# Q-Max™ Process

## Introduction

The Q-Max process represents a new generation of cumene technology based upon a highly selective, robust and stable zeolitic catalyst. The Q-Max process provides excellent cumene product quality (99.97 wt-% purity) and near-stoichiometric cumene yield (>99.7 wt-%). The QZ-2000 zeolitic catalyst used in the Q-Max process operates with low benzene circulation, resulting in low investment and utility costs for both new unit construction and revamp of existing units. QZ-2000 catalyst is non-corrosive and regenerable, avoiding the significant maintenance and catalyst disposal problems associated with SPA and $AlCl_3$ systems. UOP recently introduced QZ-2001, an enhanced stability version of its proven QZ-2000 catalyst. The new formulation exhibits twice the stability when compared to QZ-2000 in alkylation service. The lower deactivation rate allows for greater unit operation flexibility.

Compared to other zeolitic cumene technologies, the Q-Max process provides better tolerance of feedstock impurities, the highest cumene product quality in sustained commercial production, and excellent stability as demonstrated in the longest commercial catalyst run to date.

For revamps of existing SPA units, the Q-Max process offers:

- 50-100% capacity expansion for increased revenue
- 4-5 wt-% higher yield for lower cost of production
- Improved product quality for differentiable product
- Lower utility cost per unit of cumene product
- Regenerable catalyst for less solid waste and lower disposal cost
- Longer catalyst cycles for fewer turnarounds
- Non-corrosive system for lower maintenance costs

Three-fourths of all cumene units are integrated with a downstream phenol unit. Combining the Q-Max process with the Allied/UOP Phenol process results in higher phenol yields, improved product quality, and lower overall utility consumption.

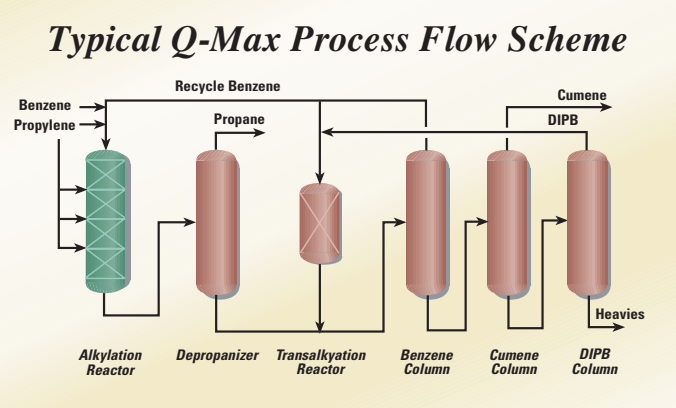
*First Q-Max Unit: JLM Chemicals, Blue Island, IL, USA*

## Description

A new Q-Max unit consists of an alkylation reactor, a distillation section, and a transalkylation reactor. Both reactors are fixed-bed. Propylene feed and a mixture of fresh and recycle benzene are charged to the alkylation reactor, where the propylene reacts to completion to form mainly cumene. Effluent from the alkylation reactor is sent to the depropanizer column, which removes the propane that entered the unit with the propylene feed, along with any excess water which may have accompanied the feeds. The depropanizer column bottoms is sent to the benzene column where benzene is collected overhead and recycled. Benzene column bottoms is sent to the cumene column where cumene product is recovered overhead. The bottoms from the cumene column, containing mostly diisopropylbenzene, is sent to the DIPB column where DIPB is recovered and recycled to the transalkylation reactor. The bottoms from the DIPB column consists of a small stream of heavy aromatic by-products which are normally blended into

fuel oil. Steam or hot oil provides the heat for the product fractionation section.

A portion of the recycle benzene from the top of the benzene column is combined with the recycle DIPB from the overhead of the DIPB column and sent to the transalkylation reactor. In the transalkylation reactor, DIPB and benzene are converted to additional cumene. The effluent from the transalkylation reactor is then sent to the benzene column.




The catalyst in both the alkylation and transalkylation reactors is regenerable. Typical design cycle length between regenerations is two years, but the unit can be designed for somewhat longer cycles if desired. Ultimate catalyst life is at least three cycles. Mild operating conditions and a corrosion-free process environment permit the use of carbon-steel construction and conventional process equipment.

## Feedstocks and Products

The Q-Max process accepts a wide range of propylene feed qualities, from FCC (65-80 mol-%) to chemical and polymer-grades (92-99.5 mol-%). Benzene is typically ASTM Refined 535 or 545 grade. The Q-Max process tolerates the sulfur, water, dioxane and arsine normally found in feeds that are otherwise suitable; the high levels of basic nitrogen and arsine found in some propylene feeds can be accommodated by proven process design options. Product quality depends on the level of impurity precursors in the feeds.

## Q-Max Process Product Quality

Typical commercial data with high-purity propylene and benzene feeds:

| | |
|---|---|
| Cumene Purity | 99.97 wt-% |
| Bromine Index | <5 |
| Sulfur | <0.05 wt-ppm |
| *Hydrocarbon Impurities* | |
| Total Non-aromatics | ~10 wt-ppm |
| Ethylbenzene | ≤15 |
| *n*-Propylbenzene | <250-300 wt-ppm |
| Butylbenzenes | ≤15 wt-ppm |
| Cymenes | 0-20 wt ppm |
| (Depends on toluene in benzene) | |
| Diisopropylbenzene | 0-5 wt-ppm |

## Commercial Experience

The first Q-Max process unit came on stream at JLM Chemicals in August 1996. The JLM project was a revamp of an existing UOP Catalytic Condensation (SPA catalyst) unit. Revamp objectives were: increased capacity, improved cumene yield, improved alpha-methylstyrene quality from the phenol unit, lower catalyst cost, longer catalyst cycle length, and less equipment corrosion. The Q-Max unit at JLM met all performance guarantees and continues to satisfy JLM's objectives. The unit continues to operate with the original catalyst loadings, adding to what is already the longest commercial zeolitic cumene catalyst run.

Since the introduction of the UOP Q-Max process in 1996, UOP has been awarded 9 projects with cumene capacities ranging from 37,000 to 700,000 MTA. Seven commercial plants are in operation worldwide having a total cumene capacity of more than 1,600,000 MTA. Two other units with a total design capacity of more than 650,000 MTA are in construction and design.

## For More Information

Q-Max technological services are available on request.For more information, contact your local UOP representative or contact our Des Plaines sales office:

e-mail: info@uop.com
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# QZ-2000™ Catalyst

## Catalyst Petrochemicals



### Description

QZ-2000 catalyst is a solid, regenerable, zeolite catalyst used to produce cumene (isopropyl-benzene) via alkylation of benzene with propylene. QZ-2000 catalyst is based on a proprietary beta zeolite formulation developed by UOP.

### Applications

QZ-2000 catalyst is used in the Q-Max™ process to convert benzene and propylene into high quality cumene product. In the Q-Max process, benzene is first reacted with propylene in the alkylation reactor to produce cumene. The addition of the first isopropyl group to the benzene ring weakly activates the ring toward further alkylation, producing a small amount of di-isopropyl-benzene and heavier poly-alkylated by-products. This poly-alkylated material is separated from the cumene product, combined with additional benzene, and recycled to the transalkylation reactor to produce additional cumene. In older Q-Max units, QZ-2000 catalyst is used in both the alkylation and transalkylation reactors. In new Q-Max units, QZ-2000 catalyst will be used only in the transalkylation reactor.

### Features and benefits

- High acid site density provides exceptional tolerance to feedstock impurities and common catalyst poisons such as sulfur.
- Excellent mass transfer properties minimize formation of heavy by-products.
- High cumene product yield – 99.7 wt-% or higher.
- Superior cumene product quality – 99.97 wt-%.
- Long cycle lengths – up to five years without regeneration.
- Proven regenerability – up to five catalyst cycles.

### Experience

QZ-2000 catalyst was commercialized in 1996 and is currently operating in seven Q-Max units throughout the world. Two additional units are currently in design or under construction and scheduled to be on stream in 2004-2005.

### Physical properties

| | |
|---|---|
| Shape | Extrudate |
| Nominal diameter, mm: | 1.6 |
| ABD, kg/m$^3$ | 550 |
| Metals | no precious metals |

### Packaging

- 55 U.S. gallon (210 liter) steel drums
- Net weight per drum of 110 kilograms

### For more information

For more information, contact your local UOP representative or our Des Plaines sales office:

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# QZ-2001™ Catalyst

## Catalyst Petrochemicals



### Description

QZ-2001 catalyst is a solid, regenerable, zeolite catalyst used to produce cumene (isopropyl-benzene) via alkylation of benzene with propylene. QZ-2001 catalyst is based on a proprietary beta zeolite formulation developed by UOP.

### Applications

QZ-2001 catalyst is UOP's newest catalyst for the production of cumene. QZ-2001 catalyst replaces QZ-2000™ catalyst as the catalyst of choice for the alkylation reactor in the Q-Max™ process. In the Q-Max process, benzene is first reacted with propylene in the alkylation reactor to produce cumene. The addition of the first isopropyl group to the benzene ring weakly activates the ring toward further alkylation, producing a small amount of di-isopropyl-benzene and heavier poly-alkylated by-products. This poly-alkylated material is separated from the cumene product, combined with additional benzene, and recycled to the transalkylation reactor to produce additional cumene. QZ-2001 catalyst has twice the stability of its predecessor, and is ideally suited for alkylation service in the Q-Max process. In older Q-Max units, QZ-2000 catalyst was used in both the alkylation and transalkylation reactors. In new Q-Max units, QZ-2001 catalyst will be used in the alkylation reactor and QZ-2000 catalyst will be used only in the transalkylation reactor.

### Features and benefits

- QZ-2001 catalyst has twice the stability of QZ-2000 catalyst in cumene alkylation service.
- High acid site density provides exceptional tolerance to feedstock impurities and common catalyst poisons such as sulfur.
- Excellent mass transfer properties minimize formation of heavy by-products.
- High cumene product yield – 99.7 wt-% or higher.
- Superior cumene product quality – 99.97 wt-%.
- Long cycle lengths – up to five years between regenerations.
- Fully regenerable – up to five catalyst cycles expected.

### Experience

QZ-2001 catalyst was commercialized in 2002 and is currently operating in three Q-Max units throughout the world.

### Physical properties

| | |
|---|---|
| Shape | Sphere |
| Nominal diameter, mm | 2.2 |
| ABD, kg/m$^3$ | 645 |
| Metals | no precious metals |

### Packaging

- 55 U.S. gallon (210 liter) steel drums
- Net weight per drum of 120 kilograms

### For more information

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