

Acetic Acid by Chiyoda CT-ACETICA™ Process

PEP Review 2018-01

January 2018



Marianne Asaro
Director of Chemistry and Catalysis

Pete Pavlechko
Principal Analyst

2018-01 | **Process Economics Program**

PEP Review 2018-01

Acetic Acid by Chiyoda CT-ACETICA™ Process**Marianne Asaro**, Director of Chemistry and Catalysis**Pete Pavlechko**, Principal Analyst**Abstract**

Acetic acid is a moderate-volume commodity chemical, with global annual production of approximately 20 million metric tons that is forecasted to show a moderate increase over the next few years. Acetic acid is used in production of vinyl acetate, terephthalic acid, acetic anhydride, ethyl acetate, and butyl acetate, as well as in various small-volume applications including production of metal acetates, cellulose acetate, vinegar, and medicine.

Methanol carbonylation dominates the current era of acetic acid production, specifically the low-water carbonylation technologies using homogeneous catalysis as developed by BP and Celanese. Celanese is the main producer in the Americas, and BP in Europe. In Asia, Celanese technology is used in China and Singapore, and BP's process is used in Korea, Malaysia, and Taiwan.

Commercial carbonylation of methanol has followed a path of homogeneous catalyst development over the years, from the BASF "high-pressure" process based on an iodide-promoted cobalt catalyst, to the Monsanto "low-pressure" improvement using a homogeneous methyl iodide-promoted rhodium catalyst, to the improved "low-water" versions of Celanese and BP that decreased the cost of downstream separations. To further simplify separations and catalyst operations, Chiyoda developed a process using a heterogeneous, supported form of the catalyst. Chiyoda also demonstrated a commercial version of the supported rhodium catalyst system, named the CT-ACETICA™ process, which is the subject of this review. The CT-ACETICA™ process is now available for licensing by KBR and Chiyoda.

This review evaluates the methanol carbonylation technology patented by Chiyoda, the industry status, and the design basis and economics for the CT-ACETICA™ process at world scale. An interactive module is included, the iPEP Navigator CT-ACETICA™ tool, that provides a snapshot of economics for the process and allows the user to select the units and global region of interest.

While the process presented herein represents the IHS Markit Chemical Process Economic Program (PEP) independent interpretation of Chiyoda's literature and may not reflect in whole or in part the actual plant configuration, we do believe it to be sufficiently representative of the plant conceptual process design to enable economic evaluation.

Contents

1	Introduction	7
2	Summary	8
3	Industry status	11
	Demand and market drivers	11
	Current producers and plant capacities	12
4	Chiyoda acetic acid technology	14
	Chemistry	14
	Side reactions	16
	Development and use of the supported catalyst system	17
	Catalyst degradation	20
	Suppression of impurities	20
	Reactor and operating conditions	21
	Corrosion	23
	Separation	23
5	Process description	25
	Section 100—Methanol carbonylation	25
	Section 200—Product purification	25
6	Process discussion	34
	Catalyst	34
	Reactor system	34
	Catalyst loss	34
	Separations	35
	Materials of construction	35
	Waste treatment	36
7	Cost estimates	37
	Fixed capital costs	37
	Production costs	38
	Comparison of the CT-ACETICA™ process with other methanol carbonylation processes for acetic acid production	43
	Appendix A—Patent summaries	46
	Appendix B—Cited references	52
	Appendix C—Process flow diagram	55

Tables

Table 2.1	Summary of process economics for acetic acid by the CT-ACETICA™ process	10
Table 3.1	Current process technologies for production of acetic acid	11
Table 5.1	Acetic acid by the CT-ACETICA™ process—Design bases and assumptions	26
Table 5.2	Acetic acid by the CT-ACETICA™ process—Stream flows	27
Table 5.3	Acetic acid by the CT-ACETICA™ process—Major equipment	31
Table 5.4	Acetic acid by the CT-ACETICA™ process—Utilities summary	33
Table 6.1	Acetic acid by the CT-ACETICA™ process—Summary of major waste streams	36
Table 7.1	Acetic acid by the CT-ACETICA™ process—Total capital investment	39
Table 7.2	Acetic acid by the CT-ACETICA™ process—Capital investment by section	40
Table 7.3	Acetic acid by the CT-ACETICA™ process—Variable costs	41
Table 7.4	Acetic acid by the CT-ACETICA™ process—Production costs	42

Table 7.5 Process economics comparison of CT-ACETICA™ versus Monsanto, AO Plus, and Cativa™ processes	45
---	----

Figures

Figure 2.1 World capacity for acetic acid by region	8
Figure 2.2 Block flow diagram for the CT-ACETICA™ process	9
Figure 3.1 Supply, demand, and capacity utilization for acetic acid	12
Figure 4.1 Relative changes to productivity and kinetics with low water in the Chiyoda process	19
Figure 4.2 Slurry bubble column reactor with catalyst recycle and heat exchange	21
Figure 7.1 Sensitivity of acetic acid cost to plant capacity utilization	43
Figure 5.1 Acetic acid by the CT-ACETICA™ process	56

IHS Markit Customer Care:

CustomerCare@ihsmarkit.com

Americas: +1 800 IHS CARE (+1 800 447 2273)

Europe, Middle East, and Africa: +44 (0) 1344 328 300

Asia and the Pacific Rim: +604 291 3600

Disclaimer

The information contained in this presentation is confidential. Any unauthorized use, disclosure, reproduction, or dissemination, in full or in part, in any media or by any means, without the prior written permission of IHS Markit Ltd. or any of its affiliates ("IHS Markit") is strictly prohibited. IHS Markit owns all IHS Markit logos and trade names contained in this presentation that are subject to license. Opinions, statements, estimates, and projections in this presentation (including other media) are solely those of the individual author(s) at the time of writing and do not necessarily reflect the opinions of IHS Markit. Neither IHS Markit nor the author(s) has any obligation to update this presentation in the event that any content, opinion, statement, estimate, or projection (collectively, "information") changes or subsequently becomes inaccurate. IHS Markit makes no warranty, expressed or implied, as to the accuracy, completeness, or timeliness of any information in this presentation, and shall not in any way be liable to any recipient for any inaccuracies or omissions. Without limiting the foregoing, IHS Markit shall have no liability whatsoever to any recipient, whether in contract, in tort (including negligence), under warranty, under statute or otherwise, in respect of any loss or damage suffered by any recipient as a result of or in connection with any information provided, or any course of action determined, by it or any third party, whether or not based on any information provided. The inclusion of a link to an external website by IHS Markit should not be understood to be an endorsement of that website or the site's owners (or their products/services). IHS Markit is not responsible for either the content or output of external websites. Copyright © 2018, IHS Markit™. All rights reserved and all intellectual property rights are retained by IHS Markit.

