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Forecast and Markets for Particulate Control Systems

There are many new particulate control technologies reaching commercialization. The market for any one specific technology is shaped more by the development of competitive technologies than it is by the growth in the total market. Air toxics legislation and power demand are two major factors that have to be considered in any long range, worldwide forecast. Technologies impacting the forecast in this decade include cleanable HEPA filters, condensing heat exchangers, wet precipitators, activated char scrubbers and dry scrubbers with additive injection. One of the most important discoveries is that the combination of electrostatic precipitators and SO_2 scrubbers perform much better than originally anticipated.

In 1992, the Asian precipitator market was considerably larger than either that in the Americas or Europe/Africa. In contrast, the largest market for fabric filters in 1992 was the Americas. In 1993, particulate control purchases in the United States will exceed those for gas treatment, primarily because of a temporary lull in the flue gas desulfurization market.

Introduction

The particulate market is technology driven. The outlook for electrostatic precipitators is shaped more by developments in competing technologies than it is by expansions and contractions in the total market. In order therefore, to predict the relative size of future markets for any one technology, it is necessary to assess the future developments in all competing technologies. This is an exciting time in particulate control. Traditional concepts are falling by the wayside and it is no longer possible to generalize on which technologies are applicable where. Who would have predicted that HEPA filters, which were traditionally considered unsuitable for dust collector applications would now be widely applied in Europe subsequent to the development of a suitable cleaning mechanism. Ten years ago, it would have been hard to convince anyone that U.S. utilities would ever become excited about pulse-jets. Who could have predicted a decade ago that activated char scrubbers would be widely applied on European municipal incinerators. At the last particulate conference, I predicted an interesting future for wet precipitators. The technology has been widely applied in the last several years. Utility boilers in Japan, sewage sludge incinerators in the United States, and a whole raft of other applications throughout the world are now incorporating wet precipitators. If one questions the fact that the market is technology driven and rapidly changing, compare the market share for wire and weight precipitators today versus 20 years ago.

Legislation

The market is also legislation driven and there is a chicken and egg relationship. Tighter legislation promotes new technology which promotes tighter legislation. A good example is the German waste incineration product developments. Early waste incinerators in Germany used combinations of precipitators and wet scrubbers for emission control. A succession of new laws, including TA Luft in 1986, and 17.Blm SchV more recently, have required augmentation and substitution of more efficient particulate control technologies. Spray dryers with the injection of activated char, when combined with fabric filters, provide considerably better particulate removal than the older systems. Another approach widely used is the incorporation of activated coke filters downstream of a two stage scrubbing system. Particulate is initially removed in an electrostatic precipitator or fabric filter. Two stages of scrubbing remove the mercury and the acid gases. The first stage is controlled at low pH to remove the mercury. The activated coke filter provides additional removal of all pollutants but specifically ensures removal of dioxins. These systems are capable of reducing total dust below 1mg/m^3 and reducing other pollutants to very low levels. The results obtained last year at the RZR Herten plant are shown in Figure 1.

Emission Laws	TA - Luft 1986		17.BImSchV		Herten IM 1 Daily
Period	Day	1/2 Hour	Day	1/2 Hour	Dec. 91 - Feb. 92
Total Dust	30	60	10	30	< 1 *
$\sum C_{org}$	20	40	10	20	< 2
CO	100	200	50	Hourly Average 100	25
HCl	50	100	10	60	< 2 *
HF	2	4	1	4	<0.5 *
SO_2 (SO_2, SO_3)	100	200	50	200	8
NO_x (NO, NO_2)	500	1 000	200	400	120
Heavy Metals	Class I: $\sum$ 0,2 Hg, Cd, Tl Class II: $\sum$ 1,0 As, Co, Ni, Se, Te Class III: $\sum$ 5,0 Pb, Sb, Cr, Cu, Mn, V, Sn		$\sum$ 0,05 Cd, Tl 0,05 Hg $\sum$ 0,5 Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V, Sn		< 0,007 ** < 0,002 * < 0,2 **
Dioxins and Furans as $\sum$ TE	not included		0.000 000 1		0.000 000 028 = 0.028 ng

FIGURE 1. HERTEN EMISSIONS (mg/M³ Adjusted to 11% O_2)

Air Toxics

A Steinmüller activated coke filter has been in operation at RZR Herten since August 1991. Extensive tests were conducted earlier this year and the results were released at Envitec. As shown in Figure 1, the performance of this system, is orders of magnitude better than required of waste incineration emission control systems in the rest of the world, and considerably better than required under the new German law 17. BlmSchV. The original German legislation, TA Luft set relatively stringent regulations in 1986 but as shown in column 3 of Figure 1, the new regulations are much tougher. With the addition of the activated coal coke filter to the system, the emissions values across the board have been reduced to very low levels. Mercury, cadmium and tantalum combined are less than 0.007 mg/m³. Dioxins and furans are only 0.028 ng/m³.

Just as in Germany the toxics shaped the decisions on particulate control technology, a similar scenario is developing in the U.S. One of the biggest decisions which will be made relative to the Clean Air Act and air toxics specifically, will be the determination of lesser quantity emission rates (LQERs). Some pollutants designated as air toxics in Title III of the Clean Air Act are thousands of times more toxic than other pollutants on the list. EPA is empowered to set definitions for major sources lower than 10 tons per year for these highly-toxic pollutants. EPA has drafted a plan to set lesser quantity emission rates (LQERs) for 47 toxic pollutants. The level below which emitters of these pollutants would be designated as major sources are shown in Figure 2.

Beryllium is limited to 0.1 tons per year or 200 pounds per year. A source emitting more than 200 pounds per year would be designated as a major source and would be required to utilize maximum achievable control technology. Assuming this requires 90 percent removal, the source would be required to emit no more than 20 pounds per year.

Since the proposed numbers are several orders of magnitude lower than the general definitions of new sources, the impact on industry will be tremendous. As we have pointed out earlier, the utility industry, which is not a participant at this stage, will be heavily impacted by these major source definitions. Many of the 47 air toxics are emitted in large quantities by utilities.

The LQERs were delayed by the Bush Administration moratorium on new regulations, but lesser quantity emission rates in one form or another are a necessary part of the Clean Air Act. The Clinton Administration may change the number, but logic says that the changes will not be orders of magnitude. This is because of the relative toxicity of the pollutants. States and localities have already utilized this relative toxicity index so if 10 tons per year is logical for a low-toxicity pollutant, then these very small quantities are logical for the highly-toxic pollutants.

When it comes to the determination of maximum achievable control technology, EPA will be looking at air pollution control equipment which has high efficiency. For example, a 5000 CFM fabric filter that emits .01 grains/SCF will emit 4000 lb/year of particulate. But there are lots of new alternatives. These include wet precipitators, accordion and rigid element filters, and cleanable absolute filters. The cleanable absolute filter manufacturers are citing emission levels as low as 0.00001 mg/Nm^3. Using our 5000 CFM example, this would result in a particulate emission per year of just a fraction of a pound. This would allow emitters of arsenic and chromium to meet MACT standards of 2 pounds per year.

	Tons/year	Lbs/year
2,3,7,8 TCDD Dioxin	0.0001	0.2
N-nitroso-N-methylurea	0.001	2
Benzidine	0.001	2
Bis(chloromethyle) ether	0.001	2
N-nitrosodimenthylamine	0.01	20
Chromium compounds	0.01	20
Asbestos	0.01	20
Hydrazine	0.01	20
Arsenic	0.01	20
1,2-propylenimine	0.01	20
2-acetylaminofluorene	0.01	20
Aziridine	0.01	20
Dimethylcarbonyl chloride	0.01	20
Beryllium compounds	0.1	200
Cadmium compounds	0.1	200
Acrylamide	0.1	200
Heptachlor	0.1	200
Coke oven emissions	0.1	200
Nickel compounds	0.1	200
Hexachlorobenzene	0.1	200
Mercury	0.1	200
Acrolein	1	2000
2-chloroacetophenone	1	2000
Phosgene	1	2000
Chlordane	1	2000
Dichloroethyl ether	1	2000
Toxaphene	1	2000
1,3-butadiene	1	2000
1,2-diphenylhydrazine	1	2000
Ethylene dibromide	1	2000
Ethylene oxide	1	2000
Vinyl chloride	1	2000
Acrylonitrile	1	2000
Benzene	1	2000
Chloromethyl methyl ether	1	2000
M-methylene diphenyl diisocynate	1	2000
Methyl hydrazine	1	2000
1,2-dibromo-3-chloropropane	1	2000
Acrylic Acid	1	2000
Manganese compounds	1	2000
Phosphorus	1	2000
Diazomethane	1	2000
Parathion	1	2000
Methyl isocyanate	1	2000
Phosphine	1	2000
Hexachlorocylcopentadiene	1	2000
Dibenzofurans	1	2000

FIGURE 2. LESSER QUANTITY EMISSIONS RATES (LQERS)

New Approaches to Utility Particulate

With the new administration, it is justifiable to predict a new approach to utility particulate emissions. The Clean Air Act of 1970 adopted a particularly tough policy toward new power plants relative to particulate emissions. Small particles were identified as possible carcinogens and new power plants were limited to emission of just 0.1 lb per million Btu. Over the next seven years, Congress became even more concerned about the emission of these small particles and mandated that new power plants be required to emit less than 0.03 lbs per million Btu. Since most power plants historically were only operated for 20 years, Congress could reasonably project that by 1990, all the old power plants would be retired and all the utility plants in the nation would be complying with New Source Performance Standards.

In reality, what happened was that the very legislation that was designed to reduce utility particulate emissions had exactly the opposite effect. Utilities stopped building new coal-fired power plants in part because it was more economical to rebuild existing plants to avoid the more stringent controls. Inexplicably, the Clean Air Act Amendments of 1990 did not address this unintended consequence of the original Act. Instead, less toxic pollutants, such as NO_x and SO_x, were the sole focus of utility regulations under Title IV. The result is that a utility can reduce its SO_2 and NO_x without regard for the impact of those decisions on particulate emissions.

Utilities have two main options for dealing with the SO_x reduction requirements. They can either switch fuels or install scrubbers. Installation of scrubbers to remove SO_2 will simultaneously remove up to 90 percent of the particulate matter now being emitted by these old plants. If they switch fuels and do not upgrade their particulate control equipment, they are likely to increase particulate emissions. However, since there are no penalties or benefits achieved by changes in particulate emissions, SO_x and NO_x, decisions have been made, in some cases, without regard to particulate implications (except in the locations with state or local regulations).

This is a major error and oversight in the Clean Air Act Amendments of 1990. In many cases, the cost of scrubbing and the cost of fuel switching are nearly the same, yet most of the utilities are opting for fuel switching. If they had been given some incentive to reduce particulates, major reductions could have been achieved at very low cost. The average German coal-fired power plant, for instance, which uses scrubbers along with its efficient precipitators, emits less than one-tenth of the particulate being emitted by the average coal-fired power plant in the United States.

The new administration has emphasized its commitment to the environment and its interest in market-based approaches for improving the environment. We see an opportunity to make major reductions in utility particulate emissions with some market-based incentives. The proper approach will not only reduce fine particulate matter, but will also achieve a major reduction in air toxics that are addressed in Title III, including the heavy metals. In fact, one logical way to implement this policy would be to give utilities the same opportunities for early reduction that chemical plants and other industries subject to air toxic laws under Title III have obtained. One of the problems is that utility air toxics have not been quantified. However, in general, it is known that the air toxics being emitted by a new coal-fired power plant with proper precipitators and scrubbers are relatively low compared to those of existing plants. The early reduction provision, therefore, could provide protection for those utilities that reduce emissions to a level equal to that of new coal-fired plants meeting New Source Performance Standards. These plants would be exempt for a given period of time from any subsequent air toxics regulation which is applicable to power plants. A benefit to the utility industry of such a policy would be to eliminate much of the uncertainty relative to air toxics. The ability of scrubbers to remove particulate is consistently underestimated.

Contracts are consistently being written wherein the SO_2 scrubber supplier is only required to guarantee that the net particulate removal efficiency is 0 across the scrubber. Just as consistently when the unit finally operates, the particulate removal is quite high. The latest instance of this is the performance of the scrubber system at Northern Indiana Public Service Company Bailly Units 7 and 8. The system is now operating. The inlet concentration to the scrubber ranges from .032 to .045 gr/SCF. The removal efficiency ranges from 65 to 82 percent. The lowest removal efficiency correlates with the lowest inlet concentration. So, at the lowest efficiency the outlet emission is 0.01 gr/SCF.

There are a number of other exciting possibilities for reducing particulate emissions. Since, however, they will be adequately covered later in this conference, there is no need to duplicate this information. The exciting possibilities for retrofitting pulse-jet filters to existing precipitator installations will be extensively covered in Session A-2 tomorrow. At 1:00 tomorrow, there will be a presentation on the condensing heat exchanger by representatives from Consolidated Edison Company. This technology offers the possibility of improving the conversion from coal to electricity by extracting enough heat from the flue gas to reduce it as low as 80° F and simultaneously by condensation effect remove heavy metals, such as mercury. In Session A-5, B & W will present data on a high temperature baghouse which also removes acid gases and Lutz Bergmann will provide information on additives that combine charcoal and lime for control of heavy metals, along with acid gas removal.

Utility Market

Market forecasts for the particulate control worldwide are based on specific assumptions relative to the penetration of novel technology. They are also based on another important assumption relative to the role of coal versus other fuels in the generation of power.

Utilities worldwide will spend over $800 billion in the next 10 years for fossil-fired power generation equipment and related air pollution control systems. Figure 1 shows the distribution of these expenditures by region. Asia will be the largest purchaser followed by the Americas and then Western Europe. Here are some specific conclusions from the study.

- Coal gasifiers will be twice as popular as fluid bed combustors. Gasifier orders will total over $120 billion during the next decade.
- Developing countries will be among the largest purchasers. For example, the Indian market will be $20 billion larger than the Japanese. China will be the largest purchaser of power generation equipment.
- More than $20 billion will be spent for particulate control equipment worldwide. Nearly 50 percent ($10 billion) will be for electrostatic precipitators in Asia. Electrostatic precipitators will outsell fabric filters 4 to 1.

Figure 4 reflects the large investment in precipitators for new coal-fired boilers. Asia will be the largest investor in precipitators. However, Australia and the United States will be two countries in which a significant percentage of the total particulate control equipment will be fabric filters. Nevertheless, we are projecting a four-to-one ratio of precipitator to fabric filter purchases by the worldwide utility industry.

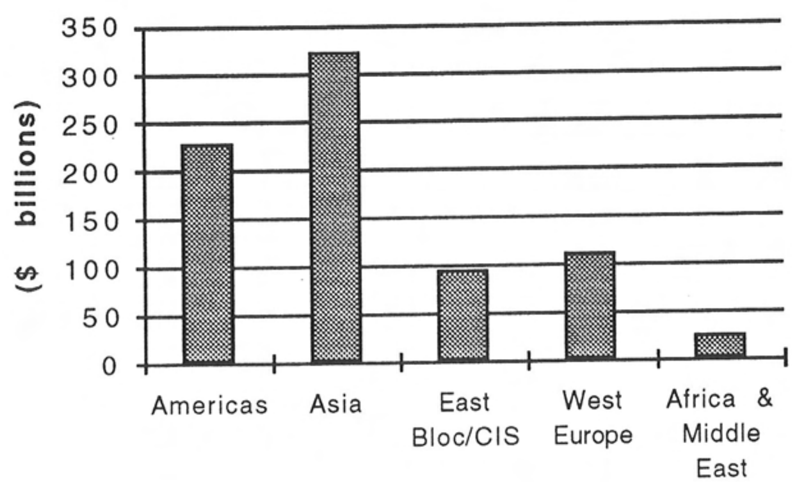

FIGURE 3. WORLD POWER GENERATION AND AIR POLLUTION CONTROL ORDERS 1993-2003

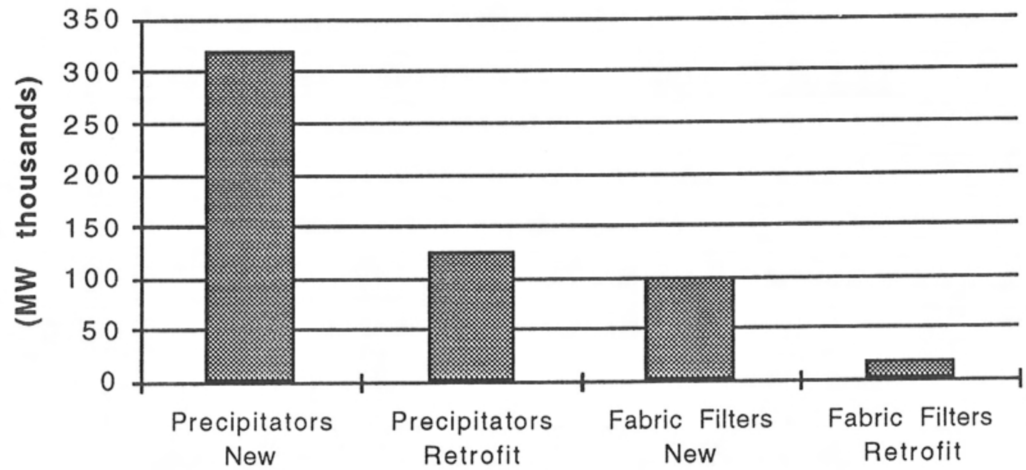

FIGURE 4. WORLD PARTICULATE CONTROL ORDERS (MW)

World Market (All Industries)

Fabric filters are much more popular in the broad range of industries. Therefore, as shown in Figures 5 and 6, the 1992 fabric filter market was larger in both the Americas and the Europe/Africa segment than was the precipitator market. Only in the Asia segment was the precipitator market in 1992 larger than the fabric filter segment.

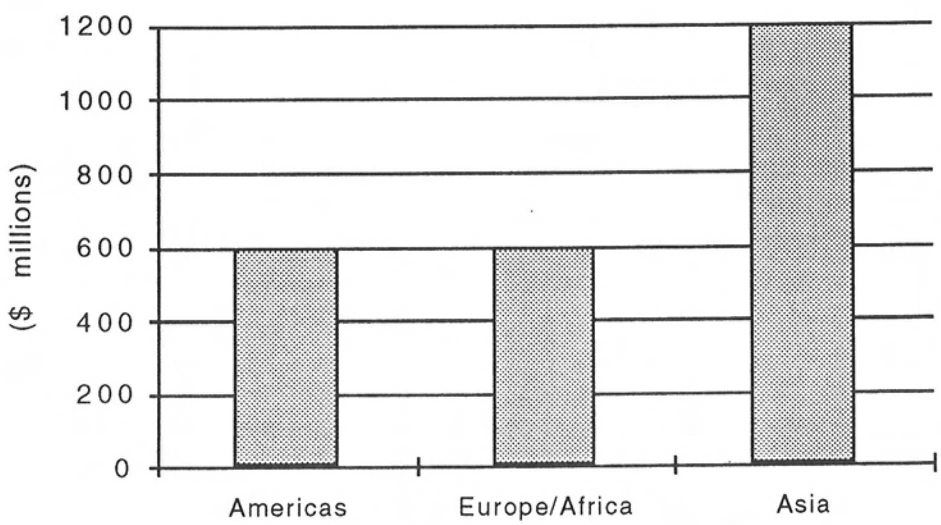

FIGURE 5. 1992 PRECIPITATOR MARKET

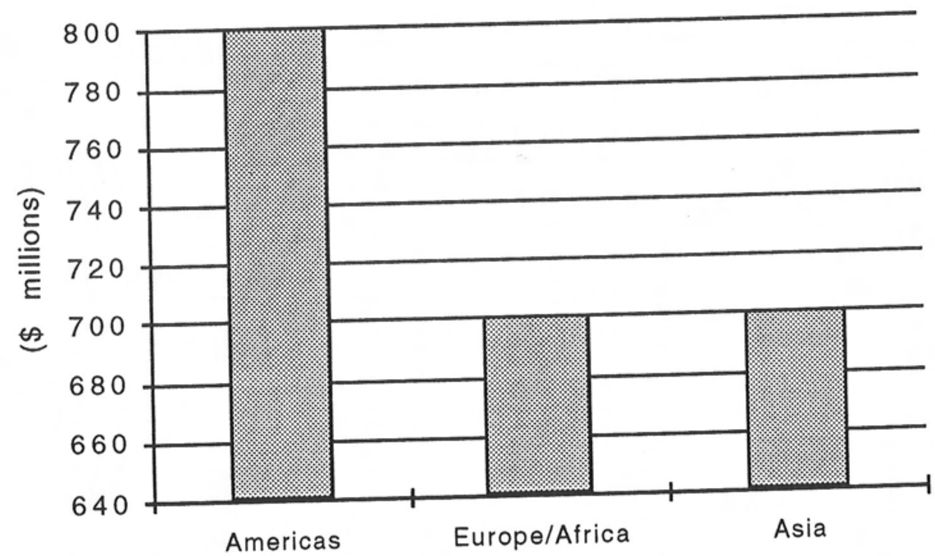

FIGURE 6. 1992 FABRIC FILTER MARKET

The fastest growing market for both air and water pollution control equipment is in a group of nations which includes the Association of Southeast Asian Nations (ASEAN) and South Korea. It includes the so-called dynamic Asian economies of Hong Kong, Malaysia, Singapore, South Korea, Taiwan, and Thailand. It also includes Indonesia, the Philippines, and Brunei. This group of nations bought over 6% of the air pollution control equipment purchased worldwide in 1992 despite having only 3% of the world's gross national product.

Taiwan will be one of the largest purchasers of air and water pollution control equipment within the region due to a commitment to spend $37 billion in the next six years to clean up land, air, and water pollution. Hong Kong is making large investments in new power plants. South Korea will build 16 large coal-fired power plants in the next 10 years.

Market Segment	$ Millions
Particulate Control Systems and Parts	$1,530
Gas Treatment	$1,456
Monitoring & Sampling	$525
Consulting	$500
Other Equipment & Systems	$200
TOTAL	$4,211

FIGURE 7. 1993 U.S. AIR POLLUTION CONTROL MARKET

U. S. Market

Figure 7 provides a forecast for the U.S. air pollution control market in 1993. This includes orders by the full gamut of industries. Utilities will be the largest purchasers, followed by the chemical industry. The pulp and paper industry will be the third largest industrial segment, while petroleum refining will be fourth. Other industries that will be making substantial investments include primary metals, iron and steel mills, cement manufacturers and the mining industry. As shown in Figure 7, particulate emission control orders will slightly exceed those for gas treatment. One reason is the reduction in orders for flue gas desulfurization systems for power plants.

California is the largest state with 12% of the U.S. population. It is the largest manufacturing state, with 10% of all U.S. manufacturing. It has the toughest air pollution regulations in the United States. So, it must therefore be the largest air pollution market? Not so. In fact, the 1993 U.S. air pollution market of $4.2 billion is spread throughout the states. Wisconsin is the leading state in the pulp and paper category, New York in printing and publishing, Texas in chemical and petro-chemical. Texas is also the largest energy producer with 12% of the fossil-fired boiler electricity generation in the U.S. Ohio is the largest manufacturer of primary metals and is also the largest emitter of sulfur oxides from power plants. New York has the largest number of planned waste-to-energy projects.

Many different industries purchase air pollution control equipment and since different industries are concentrated in different states, pollution control purchases are widely scattered. In 1993, Pennsylvania will be the leading purchaser of fabric filters, with 9% of the total purchases, followed by Texas at 8%, Illinois at 6%, Ohio at 5%, and California at 5%.

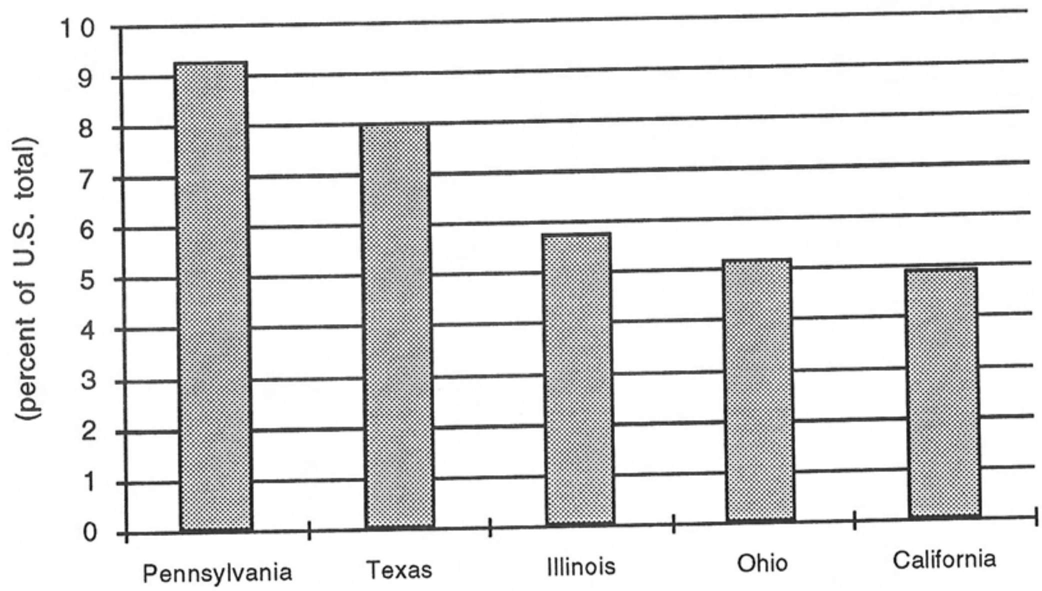

FIGURE 8. 1993 U.S. FABRIC FILTER MARKET

Summary

This is a period of rapid development in particulate control technology, coupled with legislation that is moving swiftly to greater stringency. The market for particulate control technology is large and growing. In Europe and the United States, the market will be influenced greatly by air toxics legislation. In Asia, the major influence will be the need for coal-based power generation.