PetroChina APS Introduction

PetroChina Planning and Engineering Institute

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PetroChina Company Limited ("PetroChina") is the largest oil and gas producer and distributor in oil and gas industry in China. PetroChina is the world’s top 500 companies ranked 6 in "Fortune" magazine in 2011.

PetroChina businesses are mainly involved in crude oil and natural gas exploration and development, pipeline transportation, refining and chemicals, product sales, petroleum engineering and technical services, oil machinery manufacturing, oil trade and financial fields etc.

### Operating data of PetroChina refining and chemical segment (2011)

<table>
<thead>
<tr>
<th>Product</th>
<th>Quantity</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude oil processed</td>
<td>984.6</td>
<td>million barrels</td>
</tr>
<tr>
<td>Crude oil processed capacity</td>
<td>1129</td>
<td>million barrels/year</td>
</tr>
<tr>
<td>Diesel</td>
<td>59040</td>
<td>thousand tons</td>
</tr>
<tr>
<td>Gasoline</td>
<td>25447</td>
<td>thousand tons</td>
</tr>
<tr>
<td>Kerosene</td>
<td>2663</td>
<td>thousand tons</td>
</tr>
<tr>
<td>Lubricants</td>
<td>1573</td>
<td>thousand tons</td>
</tr>
<tr>
<td>Naphtha</td>
<td>10301</td>
<td>thousand tons</td>
</tr>
<tr>
<td>Ethylene</td>
<td>3467</td>
<td>thousand tons</td>
</tr>
<tr>
<td>Synthetic resin</td>
<td>5690</td>
<td>thousand tons</td>
</tr>
</tbody>
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PetroChina APS Project

- APS (Advanced Planning System) is an unified project in the whole of PetroChina. The overall project was implemented in unified planning, unified standard, unified design, unified investment, unified construction, unified management by the leadership of PetroChina Headquarter.

- APS system is a mathematical model for PetroChina refining & petrochemical companies to build the whole supply chain from raw materials procurement, processing, to product sales, using the linear programming theoretical calculation to maximize the overall operation benefits.

- Through widely comparison, PetroChina finally selected Honeywell RPMS software and built headquarter and regional companies APS system in separately.

- PetroChina Planning and Engineering Institute (CPPEI) is responsible for implementing this project, on line technical supporting and maintenance.
PetroChina APS Project

- PetroChina APS project firstly selected Dalian refinery as an implementation pilot, then, conducted phase I rollout, phase II rollout and headquarters model integration on the experience and knowledge from the pilot project.

- PetroChina Headquarters
  - Daqing Company
  - Daqing Refine Company
  - Jilin Company
  - Jilinzhou Company
  - Jinxin Company

- Liaoyang Company
- Fushun Company
- Harbin Company
- Lanzhou Company
- Dushanzi Company
- Wulumuqí Company

Supporting Phase

- Liaohé, Huabei, Kelamayí, Ninxía, Qingyang, Yumen, Changqing etc. 14 simple models construction

Timeline:
- Aug. 2004, the pilot project started
- May 2005, pilot project on-line
- Dec. 2005, 1st rollout on-line
- Sep. 2006, 2nd rollout on-line
- Jun. 2007, 2nd rollout acceptance
There are 21 refineries with the capacity more than 500 million TPA, and 6 refining and petrochemical complexes with ethylene cracker in PetroChina. There are 17 refineries processing multi-crudes and 6 refineries processing imported crude. All the special models were built in line with the characteristics of each refinery, matching the different flowsheets and different requirements.

- The regional APS models, in addition to the typical structures, also include multi-program production structure, the whole refinery sulfur balance, fined structure of properties transport and Delta-base structure in some of refineries.

- The regional APS models, in addition to the typical linear programming, also applied recursion and mixed integer programming techniques.

PetroChina purchased Chevron crude oil database, and also built two assay analysis and evaluation laboratories in Dalian and Dushanzi. Combined with H/CAMS, crude cutting can be ensure to accurate.
PetroChina Headquarter APS

- PetroChina Headquarter model is consisted of 16 oil fields, 3 overland ports, 5 marine ports, 26 refineries, 36 provincial sales market, 16 crude pipelines, 8 product pipelines, 6 large crude repositories as well as a number of product depots.

- PetroChina Headquarter model has a large matrix as 40000 columns (variables) * 20000 rows (equations), and could be solved in 40 minutes.
At regional enterprise level, APS system is mainly used in these areas.

- Production Planning
- Multi-period Planning
- Crude Purchase Optimization
- Product Profit Estimates
- Production Optimization
The majority of processed crude in PetroChina is produced by itself, but the same oil can be processed by different enterprises; There are a lot of naphtha, propylene, butadiene, aromatics and other resources can be supply indirectly among refineries; A refinery's gasoline and diesel products can be distributed to different province markets.

At headquarter level, APS system is mainly applied in the headquarter plan scheduling, crude optimal allocation, optimization of product transport and intermediate materials interaction. The applications of headquarters APS can ensure the maximized benefit at the overall level of PetroChina, and the actual benefits have been proved significantly.

PetroChina is currently applying RPMS to build an integration model. The aim is to co-ordination all the business and achieve the integration optimization among crude oil exploration and development, refining and chemical production, product sales.
Business Scope at APS Financial Sector

- Traditionally, the applications of APS in PetroChina are planning and optimization, the main users are the planning departments.
- At present, the financial sector users begin to apply APS for financial budgeting and calculation, such as overall economic benefits analysis/evaluation, profits per ton oil, and other financial indicators calculation.
Through self-development, PetroChina have developed server-based RPMS single plant models. The online web-based platform achieved models unified management and maintenance as well as model version control.

- Model parameters Online set (RAWM, SALES, PLIM, INVD)
- Simplified model maintenance
- Black box of operation
- Operator log online analysis
- Version Control
- Optimize computing
- After Mark, Fast Data Import, DataSolv step, final results into the database
- Form of abundant Output statements
  - Online generated: PEEK reports and Excel reports
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Future Applications Prospects

PetroChina is carrying out the implementation and development of APS 2.0 project, the objective is to extend APS application scope to cover all refining and petrochemical businesses (it will be 29 refineries), to upgrade the functionality of the existing models, to develop system platform and expand the application scope, to achieve the overall management of planning and processing business, to collaborate planning and financial business, to integrated with ERP, MES and other systems; as well as to upgrade system applications and improve user interfaces.

APS 2.0 project plans to take a combination of mature software with independently developed modules to build an integrated, collaborative and visualized platform. The project will be finished in two years.
Recommendations and Suggestions

- Suggest Honeywell company to promote the research and development work of the new generation software for plan optimization.
  - To simplify modeling process, graphical modeling
  - To improve software interface between human and machine, to simplify software operation
  - To improve software output and the display format
  - To innovate software technology architecture, to change RPMS applications from distributed mode by individuals to centralized mode.

- Hope Honeywell can improve service levels, be able to respond user questions quickly and resolve software problem in time.

- Hope Honeywell and PetroChina can strengthen and enhance relation in cooperation. According to the commitment and the customary rule for large customers, Honeywell should coordinate market and sales department well. Its business should be more reasonable to achieve mutual benefits between Honeywell and the customer on the basis of good cooperation in the future.
The End
Thanks!
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