Determining the Economic Feasibility of Industrial Waste Fired Boilers

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INTRODUCTION

The purpose of this paper is to present two possible methods of determining the Economic Feasibility for Industrial Waste Fired Boilers.

Today, industry recognizes the problem of air pollution, i.e., the presence in the outdoor atmosphere of substances, in quantities, which are injurious to human, plant or animal life, to property, or which interfere with the property. Because of its existence, Federal, State and Local legislation against air pollution has been enacted. To circumvent this problem, the disposal of industrial wastes from manufacturing operations can be accomplished in different ways.

1) Burning wastes in an open dump.
2) Burning wastes in an incinerator.
3) Burying wastes in a dump.

Incineration has been adopted by industry as a reliable and effective method of disposal for solid and liquid wastes.

There is increasing use of incinerators as a means of disposing of industrial waste materials. The present high fuel cost and continuous increasing cost of waste dumping has prompted investigations to determine the engineering and economic feasibility of using industrial wastes as a fuel for steam generation. The characteristics of industrial wastes are changing with the use of plastics and synthetic materials, many of which have high heating values, with little moisture or ash.

To determine the heat available from industrial waste the unit heat values (Btu per pound) have to be obtained from scientific tables and/or through colorimeter tests. This data is a prerequisite in attempting to design an incinerator furnace.

Industrial waste materials include general plant refuse, and production wastes, with heating values ranging from 4000 to 20,000 Btu per lb.

Many problems are encountered in the burning of wastes. Each installation must be specifically engineered to take care of the needs particular to the plant involved.

Incinerator designs have been improved as a result of data made available from an accelerated research program on physical and chemical characteristics of industrial wastes.

Two approaches can be used in the evaluation of industrial waste fired boilers:

1) Consideration of a complete new boiler installation to burn industrial wastes.
2) Consideration of conversion of an existing boiler to burn wates.

NEW BOILER INSTALLATION

This portion of the paper relates to the installation of a 50,000 pounds per hour Industrial Waste Fired Boiler adjacent to an existing boiler house where the steam produced can be fed easily into the plant steam header. The new boiler house would be an extension of the existing boiler house, so that the normal operating crew would take on the duties of operating the additional unit. The waste-handling and

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storage facilities would require additional personnel. The industrial waste fired boiler would be equipped with a stoker to burn 27,000,000 pounds of waste materials annually. Fuel oil will also be burned to maintain steam loads, in addition to insure complete combustion of waste gases in the furnace.

With the present types and quantities of waste available, complete burning would be accomplished easily in a two (2) eight hour shift operation. However, the boiler will be kept on the line continuously with fuel oil being burned during those periods when no waste materials are available. This continuity of operation should minimize maintenance costs.

An overall boiler efficiency of 65% when burning industrial wastes, and an overall boiler efficiency of 75% when burning fuel oil have been assumed for the boiler operation.

CONSTRUCTION COSTS

The waste fuel-oil fired steam generator capacity was selected on the basis of a two (2) shift operation for five (5) days a week. This provides latitude to burn possible future increases in plant wastes.

Fuel firing equipment for both industrial wastes and fuel oil are adequate to carry the boiler steam load independently of each other.

In addition to the boiler and stoker, the cost estimate includes auxiliary equipment such as: piping, fans, all necessary duct work, refractory, boiler breeching, combustion control, fuel oil storage, fuel oil pumps and heaters, chemical feed pump, waste fuel handling facilities, electrical work, building expansion, site preparation and a steel stub stack. The cost estimate does not include water-treating equipment, deaerating heater, boiler feed pumps since all this equipment is available in the present installation. See Table No. 1.

OPERATING COSTS

Labor

Manpower requirements for boiler operation will not increase. The only additional manpower necessary will be to handle industrial wastes.

Crane operator 2 (one per shift).
Attendant 2 (one per shift).

Total payroll including benefits and payroll taxes amounting to an annual cost of $32,000. Maintenance is done by the present plant maintenance crew, with charges allocated to jobs done.

Maintenance

Maintenance costs include labor and material for the equipment and building extension. The estimated average annual cost is approximately $10,000.00.

Additional Electric Power

The estimated annual cost of electric power required to operate induced draft and forced draft fans, waste handling equipment, stoker, oil firing equipment and lighting is approximately $6,500.00

Cartage of Wastes

Cost of annual waste pick-up from different departments and its transportation to the boiler house is estimated at approximately $54,000.00

Fixed Charges

Fixed annual charges on capital investment including depreciation, taxes and insurance as computed for industrial installations amount to approximately $58,000.00.

Fuel Credit

The only credit assumed is the present cost for fuel necessary to generate an equivalent quantity of steam in the present boiler house operation. An annual steam production from burning wastes has been computed on the basis of an overall industrial waste fired boiler efficiency of 65 percent. The cost of fuel to produce the equivalent pounds of steam on an annual average in the present boiler house would be approximately $78,500.00.

BOILER CONVERSION

This part of the paper relates to the modification of an existing boiler to burn industrial wastes. The existing coal stoker fired boiler would be modified so that full steam generation would still be possible when burning 27,000,000 pounds of industrial wastes annually and/or fuel oil.

The steam generated will be used by the plant and be part of the overall steam supply. The regular boiler house operating crew will continue to operate the converted boiler. Additional personnel would be required to load the wastes into the fuel storage-charging area. The converted boiler will be equipped with a new stoker to burn industrial wastes, and fuel oil firing to burn fuel oil. The boiler is expected to operate at a constant load with the aid of the fuel oil burner irrespective of fluctuations caused by the variations in the characteristics of the industrial wastes fired. Burning fuel oil should also assist in completing combustion of the waste gases in the furnace.

With the present types and quantities of waste available, complete burning should be accomplished easily in a two (2) hour shift operation. However, the boiler will be kept on the line continuously with fuel oil being burned during those periods when no waste materials are available. This continuity of operation should minimize maintenance costs.

An overall boiler efficiency of 65 percent when burning industrial wastes, and an overall boiler efficiency of 75 percent when burning fuel oil have been assumed for the boiler operation.

CONSTRUCTION COSTS

The waste fuel-oil fired steam generator capacity, 50,000 pounds of steam per hour, was selected on the basis of a two (2) shift operation for five (5) days a week. This provides latitude to burn possible future increases in plant wastes. Fuel firing equipment is adequate to carry the full boiler load, using either industrial wastes or fuel oil independently of each other.

The cost estimate for the boiler conversion includes the removal of existing coal stoker, installation of new stoker, adaptable to industrial waste firing, new oil burners complete with wind box and blower, new forced draft fan, new induced draft fan with motor drives, fuel oil pump and heater set, complete furnace water cooling, changes in flues and ducts, fuel oil storage, fuel oil piping, electrical work, and waste handling equipment. The cost estimate does not include steam or boiler feed piping, deaerating heater, boiler feed pumps, etc. because all this equipment is available in this present installation. See Table No. 5.

OPERATING COSTS

Labor

Manpower requirements for boiler operation will not increase, the only additions to manpower necessary to handle industrial waste are:

Waste Material Handler 3 (one per shift).

Total payroll includes benefits and payroll taxes amounting to an annual cost of $30,000.

Regular maintenance is done by plant maintenance or outside contract with charges allocated to boiler operations.

Maintenance

Maintenance costs include labor and material for the equipment. The estimated average cost is approximately $10,000.

Additional Electric Power

The estimated annual cost of electric power required to operate induced draft fan and forced draft fans, waste handling equipment, stoker, oil firing equipment and fuel oil pumps is approximately $6,500.

Cartage of Wastes

Cost of waste pick-up from different departments and its transportation to the boiler house is estimated at approximately $54,000 per annum.

Fixed Charges

Fixed charges on capital investment including depreciation, taxes and insurance as computed for industrial installations amount to approximately $21,000 per year.

Fuel Credit

The only credit assumed is the present cost for fuel necessary to generate an equivalent quantity of steam in the present boiler house operation. An annual steam production from burning wastes has been computed on the basis of an overall industrial waste-fired boiler efficiency of 65 percent. The cost of coal to produce the equivalent pounds of steam on an annual average in the present boiler house would be approximately $78,000.

TABLE 1. ESTIMATED CONSTRUCTION COSTS FOR BOILER PLANT ADDITION

Item	
1.	Boiler Erected $270,000
	Stoker and Fuel Oil Firing
	Flues and Breeching
	F. D. Fan and I.D. Fan
2.	Fuel Oil ..... $ 20,000
	Storage
	Pump and Heater Set
3.	Auxiliaries ..... $ 15,000
	Combustion Control
	Chemical Feed
	Boiler Blowdown
4.	Waste Handling ..... $ 35,000
	Monorail
5.	Piping ..... $ 20,000
	Boiler
	Fuel Oil
	Combustion Control
	Miscellaneous
6.	Electrical ..... $ 10,000
	Feeder
	Control
	Wiring
7.	Building Expansion $210,000
	Foundations
	Structural Steel
	Walkways and Misc. Steel
	Super Structure
	Plumbing & Drains
	Lighting
8.	Site Preparation ..... $ 10,000
	Grading
	New Driveway
9.	Contingency ..... $ 60,000
10.	TOTAL ESTIMATED COST $660,000

TABLE 2. BOILER ADDITION SUMMARY OF ANNUAL OPERATING EXPENSES AND AMORTIZATION CHARGES

	ANNUAL OPERATING EXPENSES		$102,500
1.	Labor	$32,000	
2.	Maintenance	$10,000	
3.	Electric Power	$ 6,500	
4.	Cartage	$54,000	
	FIXED CHARGES		$ 58,000
5.	Depreciation		
6.	Taxes		
7.	Insurance		
	TOTAL ANNUAL EXPENSE		$160,500

TABLE 3. BOILER ADDITION ANNUAL GROSS SAVINGS

Item		Present Cartage to Dump	Proposed Waste Fired Boiler
1.	Labor	–	$ 32,000
2.	Maintenance	–	$ 10,000
3.	Electric Power	–	$ 6,500
4.	Cartage	$130,000	$ 54,000
5.	Total (Items 1 to 4)	$130,000	$102,500
6.	Fuel Credit	–	($78,500)
7.	Total (Item 5 minus Item 6)	$130,000	$ 24,000
8.	Annual Gross Savings	0	$106,000

NOTE: Depreciation, Obsolescence and Taxes not included

TABLE 4. BOILER ADDITION ESTIMATED ANNUAL RATE OF RETURN

Item		1st Yr.	2nd Yr.	3rd Yr.
1.	Estimated Annual Gross Savings	$106,000	$106,000	$106,000
2.	Expense Portion of Installation	$ 10,000	0	0
3.	Annual Increase in Fixed Charges	$ 58,000	$ 58,000	$ 58,000
4.	Savings Before Taxes	$ 38,000	$ 48,000	$ 48,000
5.	Annual Federal Tax at 52%	$ 20,000	$ 25,000	$ 25,000
6.	Net Annual Savings	$ 18,000	$ 23,000	$ 23,000
7.	Estimated Installation Cost (Capital Portion)	$650,000	$650,000	$650,000
8.	Rate of Return on Capital Portion	2.8%	3.5%	3.5%
9.	Average Rate of Return		3.3%	

TABLE 5. ESTIMATED CONSTRUCTION COSTS FOR BOILER CONVERSION

Item		
1.	Boiler Conversion Removal of present Stoker Removal of Front Wall Installation of New Stoker Installation of Complete Furnace Water Cooling Flues and Breeching Installation of New F.D. Fan and I.D. Fan Installation of Fuel Oil Firing	$200,000
2.	Fuel Oil Storage Pump and Heater Set	$ 15,000
3.	Auxiliaries Changes in Combustion Control	$ 5,000
4.	Waste Handling	$ 35,000
5.	Piping Fuel Oil Hydraulic and Combustion Control Miscellaneous	$ 10,000
6.	Electrical Feeder Control Wiring	$ 5,000
7.	Contingency	$ 30,000
8.	TOTAL ESTIMATED COST	$300,000

TABLE 6. BOILER CONVERSION SUMMARY OF ANNUAL OPERATING EXPENSES AND AMORTIZATION CHARGES

	ANNUAL OPERATING EXPENSES		$100,000
1.	Labor	$30,000	
2.	Maintenance	$10,000	
3.	Electric Power	$ 6,500	
4.	Cartage	$54,000	
	FIXED CHARGES		$ 21,000
5.	Depreciation		
6.	Taxes		
7.	Insurance		
	TOTAL ANNUAL EXPENSE		$121,000

BOILER CONVERSION ANNUAL GROSS SAVINGS

Item		Present Cartage to Dump	Proposed Converted Boilers to Waste Firing
1.	Labor	–	$ 30,000
2.	Maintenance	–	$ 10,000
3.	Electric Power	–	$ 6,500
4.	Cartage	$130,000	$ 54,000
5.	Total (Items 1 to 4)	$130,000	$100,500
6.	Fuel Credit	–	($78,500)
7.	Total (Item 5 minus Item 6)	$130,000	$ 22,000
8.	Annual Gross Savings	0	$108,000

NOTE: Depreciation, Obsolescence and Taxes not included.

TABLE 8. BOILER CONVERSION ESTIMATED ANNUAL RATE OF RETURN

Item		1st Yr.	2nd Yr.	3rd Yr.
1.	Estimated Annual Gross Savings	$108,000	$108,000	$108,000
2.	Expense Portion of Installation	$ 50,000	0	0
3.	Annual Increase in Fixed Charges	$ 21,000	$ 21,000	$ 21,000
4.	Savings Before Taxes	$ 37,000	$ 87,000	$ 87,000
5.	Annual Federal Tax at 52%	$ 19,500	$ 45,500	$ 45,500
6.	Net Annual Savings	$ 17,500	$ 41,500	$ 41,500
7.	Estimated Installation Cost (Capital Portion)	$250,000	$250,000	$250,000
8.	Rate of Return on Capital Portion	7%	16.5%	16.5%
9.	Average Rate of Return		13.5%	