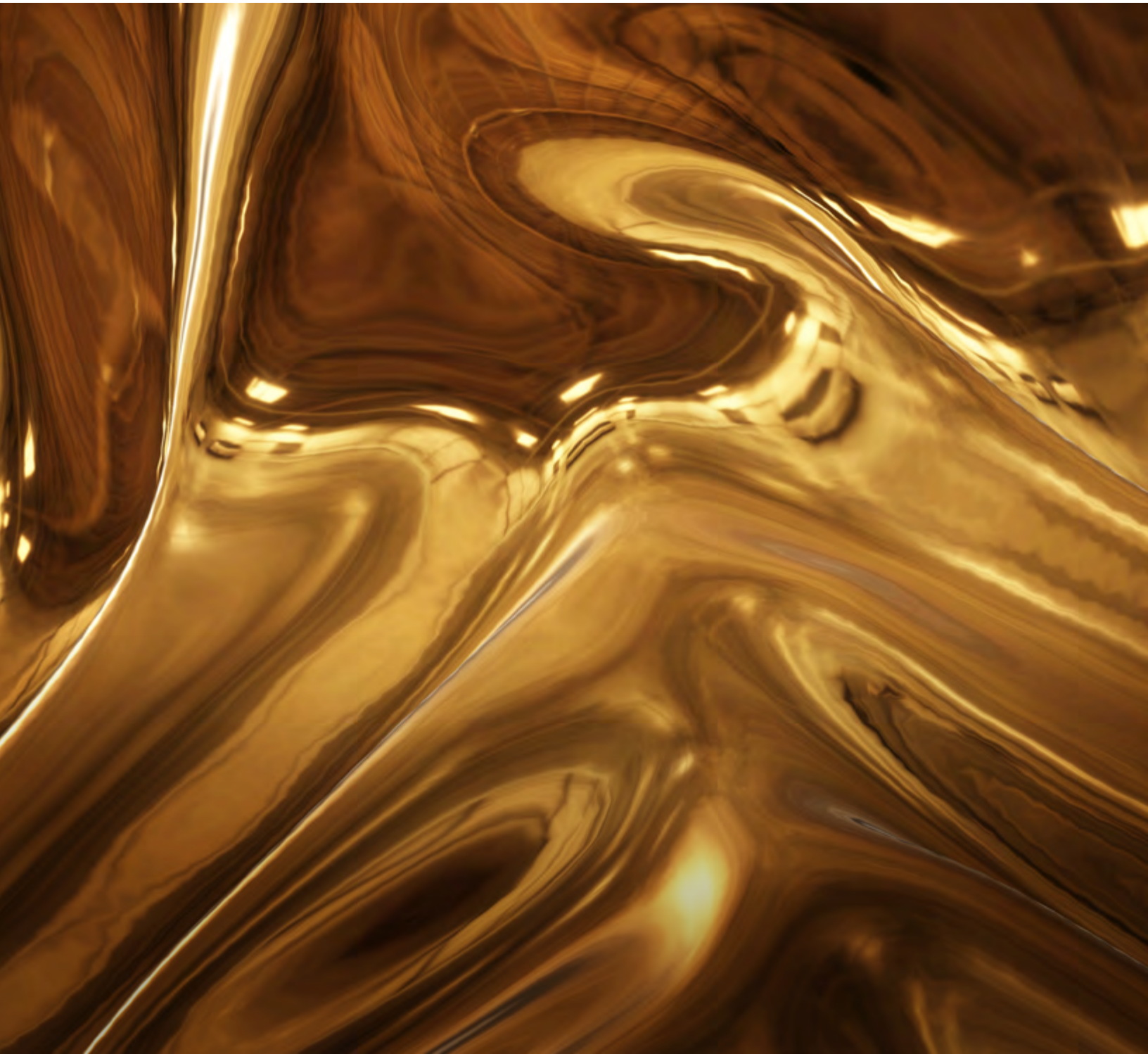


Good as Gold

DuPont™ AmberLyst™ 35 WET Polymeric Catalyst





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Raising The Gold Standard in Oxygenate Production

Oxygenates are still important chemicals in refineries. DuPont™ AmberLyst™ 35 WET polymeric catalyst from DuPont is the catalyst that produces greater returns with higher oxygenate output.

More Productive Performance

DuPont™ AmberLyst™ 35 WET is a high-performance polymeric catalyst helps deliver...

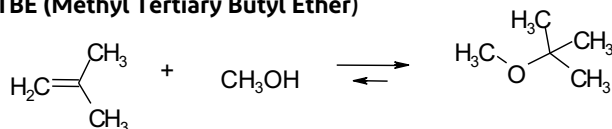
- Significantly higher ether oxygenate production than conventional catalysts
- Increased catalyst activity and reaction rate
- Increased catalyst stability and lifetime
- Higher feedstock conversion and reactor throughput for longer periods of production

More Profitable Results

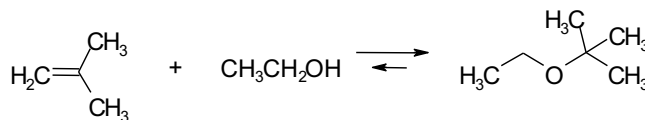
- Productive performance with DuPont™ AmberLyst™ 35 WET goes beyond higher output. It helps deliver higher returns on the bottom line by...
- Saving capital outlays for plant capacity expansions
- Increasing process and operating efficiency
- Maintaining high conversion significantly longer than conventional catalysts, resulting in fewer shutdowns to change out catalyst

Reaction Chemistry

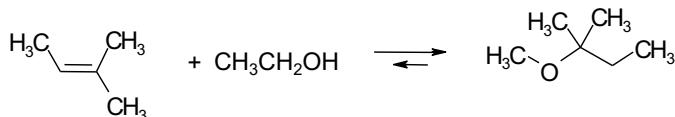
MTBE (Methyl Tertiary Butyl Ether)



ETBE (Ethyl Tertiary Butyl Ether)



TAAE (Tertiary Amyl Ether)





Next Generation Catalyst – Producing more oxygenate faster and longer

DuPont™ AmberLyst™ 15 WET was the original catalyst for ether oxygenate production, and set the performance standard that others would follow.

The next-generation chemistry of DuPont™ AmberLyst™ 35 WET raises the standard even higher. It features a significantly higher acid concentration \ than conventional catalysts – 5,3 eq/kg compared to 4,8 eq/kg. This increased amount of acid as well as enhanced gel phase properties yield measurable benefits in oxygenate production.

Equilibrium Constants and Calculated Conversions for DuPont™ AmberLyst™ 35 vs DuPont™ AmberLyst™ 15

temp(°C)	DuPont™ AmberLyst™ 35 mole fraction at equilibrium				DuPont™ AmberLyst™ 35 calculated equilibrium		DuPont™ AmberLyst™ 15 calculated equilibrium	
	MeOH	IB	MTBE	alkanes	K _x	% conversion*	K _x ^b	% conversion*
30	0.0148	0.0036	0.1982	0.7834	3693	98.2	N/A	N/A
40	0.0160	0.0049	0.1967	0.7824	2483	97.6	950	95.2
50	0.0176	0.0065	0.1948	0.7812	1711	96.8	700	94.1
70	0.0213	0.0102	0.1903	0.7782	868	94.9	300	90.1

*Equilibrium conversion calculated by solving for *f* for a given value of K_x when A ≥ B:

$$K_x = \frac{[C + Bf] / [A - Bf + B + C + N]}{[A - Bf] / [B(1-f)]}$$

where K_x is the: (composition-dependent equilibrium constant as a function of temperature and A = moles of methanol, B = moles of IB, C = moles of MTBE, and N = mole, inert. The percent conversion is then given by [C(C + B)] x 100. (b) As reported in Industrial and Engineering Chemistry Research, volume 32, Number 9: pages 1888-1894, Catalyst-induced Yield Enhancement in a Tubular Reactor.

DuPont™ AmberLyst™ 35 WET – Proven to Work Longer

Along with producing more oxygenate faster, higher acid content extends productive catalyst life with:

- Higher thermal stability
- Longer time before active acid sites are depleted
- Consistent performance differential between DuPont™ AmberLyst™ 35 WET and conventional catalysts during deactivation

Test results indicate that DuPont™ AmberLyst™ 35 WET may last as much as two times longer than conventional catalysts.

Comparisons of Maximum Conversions at 1½ Months to 11 Months

	1-1/2	Time on Stream (Months)		
		7	7	11
% IB Conversion	97.5	97.6	97.3	97.2
Flowrate, gpm	364	349	346	N/A
Methanol/IB Mole Ratio	Stoichiometric	N/A	Sub Stoichiometric	N/A

In a commercial MTBE reactor, DuPont™ AmberLyst™ 35 WET showed no measurable decline in catalytic activity after nearly 12 months on stream. IB conversion and selectivity to MTBE remained over 97% and 99% respectively, with no significant formation of C8 dimers or dimethyl ether.

Presently, 2 years after start-up, DuPont™ AmberLyst™ 35 WET is still performing better than new conventional catalyst.

DuPont™ AmberLyst™ 35 WET – Higher Production with Wide Latitude

The increased activity of DuPont™ AmberLyst™ 35 WET yields further benefits by minimizing the impact of process variations on reactor productivity. High catalyst performance and oxygenate production are maintained over a wide range of conditions.

Furthermore, DuPont™ AmberLyst™ 35 WET has been used in the production of a wide range of ether oxygenates, including:

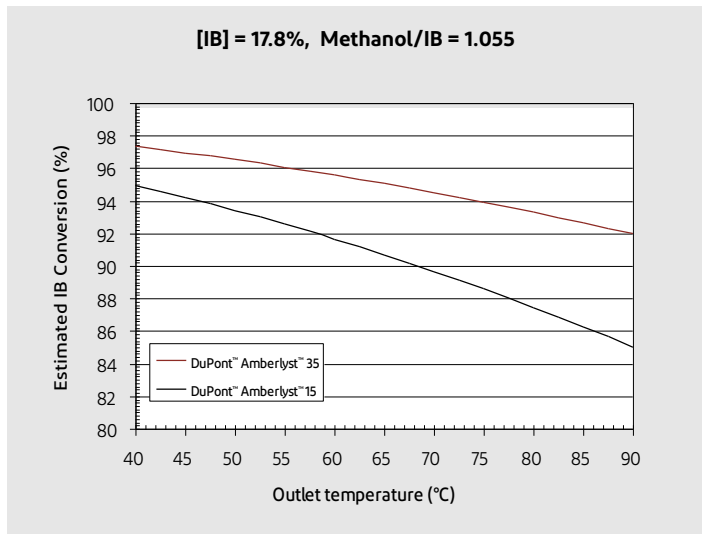
- MTBE
- TAME
- ETBE

DuPont™ AmberLyst™ 35 WET – Proven to Boost Conversion

An enhanced gel phase changes the activity coefficients of the reaction components, which increases the equilibrium conversion of feedstock to oxygenate.

In pilot tests, DuPont™ AmberLyst™ 35 WET increased conversion of isobutylene (IB) to MTBE by 5% compared with conventional catalysts. Similar results were also achieved in an MTBE industrial-scale commercial trial. Before the trial, conversion with a conventional catalyst was typically 90-92%. With DuPont™ AmberLyst™ 35 WET, conversion increased to 94-97% without additional by-product formation.

MTBE Equilibrium Conversion

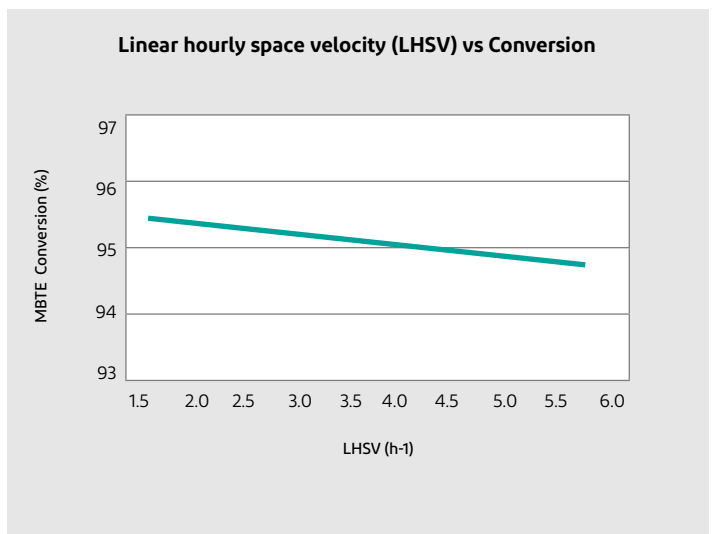


DuPont™ AmberLyst™ 35 WET – Proven to Increase Production

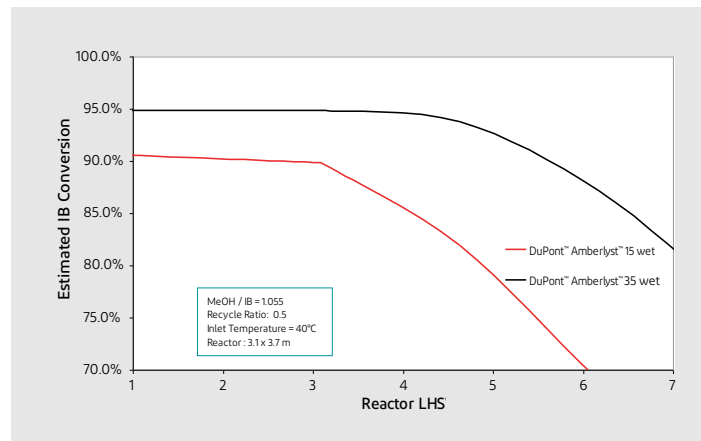
Higher acid concentration also raises production rate. With increased catalyst activity, the rate of reaction increases and permits faster reactor flow rates.

Under commercial operating conditions, DuPont™ AmberLyst™ 35 WET increased throughput in a MTBE reactor by 20-40% while maintaining high conversion. Liquid Hourly Space Velocity (LHSV) rose from 3.2 to 4.6 while IB conversion remained consistently around 95%.

Increased TAME production is also possible as the reaction rate using DuPont™ AmberLyst™ 35 WET is nearly double that of conventional catalysts.



Kinetic Effect on IB Conversion





Advanced Performance with World-Class Service

Higher-performance chemistry is only the beginning of DuPont™ AmberLyst™ 35 WET's advantages for enhanced oxygenate operations. Added reactor output is delivered with a full array of value-added benefits and services, including...

Worldwide Technical Service and Support

DuPont catalyst experts throughout the world provide all the support you need with:

- Oxygenate and catalyst technical seminars
- Catalyst analysis
- Troubleshooting and technical advice
- Catalyst loading/unloading
- Contaminant identification

Complete Understanding of Oxygenate Production

Years of experience in conjunction with our research investment at Purdue University enabled Rohm and Haas and now DuPont oxygenate specialists to prepare computer projections of production under your specific operating conditions. Through this service, we can give you an accurate picture of results and closely predict the increased oxygenate output and revenue you'll gain with DuPont™ AmberLyst™ 35 WET.

Testing of Spent Catalyst

Any time a catalyst stops working, we'll pinpoint the reason. DuPont scientists will extensively analyze the spent catalyst, determine the cause of deactivation, and give you a full report that includes a complete review of the results.

Quality Manufacturing

In our high-tech production plants, we use state-of-the-art Statistical Process Control (SPC) to ensure the highest quality oxygenate catalysts. Tight controls on key process conditions assure that the catalyst supplied delivers superior performance.

Efficient Teamwork

A dedicated DuPont™ AmberLyst™ 35 WET customer support team assures effective customer service, delivery, inventory, quality control, and production efficiency around the globe.

Total Quality Leadership

A continuous program of quality improvement at DuPont drives our efforts to exceed customers' expectations with top quality products and support.

Long-Term Commitment

Like all DuPont catalysts, DuPont™ AmberLyst™ 35 WET is backed by a long standing commitment to the industry – a commitment demonstrated by more than four decades of experience. Manufacturing in Europe and Asia is able to deliver this specialty catalyst to the world.





Bottom Line: More for Your Money

The immediate result of DuPont™ AmberLyst™ 35 WET is higher oxygenate flow. The end result is higher positive cash flow with...

More Revenue Without Additional Capital Expense

DuPont™ AmberLyst™ 35 WET can eliminate the need for upgrading equipment and facilities. Additional production volume is achieved with existing reactors, and higher income gained with little or no capital outlay.

Expanded Profitability

DuPont™ AmberLyst™ 35 WET's ultimate value is the ultimate goal of oxygenate production:

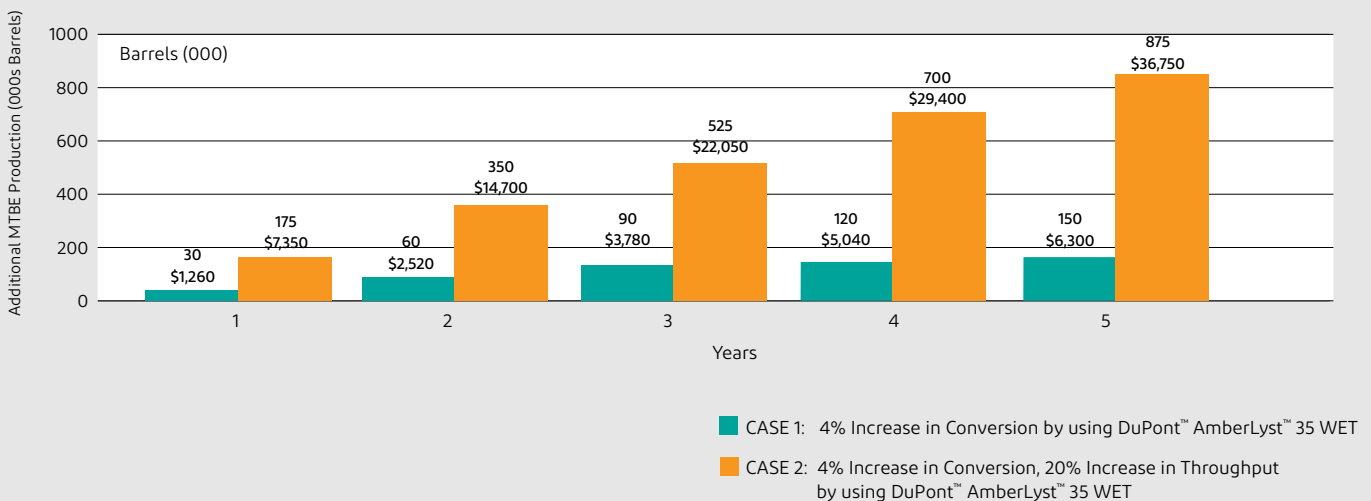
- Higher output and income with greater conversion and throughput
- Higher returns on the bottom line with more cost-effective operations.

For example, in a MTBE facility producing 2000 barrels per day with a conventional catalyst, switching to DuPont™ AmberLyst™ 35 WET can yield:

- Increase of 30,000 extra MTBE barrels per year compared to DuPont™ AmberLyst™ 15 WET (result of a 4% higher IB conversion).
- Assuming a \$1.00/gallon selling price and 42 gallons/barrel, that adds up to \$1,260,000 additional revenue per year (CASE 1)
- 175,000 more barrels of MTBE per year based on the 4% higher conversion PLUS a 20% increase in throughput, totaling \$7,350,000 more revenue

It's a proven success story that makes DuPont™ AmberLyst™ 35 WET as good as gold for pumping up oxygenate production and profits.

Productivity MTBE vs Years Comparison
Case 1: DuPont™ AmberLyst™ 15 WET over DuPont™ AmberLyst™ 15 WET and
Case 2: DuPont™ AmberLyst™ 35 WET at Higher Flow Rate Process





Water Solutions

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