

Practitioner's Section

Chemical Plant Engineering Projects – Customers Around the World Prefer Cutting-edge Technology “Made in Germany”

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Abstract: The German large industrial plant manufacturing industry is currently going through an extraordinary boom phase. Bookings by members of the Large Industrial Plant Manufacturer's Group (AGAB) at the German Engineering Federation (VDMA) set a new record in 2006 for the second straight year. This paper highlights the underlying developments in the sale of new plants, putting special emphasis on the regional and industrial particularities and closes with an outlook for 2007 and 2008.

Introduction

The German large industrial plant manufacturing industry is currently going through an extraordinary boom phase. Bookings by members of the Large Industrial Plant Manufacturer's Group (AGAB) at the German Engineering Federation (VDMA) set a new record in 2006 for the second straight year. Orders valued at €26.3 billion represented a 9% increase compared to the previous record of €24.1 billion which was set in 2005. Bookings in 2006 were actually about 50% higher than the average for the ten year period between 1997 and 2006 (€17.6 billion). The industry has now been in an expansion phase for four consecutive years. The last time the industry experienced similar growth was during the boom at the beginning of the 1990s in the wake of German reunification. Growth in the German large industrial plant manufacturing industry has also been very impressive in the international context. Market share increased to around 20%, placing German engineering firms among the world's elite corporations from

Western Europe, the US and Japan which construct industrial production facilities. Using bookings as the yardstick, power stations, steel plants and rolling mills were the most important market segments. Last year, chemical plants were the third most popular type of project. Bookings in this segment were up by 10% to a record of €2.7 billion (€2.4 billion in 2005). Orders for the year were an impressive 42% higher than the long-term average of €1.9 billion between 1997 and 2006.

The German chemical plant engineering industry can design and build a wide range of facilities for a variety of different applications. The list of examples includes fertilizer plants, refineries, synthetic fiber and polymer production plants, electrolysis plants and gas or coal liquefaction facilities. The value of individual orders often exceeds €100 million and can even be as high as a billion euros.

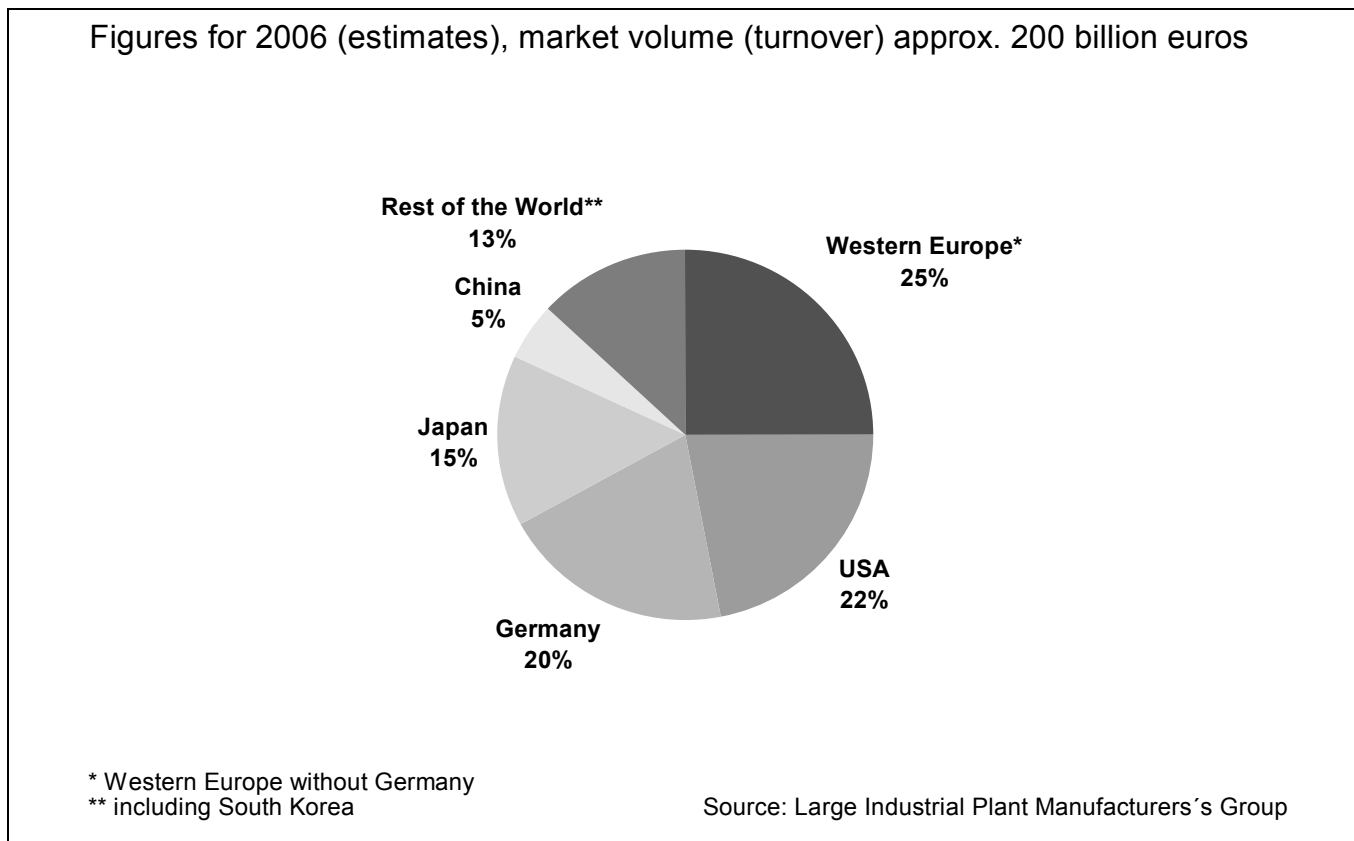


Figure 1: World Market share – large industrial projects – breakdown by country and region



Figure 2: Incoming orders for chemical plants 1997 - 2006

Growth in the domestic market

Following years of investment restraint, domestic demand for chemical production facilities began to recover at the end of 2005. This trend continued into 2006 on the back of a good investment climate in the chemical industry. Domestic orders acquired by working group members were up by 14% to €395 million

compared to €347 million in 2005. The last time bookings exceeded that level was in 2000 when total orders amounted to €600 million. Large-scale modernization projects to increase the efficiency or expand the capacity of existing plants combined with new construction (e.g. in the petrochemical industry) have contributed to the upswing.

Region	Inorganic chemistry		Organic chemistry		Total	
	2006	Change compared to 2005 in %	2006	Change compared to 2005 in %	2006	Change compared to 2005 in %
Domestic	166	118	229	-16	395	14
International	241	-40	2,025	21	2,266	9
Total	407	-15	2,254	16	2,661	10

Table 1: Incoming orders – German chemical plants projects (2006 in million euros)

Germany: The end of the biodiesel boom?

On the other hand, the crest of the biodiesel wave in Germany, at least as far as new production facility construction is concerned, seems to have passed. Existing annual production capacity of around four million tons of biodiesel, higher taxes on this alternative fuel and a shortage of additional land for rapeseed cultivation (which is the basis of domestic biodiesel production) lead experts to believe that demand for new plant construction will be weak in the medium term, at least as long as only domestic feedstock is used. It came as no surprise that orders in this segment were only a modest €14 million in the reporting period compared to a record of €180 million in 2005. New production facilities for biodiesel and bioethanol will be built primarily in the EU, the US, China and Brazil in the near future.

International orders at a record high

Demand in the chemical engineering sector was driven primarily by international orders. The export quota was 85% (2006: 86%), which was significantly above the overall average for the large industrial plant manufacturing industry (77%). International orders reached a record of €2.3 billion, a 9% increase compared to 2005 (€2.1 billion). The main markets were the Caribbean, North Africa, the Middle East and the former Soviet Union. Large sums were invested in these regions in gas and oil processing facilities. Members of the working group also reported bookings from countries which traditionally have a strong chemical industry or a large local increase in consumption, for example China, Poland and Malaysia.

Latin America: Large investment in Trinidad and Tobago

In the wake of the economic crisis which shook Latin America in 2001, business activity slowed down significantly in the region. The effects of these events on the German plant engineering industry were reflected in lower bookings. Order volumes between 2003 and 2005 were down 35% compared to the long-term average. As the business recovery in Latin America has gathered

pace, investment activity has increased again, and this has been most noticeable in the chemical plant engineering sector. The largest market was Trinidad and Tobago. Construction of a huge petrochemical factory accounts for the lion's share of the orders valued at €850 million which were received from the island nation. Ammonia, liquid fertilizer and melamine can be produced at the new complex. Natural gas, which is extracted off the coast of Trinidad and Tobago and processed at the plant, is used as the feedstock for these products.

Medium-term sales prospects for the German chemical plant engineering sector are encouraging in Mexico and other Central American countries, because plans are in place for several large petrochemical projects and new refineries. The current biofuel boom in Brazil has driven demand for production facilities in recent years. There are plans to build 75 bioethanol plants between now and 2013 at a total cost of more than ten billion euros. Venezuela has large oil reserves, making it an attractive market for the chemical plant engineering sector. However, increased government control of the oil and energy market is having a negative effect on the domestic investment climate.

A slowdown in investments in the Middle East – Business potential in North Africa

The Middle East remains a key market for the German chemical plant engineering industry, despite the fact that bookings dropped significantly from €1.2 billion in 2005 to €345 million in 2006. However, this is only a snapshot view. The sustained trend towards increased value-add and the resulting planned investment in petrochemical plants and refineries would seem to indicate that demand will increase again in the near future. The fact that orders worth more than €700 million from the region were received from January to June 2007 (which is double the total for all of 2006) is a good indication that this assumption is well founded. Saudi Arabia was the most important customer for the German chemical plant manufacturing sector in the reporting period. Bookings from the kingdom stood at €266 million, and additional orders worth

Region	Inorganic chemistry		Organic chemistry		Total	
	2006	2005	2006	2005	2006	2005
Middle East	2	346	352	862	354	1,210
Asian-Pacific Region	40	23	300	230	340	253
Eastern Europe and CIS	152	2	183	38	335	40
Industrialized Nations	26	21	69	311	95	332
Rest of the World	21	7	1,121	233	1,142	240
Total	241	399	2,025	1,674	2,266	2,073

Table 2: International incoming orders by country group (2006 and 2005 in million euros)

€60 million were received from Iran. Overall, three of the ten largest national markets were in the Middle East during the past five years (see table 3).

The countries of North Africa, particularly Egypt and Algeria, are actively pursuing the goal of increasing local value-add. They are strengthening their economic base by converting oil and natural gas into high-value chemical and petrochemical products. The Egyptian fertilizer industry has recently been making massive investments to expand capacity, and German chemical plant engineering companies have received sustained benefit from these efforts. Orders valued at €228 million were received from Egypt last year (compared to €82 million in 2005). However, hopes for more orders from Libya following the improvement in political relations have not yet been fulfilled. A difficult restructuring process has just gotten underway at the large state-owned companies, and this has noticeably delayed the planned modernization of the refinery sector.

China still the leading market in Asia

China remains the major export market for German plant engineering firms in general, and this is particularly true for the chemical sector. German companies booked orders worth €166 million (2005: €183 million) from the People's Republic. The requirement for above-average local content, an extremely tough competitive environment and insufficient protection of intellectual property rights are characteristic features of the Chinese market. As domestic

demand continues to rise in China, the level of investment will increase across the board in the chemical industry, and in the petrochemical sector in particular. The country has large coal reserves, and there is significant interest in exploiting this resource as a raw material for the petrochemical industry. Initial orders have already been placed with German companies.

The national economies are growing very rapidly in Southeast and East Asia, and as a result the chemical industry is gaining a foothold or expanding in many countries in the region. In addition to China, Thailand and Malaysia are major markets for the plant engineering industry. A biodiesel industry using palm oil as the raw material is currently being established in these two Southeast Asian nations. The goal is to reduce dependency on imports of conventional fuel. Plants are also being built for the production of hydrogen and fatty alcohols which are used to make cosmetics and cleansers. Vietnam, South Korea and Taiwan are further important markets for the German plant engineering industry.

The Indian economy is growing at a remarkable rate. Political stability and a well functioning financial market provide a favorable environment for the manufacturing sector. Investments in infrastructure and expansion of the country's chemical industry have accelerated in recent years. Production of polymers, fine and special chemicals has grown at disproportionate rates. Despite intense international competition, German chemical plant engineering firms have good opportunities to modernize existing plants and

construct new production facilities. India is expected to remain one of the world's most attractive growth markets.

Strong growth in Eastern Europe and CIS countries – The market in the industrialized countries remains sluggish

German plant engineering companies booked orders worth €335 million from Eastern Europe and the CIS countries in 2006, which is a five-year high. Orders valued at an impressive €137 million were received from Poland (compared to €10 million in 2005). This mainly reflects investment in the petroleum processing industry. The growth of the Russian and Ukrainian economies, particularly the chemical sector, provided the stimulus behind several large contracts for electrolysis and PVC plants. Increased project activity is also evident in other countries in Eastern Europe and Central Asia.

No significant orders were received from Western Europe and North America last year. Working group members only received contracts for a few small expansion or revamp projects. However, because the European chemical industry is running at full capacity, there should be demand

for new orders including new turnkey projects in the medium term.

Despite sluggish economic performance, the North American market offers some attractive opportunities in the chemical plant engineering sector. The US market for coal liquefaction facilities is expected to show sustained growth, because the country plans to increase investment in this type of plant as part of its energy autonomy program. German chemical plant engineering firms have the right technology and should be well positioned to take advantage of increasing demand in this segment. The same applies to the biodiesel industry. Expansion of oil sand production in Canada will require significant new investment in large-scale production facilities (for example to extract heavy oil). This should also provide significant opportunities to the German companies.

Air separation and gas liquefaction

Air separation and gas liquefaction facilities are not included in the above mentioned bookings for the chemical plant engineering industry. However, it is an important market segment for the process industry, and it is worth mentioning. Orders received by suppliers of air separation and gas liquefaction systems increased last year by 71% to

Country	Orders	Types of plants ordered (examples)
1. Trinidad & Tobago	1,691	Facilities to produce methanol, ammonia and melamine
2. Saudi Arabia	1,113	Facilities to produce ethylene, propylene, fertilizer and olefins
3. Egypt	1,000	Fertilizer plants
4. Iran	983	Ethylene production facilities
5. P.R. China	613	Coal liquefaction and gasification facilities, coke plants
6. Poland	350	Electrolysis plants, production of aromatics
7. Oman	330	Fertilizer plant, methanol production facility
8. Belgium	321	Electrolysis plant, ethylene dichloride production facility (EDC)
9. Turkmenistan	249	Fertilizer plant
10. Libya	237	Petrochemical production facilities

Table 3: International bookings in major markets 2002-2006

a record €1.7 billion (2005: €1 billion). Strong demand for air separation facilities in 2006 was driven by applications such as the production of fuels from natural gas (gas to liquids or GtL) which has now become competitive due to the high cost of raw materials. Strong economic performance in the industrial gas sector is also stimulating the market. Demand for GtL facilities comes primarily from Northern Europe and the Middle East where liquefaction of natural gas is an economically attractive alternative to conventional transport of gas through pipelines.

Production capacity continues to increase

Customers have been asking engineering firms to build larger and more efficient chemical plants in recent years. Average output volumes of commodities (e.g. ethanol, methanol and ammonia) have increased by a factor of 2 – 5 during the past ten years (see table 4). It is still possible to manage even larger material and energy flows, but the production, transportation and handling of very large, heavy subsystems are becoming increasingly difficult. Furthermore, as more capacity comes online, concentration on a few mega projects represents a financial risk to the plant owners.

For the time being, the popularity of mega commodity plants is likely to continue. Increasing demand for the chemicals which are produced at those plants, particularly from customers in China and India, will ensure that global capacity does not

reach the saturation point. Relatively low investment per unit of output at these large-scale plants makes them significantly more profitable for their owners. For German companies which have established a solid position in the chemical plant engineering market, this trend is definitely good news, because it makes things more difficult for new entrants to the market. Engineering firms that cannot produce references from large, risky projects cannot obtain credit insurance, and for that reason alone they will not be invited to submit bids for these contracts.

Over the long term, increases in productivity and output capacity will be achieved through advances in process technology rather than through economies of scale. With this in mind, plant engineering firms are investing in the further development of nano, microprocess and microsystem technology. However, these technologies are still in their infancy, and it will take another few years before they are ready for wide-scale deployment.

New raw materials for the chemical industry

Petroleum has been the dominant raw material in the chemical industry for many years. However, rising oil prices in recent years have accelerated the search for alternatives. Natural gas, coal and biomass are potential substitutes. Which of these raw materials will be used on a larger scale in the chemical industry depends among other things on the availability and relative price of the raw

Plant Type	Capacity		
	~ 2000	~ 2005	~ 2010
- Ammonia urea plant	2,000 t/day	3,500 t/day	4,500 t/day
- Biodiesel plant	50,000 t/year	300,000 t/year	600,000 t/year
- Ethylene plant	600,000 t/year	1.5 million t/year	no information
- GTL plant	35,000 b/day	35,000 b/day	70,000 b/day
- Methanol plant	2,000 t/day	5,000 t/day	10,000 t/day

Table 4: Capacity of the largest process manufacturing plants (in metric tons per day (t/day), metric tons per year (t/year) or barrels per day (b/day))

materials.

In the short term, oil and above all natural gas will be important basic materials in the chemical industry. Coal should become more significant in the medium term. Projects which are focused on the production of chemicals or fuel directly from coal are underway or are in the planning stages in countries which have large coal reserves such as China, the US and Australia. However, high investment costs and problems surrounding carbon dioxide emissions are impeding the widespread use of coal-based techniques.

The use of biomass will increase in the long term assuming that prices for fossil-based raw materials do not fall significantly below current levels (and that appears to be a safe assumption). In the initial stages, improved conversion technology should make renewable raw materials economically attractive for selected chemical products. If the price relationship between fossil and sustainable raw materials continues to change significantly, then biomass could become a more important factor in the production of basic chemicals.

The members of the working group have in-depth expertise in the types of feedstock mentioned above. The companies are well-positioned to take advantage of future growth in the chemical industry regardless of whether oil, gas, coal or biomass is used as the raw material.

China – A new competitor in the international (chemical) plant engineering market

Companies based in Western Europe and North America dominated the plant engineering business until around 1960. Japanese plant engineering firms joined the elite group in the mid 1960s, and Korean companies became serious competitors in the early 1990s. Another Far East competitor entered the scene at the beginning of the current decade, namely the Chinese plant engineering industry.

In recent years, Chinese plant manufacturing companies have caught up very quickly and with a great deal of success. Their market share was negligible just a few years ago, but they have now captured market share in the three to five percent

range outside the People's Republic, and the figure is rising (see figure 1). Companies such as SINOMA (cement plants) and CTIEI (synthetic fiber plants) are already important players in their market segments.

Chinese companies have also become serious competitors in the chemical plant engineering market. Following initial successes in the South and Southeast Asian region early in this decade, Chinese engineering firms such as SINOPEC have been able to acquire more demanding customers in the Middle East.

Established market players have taken wide-ranging measures to counteract stiffer competition from the Chinese. In response to increasing price pressures in particular, German chemical plant engineering firms have set up or expanded their own local engineering, administrative and production capacity at sites in Eastern Europe, India and China.

There is no way of predicting where the Chinese plant engineering industry will be ten or fifteen years from now. In the short term, increased competition appears to be virtually unavoidable. German engineering firms will have to make every effort to maintain their technological and methodological advantage while keeping costs under control. They must also ensure that customers understand the economic advantages of German solutions. A holistic cost/benefit analysis which includes the ongoing operation phase reveals that engineering and hardware costs account for only a small percentage of total cost. The quality of the supplies, performance to schedule, availability, energy efficiency, plant productivity and the cost of the raw materials used in the process are far more important.

These factors in turn have a major impact on the financing terms and project ROI. A lifecycle analysis shows that initial construction only accounts for 10% of total cost, whereas raw materials account for 35%. From the holistic point of view, German engineering firms will still maintain a crucial advantage in the medium term over their Far Eastern competitors.

Industry strengths

In-depth expertise in project and risk management methodologies coupled with technology leadership and solid financing are the real strengths of the German chemical plant engineering industry. However, companies must continue to develop their expertise to ensure that they are able to cope as projects become larger and larger. The companies also have impressive world-wide procurement expertise, and they continue to expand their supply base without compromising their quality standards. They also fully exploit the advantages of global project management. After all, the international competitiveness of the German plant engineering industry is based on world-wide presence, innovation, excellent quality, performance to schedule and the ability to supply solutions which offer low lifecycle costs. In order to maintain their leadership role in the face of tough competition from companies in Europe, the US and Asia, German companies will have to continually develop their expertise.

Positive outlook for 2007 and 2008

The industry expects that demand will remain strong in 2007 and that orders will at least equal the good results of the previous year (€2.7 billion). Given the strong business performance of the chemical industry, the three billion Euro threshold could be reached this year for the first time. The long-term outlook for the chemical plant engineering industry is also excellent. The optimistic forecast is based on factors such as the continuing need for high investment in the rapidly growing economies in China and India, a recovery in the European chemical industry and the ample funds which are available for investment in countries that have large raw material reserves in the Persian Gulf region, North Africa, South America and the CIS. A continued deterioration in the Euro/Dollar exchange rate could dampen the outlook in key customer markets in the Middle East. However, the positives outweigh the negatives. The German chemical engineering companies are therefore optimistic that 2007 and 2008 will be good years for the industry.