

## Process Automation Development in China<sup>\*</sup>

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**Abstract:** A short historical view of process automation in China is provided. The development of essential aspects of process automation, including Distributed Control System (DCS), Advanced Process Control (APC) and Manufacturing Execution System (MES), are discussed in detail. The contribution of local process automation companies, i.e. SUPCON, and HOLLYSYS are highlighted.

Keywords: Advanced Process Control; Model Predictive Control (MPC); Manufacturing Execution System(MES); Petrochemical Industry; Chemical Industry; Oil Refinery Industry

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### 1. INTRODUCTION

With the rapid growth of China's economy, severe environmental pollution and high energy consumption per unit GDP become significant issues to address. The Chinese government pays close attention to these issues and stipulates that the GDP per capita by 2010 should double of its value in 2000 while energy consumption per unit GDP should be cut by 20% as against 2005. Intense requirements on industrial product quality, environment-friendly production will not be satisfied without constant interdisciplinary research and application and process automation will play increasingly important role in environment protection, energy-saving and cost-cutting for higher efficiency.

The paper proceeds as follows. A short historical view of process automation in China first provides an overall perspective. Then the development of essential aspects of process automation, including Distributed Control System (DCS), Advanced Process Control (APC) and Manufacturing Execution System (MES), are discussed in detail. The contribution of local process automation companies, i.e. SUPCON, SUNYTECH, and HOLLYSYS are highlighted.

### 2. HISTORICAL PERSPECTIVE

The trajectory of process automation in China has passed 3 key stages, i.e. from initial Direct Digital Control (DDC), through DCS and Computer Integrated Process System (CIPS). The DDC was first applied in China before 1970 to replace the analog PID devices.

Due to the low reliability of computers, DDC was not widely adopted in practice. Since 1975, thanks to the

rapid development of microprocessors, DCS appeared and can now be found in a wide variety of application in China industrial areas. At its early stage, the DCS market in China is occupied by several foreign DCS vendors, including Honeywell, Yokogawa and Siemens etc. It is not rare that one can still find DCS products from these companies in old refinery and petrochemical factories of China. The first homemade DCS JX100 was produced by SUPCON in 1993 and SUPCON now shares more than 24% of the local DCS market.

Computer Integrated Process System (CIPS), which inherits its basic ideas from Computer Integrated Manufacturing System (CIMS), increases the profit and competitive power of a company by supporting the decision making, information management, scheduling, supervisory control etc. In 1986, CIPS was listed in National High Technology Development Program, which is also known as the 863 Program. Since then, the China government has invested a lot on the research and application of CIPS technology. In 1990, the first CIPS system was applied in Shengli refinery factory, a subsidiary of SINOPEC. Nowadays, CIPS has been widely applied in almost every industrial sector, including refinery, petrochemical, pharmaceutical etc and the underlying five-layer CIPS model has evolved to the typical two-database (real time database and relational database) three-layer model, which is illustrated in Figure 1. Since 1990s, several famous international process automation companies have delivered their own CIPS systems including e-Manufacturing<sup>?</sup> of Rockwell, Plantelligence<sup>TM</sup> of Aspen-Tech, Unified Manufacturing<sup>TM</sup> of Honeywell etc. The In-Plant system of SUPCON also follows the standard three-layer standard of CIPS, as shown in Figure 2. In-Plant system includes Intelligent Instrument (SupField Series Field Instruments, MultiF Series Paperless Recorders and AnaPro Series Analytical Instruments), DCS (WebField

<sup>\*</sup> This work was supported in part by the National Science foundation of China(No. 60721062).

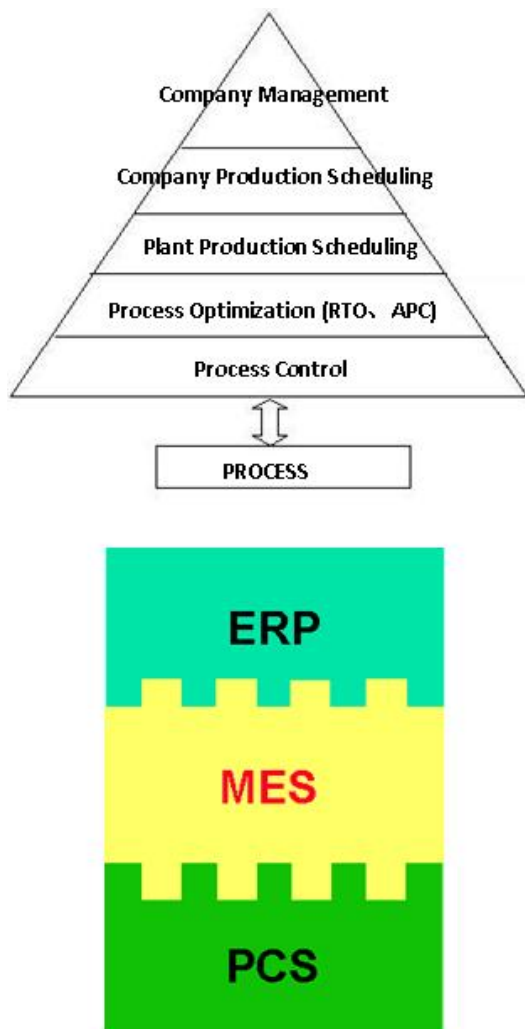


Fig. 1. The evolution of CIPS

JX Series Control Systems, WebField ECS Series Control Systems and WebField GCS Series Control Systems), ESP or Enterprise Solution for Profit suite (Advanced Process Control Software Series, ESP-*i*SYS realtime database, MES-suite).

### 3. DEVELOPMENT OF DISTRIBUTED CONTROL SYSTEM

With the help of computer technology, DCS realizes the centralized monitoring, management and distributed control structure. Since Honeywell invented the first DCS system, i.e. TDC-2000, in 1975, DCS has found wide application in industrial process control.

In China, the main international DCS vendors include ABB, Yokogawa, Honeywell, Siemens, Emerson, Rockwell and Invensys etc. In contrast, SUPCON, HOLLYSYS, XINHUA and SUNYTECH are the leading local DCS companies. According to a recent survey in China by GONGKONG, an official website of China Association of Automation, the DCS name recognition is ranked in Table 1 [1]. It should be noted that the popularity of SUPCON is only less than ABB, and the difference is just 1 percent. In 2005, SUPCON WebField JX series DCS occupied 26.4% of the chemical industry DCS market and

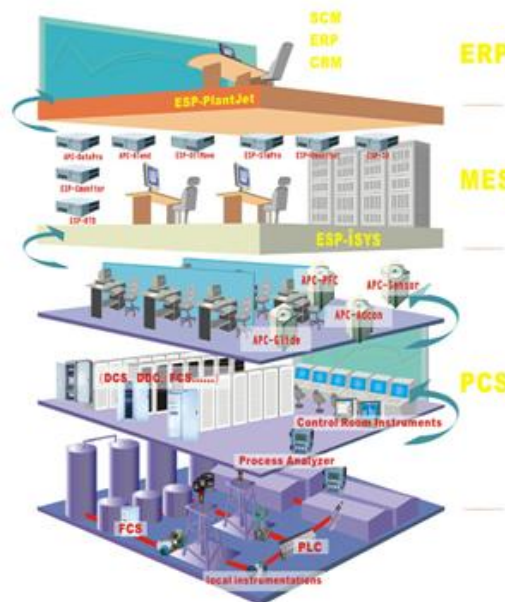


Fig. 2. InPlant total solution for process automation

Table 1. DCS Brands Recognition Comparison

Brand	Recognition Rate%
ABB	25%
Supcon	24%
Yokogawa	22%
Honeywell	22%
Hollysys	18%
Siemens	16%
Emerson	14%
Xinhua	7%
Rockwell	6%
Invensys	5%
Others	5%

more than 50% market share for homemade DCS systems, with annual sales of 280 Million RMB. Until 2006, there have been 5'100 DCS systems by SUPCON applied in China mainland.

### 4. DEVELOPMENT OF ADVANCED PROCESS CONTROL

Advanced Process Control refers to the control strategy which is not the traditional PID control and has better control results. In general, APC is not limited to one specified computer control algorithm. Although the precise definition for APC is not available, the task of APC is obvious and clear, i.e. to address the industrial control problem which can not be solved or well solved by traditional control strategy. It has been well recognized that the proper application of APC can results in significant economical benefits.

In developed countries, APC has been widely used in process industries with 60% DCS systems have installed APC while this rate is only 10% in China. In the near future, the process industries, especially refinery and petrochemical, will emphasize the application of APC technology and it will definitely enlarge the potential APC market.

In China, major commercial APC products include DMC plus of AspenTech, RMPCT of Honeywell and APC-Suite of SUPCON. SINOPEC, or China Petroleum & Chemical Cooperation is the largest customer of DMC plus. In 2006, there has been 16 DMC plus systems installed in SINOPEC and the engineering services of 5 systems are offered by SUPCON. In contrast, Honeywell has achieved 103 application cases of its RMPCT, most of which are installed in refinery factories.

The key components of APC-Suite software series are ESP-*i*SYS-A(Advanced process control software platform), APC-Sensor(Intelligent soft measurement and process computing software), APC-Adcon(Advanced multivariable robust predictive control software). (i) ESP-*i*SYS is comprised of a core RealTime DataBase, application components and configuration components. It is the basic data platform to implement advanced process control, soft measurement, process computing, process simulation and optimization. (ii) APC-Sensor intelligent soft measurement and process computing software uses the technology of neural networks and first-principle modeling as its core, integrating the functions of data pre-processing, secondary variable selection, off-line modeling & Simulation, and on-line operation. It is an important helper software program in process operation and advanced process control. (iii) APC-Adcon advanced multivariable robust predictive control software is the core product of the APC-Suite. It covers modeling, controller design, simulation, configuration and online application. It has the following functions: implement set-point control and zone control of complex process with multiple variables, long time lags and constraints and strong coupling, while keeping good stability and strong robustness.

Until 2007, 60 APC-Suite systems have been applied in China. Typical application cases cover the largest CCR (Continuous Catalyst Regeneration) Reforming process in Asia, the largest calcined alum process in the world, all representative equipments in refinery and petrochemical processes such as FCCU, PTA, and PX etc.

## 5. DEVELOPMENT OF MANUFACTURING EXECUTION SYSTEM

MES is the essential part of CIPS and bridges the production and management activity of a company. As the middle layer of ERP and FCS, MES copes with the management and optimization of all production essentials. As depicted in Figure 2, the standard MES is composed of 11 key functional modules: Resource Allocation and Status, Operations/Detailed Scheduling, Dispatching Production Units, Document Control, Data Collection/Acquisition, Labor Management, Quality Management, Process Management, Maintenance Management, Product Tracking and Genealogy and Performance Analysis.

In China, the research and application of MES is now in full swing. As the leading process companies, SINOPEC and PetroChina are extending the application of MES in their subsidiaries. In SINOPEC, the MES system is developed by an intercompany group organized by PetroCyberWorks, SUPCON, Salien and Institute of Software from Chinese Academy of Science. This group is under the supervision of SINOPEC information department. Cur-

rently 9 SINOPEC subsidiaries have successfully installed MES systems and gained great economical and social profits. In contrast, PetroChina utilizes the MES products of Honeywell and the engineering services are offered by another intercompany group by BearingPoint, SUPCON and PetroChina. The first PetroChina MES system came into practice in its Dalian subsidiary in 2005.

## 6. CONCLUSIONS

In this paper, a brief historical perspective of the development of process automation in China is introduced. State-of-art of the research and application of DCS, APC and MES are given consequently.

## REFERENCES

- [1] GongKong Website: [www.gongkong.com](http://www.gongkong.com)