INCREASED OPPORTUNITIES FOR COAL IN INDUSTRIAL MARKETS

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Introduction

The national and world situation today present a tremendous opportunity for coal in the industrial market. Oil prices have abruptly risen to about four times the Btu price of coal. There is some shift in political climate in the direction of more carefully considering the economic impact of environmental constraints on burning coal. Technologies have evolved which permit the use of coal in systems which meet and often exceed environmental regulations with respect to emissions of SO_2, NO_x, and particulates.

Price of Oil and Gas Relative to Coal

The historical prices of oil and gas relative to coal on a Btu basis are shown in Figure 1. (References 1, 2, and 3) From 1930 till 1979, the price of oil relative to coal averaged a little over twice the Btu cost of coal. During the same period, natural gas prices never exceeded the price of coal. These trends were abruptly broken beginning in 1979 when oil prices relative to coal reached about 4:1 and gas prices for the first time exceeded coal prices. There is every reason to believe that natural gas prices will approach oil prices over the next few years and that the overall upward trends in price will continue.

In 1930, 80-90% of all industrial boilers fired coal. During intervening years, oil and gas have become the predominant fuels for industrial boilers because of their relative low cost, environmental acceptance, lower capital costs for equipment and overall ease of operation. Fewer and fewer boilers capable of firing coal were installed during this period.

It is a thesis of this paper that the present and anticipated price advantage of coal will trigger a major increase in industrial use of coal. In fact, some vendors report that essentially no new oil fired boilers are being built today.

In Figure 2, the historical, present and future trends for boilers with capability to fire coal (Reference 4) are shown. New coal fired systems were almost non-existant through the late 70's.

The evidence is now very strong that coal will have increasing role in the next ten years, especially in the larger boilers.

The information in Figure 3 illustrates the economic driving force for converting oil fired to coal fired boilers. The long term trend for oil prices is clearly up in spite of significant decreases during the last 12 months. Coal prices, even with relatively expensive environmental control devices, are still much lower than oil costs. Based on these data, coal is clearly a bargain now and is likely to be even more of a bargain in the future.

Market Potential

A detailed examination of the potential market for industrial coal fired units will be presented later today. (Reference 5) However, the magnitude of the market potential can be inferred from the data presented in Table 2 (Reference 6). At an assumed load factor of 50% some 267 million tons of coal could be required to replace existing oil fired capacity. Although some coal fired units have been sold in sizes of only a few thousand pounds per hour of steam (pph), it is likely the convenience of oil and gas firing will make it difficult for coal to dominate the under 10,000 pph market. Table 2 shows that even the market limited to boilers of greater than 25,000 pph could still yield coal sales of 150 million tons per year. Realization of only a small percentage of this total market potential could have an enormous impact on coal sales, equipment vendors, etc.

Boiler Technology and Pollution Control

Industrial boilers over 250,000 pph are governed by the Federal New Source Performance Standards (NSPS) with respect to SO_2, NO_x and particulates. Boilers in the 100,000 to 250,000 pph size range, are not federally controlled but regulations for NO_x and particulates for these units are being reviewed.

Various state requirements may be set up for units over 10,000 pph and local areas may also have their own emission regulations. There are several boiler technologies available and these can cope with emission control in different ways. Figure 4 (Reference 4) shows the breakdown by firing method and size for industrial boilers as a function of time. In 1930 the spreader stoker had not yet been introduced and PC (pulverized coal) firing was just taking hold. Stokers dominated the market. By 1950 the spreader stoker had gained wide acceptance in all size ranges and PC units dominated the 250-500,000 pph size range. PC units accounted for about 80% of the latter sized units in 1970 and will continue to hold this share in 1990. The smaller size range was dominated by stokers, especially the spreader stoker, and this should also be true in 1990.

Some of the technologies now available for emission controls in the larger boilers can be briefly listed. Discussion of individual processes is beyond the scope of this paper.

SO_2 Removal

1. Pulverized coal systems using wet or dry scrubbers.
2. Limestone injection into modified burners (LIMB Process).
3. Stokers with wet or dry scrubbers.
4. FBC with limestone addition.

NO_x Control

1. Pulverized coal using burner adjustments to control NO_x.
2. Stoker systems usually do not exceed NO_x requirements (0.6 lb/MM Btu).
3. FBC units operating at low temperatures have very low NO_x emissions ($\approx$ 0.3 lbs/ MM Btu).

Particulate Control

Based on site specific conditions, cyclones, wet scrubbers, electrostatic precipitators, or bag houses can be used to control particulates.

We believe that the emerging fluid bed combustion technology offers an improved way to burn all grades of coal in an environmentally acceptable manner. There are several exciting new processes now being offered in the 50-200,000 pph size. The status of this technology will be described in another paper later in this conference. (Reference 5)

In very small installations (less than 25,000 pph), the high cost of control systems makes low sulfur coal about the only reasonable option. This coal does sell at a premium and may have limited availability.

Capital Costs of Coal Fired Boilers

The cost of equipment to burn coal is somewhat greater than equipment costs to burn oil or gas. However, these costs are low

compared to other technologies being considered to replace oil in the American economy.

Table 2 compares the relative capital costs of synfuels, power generation and industrial boilers required to replace a barrel per day of oil. Synfuels have the greatest technological risk and require the most capital. Additionally this capital is required in massive chunks which can strain the budget of even the largest energy company. Power generation is still expensive but the risk factor is reduced. Industrial systems are the least expensive option of all.

Summary

In considering all the major factors influencing the choice of fuel, a strong case can be made for increased use of coal in future industrial markets.

1. Cost of Fuel

   Cost advantage of coal (including control technology) is very substantial compared to oil. As the cost of oil and gas become prohibitive, the coal option becomes of very great importance.

2. Capital Cost of Boiler

   Capital cost of coal fired industrial boilers to replace oil units is significantly lower than the cost of electric utility plants or synthetic fuel plants. These costs are greater than capital costs to burn oil but we assume that oil costs make its future use prohibitive for much of the industrial market.

3. Environmental Constraints

   Advanced technology is just becoming available to meet SO_2 and NO_x requirements on industrial size boilers. The cost of suitable technology to remove sulfur from coal has been a major impediment to the expanded use of coal as an industrial fuel. It is hoped that economical solutions to this problem are near.

4. Convenience of Fuel Use

   Oil and gas firing are clearly the choice from the standpoint of user convenience. However, continued improvements in boiler systems make coal a more

acceptable choice — especially considering the overall savings in annual cost of fuel. Remember that essentially all industrial boilers were coal fired in the early 30's.

It is our considered judgment that the economic driving force and new technological developments will lead to significant increases in environmentally acceptable coal utilization in the next ten years.

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TABLE 1

Distribution by Size of Oil Fired Industrial Boilers

Size MM Btu/hr	Number of Units	Total Capacity MMM Btu/hr	MM[1] Bbl/day	Coal Equivalent[2] MM tons/yr
1.5 - 25	93,083	551.4	1.10	105.0
25 - 250	11,254	663.4	1.33	126.3
250 - 500	341	114.3	0.23	21.8
>500	78	74.1	0.15	14.1
Total	104,756	1403.2	2.81	267.2

1. Based on 50% load factor and 6.0 MM Btu/Bbl
2. Based on 50% load factor and 23 MM Btu/ton

TABLE 2

ROUGH COMPARISON OF CAPITAL COSTS TO REPLACE ONE BARREL PER DAY OF OIL

	Annual Load Factor, %	Capital Cost $/BPD Replaced of Oil
Synfuels	90	28,000 to 44,000
Electricity	70	37,500
Steam/Heat (Industrial Boilers)	50	14,000
	95	7,400
Heat (Home Furnace)	25	12,000 to 48,000
	40	7,500 to 30,000

Note: Steam/Heat Industrial Boilers are shown to be less capital intensive than either synfuels or electricity.

RATIO OF OIL OR GAS COST TO COAL COST

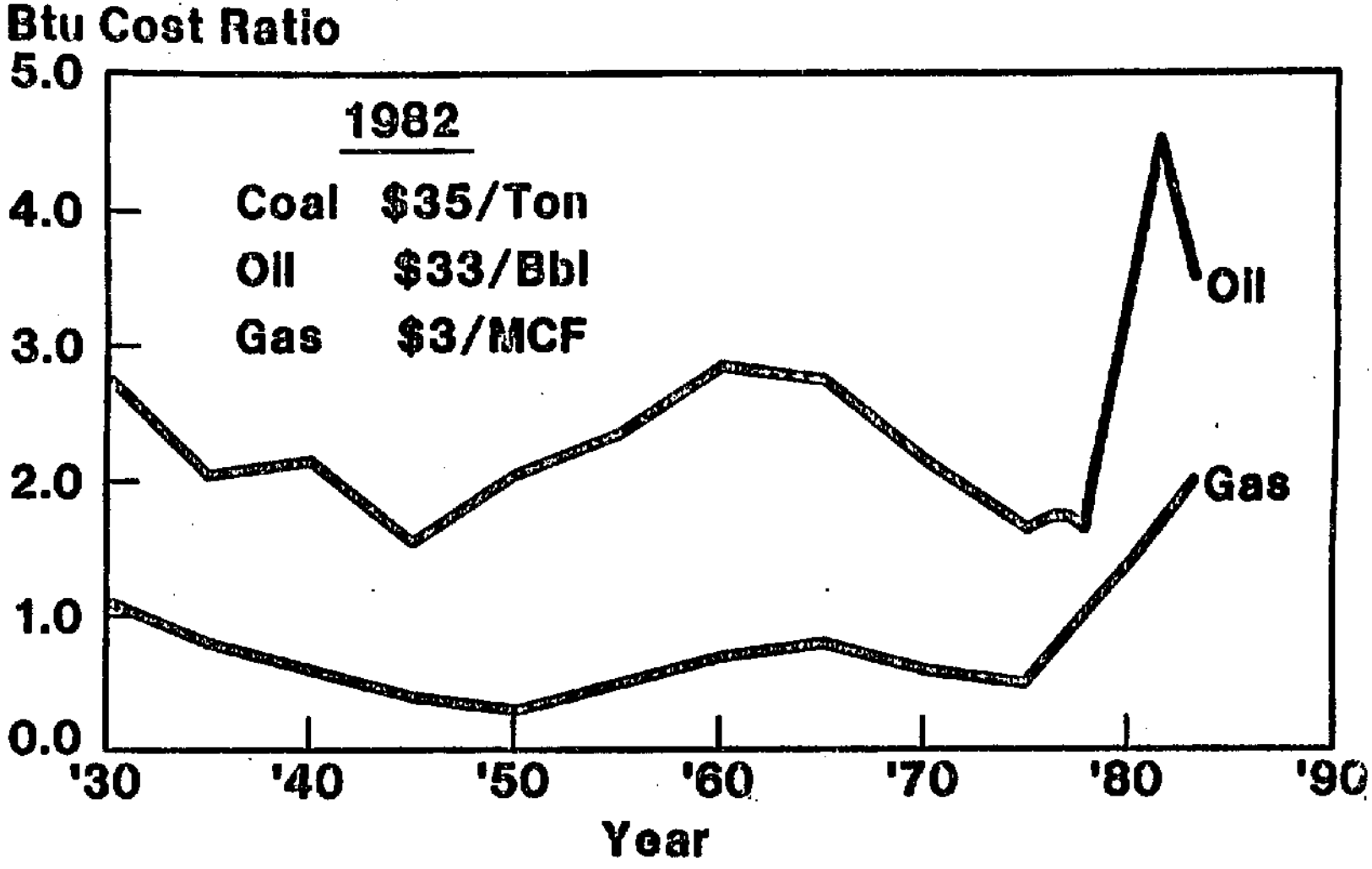

FIGURE 1

BOILERS HAVING CAPABILITY TO FIRE COAL

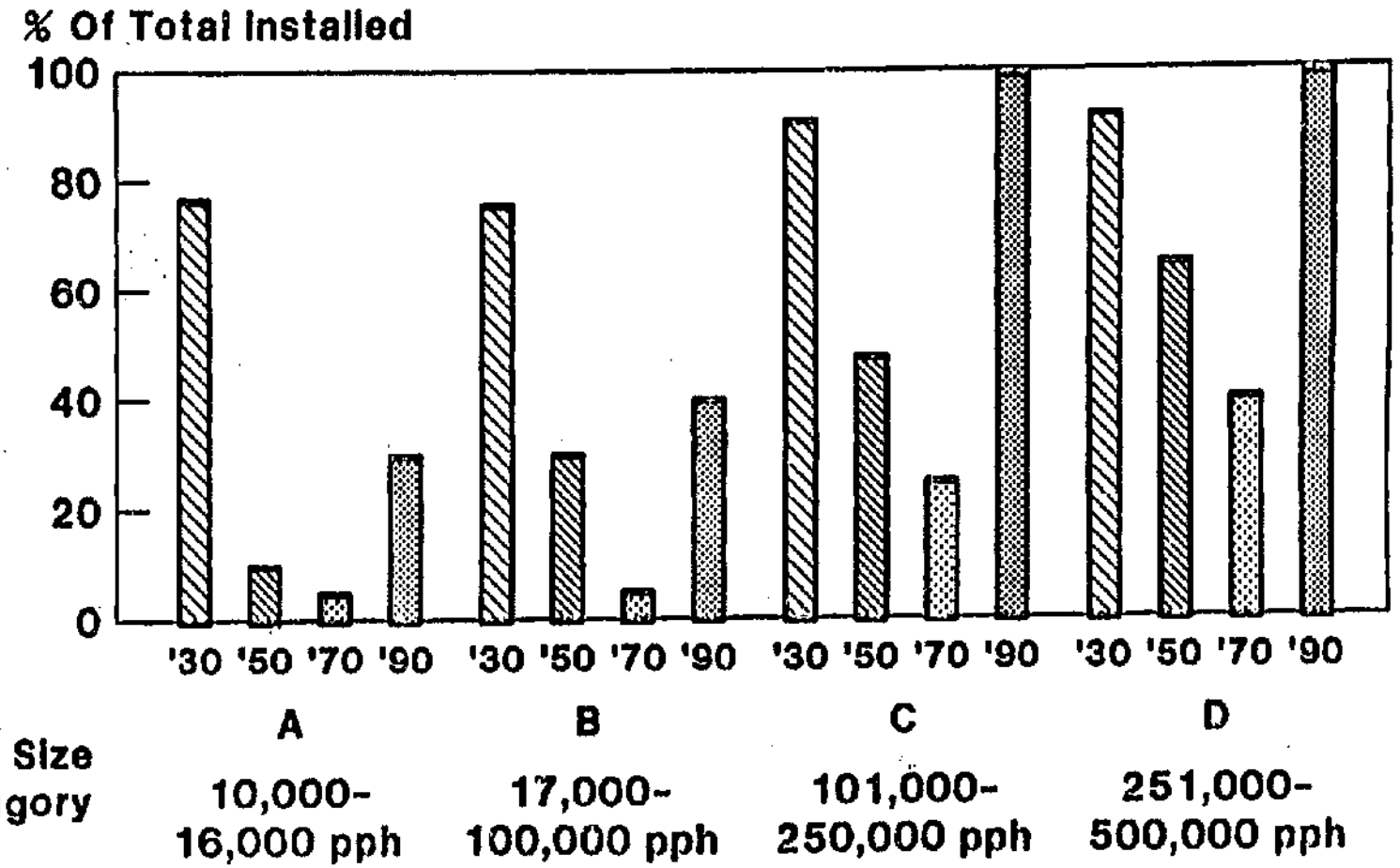

FIGURE 2

ROUGH COMPARISON BETWEEN COST OF OIL AND COAL PLUS FGD

BASIS: (1) OIL PRICE AT $40 PER BBL AND 15% ESCALATION PER YR (SINCE 1973, CRUDE OIL HAS INCREASED IN PRICE AT AN AVERAGE ANNUAL RATE OF 35%).

(2) COAL PRICE AT $1.45 PER MM BTU PLUS FLUE GAS DESULFURIZATION AND 10% ESCALATION PER YR.

(3) COAL PRICE AT $1.28 PER MM BTU PLUS FLUE GAS DESULFURIZATION AND 10% ESCALATION PER YR.

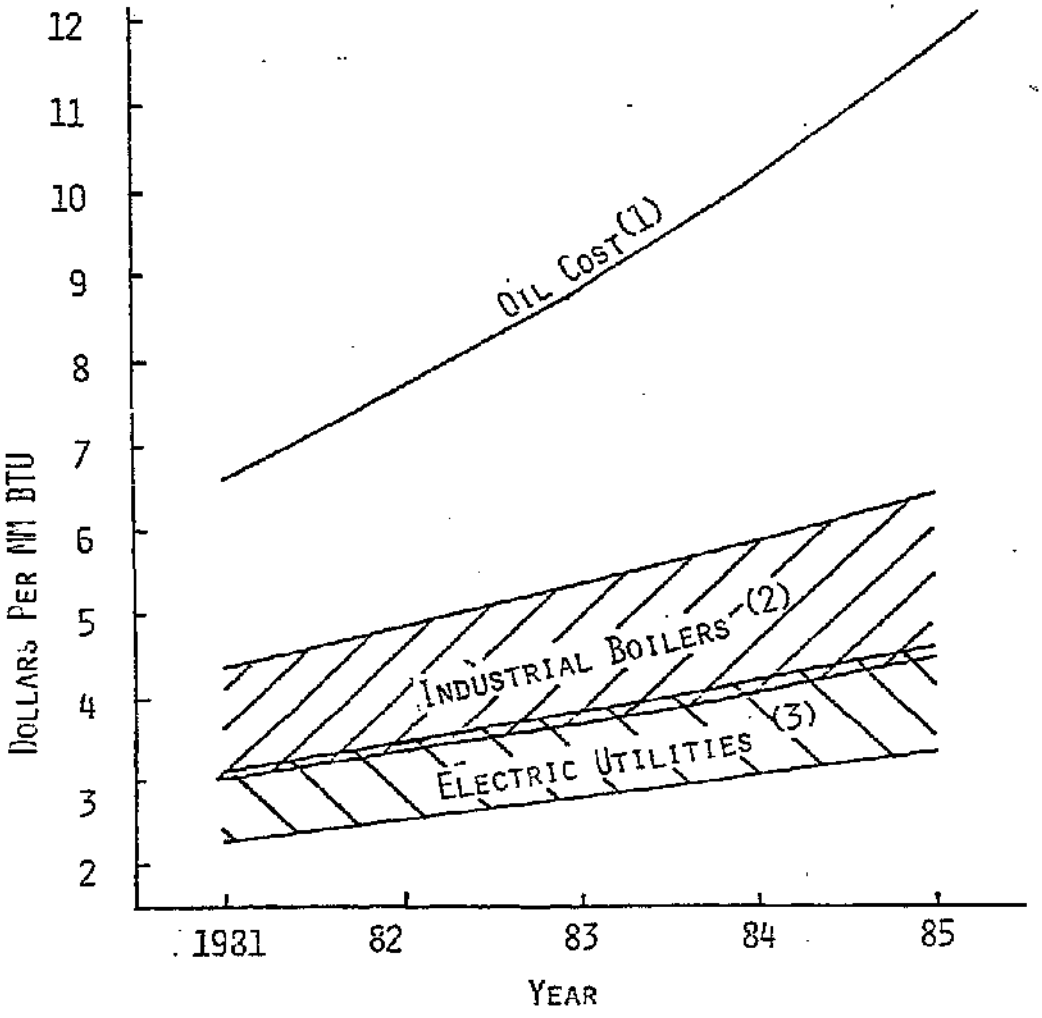

FIGURE 3

BREAKDOWN BY FIRING METHOD OF SOLID-FUEL BOILERS

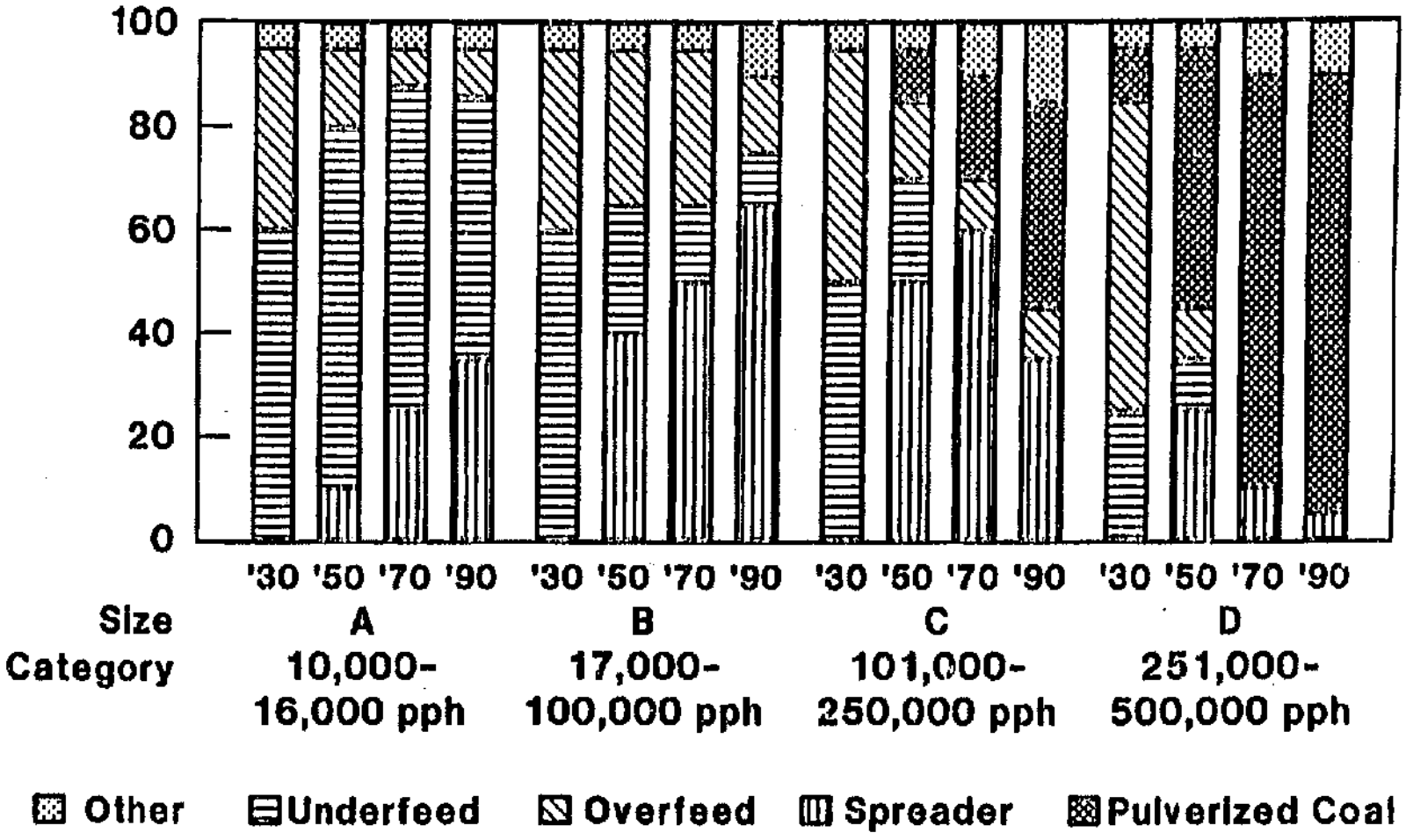

FIGURE 4