Prospectus

Squeezing Profitability from the PTA/PET Value Chain: Impact of the Latest Technology
Prospectus

Squeezing Profitability from the PTA/PET Value Chain: Impact of the Latest Technology Advances

June 2005
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1.1 OVERVIEW

The polyester resin industry is facing important decisions. Though blessed with high growth rates globally, escalating raw material prices and reduced margins are causing low profitability. In addition, because of relative ease of entry, new capacity continues to come on-stream, further threatening existing producers. At the same time there have been several important technology and commercial developments, some recent and some yet to emerge, including the emergence of medium quality terephthalic acid, that may change the landscape of the industry. A new report from Nexant, Inc., *Squeezing Profitability from the PTA/PET Value Chain: Impact of the Latest Technology Advances*, describes and analyzes these developments and forecasts the effects of the advances on PET resin demand, plant and producer competitiveness, intermaterial competition, and regional supply/demand and trade dynamics. Major topics evaluated include the following:

1.2 MEDIUM QUALITY TEREPHTHALIC ACID

The development of purified terephthalic acid (PTA) triggered the widespread replacement of dimethyl terephthalate (DMT) in the production of most polyester applications, especially bottle-grade resin, the fastest growing end-use. PTA, which is cheaper and easier to handle and transport, and allows for faster reaction times than DMT, became the raw material of choice in most new plants and caused a continuing revamping of existing plants.

Medium quality terephthalic acid (medium quality TPA), variously known as MTA, QTA or EPTA, is now making strong inroads in the polyester markets. Eastman has long produced bottle-resin from its own proprietary medium quality TPA process without limitations in the marketplace. Eastman is now offering the technology for license along with other producers or licensors offering their own proprietary medium quality TPA technologies, such as Mitsubishi Chemical. In addition, producers such as Sam Nam in Korea are marketing their QTA (qualified terephthalic acid) as compatible for virtually all polyester applications, including bottle, fiber and film.

The cost to produce medium quality TPA is claimed to be lower than that of PTA, with a cost effect that can result in competitively priced polyester. Also, the process is claimed to have a lower investment capital cost, which can have a large impact for polyester producers interested in licensing and back-integrating into terephthalic acid. An estimate of medium quality TPA cost of production compared to conventional PTA technology is shown in Figure 1.1.
This comparison does not include one PTA licensor that claims its capital cost and production costs are not only lower than conventional PTA processes, but also lower than claimed medium quality TPA.

This study examines the following terephthalic acid related issues:

- The features and estimated costs of production of conventional PTA versus lower cost alternate terephthalic acid technologies
- Uses and limitations of the medium quality material
- Product quality issues and remediation, e.g., color masking, etc.
- Trends in conventional PTA technology, e.g., single-line capacity, materials of construction, raw material yields
- “Step-out” developments in conventional or nonconventional high purity PTA technology that might result in competitive cost reduction, including alternate technology and mega-scale plants
- The effect of major construction in Asia, principally China, on regional and global economic competitiveness
There are currently 10 million tons of additional PTA capacity (grass-roots and expansions) announced or under study for China. While all of this capacity will not be added, there will certainly be sufficient capacity brought on-stream to have a great affect on regional PTA and PET economics and trade patterns. There are firm commitments for 2.8 million tons of additional PTA capacity in China by 2007, a 70 percent increase, as shown in Figure 1.2, which follows an already significant increase in the 2000 – 2003 period. This figure will likely be even larger, as major announcements of capacity addition in China have been made.

These plants will be among the largest in the world with distinct cost advantage compared to Asian exporters now serving China, such as Korea, Indonesia, Taiwan and Japan, as shown in Figure 1.3. Chinese-produced PTA, which serves the domestic demand, will cause a shift in regional trade patterns and have global implications as well.
Nexant has reviewed these important issues with technology providers, product suppliers and end-users in order to get a complete picture of the pros and cons of the medium quality TPA, its applicability, the effect of its cost benefits, its future growth in polyester production, and the implications to conventional PTA technology and suppliers.

### 1.3 DEVELOPING PTA MARKETS

A terephthalic acid derivative product is emerging that may cause a major change in the terephthalic acid market and price dynamics. With the emergence of PTT (polytrimethylene terephthalate) and the potential threat to traditional nylon and polyester markets, there has been much speculation as to the applicability and growth of this resin into traditional markets, based on price and performance characteristics. In addition, potentially new 1,3-PDO technology developments may impact upon the eventual price of this important intermediate and the final cost of producing PTT resin.

The growth of PTT and its affect on terephthalic acid will depend on the cost/benefit opportunities of this new resin in major targeted applications. Key issues in the growth of PTT include:

- Actual versus promised/claimed performance: the actual performance characteristics of the PTT fiber in carpet and textile applications as compared to claims based on laboratory testing
- Market entry barriers: the level of resistance to acceptance of PTT as a substitute resin from the end-users and actions that will have to be taken to gain more widespread acceptance, such as favorable price setting or mill machinery retrofit or replacement.

- Processability issues – degree (if any) of equipment modification needed to use PTT by fabricators and impact on their choice of resin

- Differential cost to use (fabricate) relative to nylon, PET and PBT

- Overall quality and repeatability on a commercial scale

- Specific benefits gained in retrofitting PET capacity, such as increased market share, increased capacity utilization, etc.

- Conversion issues for retrofit PET producers, such as cost to enter, serve and maintain the business

- PDO and PTT technology barriers and limitations: How do the PTT resin technologies being developed compare? What are the technical features and shortcomings of each? Which is more likely to be competitive on a commercial scale? Can existing PET processes be retrofit to PTT production given issues of increased byproduct production?

- How will PTT growth affect the supply and price mechanism for PTA and medium quality TPA?

### 1.4 NEW PET TECHNOLOGIES

In addition to medium quality and lower cost terephthalic acid, developments in lower capital/lower operating cost PET technology will also impact competitiveness. DuPont’s INVISTA NG3™ PET technology claims both lower capital and operating costs with similar product capability. Figure 1.4 shows Nexant’s comparison of production cost for the INVISTA NG3™ technology and conventional PET technology for bottle-resin production.
Similar advances are being made elsewhere, with the implication of lower overall production costs. This is especially important in the bottle-resin business, where global demand is projected to grow by as much as 10 percent annually. The price of PET resin is not a significant factor in many of its major applications (e.g. soft drink bottles) where there is no real intermaterial competition; however, penetration into new packaging areas is more competitive and may be dependent upon resin pricing. These new container applications, also highly dependent upon PET properties and consumer acceptance, include the following:

- Beer
- Milk
- Food applications
- 12-ounce soft drink bottles (can replacement)
- Detergents
- Health and beauty aids (e.g. shampoo) containers

Nexant has examined the effects of PET production costs and price competitiveness in light of the new technology developments, how changes in resin pricing may impact demand in traditional applications as well as new applications, and the threats of intermaterial competition.
PET blends and copolymers with improved barrier and thermal properties are also forecast to have an effect on overall PET resin demand (new applications). Nexant examined the uses and potential for these resins and analyzed the cost to produce the blends and copolymers compared to conventional bottle-resin and competing materials. We have estimated the growth potential and affect on PTA consumption and examined whether medium quality TPA is suitable for the demands of these resins. This evaluation includes:

- A review of the latest developments in barrier resins
- A review and comparison of properties of PET blends and copolymers with improved barrier and thermal properties
- Costs to produce these resins
- Comparison of competing materials on a property and cost to produce basis
- Forecast demand and effect on total PET resin demand
- Effect on resin growth on PTA market forecast
- Applicability or limitations of medium quality TPA in these applications

1.5 PET CATALYST DESELECTION

Another important issue in polyester production is the threat to continued use of environmentally challenged antimony-based catalysts. These catalysts, either in triacetate or oxide form, are the established leaders in the industry, but may be outlawed or severely limited in use. Other polyester catalysts exist commercially, such as those that are titanium and germanium based. However, these have proven to be less effective in terms of product consistency and quality and/or more expensive. Anticipating the potential environmental regulations, much research has been done with alternate catalysts, with several recently commercialized that claim to have overcome the past operating problems. These catalyst developments have been reviewed, both as offered commercially and in patent development stage, as to their potential for antimony replacement. Important issues include:

- A comparison of operability issues associated with current antimony oxide and antimony triacetate catalysts and plant remediation practices and additives now in practice
- Operating problems and production limitations and liabilities associated with other current catalyst systems
- Expected product characteristics from alternate catalysts and applicability in major applications
- Cost implications of newer catalysts, both for the catalyst itself (e.g. catalyst cost, productivity, plant throughput, etc.) and product remediation (e.g. need for and use of colorants, plant downtime, etc.)
1.6 IMPROVEMENTS IN ETHYLENE GLYCOL TECHNOLOGY

Ethylene glycol (EG) is produced by the oxidation of ethylene to ethylene oxide (EO) followed by hydrolysis to ethylene glycol. Research and improvements in technology have largely been in the area of catalyst selectivity to increase the ethylene yield in the oxidation step and improved hydrolysis to decrease formation of diethylene glycol and triethylene glycol byproducts as well as decreasing the water/EO ratio used in hydrolysis, which has a large affect on capital and operating costs.

Improvement in EG economics can have a large effect on polyester economics and competitiveness. Several developments in EO/EG or direct EG technology offer the promise of lower capital and operating costs and lower byproduct formation. Nexant has analyzed these important developments:

- Improved oxidation catalysts
- Catalytic hydrolysis of EO
- EG from EO via carbonylation to ethylene carbonate followed by hydrolysis to EG
- Direct ethylene oxidation to EG

1.7 FUNDAMENTALS OF PET COMPETITIVENESS AND BUSINESS STRATEGY

Polyester cost of production will play a large part in the U.S. and West European competitiveness in domestic and export markets. Low cost resin from Asia is becoming an increasing threat to U.S. and European sales and is taking away export opportunities. Globally, there are several important factors:

- Severe overcapacity
- Significant expansion in China and other areas (e.g. Iran), especially terephthalic acid, which may change the regional competitiveness in Asia
- Larger, more efficient plant design and construction
- Short-term high-prices of raw materials, e.g. Asia short in para-xylene, the key feedstock for PTA, and its effect on pricing

Historic PTA/para-xylene pricing shows the effect of para-xylene margins on PTA market price. In 1995/1996, para-xylene margins rose significantly, as shown for the U.S. in Figure 1.5.
This was passed on to PTA and, ultimately PET, prices as the downstream producers more than recovered the para-xylene costs (Figure 1.6).
With forecast shortage in *para*-xylene capacity, the anticipated rise in prices will affect terephthalic acid and PET prices and resin growth. Nexant analyzed this important issue in regards to forecast PET demand and regional costs, and competitiveness in the global market.

- Business strategy, e.g. acquisitions, marketing agreements with Asian producers, etc.

Nexant examined the costs of production and competitiveness of key U.S. and West European producers compared to major producers and exporters, such as in Asia.

The report was completed in November, 2004 and the cost is US$15,000.00.
Section 2  Scope of Work

Nexant’s overall objective for this study, “Squeezing Profitability from the PTA/PET Value Chain: Impact of the Latest Technology Advances”, was to assess and evaluate the important technology and commercial issues that will affect the future markets and cost dynamics of the polyester chain from terephthalic acid, its production and issues regarding properties, through polyester resin and fiber, its technology advances affecting costs, and product characteristics. The study provides an in-depth quantitative and qualitative analysis of the various new and developing technologies for the production of terephthalic acid and polyester resin, and qualifies the differences in lower quality terephthalic acid versus conventional PTA and how these differences are seen in the marketplace. An important part of this assessment and evaluation is a discussion of the commercial issues including projected impact of these technologies on polyester demand and use and the effects on regional PET resin demand, supply, and trade.

The report analyzed the major technical and cost issues:

**Technology Evaluation** – Nexant assessed and reported on the capabilities and limitations of medium quality TPA as compared to conventional PTA in the major polyester applications. Differences in handling, operating characteristics, effect on product properties and quality, first-time prime grade material, and effective capacity are some of the important issues that were addressed, as well as possible plant remediations for lower quality material and effect on quality and cost.

The information regarding the use of medium quality TPA was gathered from a range of sources: technology providers, producers, industry experts, purchasers, and end-users of the various polyethylene terephthalate products. It is vitally important to get the perspective of purchasers and end-users, which is generally unbiased in nature. Nexant surveyed these contacts on a global basis in order to gain a full understanding of the issues on a global and regional basis.

The results of the data gathering were tabulated and evaluated so as to arrive at an industry consensus. Data relating to operating costs, such as use and cost of additives, on-spec rate, and downtime, was used to generate comparative economics for PTA versus medium quality TPA in the various polyester products.

**Economic Evaluation** – A detailed review and status of the various process routes including: patent review and analysis, technology holders and offerers, licensor package analysis and cost of production development for what would be considered representative of each technology, and identification of the stage of process package commercial development with a listing of actual and announced projects.

**PTA**

- Conventional aqueous para-xylene oxidation/hydrogenation
- Lower quality purified terephthalic acid
- Alternate developments in conventional PTA
Mega-scale PTA

Nexant examined and analyzed licensor offerings for both PTA and medium quality TPA, qualitatively, assessing differences in design and operability, and quantitatively where available. Cost of production estimates were developed for capacities suitable for each technology and were compared on both a USGC grass-roots basis and China, befitting the large capacity additions forecast there. Promising new technology developments were assessed from publicly available information such as patents. The effects of process developments were incorporated into conventional process economics in order to quantify the degree of improvement.

A typical cost of production worksheet is shown in Table 2.1.

Table 2.1 Cost of Production for PTA

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<thead>
<tr>
<th>CAPITAL COST</th>
<th>MILLION U.S. $</th>
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<td>ISBL</td>
<td>153.1</td>
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<tr>
<td>OSBL</td>
<td>61.2</td>
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<tr>
<td>Total Plant Capital</td>
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<tr>
<td>Other Project Costs</td>
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<tr>
<td>Total Project Investment</td>
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<tr>
<td>Total Capital Investment</td>
<td>296.7</td>
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<table>
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<tr>
<th>PRODUCTION COST SUMMARY</th>
<th>UNITS</th>
<th>PRICE</th>
<th>U.S. $ PER UNIT</th>
<th>U.S. $ PER PRODUCTION</th>
</tr>
</thead>
<tbody>
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<td>RAW MATERIALS</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>para-Xylene</td>
<td>LB</td>
<td>0.6700</td>
<td>0.2250</td>
<td>0.151</td>
</tr>
<tr>
<td>Acetic Acid</td>
<td>LB</td>
<td>0.0550</td>
<td>0.3400</td>
<td>0.019</td>
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<tr>
<td>Hydrogen - reformer</td>
<td>kSCF</td>
<td>0.0001</td>
<td>1.8999</td>
<td>0.000</td>
</tr>
<tr>
<td>Catalyst &amp; Chemicals</td>
<td>U.S.$</td>
<td>0.0047</td>
<td>0.005</td>
<td>0.005</td>
</tr>
<tr>
<td>TOTAL RAW MATERIALS</td>
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<td>0.174</td>
<td>134.43</td>
<td>384.1</td>
</tr>
<tr>
<td>NET RAW MATERIALS &amp; UTILITIES</td>
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<td>0.174</td>
<td>134.43</td>
<td>384.1</td>
</tr>
<tr>
<td>UTILITIES</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Power (Purchased)</td>
<td>kWh</td>
<td>0.09850</td>
<td>0.0460</td>
<td>0.005</td>
</tr>
<tr>
<td>Cooling Water</td>
<td>M GALS</td>
<td>0.01760</td>
<td>0.0882</td>
<td>0.002</td>
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<td>Boiler Feedwater</td>
<td>M GALS</td>
<td>0.00030</td>
<td>1.6626</td>
<td>0.000</td>
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<tr>
<td>Steam, 600 psig (Gas)</td>
<td>M LBS</td>
<td>0.00046</td>
<td>5.3883</td>
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<tr>
<td>Inert Gas</td>
<td>kSCF</td>
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<tr>
<td>Fuel</td>
<td>MBtu</td>
<td>0.00027</td>
<td>2.5300</td>
<td>0.001</td>
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<tr>
<td>TOTAL UTILITIES</td>
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<td>0.010</td>
<td>7.88</td>
<td>22.5</td>
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<tr>
<td>NET RAW MATERIALS &amp; UTILITIES</td>
<td></td>
<td>0.184</td>
<td>142.31</td>
<td>406.6</td>
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<tr>
<td>VARIABLE COST</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>LABORERS</td>
<td>41 People</td>
<td>40100 U.S. $</td>
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<td>1.64</td>
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<td>Foremen</td>
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<td>1 People</td>
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<td>General Plant Overhead</td>
<td>60 % Direct Fixed Costs</td>
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<tr>
<td>Insurance, Property Tax</td>
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<td>Environmental</td>
<td>0.5 % Total Plant Capital</td>
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<td>1.07</td>
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<td>TOTAL ALLOCATED FIXED COSTS</td>
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<td>0.010</td>
<td>8.00</td>
<td>22.9</td>
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<tr>
<td>TOTAL FIXED COSTS</td>
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<td>0.022</td>
<td>17.05</td>
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<td>Depreciation @</td>
<td>10.0 % for ISBL and OPC</td>
<td>0.031</td>
<td>23.72</td>
<td></td>
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<tr>
<td>5.0 % for OSBL</td>
<td></td>
<td></td>
<td></td>
<td>67.8</td>
</tr>
<tr>
<td>COST OF PRODUCTION</td>
<td></td>
<td>0.237</td>
<td>183.08</td>
<td>523.1</td>
</tr>
<tr>
<td>Return on Investment (ROI-Total Plant Capital)</td>
<td>10.0 Percent</td>
<td>0.028</td>
<td>21.43</td>
<td></td>
</tr>
<tr>
<td>COST OF PRODUCTION + ROI</td>
<td></td>
<td>0.265</td>
<td>204.51</td>
<td>584.4</td>
</tr>
</tbody>
</table>
PET

- Conventional melt phase/solid-stating PET resin
- Alternate commercial technologies such as DuPont’s INVISTA NG3™
- Improved barrier property PET
- Effect of catalyst selection on PET resins
- Polyester fiber

Nexant reviewed available technology offerings and improvement developments, and estimated economics for world-scale capacity. The influence of catalyst selection included effects such as catalyst activity, yield, unit cost, plant downtime, necessity and cost of additives, etc. Polyester fiber technology developments and effect on cost competitiveness were analyzed and reviewed.

EG

- Conventional ethylene oxidation/non-catalyzed hydrolysis
- Improved oxidation catalyst
- Ethylene oxidation/catalyzed hydrolysis
- Direct ethylene oxidation to EG
- EG from EO via carbonylation to ethylene carbonate followed by hydrolysis to EG

Nexant compared the production economics for the conventional route at world-scale capacity versus the developing processes. Improvements in catalyst selectivity were estimated as drop-in to conventional technology.

Cost of production estimates for typical 2003 conditions were developed for the terephthalic acid and polyester technologies. Costs were developed for the USGC and China (for PTA/MTA), recognizing the capacity growth in that country.

The economic evaluations considered important variables and estimates were made as to potential improvements and their implications. Nexant estimated the production costs and potential improvements to these costs in order to speculate on the potential for the developing technologies to displace their conventional counterparts.

Commercial Evaluation – Nexant developed forecasts of terephthalic acid, polyester fiber and PET resin demand, production and trade, globally and by region to 2015.
Section 3  

Approach

The evaluations of conventional technology were based on Nexant’s in-house and published information regarding process technology, augmented by contacts with licensors, engineering contractors and other experts in the industry. Developing technology evaluations were “built up” from a review of patents, public domain information, and discussions with the technology developing companies and engineering contractors.

Nexant used proprietary and commercial state-of-the-art software tools to develop the technology and economic estimates. These are well established, state-of-the-art engineering tools in the process chemical industry and are used by major engineering contractors. To the degree allowed under copyright and licensed user restrictions, the detailed software generated output was included in the report.

Commercial information and forecasts were developed from Nexant’s extensive in-house databases, augmented with selected regional fieldwork.

Market projections were developed with the aid of Nexant’s Supply/Demand computer modeling systems.
Section 4

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3. The information disclosed in this report will be retained by Client for the sole and confidential use of Client and its 51 percent or greater owned affiliates in their own research and commercial activities, including loaning the reports on a confidential basis to third parties for temporary and specific use for the sole benefit of Client.

4. Client further agrees that it will use reasonable efforts to keep the information in the reports for its sole use; however, this restriction shall not apply to information which is or becomes generally available to the public in a printed publication, which is already in the possession of Client, or which is received by Client in good faith from a third party without an obligation of confidentiality.

5. Client shall not republish any of the report except within its own organization or that of its 51 percent or greater owned affiliates. Client further agrees to refrain from any general publication of the reports, either directly or through its affiliates, so as to constitute passage of title into the public domain or otherwise jeopardize common law or statutory copyright in said report.

6. Client will be billed by and shall pay Nexant a total of US$15,000.00 (fifteen thousand U.S. dollars). Amounts are due upon receipt of invoice and payable within thirty (30) days. Late payments shall accrue interest at the rate of 1.5 percent per month. Fees quoted do not include any applicable sales tax, or use or value added tax, all of which are for the account of Client.

7. Additional copies of the report are available at US$500 each. The complete report will also be available electronically on CD-ROM at a cost of US$1,000.

8. The obligations of paragraphs 3 and 4 shall terminate five (5) years from receipt of reports.

9. Unless specified otherwise, there are no warranties of any kind for reports and consulting services provided under this Agreement. Nexant’s total liability under this Agreement is limited to the total amount paid to Nexant for the reports.

10. This Agreement will be governed by the laws of the State of New York.
AUTHORIZATION FORM

AGREED TO AND ACCEPTED BY:                                     AGREED TO AND ACCEPTED BY:
CLIENT: ______________________________ NEXANT, INC.
Name: ______________________________ Name: ______________________________
Signature: __________________________ Signature: __________________________
Title: ______________________________ Title: ______________________________
Date: ______________________________ Date: ______________________________

Reports to be sent to:
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

Phone: ______________________________ Fax: ______________________________
E-mail address: ______________________________
Number of Hard Copies: ____________ Number of CD ROM copies: __________________

Total Cost: __________________

If purchase order is required, please provide the purchase order number below:

Purchase Order Number: __________________

NEXANT, INC.
44 SOUTH BROADWAY, 5th Floor
WHITE PLAINS, NY  10601-4425, U.S.A.
Fax: 1-914-609-0399
Web: www.nexant.com
Section 6 Qualifications

6.1 GENERAL

Nexant uses multidisciplinary project teams drawn from the ranks of our international staff of engineers, chemists, economists and financial professionals, and from other Nexant groups to respond to the requirements of each assignment. Most of the staff of consultants possess credentials in both scientific and commercial disciplines plus substantial industrial experience. The collective talents of our staff, strategically located and closely linked throughout the world, result in valuable insights gained through a variety of perspectives.

ChemSystems is an international consultancy that is now part of Nexant, Inc., and is dedicated to assisting businesses within the global energy, chemical, plastics and process industries by providing incisive, objective, results-oriented management consulting. Over four decades of significant activity translate into an effective base of knowledge and resources for addressing the complex dynamics of specialized marketplaces. By assisting companies in developing and reviewing their business strategies, in planning and implementing new projects and products, diversification and divestiture endeavors and other management initiatives, Nexant helps clients increase the value of their businesses. Additionally we advise financial firms, vendors, utilities, government agencies and others interested in issues and trends affecting industry segments and individual companies. Whether identifying opportunities, managing change or confronting competitive challenges, we adhere to the highest ethical and professional standards.

ChemSystems, founded in 1964, was originally an independent, management-owned consultancy. IBM acquired it in 1998, and from early 1998 until August, 2001 ChemSystems was a part of IBM Global Services and IBM’s Chemical and Petroleum group. Effective September 1, 2001, the ChemSystems unit of IBM was acquired by Nexant, Inc. Nexant, Inc. is an independent industry-expert consulting firm, that was spun off from Bechtel over three years ago, that provides technology solutions and experienced-based technical and management consulting services to electric utilities, energy producers, chemical companies, oil and gas companies, governments, and energy end-users worldwide. All of the staff and intellectual capital of ChemSystems was acquired by Nexant, Inc. Thus, Nexant, Inc., with ChemSystems as part of its Chemicals and Petroleum Division, continues to maintain fully-integrated operations in White Plains, New York; London, England; San Francisco, California; and Washington, D.C. Other business unit offices are located in Boulder, CO and Phoenix, AZ, and satellite business or project offices are located in Tokyo, Bangkok, Beijing, Seoul, and Houston. We also work with representatives throughout the world.

From major multinationals to locally-based firms and governmental entities, our clients look to us for expert judgment in solving compelling business and technical problems and in making critical decisions. The acquisition of ChemSystems by Nexant, Inc., has enhanced ChemSystems’ ability to successfully serve its clients. This merger’s success arises from complementary methodologies and technologies, which are used to provide services to clients and allow us to provide more complete and effective consulting.
Nexant’s clients include most of the world’s leading oil and chemical companies, financial institutions, and many national and regional governments. Nexant, Inc./ChemSystems is active in most of the industrialized countries of the world, as well as in most of the developing areas including the Middle East, Africa, and East and Southeast Asia.

Major annual programs are:

- Process Evaluation/Research Planning (PERP)
- Petroleum and Petrochemical Economics (PPE)/ChemSystems Online (CSOL) – United States, Western Europe and Asia

The PERP service covers technology, commercial trends, and economics applicable to the chemical industry. The program has more than 50 subscribers, including most of the major international chemical companies. Many of the processes to be analyzed in this multiclient have been assessed in the PERP program.

PPE/CSOL covers the market and manufacturing economics for major petrochemicals.

Over the past three years, the program has been completely overhauled and upgraded. The models and databases that run the analysis have been replaced with a start-of-the-art industry simulation program that has taken the 30 years of industry knowledge and experience of our consultants and enhanced it to prove a new level of forecasting expertise.

The new simulation model is used to generate the PPE reports and also an internet serviced brand ChemSytems Online, that provides global data, analysis and forecasts of:

- Plant capacity
- Production
- Consumption
- Supply/demand and trade
- Profitability analysis
- Forecast
- Price forecast
- Techno-economic analysis

Subscription to ChemSytems Online includes both written reports (the PPE program) on the petroleum and petrochemical industry and internet access to all data analysis and forecasts. Your subscription may be tailored to meet your specific company requirements and the fees reflect the value brought to your business. Insightful analysis and a reliable forecasting methodology provide the means to significantly improve your business performance though better investment decisions and improved competitive position.
6.2 SUMMARY OF PROJECTS SPECIFICALLY RELATED TO PET AND PTA

Nexant is one of the leading consulting firms serving the PET and PTA businesses. We provide a wide range of information, analyses, and insight to help companies make business decisions. We have performed over 150 studies in the past decade dealing with various aspects of the PTA and PET businesses. The following provides additional description of the types of studies we have performed for the PET business.

STRATEGIC PLANNING

- STRATEGIC PLAN DEVELOPMENT – Nexant has been retained by several firms to provide assistance in the development of strategic plans for companies either in, or considering entering, the PET and PTA businesses. This assistance typically involved developing long term growth and industry outlooks, competitive analyses, and economic analyses and projections, while considering the firms’ competencies and resource base.

- STRATEGY PLANNING ASSISTANCE – In these types of studies, Nexant works with the client in overall PTA/PET strategy formulation, providing assistance as needed. This assistance can range from detailed informational inputs to extensive help in economic modeling.

- OPPORTUNITY ANALYSIS -- Sometimes firms have already made the decision to enter a business, but wish to perform additional analysis on the timing and risks, or develop additional detail on the investment associated with that decision. As an example, a Brazilian chemical company retained Nexant to evaluate prospects for a new PET bottle resin producer in that country. The scope of the study encompassed: demand analysis for PET bottle resin and film for Brazil and Argentina including export opportunities; economics of competing materials and environmental issues; supply and supply/demand balances; technology; product portfolio selection; raw material position; competitor cost position; project economics and market entry strategy.

- MASTER PLAN DEVELOPMENT – Nexant has performed a number of large “Master Plan” development studies for regions in developed countries, as well as developing countries. These plans, some of which have included PTA/PET, typically begin with an assessment of the region’s chemical and polymer needs and resources. Specific recommendations on petrochemical products are then developed. These plans are always supported with detailed financial analyses so as to measure return on capital, and to help in feedstock valuation.

- PROJECT ADVISOR -- Nexant has been retained a number of times as a commercial advisor or technical advisor on PET projects. In the commercial advisor role, Nexant has advised on contract negotiations for raw materials, worked with financial institutions on project financing, and assisted in preparation of project strategy and economic forecasts. As a technical advisor, Nexant has worked on the selection of licensor/contractor bidders, preparation of the invitation to bid, participated in the evaluation/selection of bidders, and assisted in contract negotiations with the selected bidder.
FEASIBILITY ANALYSIS -- An independent assessment of the viability of building PTA or PET facilities often involves an evaluation of issues such as: site selection (location, suitability for marine facilities, utilities, ease of financing and tax incentives, and environmental considerations); regional supply and demand issues; analysis of important commercial factors; technology evaluation; recommendations on project implementation, plant capacity, processes and operating assumptions; analysis of commercial factors such as global supply/demand balances; review of competitive environment; historical and forecast pricing, estimated capital investment and cash flow model for likely configuration; and a review of potential partners, suppliers and off-takers.

COMPETITIVE AND ECONOMIC ANALYSES – Nexant has performed several analyses which focused on the competitive position of various PTA and PET producers, as well as an economic analysis of their businesses. The economic analysis has frequently incorporated estimates for business overhead costs.

GROWTH OPPORTUNITY SCREENING – As part of broader growth strategy development engagements, Nexant has often performed growth opportunity screening analyses on the PTA and PET industries, to see if PTA and/or PET met the clients growth criteria and capabilities. The projects provide detailed information on the current status of PET and PTA developments, market potential, competitive technologies, and commercial and economic viability.

TECHNOLOGY EVALUATION

BENCHMARKING -- Nexant has performed several studies to benchmark participants in the PTA and PET industries. The characteristics for benchmarking included: reactor configuration; capacity expansion plans; raw material sourcing and purchase price; production cost if back integrated and transfer price; cost of production; operating rate; percent premium; market position by end use; strategy, strategic alliances, and pricing policies; and organizational structure.

PET AND PTA TECHNOLOGY SELECTION AND EVALUATION -- Nexant has assisted a number of firms in evaluating and selecting both PTA as well as PET technologies. Typically, these projects begin with project initiation and continue through signed construction contracts, and include technical analysis, preliminary licensor evaluations, invitation to bidders, bid analysis, contract selection and contract development.

PROCESS EVALUATION -- For both producers as well as licensing companies, Nexant has performed process analyses and comparisons. These projects might include demand forecasts as well as detailed technical and economic analyses, a review of current activities in the development of new technology and an evaluation of their impact. Projects for licensing companies often incorporate an analysis of the licensing environment, sources of technology, process description, innovation potential, and potential revenue forecast by technology and by potential licensor.
MARKET ASSESSMENT

- **MARKET ANALYSES** -- Nexant has performed many regional as well as global PTA, DMT and PET market analyses. These analyses typically include demand, demand forecasts, growth drivers, opportunities and threats, and industry structure.

- **PRICE FORECASTS** -- Nexant tracks a number of PET and raw material prices. We have frequently been asked to provide our forecasts and views on pricing in support of a range of analyses.

FINANCIAL

- **BUSINESS VALUATION** -- These analyses are performed for acquiring firms or for banks or other lending institutions. Nexant is often asked to provide views on: rationale of the combination (synergy/value creation); a detailed explanation of the technology and market position of the target; and economic projections.

- **PROJECT FEASIBILITY STUDIES** -- A number of project feasibility studies have been performed for a range of clients including public firms, private firms, state-owned companies as well as banks and lending institutions. These studies typically provide sufficient information to perform detailed economic and risk analyses on investments in the PTA and PET businesses.

MULTI SUBSCRIBER SERVICES AND SPECIAL INDUSTRY REPORTS

- **PETROLEUM AND PETROCHEMICAL ANALYSIS (PPE)** -- This multiclient service analyzes the historical and future performance of twenty chemicals and plastics in key producing areas - U.S., Europe, Asia. The program reports on ethylene, propylene, low density polyethylene, linear low density polyethylene, high density polyethylene (injection molding), high density polyethylene (blow molding), polypropylene, PVC, para-xylene, PTA, and PET. Each quarter, the profitability of each material is analyzed. Specific production costs, operating rates and selling prices are reviewed. In addition, annual reports are issued for each region that include global capacity (historical plus forecast), pricing forecasts and reports devoted to specific issues or regions.

- **PROCESS EVALUATION AND RESEARCH PLANNING (PERP)** -- A technology oriented program that analyzes existing polymer technology as well as emerging and newly patented technologies. Some of the polymer specific reports include:
  - PTA
  - PET Resin
  - Polyester Fiber
  - PET Recycling
  - High Performance Polyesters (including PEN)
  - Barrier Resins
• **ASIAN COMPETITIVE COST ISSUES - THE BASIS FOR REGIONAL DECISIONS** covers Japan, South Korea, China, Taiwan, Malaysia, Thailand, Singapore, Indonesia, the Philippines, Australia and India, and reviews current factors, analyzes trends and projects. For reference purposes, U.S. economics have been developed. The products covered included PTA and PET.

• **THE INDIAN AGENDA** – This report provides an analysis of domestic demand and profitability for a wide range of petrochemical and polymeric products, including PET and PTA.

• **CHEMICALS AND PLASTICS IN CHINA** – The report provided an analysis of the Chinese petrochemical industry, as well an outlook for the future. The study covered 22 petrochemical products, including PTA.

• **THE LATIN AMERICAN ENERGY, REFINING, AND PETROCHEMICAL INDUSTRIES IN TRANSITION** – The study, which covered PTA as well as PET, evaluated the opportunities and challenges facing the Latin American petrochemical industry.

• **PET AND POLYESTER INTERMEDIATES: para-XYLENE; PTA; AND DMT** – This study considered the impact of a large number of Asian PET and raw materials production facilities on the global PET and intermediates businesses.