly higher
15 product purity, specifically xylene impurities in the case of ethylbenzene production. Capacity expansion is achieved by incorporation of liquid phase transalkylator at facilities that did not previously have transalkylation capability and makes it possible to debottleneck the alkylation unit. The present invention may obtain incremental improvement in the overall yield and feedstock utilization efficiency. The present invention may also be used in units where, for
20 whatever reason, the polyethylbenzene stream has a high level of olefins and styrene or other impurities that can deactivate transalkylation catalysts.

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CLAIMS:

1. An aromatic alkylation process comprising the steps of:
 - (a) contacting at least one alkylatable aromatic compound with at least one alkylating agent in the presence of a catalyst to provide an alkylation product comprising at least one monoalkylated aromatic compound and at least one polyalkylated aromatic compound;
 - (b) contacting at least a portion of the alkylation product with a purification medium in a liquid phase pre-reaction step to remove impurities and form a purified stream comprising at least one polyalkylated aromatic compound;
 - (c) contacting the purified stream with at least one alkylatable aromatic compound under liquid phase conditions in a transalkylation section in the presence of a catalyst to convert at least a portion of said at least one polyalkylated aromatic compound to a monoalkylated aromatic compound.
2. The process of claim 1 wherein the impurities are selected from the group consisting of olefins, diolefins, styrene, oxygenated organic compounds, sulfur containing compounds, nitrogen containing compounds, oligomeric compounds, and combinations thereof.
3. The process of claim 1 wherein the purification medium is a molecular sieve catalyst.
4. The process of claim 3 wherein the molecular sieve catalyst is selected from MCM-22, MCM-36, MCM-49, MCM-56 and combinations thereof.
5. The process of claim 3 wherein the molecular sieve catalyst is MCM-22.

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6. The process of claim 1 wherein the purification medium further comprises a metal function such that unsaturated compounds are converted to saturated compounds in the presence of a hydrogen co-feed.

7. The process of claim 1 wherein the conditions employed in the pre-reaction step include a temperature of 100° to 600°F (38° to 315°C), a weight hourly space velocity (WHSV) of 0.1 to 200 hr⁻¹ and a pressure of ambient to 400 psig (2860 kPa).

8. The process of claim 1 wherein the purification medium is contained in a pre-reactor located directly upstream of the transalkylation section.

9. The process of claim 1 wherein the purification medium is contained in a pre-reactor located in a distillation section of the alkylation process.

10. The process of claim 1 wherein the alkylatable aromatic compound is benzene and the alkylating agent is ethylene or propylene.

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11. An aromatic alkylation process comprising the steps of:

- (a) contacting at least one alkylatable aromatic compound with at least one alkylating agent in the presence of a catalyst to provide an alkylation product comprising at least one monoalkylated aromatic compound and at least one polyalkylated aromatic compound;
- (b) contacting at least a portion of the alkylation product with a purification medium comprising a molecular sieve catalyst selected from MCM-22, MCM-36, MCM-49, MCM-56 and combinations thereof in a liquid phase pre-reaction step to remove impurities and form a purified stream comprising at least one polyalkylated aromatic compound;
- (c) before or after step (b), separating said at least one monoalkylated aromatic compound from the alkylation product; and
- (d) after steps (b) and (c), contacting the purified stream with at least one alkylatable aromatic compound under liquid phase conditions in a transalkylation section in the presence of a catalyst to convert at least a portion of said at least one polyalkylated aromatic compound to a monoalkylated aromatic compound.

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