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

Figures

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