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(54) Title: PROCESS FOR THE PREPARATION OF AN OLEFINIC PRODUCT COMPRISING ETHYLENE AND/OR PROPYLENE

(57) Abstract: A process for the preparation of a product stream comprising ethylene and/or propylene. The process comprises the steps of: (a) introducing into a reactor a feed including an oxygenate component and/or an olefin component, and a diluent component; and (b) reacting the feed in the reactor in the presence of a molecular sieve catalyst to form the product stream comprising ethylene and/or propylene. The amount of diluent component in the feed is controlled or adjusted based on a signal that is a function of a molar ratio of hydrocarbon molecular units to diluent molecular units in the feed.



PROCESS FOR THE PREPARATION OF AN OLEFINIC PRODUCT
COMPRISING ETHYLENE AND/OR PROPYLENE

Field of the Invention

This invention relates to processes for producing ethylene and propylene. In particular, though not exclusively, the invention relates to optimising and/or maintaining selectivity in such processes, particularly where they are performed with feeds comprising varying amounts of oxygenates and/or olefins.

Background to the Invention

Conventionally, ethylene and propylene are produced via steam cracking of paraffinic feedstocks including ethane, propane, naphtha and hydrowax. An alternative route to ethylene and propylene is an oxygenate-to-olefin (OTO) process. Interest in OTO processes for producing ethylene and propylene is growing in view of the increasing availability of natural gas. Methane in the natural gas can be converted, for instance, to methanol or dimethylether (DME), both of which are suitable feedstocks for an OTO process.

In an OTO process, an oxygenate such as methanol is provided to a reaction zone comprising a suitable conversion catalyst and converted to ethylene and propylene. In addition to the desired ethylene and propylene, a substantial part of the methanol is converted to higher hydrocarbons including C4+ olefins.

In order to increase ethylene and propylene yield, WO2009/156433 proposes to further crack the C4+ olefins in a dedicated olefin cracking zone to produce further ethylene and propylene. In WO2009/156433, a process is described, wherein an oxygenate feedstock is

converted in an OTO zone (XTO zone) to an ethylene and propylene product. Higher olefins, i.e. C4+ olefins, produced in the OTO zone are directed to an olefin cracking zone. In the olefin cracking zone, part of the higher olefins is converted to additional ethylene and propylene to increase the overall selectivity of the process to ethylene and propylene.

A disadvantage of the process of WO2009/156433 is that it requires an additional olefin cracking zone, with accompanying CAPEX, while the increase in the yield of ethylene and propylene of the overall process is minimal as the C4+ olefins cracking is not particularly selective for ethylene and propylene. This disadvantage becomes even more pronounced should it be desired to additionally feed external C4+ olefins, together with the C4+ olefins obtained from the OTO zone, to the olefin cracking zone.

An alternative is for C4+ olefins produced by an OTO process to be recycled and provided together with the oxygenate to the OTO reaction zone. WO2009/039948 A2 discloses a process for producing C2-C4 olefins by using an integrated system of a methanol-to-propylene (MTP) reactor and a steam cracker, so as to increase the production of propylene. In the MTP reactor a shape-selective zeolite, in particular ZSM-5, is used. Moreover, ethane and propane are recycled to the cracker. Methane/light ends, as well as a C4/C4= stream after butadiene extraction, are at least partly recycled to the MTP reactor. A C5/C6 product stream is also recycled to the MTP reactor.

When recycling C4+ olefins to an OTO reactor, the feed entering the reactor may vary in terms of its composition. More generally, it may be desired in ethylene and propylene production processes to vary the

process feed between oxygenates, olefins and different mixtures thereof for reasons of local feedstock availability. Such variations in the feed present a challenge in terms of controlling and maintaining selectivity to ethylene and propylene. However, controlling and maintaining such selectivity may be important to ensure smooth operation of downstream sections of the process. Furthermore, it is of course generally desired to maintain selectivity at high levels.

It is an object of the invention to solve the problem of controlling or maintaining selectivity in an ethylene and propylene production process, particularly when the feed is varied.

Summary of the invention

According to a first aspect of the invention there is provided a process for the preparation of a product stream comprising ethylene and/or propylene, the process comprising the steps of:

(a) introducing into a reactor a feed including an oxygenate component and/or an olefin component, and a diluent component; and

(b) reacting the feed in the reactor in the presence of a molecular sieve catalyst to form the product stream comprising ethylene and/or propylene;

wherein the proportion of diluent component in the feed is controlled or adjusted based on a signal that is a function of a molar ratio of hydrocarbon molecular units to diluent molecular units in the feed.

Detailed Description

It has been found that the molar ratio of hydrocarbon molecular units to diluent molecular units in the feed is of significance in determining the selectivity of the process towards ethylene and

propylene. Accordingly, controlling this molar ratio is of benefit, particularly in the context of varying feeds.

Embodiments of the invention provide for a process which may advantageously accommodate varying feeds and/or enables control of selectivity through adjustment of the diluent component. This is of particular advantage where the feed comprises a recycle stream, or where the feed is desired to be varied due to local availability of feed components.

The molar ratio of hydrocarbon molecular units to diluent molecular units is defined herein as moles of hydrocarbon molecular units divided by moles of diluent molecular units in the feed. This molar ratio is hereinafter referred to as the HC/D ratio.

In the context of this invention, diluent molecular units are molecular units that may be assumed to give rise to inert or substantially inert species within the reactor in the context of the reaction. Hydrocarbon molecular units are molecular units that may be assumed to give rise to species within the reactor that take part in the reaction.

In principle, the HC/D ratio may be determined in any manner consistent with providing a ratio between diluent and hydrocarbon species that is correlated with selectivity towards ethylene and/or propylene in the reaction.

In one embodiment, the HC/D ratio is determined from empirical formulae and molar amounts of species in the feed, based on calculation of theoretical molar amounts of diluent molecular units and hydrocarbon molecular units available from the feed.

In an exemplary calculation according to the invention, the diluent molecular units are taken to be

H₂O, N₂, methane, ethane, propane, and butane (including isobutane), where present. To determine the molar amount of diluent molecular units in the feed according to this particular calculation, the molar amount of diluent molecular units contributed by each diluent species and by certain hydrocarbons is determined. Each mole of diluent species is taken to contribute one mole of diluent molecular units. Thus each mole of H₂O, N₂, methane, ethane, propane, or butane in the feed is taken to contribute one mole of diluent molecular units.

Additionally, two further types of hydrocarbon species are considered in this calculation to contribute diluent molecular units: oxygenates that include one or more H₂O units in their formula (each H₂O is taken as one diluent molecular unit) and C₅+ alkanes, which are deemed to include a single ethane diluent molecular unit. Thus, for example, one mole of methanol is taken to contribute one mole of diluent molecular units in the form of H₂O. Similarly, one mole of dimethyl ether is also taken to contribute one mole of diluent molecular units in the form of H₂O. In terms of C₅+ alkanes, each mole of hexane, for example, is taken to contribute one mole of diluent molecular units in the form of ethane. No further hydrocarbons other than oxygenates and C₅+ alkanes are considered to contribute any diluent molecular units in this calculation.

In this exemplary calculation, the molar amount of hydrocarbon molecular units is determined based on the empirical formulae and molar quantities of certain hydrocarbon-containing species in the feed. Hydrocarbon molecular units are taken to be each CH₂ in the empirical formulae of any monoolefin species, oxygenate species

following subtraction of any H₂O units and C₅+ alkane species following subtraction of ethane.

The molar amount of hydrocarbon molecular units contributed by each monoolefin species is determined by multiplying the molar amount of the species in the feed by the number of CH₂ molecular units identified in the empirical formula of the species. For example, in the case of butene (C₄H₈), four CH₂ molecular units are identified in the empirical formula and, accordingly, one mole of butene in the feed is taken to contribute four moles of hydrocarbon molecular units.

The molar amount of hydrocarbon molecular units contributed by each further hydrocarbons species is determined by multiplying the molar amount of the species in the feed by the number of CH₂ molecular units identified in the empirical formula of the species following subtraction of the diluent molecular units. For example, in methanol there remains a single CH₂ molecular unit following subtraction of H₂O, and so one mole of methanol is taken to contribute one mole of hydrocarbon molecular units. In dimethyl ether two CH₂ units remain and so one mole of dimethyl ether is taken to contribute two moles of hydrocarbon molecular units. In the example of hexane, four CH₂ units remain following subtraction of ethane and so one mole of hexane is taken to contribute four moles of hydrocarbon molecular units. No hydrocarbon species other than monoolefins, oxygenates and C₅+ alkanes are considered to contribute any hydrocarbon molecular units in this calculation.

In one embodiment, the HC/D ratio is determined based on a calculation in which:

(i) the diluent molecular units are taken to consist of H₂O, N₂, methane, ethane, propane, and butane

(including isobutane) and hydrocarbon molecular units are taken to consist of CH_2 ;

(ii) diluent molecular units are considered to be contributed in the feed by diluent species (taken to contribute one mole of diluent molecular units per mole of species), oxygenate species that include one or more H_2O units in their empirical formula (taken to contribute one mole of diluent molecular units per mole of species, per number of H_2O in the formula), and C_5+ alkane species (taken to contribute one mole of diluent molecular units per mole of species);

(iii) hydrocarbon molecular units are considered to be contributed in the feed by monoolefin species (taken to contribute one mole of hydrocarbon molecular units per mole of species, per CH_2 in the formula), oxygenate species (taken to contribute one mole of hydrocarbon molecular units per mole of species, per CH_2 in the formula after subtraction of all available H_2O) and C_5+ alkane species (taken to contribute one mole of hydrocarbon molecular units per mole of species, per CH_2 in the formula after subtraction of C_2H_6).

Of course not all possible diluent or hydrocarbon molecular units need be present in the feed.

The moles of diluent molecular units contributed by all relevant species of the feed are added up to provide the theoretical molar amount of diluent molecular units in the feed. The moles of hydrocarbon molecular units contributed by all relevant the species are added up to provide the theoretical molar amount of hydrocarbon molecular units in the feed. From these total values, the HC/D ratio is determined.

It will be appreciated that accuracy of calculation may be enhanced for feeds that comprise a

high proportion of species for which amounts of molecular units can be calculated as set out above. Conveniently, such species include monoolefins, as well as alcohols such as methanol and ethers such as dimethyl ether, which currently represent major species in feeds for most commercial oxygenate-to-olefin processes. Preferably, the feed may comprise at most 10 mol% more preferably at most 5 mol%, such as at most 1 mol% of species that are neither diluents nor monoolefins nor oxygenates nor C5+ alkanes. Ideally, the feed may be free from or substantially free from such species.

Calculation of the HC/D ratio may be simplified by approximation. In one embodiment the HC/D ratio is determined only in respect of major species of the feed, said major species consisting of the smallest possible set of the largest mole fraction species together making up at least 80 mol%, preferably at least 90 mol% of the feed.

Whilst calculation of the HC/D ratio from the feed species is preferred, it is possible, in embodiments of the invention to infer the HC/D ratio from a diluent stream produced by the reaction. For example, where H₂O is the sole diluent present or considered, a total amount of water obtained after cooling of the product stream may provide an indication of the amount of diluent available in the reactor, which in turn enables calculation of a HC/D ratio.

Advantageously, the process may comprise adjusting or controlling the proportion of diluent component to achieve a set point HC/D ratio. For example the HC/D ratio of the feed may be compared to a HC/D ratio set point to generate a variance signal. The variance signal may be used to adjust or control the

proportion of diluent component to achieve the set point in the feed. The set point HC/D ratio may be as desired. In one embodiment, the set point HC/D ratio is in the range of from 0.2 to 3, preferably in the range of from 0.3 to 2, more preferably in the range of from 0.4 to 1.5, or even in the range of from 0.6 to 1.

Given the link between the HC/D ratio and selectivity of the process to ethylene and propylene, the proportion of diluent component in the feed may be controlled or adjusted to keep the HC/D ratio of the feed substantially constant e.g. substantially at a HC/D set point. This helps to maintain the selectivity of the process towards ethylene and/or propylene at a desired level. In one particularly beneficial embodiment, a proportion of oxygenate component to olefin component in the feed is varied while keeping the HC/D ratio substantially constant. This embodiment provides for flexibility in the composition of the feed whilst helping to retain a predictable selectivity.

In one embodiment the HC/D ratio may be kept substantially constant in real time. Suitably, this may be achieved with one or more computerised process control modules.

In another embodiment, the HC/D ratio may be kept substantially constant in two or more sequentially introduced feed amounts.

According to a second aspect, the invention provides a process for the preparation of a product stream comprising ethylene and/or propylene, the process comprising the steps of:

(a) introducing sequentially into a reactor at least first and second feed amounts; and

(b) reacting the first and second feed amounts in the reactor in the presence of a molecular sieve catalyst to form the product stream comprising ethylene and/or propylene;

wherein the first feed amount has a first composition including an oxygenate component and/or an olefin component and a diluent component and the second feed amount has a second composition including an oxygenate component and/or an olefin component and a diluent component, the second composition being different from the first composition, and the HC/D ratio of the first and second feed amounts being substantially constant.

Each feed amount may correspond to an amount of feedstock introduced into the reactor during a period of time, e.g. one second, one minute, thirty minutes, one hour, one day, or one entire process cycle from start-up to shut-down.

The first and second aspects of the invention may be readily combined. Thus the proportion of the diluent component in each feed amount may be controlled or adjusted based on a signal that is a function of the HC/D ratio in the feed amount.

The HC/D ratio may be kept substantially constant, be it in real time or between a plurality of feed amounts, by keeping it within thresholds consistent with achieving a desired selectivity value or selectivity range in the process. In one embodiment, the HC/D ratio is kept substantially constant by ensuring that it remains within $\pm 15\%$, preferably within $\pm 10\%$, more preferably within $\pm 5\%$ or most preferably within $\pm 2\%$ or $\pm 1\%$ of a HC/D set point. The set point may advantageously lie within $\pm 10\%$, more advantageously $\pm 5\%$ of an optimum

value for selectivity towards ethylene and/or propylene in the process. Selectivity is defined herein as: the % ratio on weight basis between the yield(ethylene+propylene) to the sum of yield(ethylene+propylene) and yield(by-products).

In another embodiment, the HC/D ratio is kept substantially constant by ensuring that it remains within $\pm 15\%$, preferably within $\pm 10\%$, most preferably within $\pm 5\%$ or even within $\pm 2\%$ or $\pm 1\%$ of an average or mean value of the HC/D ratio. Ideally the HC/D ratio may be kept absolutely constant.

The HC/D ratio may advantageously be kept substantially constant during or across at least one variation of the composition of the feed. Such a variation may occur in real-time or from one feed unit to another, as described above. In one embodiment, the HC/D ratio is kept substantially constant during or across a plurality of such variations.

Some variations are particularly significant in the context of the invention. In one embodiment, the HC/D ratio is kept substantially constant following a variation comprising a change of at least 5% , or even at least 10% , in the molar ratio between at least two of the three largest hydrocarbon species of the feed.

In one embodiment, the HC/D ratio is kept substantially constant following a variation comprising a change of at least 5% , or even at least 10% or at least 20% in the molar ratio between total oxygenate and olefin species in the feed. Such a change may have particular benefits in commercial operation and it is a significant advantage to be able to minimise its effects on ethylene and propylene selectivity.

The HC/D ratio may be kept substantially constant for a particular time period. Whilst the benefits of the invention may be achieved within a relatively short time period, e.g. only part of an overall continuous oxygenate-to-olefin process time, keeping the HC/D ratio substantially constant for longer time periods is advantageous. Therefore, the time period may, for example, be at least two hours, at least 6 hours, at least 24 hours, at least one week, or even at least one month. In an embodiment of the invention, the HC/D ratio may be kept substantially constant from a start-up of the process to a shutdown of the process. Indeed, in one embodiment, the ratio may be kept substantially constant across multiple process cycles, i.e. following a shutdown and subsequent re-start of the process.

The HC/D ratio may be adjusted or kept substantially constant by increasing or decreasing the proportion of diluent species (i.e. the diluent component) in the feed. For example, where the feed is varied to comprise a greater proportion of a first species that does not include a diluent molecular unit (e.g. butene) at the expense of a second species that does include a diluent molecular unit (e.g. methanol), the amount of a diluent species (e.g. H₂O in the form of steam, or N₂) may be increased to keep the HC/D ratio substantially constant. If on the other hand the feed is varied to comprise a greater proportion of the second species, which includes a diluent molecular unit (e.g. methanol), at the expense of the first species, which does not include a diluent molecular unit (e.g. butene), the amount of diluent species (e.g. H₂O in the form of steam, or N₂) in the feed may be decreased to keep the HC/D ratio substantially constant. In each case the

amount of diluent component required to be added or removed to keep the HC/D ratio substantially constant can be calculated based on the net moles of hydrocarbon molecular units and diluent molecular units removed from or added to the feed by variation of the first and second species, and further taking into account the moles of diluent molecular units added per mole of diluent component.

Determination of the HC/D ratio of the feed, as well as the control of adjustments to keep it substantially constant, may be carried out by a computer or other processing module. Accordingly, the process may advantageously be performed as a computer implemented method. From a second aspect, the invention resides in a computer program product which comprises a computer readable medium and a computer readable program code, recorded on the computer readable medium, suitable for instructing a data processing system of a computer system to execute calculations for carrying out a process for the preparation of a product stream comprising ethylene and/or propylene as described anywhere herein.

Given that the HC/D ratio may be controlled or maintained by adjusting an amount of diluent in the feed, the invention also embraces, from a third aspect, the use of a diluent in a feed comprising an oxygenate component and/or olefin component, for the purpose of achieving a target ethylene and/or propylene selectivity in a process comprising reacting said feed in the presence of a molecular sieve catalyst.

Based on the appreciation that selectivity in the process is linked to the HC/D ratio, it has also been possible to identify advantageous feeds, particularly feeds including both an oxygenate and an olefin.

From a fourth aspect, the invention resides in a feed or feedstock comprising an oxygenate component, an olefin component and a diluent component, wherein a molar ratio of hydrocarbon molecular units to diluent molecular units in the feed or feedstock is in the range of from 0.2 to 3, preferably in the range of from 0.3 to 2, more preferably in the range of from 0.4 to 1.5, or even in the range of from 0.6 to 1.

From a fifth aspect, the invention resides in a process for the preparation of a product stream comprising ethylene and/or propylene, the process comprising the steps of:

(a) introducing into a reactor a feed according to the fourth aspect of the invention; and

(b) reacting the feed in the reactor in the presence of a molecular sieve catalyst to form the product stream comprising ethylene and/or propylene.

Further embodiments and optional features of the invention will now be described and it is to be understood that this description applies to all aspects of the invention where context permits.

In the present invention, a feed is reacted or converted to form ethylene and/or propylene in an oxygenate-to-olefins (OTO) process and/or in an olefin cracking process (OCP).

In particular, the invention provides a process in which a feed comprising an oxygenate component and/or an olefin component, and a diluent component is converted to a product stream comprising ethylene and/or propylene. The feed is typically a gaseous feed.

In the process, the feed is introduced into a reactor. This can be done by means of any known introduction means. In one embodiment, introduction means

are used that allow an inlet mass gas flow of the feed to be adjusted. The introduction means suitably comprises one or more devices that comprise one or more nozzles or open pipes or gas distributors.

5 The feed is reacted in the reactor in the presence of a molecular sieve catalyst to form a product stream comprising ethylene and/or propylene. The reaction ensures that the product stream is enriched in ethylene and/or propylene compared to the feed. Typically both
10 ethylene and propylene are present in the product stream, which typically forms part of a reactor output stream additionally comprising catalyst that is at least partially coked.

 The reactor may comprise an OTO reaction zone
15 wherein oxygenate species in the feed are contacted with the molecular sieve catalyst under oxygenate conversion conditions, to obtain a conversion effluent comprising lower olefins, e.g. ethylene and/or propylene. Thus, in the OTO reaction zone, at least part of any oxygenate
20 component in the feed is converted into a product containing one or more olefins, preferably including lower olefins, in particular ethylene and typically propylene.

 The reactor may also comprise an OCP reaction
25 zone wherein olefin species in the feed are contacted with the molecular sieve catalyst under olefin conversion conditions, to obtain a cracking effluent comprising lower olefins, in particular ethylene and typically propylene.

30 The OCP reaction zone may be integral with, or one and the same as, the OTO reaction zone. In other words, the OTO reaction zone may preferably also function as an OCP reaction zone and vice versa.

One or more oxygenates (oxygenate species) may be introduced into the feed by the oxygenate component.

Reference herein to an oxygenate component of the feed is to an oxygenate-comprising component. Oxygenates in the oxygenate component comprise at least one oxygen-bonded alkyl group. The alkyl group preferably is a C1-C5 alkyl group, more preferably C1-C4 alkyl group, i.e. comprises 1 to 5, respectively, 4 carbon atoms; more preferably the alkyl group comprises 1 or 2 carbon atoms and most preferably one carbon atom. Examples of oxygenates include alcohols and ethers. Examples of preferred oxygenates include alcohols, such as methanol, ethanol, propanol; and dialkyl ethers, such as dimethylether, diethylether, methylethylether. In an embodiment, the oxygenate component comprises methanol or dimethylether, or a mixture thereof.

Preferably the oxygenate component comprises at least 50 wt% of one or more oxygenates, in particular methanol and/or dimethylether, based on total hydrocarbons, more preferably at least 70 wt%. In one embodiment, the oxygenate component consists or consists essentially of one or more oxygenates, e.g. as specified above.

One or more olefins (olefin species) may be introduced into the feed by the olefin component. Reference herein to an olefin component of the feed is to an olefin-comprising component. The olefin component preferably comprises C4 and higher olefins (C4+ olefins), e.g. C4 to C8 olefins, more preferably C4 and C5 olefins. Preferably, the olefin component comprises at least 25 wt%, more preferably at least 50 wt%, of C4+, preferably of C4 olefins, most preferably butene. The olefin component may optionally also comprise propylene. In an

embodiment, the olefin component is substantially free from ethylene and propylene.

The olefin component may advantageously be a recycle stream. Preferably the olefin component comprises at least 10 wt% of one or more olefins, in particular C4+ olefins, based on total hydrocarbons, more preferably at least 50 wt%. Preferably it comprises at least a total of 70 wt% of C4 hydrocarbon species. In one embodiment, the olefin component consists or consists essentially of one or more olefins, e.g. as specified above.

The feed also comprises a diluent component which comprises one or more diluents substantially inert under the reactor conditions. Examples of suitable diluents are nitrogen and water, preferably in the form of steam, though lower alkanes such as methane, ethane, propane, butane and isobutane may also be used.

In one embodiment the diluent component consists or consists essentially of one or more diluents specified herein, e.g. steam and/or nitrogen.

The oxygenate component and/or olefin component, together with the diluent component are considered to be core components of the feed. However, in principle, these components may be accompanied in the feed by one or more further species consistent with permitting or further facilitating the reaction in the reactor. Preferably the oxygenate component and/or olefin component and the diluent component make up at least 75wt%, preferably at least 90wt% and more preferably at least 95wt% of the feed. In one embodiment, the feed consists or consists essentially of the core components.

In one embodiment, the feed comprises no more than 50% preferably no more than 20%, more preferably no more than 10% by weight of species that are neither

oxygenates nor olefins nor a diluent as defined herein.
In one embodiment, the feed is free or substantially free
from such species. The feed may thus consist or consist
essentially of oxygenate and/or olefin species and
5 diluent.

The molar ratio between individual components of
the feed may vary. As aforesaid, it is an advantage of
the invention that the composition of the feed can be
varied. The molar ratio between the oxygenate component
10 and the olefin component may in principle be varied
between 1:0 and 0:1. Preferably the molar ratio of
oxygenate species to olefin species in the feed lies in
the range of 20:1 to 1:10, more preferably in the range
of 18:1 to 1:5, still more preferably in the range of
15 15:1 to 1:3, even still more preferably in the range of
12:1 to 1:3.

The amount of diluent in the feed may be adjusted
to control the selectivity of the process towards
ethylene and/or propylene during or across variations of
20 the feed. In embodiments of the invention, the molar
ratio of oxygenate component and/or olefin component to
diluent component may be adjusted to between 10:1 and
1:10, preferably between 4:1 and 1:2, in particular when
the oxygenate component consists of methanol, the olefin
25 component is a recycled stream and the diluent is water
(steam).

A variety of OTO processes are known for
converting oxygenates such as for instance methanol or
dimethylether to an olefin-containing product, as already
30 referred to above. One such process is described in
WOA 2006/020083. Processes integrating the production of
oxygenates from synthesis gas and their conversion to

light olefins are described in US20070203380A1 and US20070155999A1.

Catalysts suitable for converting oxygenate species in the feed in accordance with the present invention include molecular sieve-catalysts. The molecular sieve catalyst suitably comprises one or more zeolite catalysts and/or one or more SAPO catalysts. Molecular sieve catalysts typically also include binder materials, matrix material and optionally fillers. Suitable matrix materials include clays, such as kaolin. Suitable binder materials include silica, alumina, silica-alumina, titania and zirconia, wherein silica is preferred due to its low acidity.

Molecular sieve catalysts preferably have a molecular framework of one, preferably two or more corner-sharing $[TO_4]$ tetrahedral units, more preferably, two or more $[SiO_4]$, $[AlO_4]$ and/or $[PO_4]$ tetrahedral units. These silicon, aluminium and/or phosphorous based molecular sieves and metal containing silicon, aluminium and/or phosphorous based molecular sieves have been described in detail in numerous publications including for example, U.S. Pat. No. 4,567,029. In a preferred embodiment, the molecular sieve catalysts have 8-, 10- or 12-ring structures and an average pore size in the range of from about 3 Å to 15 Å.

Suitable molecular sieve catalysts are silicoaluminophosphates (SAPO), such as SAPO-17, -18, 34, -35, -44, but also SAPO-5, -8, -11, -20, -31, -36, 37, -40, -41, -42, -47 and -56; aluminophosphates (AlPO) and metal substituted (silico)aluminophosphates (MeAlPO), wherein the Me in MeAlPO refers to a substituted metal atom, including metal selected from one of Group IA, IIA, IB, IIIB, IVB, VB, VIB, VIIB, VIIIB and Lanthanides of

the Periodic Table of Elements, preferably Me is selected from one of the group consisting of Co, Cr, Cu, Fe, Ga, Ge, Mg, Mn, Ni, Sn, Ti, Zn and Zr.

Preferably, the conversion of the oxygenate component may be accomplished by the use of an aluminosilicate-comprising catalyst, in particular a zeolite-comprising catalyst. In a zeolite-comprising catalyst the amount of zeolite is suitably from 20 to 50 wt%, preferably from 35 to 45 wt%, based on total catalyst composition.

Suitable catalysts include those containing a zeolite of the ZSM group, in particular of the MFI type, such as ZSM-5, the MTT type, such as ZSM-23, the TON type, such as ZSM-22, the MEL type, such as ZSM-11, the FER type. Other suitable zeolites are for example zeolites of the STF-type, such as SSZ-35, the SFF type, such as SSZ-44 and the EU-2 type, such as ZSM-48.

Aluminosilicates-comprising catalyst, and in particular zeolite-comprising catalyst are preferred when the feed comprises olefin component in addition to oxygenate component, as they are particularly suited for an integral OTO and OCP reaction zone providing increased production of ethylene and propylene. Aluminosilicate catalysts, and in particular zeolite catalysts, have the additional advantage that in addition to the conversion of oxygenates, these catalysts also induce the conversion of olefins to ethylene and/or propylene. Therefore, aluminosilicate catalysts, and in particular zeolite catalysts, are particularly suitable for use as the catalysts in the process.

Preferred catalysts comprise a more-dimensional zeolite, in particular of the MFI type, more in particular ZSM-5, or of the MEL type, such as zeolite

ZSM-11. Such zeolites are particularly suitable for converting olefins, including iso-olefins, to ethylene and/or propylene. The zeolite having more-dimensional channels has intersecting channels in at least two directions. So, for example, the channel structure is formed of substantially parallel channels in a first direction, and substantially parallel channels in a second direction, wherein channels in the first and second directions intersect. Intersections with a further channel type are also possible. Preferably, the channels in at least one of the directions are 10-membered ring channels. A preferred MFI-type zeolite has a Silica-to-Alumina ratio (SAR) of at least 60, preferably at least 80.

Particular catalysts include catalysts comprising one or more zeolite having one-dimensional 10-membered ring channels, i.e. one-dimensional 10-membered ring channels, which are not intersected by other channels.

Preferred examples are zeolites of the MTT and/or TON type.

In a preferred embodiment the catalyst comprises in addition to one or more one-dimensional zeolites having 10-membered ring channels, such as of the MTT and/or TON type, a more-dimensional zeolite, in particular of the MFI type, more in particular ZSM-5.

The catalyst may comprise phosphorus as such, i.e. in elemental form, or in a compound, i.e. phosphorous other than any phosphorus included in the framework of the molecular sieve. It is preferred that an MEL or MFI-type zeolites comprising catalyst additionally comprises phosphorus. The phosphorus may be introduced by pre-treating the MEL or MFI-type zeolites prior to formulating the catalyst and/or by post-treating the

formulated catalyst comprising the MEL or MFI-type zeolites. Preferably, the catalyst comprising MEL or MFI-type zeolites comprises phosphorus as such or in a compound in an elemental amount of from 0.05 - 10 wt% based on the weight of the formulated catalyst. A particularly preferred catalyst comprises phosphor and MEL or MFI-type zeolites having SAR of in the range of from 60 to 150, more preferably of from 80 to 100. An even more particularly preferred catalyst comprises phosphorus and ZSM-5 having SAR of in the range of from 60 to 150, more preferably of from 80 to 100. A further particularly preferred catalyst comprises phosphorus-treated MEL or MFI-type zeolites having SAR of in the range of from 60 to 150, more preferably of from 80 to 100. An even more particularly preferred catalyst comprises phosphorus-treated ZSM-5 having SAR of in the range of from 60 to 150, more preferably of from 80 to 100.

It is preferred that the molecular sieves in the hydrogen form are used in the oxygenate conversion catalyst, e.g., HZSM-22, HZSM-23, and HZSM-48, HZSM-5. Preferably at least 50% w/w, more preferably at least 90% w/w, still more preferably at least 95% w/w and most preferably 100% of the total amount of molecular sieve used is in the hydrogen form. It is well known in the art how to produce such molecular sieves in the hydrogen form.

The catalyst particles used in the process of the present invention can have any shape known to the skilled person to be suitable for this purpose, for it can be present in the form of spray dried catalyst particles, spheres, tablets, rings, extrudates, etc. Extruded catalysts can be applied in various shapes, such as,

cylinders and trilobes. Spherical particles are normally obtained by spray drying. Preferably the weight average particle size is in the range of 1-500 μm , preferably 50-100 μm .

5 The reaction conditions for oxygenate conversion in step (b) include a reaction temperature of 350 to 1000 °C, suitably from 350 to 750 °C, preferably from 450 to 750 °C, more preferably from 450 to 700°C, even more preferably 500 to 650°C; and a pressure suitably from 1
10 bara to 50 bara, preferably from 1-15 bara, more preferably from 1-4 bara, even more preferably from 1.1-3 bara, and most preferably in from 1.3-2 bara.

 Suitably, the feed is preheated to a temperature in the range of from 120 to 550°C, preferably 250 to
15 500°C prior to introducing it into the reactor in step (a).

 The reaction in step (b) may suitably be operated in a fluidized bed, e.g. a dense, turbulent or fast
20 fluidized bed or a riser reactor system, and also in a fixed bed reactor, moving bed reactor or a tubular reactor. A fluidized bed, e.g. a turbulent fluidized bed, fast fluidized bed or a riser reactor or downward reactor system are preferred.

 The superficial velocity of the gas components in a dense fluidized bed will generally be from 0 to 1 m/s;
25 the superficial velocity of the gas components in a turbulent fluidized bed will generally be from 1 to 3 m/s; the superficial velocity of the gas components in a fast fluidized bed will generally be from 3 to 5 m/s; and
30 the superficial velocity of the gas components in a riser reactor will generally be from 5 to about 25 m/s.

 It will be understood that dense, turbulent and fast fluidized beds will include a dense lower reaction

zone with densities generally above 300 kg/m^3 . Moreover, when working with a fluidized bed several possible configurations can be used: (a) co-current flow meaning that the gas (going upward) and the catalyst travels through the bed in the same direction, and (b) countercurrent, meaning that the catalyst is fed at the top of the bed and travels through the bed in opposite direction with respect to the gas, whereby the catalyst leaves the vessel at the bottom. In a conventional riser reactor system the catalyst and the vapors will travel co-currently.

More preferably, a fluidized bed, in particular a turbulent fluidized bed system is used. Suitably, in such a moving bed reactor the oxygenate feed is contacted with the molecular sieve catalyst at a weight hourly space velocity of at least 1 hr^{-1} , suitably from 1 to 1000 hr^{-1} , preferably from 1 to 500 hr^{-1} , more preferably 1 to 250 hr^{-1} , even more preferably from 1 to 100 hr^{-1} , and most preferably from 1 to 50 hr^{-1} .

The reactor in step (b) can also be a OCP reaction zone for converting olefin species in the feed to ethylene and/or propylene by contacting the feed with a molecular sieve catalyst. Preferably, the olefinic feed is contacted with the molecular sieve catalyst in step (b) at a reaction temperature of 350 to 1000°C , preferably from 375 to 750°C , more preferably 450 to 700°C , even more preferably 500 to 650°C ; and a pressure from 1 bara to 50 bara, preferably from 1-15 bara. Under these conditions, at least part of the olefins in the feed are converted to further ethylene and/or propylene.

In an OCP reaction zone suitably aluminosilicate catalysts are used. Particular preferred catalyst for the OCP reaction are catalysts comprising at least one

zeolite selected from MFI, MEL, TON and MTT type zeolites, more preferably at least one of ZSM-5, ZSM-11, ZSM-22 and ZSM-23 zeolites.

Also an OCP reaction zone may suitably be operated in a fluidized bed, e.g. a fast fluidized bed or a riser reactor or a downward reactor system, and also in a fixed bed reactor, moving bed reactor or a tubular reactor. A fluidized bed, e.g. a fast fluidized bed or a riser reactor system are preferred.

The process may comprise a step (c) in which the product stream and at least partially coked catalyst are separated to obtain olefins.

The separation in step (c) can be carried out by one or more cyclone separators. Such one or more cyclone separators may be located inside, partly inside and partly outside, or outside the reactor. Such cyclone separators are well known in the art. Cyclone separators are preferred, but other methods for separating the catalyst from the olefins can be used, e.g. methods that apply plates, caps, elbows, and the like.

Olefins may be recovered from the product stream obtained in step (c) in a recovery step (d). Suitably, the olefins as recovered in step (d) are separated into at least one olefinic product fraction containing ethylene and/or propylene and one or more further olefinic fractions containing olefins having four or more carbon atoms, which further olefinic fraction(s) may be at least partly recycled to step (a) for use as a recycle stream providing the olefin component.

Preferably, the olefins as recovered in step (d) are subjected to a quenching treatment before they are separated into at least one olefinic product fraction containing ethylene and/or propylene and one or more

further olefinic fractions. In such a quenching treatment water and C6+ hydrocarbons can be removed from the olefins. Suitably, the olefins are subjected to a heat recovery step before they are subjected to the quenching treatment.

More preferably, olefins obtained after the quenching treatment are first compressed before they are separated into at least one olefinic product fraction containing ethylene and/or propylene and one or more further olefinic fractions.

Instead of a quenching treatment of the olefins, use can alternatively be made of air coolers to bring down the temperature of the olefins.

Preferably, at least 70 wt% of the olefin component, during normal operation, is formed by the recycle stream of the one or more further olefinic fractions containing olefins having four or more carbon atoms. Preferably at least 90 wt% of the olefin component, based on the whole olefin component, is formed by such recycled olefins.

In order to maximize production of ethylene and propylene, it is desirable to optimize the recycle of C4 olefins. This can be done by recycling only a part of the one or more further olefinic fractions containing olefins having four or more carbon atoms, preferably the C4-C5 hydrocarbon fraction, more preferably the C4 hydrocarbon fraction, to the OTO or OCP reaction zone in step (a). Suitably, however, a certain part of the further fractions, such as between 1 and 15 wt%, is withdrawn as purge, since otherwise saturated hydrocarbons, in particular C4's (butane) would build up in the process, which are substantially not converted under the OTO or OCP reaction conditions.

The invention provides additional flexibility in recycling to the feed provided to the OTO reaction zone in step (a). This is because, in accordance with the invention, the HC/D ratio can be adjusted with the help of the diluent component to help preserve selectivity.

Although the one or more further olefinic fractions containing olefins having four or more carbon atoms as separated from the olefins as recovered in step (d) may be recycled as an olefin component to the OTO reaction zone in step (a), alternatively at least part of the olefins in these olefinic fractions may be converted to ethylene and/or propylene by contacting such C4+ hydrocarbon fraction in a separate unit with a zeolite-comprising catalyst. Such a separate process step directed at converting C4+ olefins to ethylene and propylene is, as will be clear from the foregoing, also referred to as an olefin cracking process (OCP) and the described preferences provided hereinabove for an OCP also apply here.

A separate unit for olefin conversion is particularly preferred when the molecular sieve catalyst in step (b) comprises a least one SAPO, AlPO, or MeAlPO type molecular sieve, preferably SAPO-34. These catalysts are less suitable for converting olefins.

The mixture comprising olefins and catalyst obtained from the process in step (b) comprises ethylene and/or propylene, which may be separated from the remainder of the components in the mixture comprising olefins and catalyst into the olefinic product stream. The olefinic product stream comprises advantageously at least 50 mol%, in particular at least 50 wt%, ethylene and propylene, based on total hydrocarbon content.

When the mixture comprising olefins and catalyst obtained in step (b) comprises ethylene, least part of the ethylene may optionally be further converted into at least one of polyethylene, ethylene oxide, mono-ethylene-glycol, ethylbenzene and styrene monomer. When the mixture comprising olefins and catalyst obtained in step (b) comprises propylene, at least part of the propylene may optionally be further converted into at least one of polypropylene and propylene oxide.

Suitably, in the present process at least part of the at least partially coked catalyst as obtained in step (c) is passed in a further step (e) to a regenerator in which the at least partially coked catalyst is contacted in a further step (f) with an oxygen-containing gas, thereby producing a gaseous mixture and at least partially regenerated catalyst. Subsequently, the at least partially regenerated catalyst and at least part of the gaseous mixture so obtained may be separated in a further step (g), and at least part of the at least partially regenerated catalyst recycled to the reactor in a further step (h).

Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of the words, for example "comprising" and "comprises", mean "including but not limited to", and do not exclude other moieties, additives, components, integers or steps. Moreover the singular encompasses the plural unless the context otherwise requires: in particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

Preferred features of each aspect of the invention may be as described in connection with any of the other aspects. Other features of the invention will become apparent from the following examples. Generally speaking the invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims and drawings). Thus features, integers, characteristics, compounds, chemical moieties or groups described in conjunction with a particular aspect, embodiment or example of the invention are to be understood to be applicable to any other aspect, embodiment or example described herein unless incompatible therewith. Moreover unless stated otherwise, any feature disclosed herein may be replaced by an alternative feature serving the same or a similar purpose.

Where upper and lower limits are quoted for a property, then a range of values defined by a combination of any of the upper limits with any of the lower limits may also be implied.

In this specification, references to properties are - unless stated otherwise - to properties measured under ambient conditions, ie at atmospheric pressure and at a temperature of from 16 to 22 or 25°C, or from 18 to 22 or 25°C, for example about 20°C.

The present invention will now be further described with reference to the following non-limiting examples.

Example catalyst preparation

In the preparation of an exemplary catalyst, ZSM-5 zeolite powder with a SAR of 80 was used. The ZSM-5 powder was first calcined at 550 °C. Then, it was added

to an aqueous solution and subsequently the slurry was milled. Next, kaolin clay and a silica sol were added and the resulting mixture was spray dried wherein the weight-based average particle size was between 70-90 μm . The spray dried catalysts were exposed to ion-exchange using an ammonium nitrate solution. Then, phosphorus was deposited on the catalyst by means of impregnation using acidic solutions containing phosphoric acid (H_3PO_4). The concentration of the solution was adjusted to impregnate 1.5 wt% of phosphorus on the catalyst. After impregnation the catalysts were dried at 140 $^{\circ}\text{C}$ and were calcined at 550 $^{\circ}\text{C}$ for 2 hours.

The phosphorus loading on the final catalysts is given based on the weight percentage of the elemental phosphorus in any phosphor species, based on the total weight of the formulated catalyst. In the Examples described below the catalyst formulation was used as prepared.

Example 1

Dimethyl ether (DME) and butene were used as feed in this example. A mole of DME is taken to comprise 2 moles of CH_2 and 1 mole H_2O , whereas a mole of butene was taken to comprise 4 moles of CH_2 .

The feed was cracked in a fluidized bed reactor (volume ~ 100 ml) placed inside a hot oven. Two sets of experiments were done - (1) using DME only at varying CH_2 dilutions and (2) using butene (C_4) only at varying CH_2 dilutions. In both sets, while varying the CH_2 content in the feed, steam was used as the diluent. The said feed was continuously dosed to the fluidized bed reactor with continuous removal of the reaction products as off gas for a reaction period of 30 minutes. Hereafter the

reaction products in the off gas were sampled for analysis by Gas Chromatography.

After the reaction period, the reactor was purged with nitrogen before being subjected to catalyst regeneration with air for 15 minutes to burn-off the coke formed during reaction. After regeneration, the reactor was purged again with nitrogen before reinjection of feed. The said reaction and regeneration sequence was repeated 10 times for each experiment before moving on to the next one. The pressure inside the reactor during the said reaction and regeneration sequence was 1.8 bara and 1.0 bara respectively.

As the reaction with DME is exothermic and the reaction with butene is endothermic, the temperature during reaction was adjusted using the oven settings such that reaction temperature was around 600°C. The oven temperature during the regeneration sequence was 630°C.

The product compositions were calculated as a carbon based weight percentage of the hydrocarbons analyzed. The experiments were carried out at WHSV (1/h) of ~10.

The %selectivity is defined as the ratio between the yield(ethylene+propylene) to the sum of yield(ethylene+propylene) and yield(by-products). Paraffins, cyclics, aromatics and lights are reported collectively as by-products. The results are given in Table 1 and the selectivity points reported were time averaged.

For each set of conditions, the molar percentage of hydrocarbons (HC) and the molar percentage of CH₂ in the stream were calculated.

For each set of conditions, the ratio of hydrocarbon molecular units to diluent molecular units (HC/D) was determined by:

(i) calculating the mol% of each feed component from the normalised flows;

(ii) assuming each mole of DME consists of 2 moles of CH_2 and 1 mole of H_2O , each mole of butene consists of 4 moles of CH_2 , each mole of steam consists of 1 mole of H_2O ;

(iii) calculating mol% CH_2 and mol% H_2O based on the mol% determined in (i) and assumption made in (ii);

(iv) calculating HC/D by dividing mol% CH_2 by mol% H_2O .

The results are shown in Table 1.

Table 1

Seq.	Flows (NmL/min)			Calculated values				
	DME	C4	Steam	Total	% HC (molar basis)	% CH ₂ (molar basis)	HC/D (molar basis)	Sel% (wt basis)
1	245	0	360	605	40	45	0.81	71.8
2	230	0	449	679	34	40	0.68	72.0
3	120	0	600	720	17	25	0.33	75.6
4	0	97	582	679	14	40	0.67	72.4

It is shown that by properly adjusting the HC/D ratio nearly the same selectivity can be accomplished with either DME or butene feed.

A process in which the amount of diluent in the feed is controlled to maintain a desired HC/D ratio, e.g. for the purpose of achieving a certain selectivity is hence envisaged.

Example 2

A feed comprising dimethyl ether, butene and nitrogen as diluent was reacted in a fluidized bed reactor in the presence of the zeolite (ZSM5) oxygenate-to-olefin catalyst.

Two sets of experiments were done - one at HC/D ratio ~0.78 (A1 and A2) and the other at HC/D ratio ~0.9 (B1 and B2). The DME/butene molar ratio was varied. All other reaction parameters were kept substantially the same. The reaction products in the off gas were sampled for analysis by Gas Chromatography to determine selectivity (Sel) and the ratio between ethylene and propylene ($C_2=/C_3=$). The molar percentage of hydrocarbons (HC) and the molar percentage of CH_2 in the stream were calculated, as was the DME to butene ratio, the HC/D ratio. The calculations were performed according to the manner described in Example 1.

The results shown in Table 2.

Table 2

Seq.	Flows (Nl/h)				Calculated values					
	DME	C4	N2	Total	DME/C ₄ = (molar basis)	% CH ₂ (molar basis)	HC/D (molar basis)	C ₂ =/C ₃ = (molar basis)	Sel% (wt basis)	
A1	467.8	70.0	1,088.0	1,625.8	6.68	43.9	0.781	0.701	75.0	
A2	222.4	172.7	1,230.8	1,625.9	1.29	43.9	0.781	0.717	76.6	
B1	402.3	136.8	1,087.9	1,627.0	2.94	47.6	0.907	0.710	75.6	
B2	350.3	136.8	1,087.8	1,574.9	2.56	46.5	0.868	0.717	76.2	

The results show that, providing the HC/D ratio is maintained, the selectivity and yield remain substantially unchanged regardless of the DME/butene feed ratio. Accordingly, the HC/D ratio is confirmed to be a useful control parameter for the process.

The results also show that the ratio of ethylene to propylene remained substantially constant.

C L A I M S

1. A process for the preparation of a product stream comprising ethylene and/or propylene, the process comprising the steps of:

(a) introducing into a reactor a feed including an oxygenate component and/or an olefin component, and a diluent component; and

(b) reacting the feed in the reactor in the presence of a molecular sieve catalyst to form the product stream comprising ethylene and/or propylene;

wherein the proportion of diluent component in the feed is controlled or adjusted based on a signal that is a function of a molar ratio of hydrocarbon molecular units to diluent molecular units in the feed.

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2. The process of claim 1, wherein said ratio is determined from empirical formulae and molar amounts of species in the feed, based on a calculation of theoretical molar amounts of diluent molecular units and hydrocarbon molecular units available from the feed.

3. The process of claim 1 or claim 2, wherein said ratio is determined based on a calculation in which:

(i) the diluent molecular units are taken to consist of H₂O, N₂, methane, ethane, propane, and butane (including isobutane) and hydrocarbon molecular units are taken to consist of CH₂;

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(ii) diluent molecular units are considered to be contributed in the feed by diluent species (taken to contribute one mole of diluent molecular units per mole of species), oxygenate species that include one or more H₂O units in their empirical formula (taken to contribute one mole of diluent molecular units per mole of species, per number of H₂O in the formula), and C₅+ alkane species

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(taken to contribute one mole of diluent molecular units per mole of species);

(iii) hydrocarbon molecular units are considered to be contributed in the feed by monoolefin species (taken to contribute one mole of hydrocarbon molecular units per mole of species, per CH_2 in the formula), oxygenate species (taken to contribute one mole of hydrocarbon molecular units per mole of species, per CH_2 in the formula after subtraction of all available H_2O) and C_5+ alkane species (taken to contribute one mole of hydrocarbon molecular units per mole of species, per CH_2 in the formula after subtraction of C_2H_6).

4. The process of any preceding claim, wherein said ratio is determined only in respect of major species of the feed, said major species consisting of the smallest possible set of the largest mole fraction species together making up at least 80 mol% of the feed.

5. The process of any preceding claim, wherein said ratio is compared to a ratio set point to generate a variance signal used to adjust or control the proportion of diluent component in the feed to achieve the ratio set point in the feed.

6. The process of any preceding claim, wherein the proportion of diluent component in the feed is controlled or adjusted to keep said ratio substantially constant in the feed.

7. The process of claim 6, wherein a proportion of oxygenate component to olefin component in the feed is varied while keeping said ratio substantially constant.

8. The process of claim 6 or claim 7, wherein said ratio is kept substantially constant in real time and/or between a plurality of feed amounts.

9. The process of any one of claims 6 to 8, wherein said ratio is kept substantially constant by ensuring that it remains within $\pm 10\%$ of a set point.

10. The process of any one of claims 6 to 9, wherein said ratio is kept substantially constant for at least 24 hours.

11. The process of any preceding claim wherein the molecular sieve catalyst comprises a zeolite.

12. The process of any preceding claim further comprising the steps of:

5 (c) separating the product stream and at least partially coked catalyst obtained in step (b);

(d) recovering olefins from the product stream obtained in step (c);

10 (e) passing the at least partially coked catalyst as obtained in step (c) to a regenerator;

(f) introducing into the regenerator an oxygen-containing gas to regenerate at least part of the at least partially coked catalyst, thereby producing a gaseous mixture and at least partially regenerated catalyst;

15 (g) separating at least partially regenerated catalyst and at least part of the gaseous mixture as obtained in step (f); and

20 (h) recycling at least part of the at least partially regenerated catalyst as obtained in step (g) to the reactor.

13. A computer program product which comprises a computer readable medium and a computer readable program code, recorded on the computer readable medium, suitable for instructing a data processing system of a computer system to execute calculations for carrying out a process for the preparation of a product stream comprising

ethylene and/or propylene according to any preceding claim.

14. Use of a diluent in a feed comprising an oxygenate component and/or olefin component, for the purpose of achieving a target ethylene and/or propylene selectivity in a process comprising reacting said feed in the presence of a molecular sieve catalyst.

15. A feed or feedstock comprising an oxygenate component, an olefin component and a diluent component, wherein a molar ratio of hydrocarbon molecular units to diluent molecular units in the feed or feedstock is in the range of from 0.2 to 3.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/078005

A. CLASSIFICATION OF SUBJECT MATTER

INV. C07C1/20 C07C11/04 C07C11/06 G05B24/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C07C G05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/063956 A1 (KALNES TOM N [US] ET AL) 23 March 2006 (2006-03-23)	14, 15
Y	paragraphs [0022], [0027] - [0030]; claims 1-31	1-13
Y	----- US 5 371 895 A (BRISTOL EDGAR H [US]) 6 December 1994 (1994-12-06) column 6, line 24 - line 31; claims 1-10 -----	1-13



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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