Title: INDUSTRIAL PROCESS FOR THE PREPARATION OF DIISOPROPYL ETHER (DIPE)

Abstract: Industrial production process of large quantities of diisopropyl ether using the propylene coming out from the crude oil refining, using catalyzed reactors at high efficiency, working at medium pressures and temperatures, thus allowing plant simplifications.
of the industrial invention bearing the title
"Industrial production process, called DIPE-R2, for diisopropyl ether compound
through catalytic reactors"

During the next decade it is forecast an increasing request of oxygenates to add to
vehicle fuels. The basic components of these reformulated oxygenates are the
ethers that are obtained starting from the gases available in large quantities from
refineries.

The industrial attention is focalized on two starting gases: the butane from which
the methyl tertiary butyl ether (MBTE) derives and the propylene from which the
diisopropyl ether (DIPE) derives.

From the point of view of final use, the two products show similar characteristics
so that they can be assumed (beside the mixing proportions) interchangeable.

The industrial production of MTBE requires instead very big reactors (up to 80
meter high), working under severe conditions of pressure and temperature
(ETHERMAX technology) with consequent high plant cost (see Fig. 4).

The production of DIPE according to the enclosed scheme (see Fig. 1), developed
in the process DIPE-R2 (see Fig. 2) according to the technology of appropriately
catalyzed reactors (see Fig. 3) allows a structural simplification as it works at not
elevated pressures and temperatures; consequently the plant cost is lower while
there is a high production efficiency and a more simple and reliable plant
management.

The raw materials, water and propylene, are introduced, with pressure between 15
and 145 bar and temperature between 75°C and 380°C, into the hydration reactor
R1 (see Fig. 3). Inside the reactor, water and propylene cross the high efficiency
catalyst obtaining diisopropyl ether, isopropyl alcohol and not reacted water.
Inside the etherification reactor R2, working at temperature between 900°C and 196°C and pressure between 4.5 and 8.6 bar, the isopropyl alcohol (IPA) is continuously converted, with high efficiency, to diisopropyl ether through the zeolite β (65%) plus alumina catalyst (see Fig. 3).

The chemical reactions inside the reactors, even they are optimized at very high efficiency, require a reagents recycling through phase separators (see Fig. 2).

Basically the process consists of hydration reactor R1 and etherification reactor R2 catalyzed with zeolites. The other equipments are used only for the full reuse of intermediate products; consequently according to the plant capacity, they might have different characteristics because they don't have an importance in the chemical dynamic of the process but only a physical expansion more or less important, therefore their description is omitted because it is not innovative.
CLAIMS

1) **CLAIM 1**: we claim a system of catalytic reactors for the industrial production of diisopropyl ether, composed by a hydration reactor and an etherification reactor.

2) **CLAIM 2**: we claim a hydration reactor **AS CLAIMED IN CLAIM 1**, made with carbon steel, at annular chamber and tangential input, modular construction, catalyzed with zeolite ZSM 5, with high efficiency.

3) **CLAIM 3**: we claim a hydration reactor **AS CLAIMED IN CLAIM 2** working at pressure between 15 and 145 bar and temperature between 75°C and 380°C.

4) **CLAIM 4**: we claim an etherification reactor at high efficiency **AS CLAIMED IN CLAIM 1** transforming the isopropyl alcohol (IPA) to diisopropyl ether through the zeolite β (65%) plus alumina catalyst.

5) **CLAIM 5**: we claim an etherification reactor **AS CLAIMED IN CLAIM 4** working at pressure between 4.5 and 86 bar and temperature between 90°C and 196°C.

6) **CLAIM 6**: we claim that the high efficiency of the etherification reactor **CLAIMED IN CLAIM 4** is kept for every and all concentrations of isopropyl alcohol (IPA) arriving from the distilling apparatus as the reactor adjusts itself duly varying all the parameters within the settled range.

7) **CLAIM 7**: we claim the configuration and the modular construction of the hydration reactor and of the etherification reactor **CLAIMED IN ALL THE PREVIOUS CLAIMS 1-2-3-4-5-6** that consequently allow a more flexible and simple plant with a remarkably lower production total cost when compared to other.
oxygenates available in the market (about one eight in a plant with 1 million barrels production capacity)
DIPE [(CH₃)₂ CH]₂O production plant block scheme

Water

hydration reactor

propylene

C₃H₆

fractioning tower

(X%) IPA
(Y%) H₂O

etherification reactor

IPA

separator

50% IPA
50% C₃-

DIPE

DIPE storage tank

basic raw materials

H₂O

C₃H₆

final product (DIPE)

[(C₃H₆)₂]₂O

Fig. 1
DIPE [(CH₃)₂ CH₂O production plant
process scheme

Fig. 2
**Fig. 3**

**HYDRATION REACTOR SCHEME**

Zeolite catalyst
ZSM-5 (alumina)

\[
\text{H}_2\text{O}\rightarrow 15\text{÷}145\text{ bar}
\]

\[
\text{C}_3\text{H}_6 \rightarrow t=75\text{÷}380^\circ\text{C}
\]

\[
\text{DIPE} + \text{IPA} + \text{H}_2\text{O}
\]

---

**IPA 100% to DIPE conversion efficiency diagram with etherification 65% zeolite b on etherification reactor**

\[
t = 90\text{÷}196^\circ\text{C} \quad p = 4.5\text{÷}8.6\text{ bar}
\]

---

**100% pure IPA**

60%

IPA 80% 
H \(_2\) \(_2\)O 20%
COSTS COMPARISON BETWEEN MTBE and DIPE

**ETHERMAX process**

**MTBE production**

**new process DIPE-R2**

![Graph showing costs comparison between MTBE and DIPE](image)

**Fig. 4**
A. CLASSIFICATION OF SUBJECT MATTER
INV. C07C41/09 C07C29/04 C07C41/06

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C07C

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 practical, search terms used)
EPO-Internal, WPI Data, BEILSTEIN Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search

20 January 2009

Date of mailing of the international search report

30/01/2009

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Kiernan, Andrea
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