UPDATE OF COAL GASIFICATION FOR INDUSTRY

by

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RILEY STOKER CORPORATION
WORCESTER, MASSACHUSETTS

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Remember these headlines? They're less than a year old but are now almost forgotten. A warm summer has a way of dulling our memory of a previous winter. These headlines recall the winter of 1976-1977 when temperatures dropped to record lows, natural gas was in short supply, freight trains were frozen and oil and coal barges were locked in the ice of eastern rivers and bays, industrial plants closed throughout the eastern and midwestern parts of the country, and millions were added to the rolls of the unemployed.

At the time I had mixed emotions. As a home owner I watched my heating bills go out of sight and, unlike Congress, I had no way of voting myself a cost of living increase. However, as a sales manager I saw the winter as a means of overcoming the apathy that had gripped the nation regarding energy.

Last winter finally brought home to the public and to industry that there truly was a shortage of domestic oil and natural gas. Interest in coal firing, particularly coal gasification, grew tremendously. Inquiries from industry inundated our office while visits to our gas producer installation increased fourfold and inquiries from A&E's representing a broad range of industry occupied a good deal of our time. During this same period, ERDA was signing contracts for half a dozen low BTU demonstration plants for industrial applications and had plans for approximately thirty more. A dozen manufacturers were geared up to meet the anticipated demand. It looked to us at Riley Stoker Corporation as if five years of development work and millions of dollars invested in gas producer technology was about to pay off.

SPRING THAW

Then came a new administration in Washington and a spring thaw. The pressure was off, fuel demands were down, industrial plants were reopening, and people were going back to work. The administration, demonstrating its faith in the American way and free enterprise, decided not to deregulate natural gas and oil nor to create incentives for finding new reserves. Instead a price would be set on natural gas, well below that of imported oil and any synthetic fuel including producer gas. In addition there would be no incentives for the installation of first generation gas producers to solve today's shortage; instead R&D money would be spent on solving the energy problems of the 1990's. For the 1970's and 1980's, we can huddle around our fireplaces wearing longjohns and heavy sweaters. That is referred to as "conservation".

Up to the present time, Riley Stoker Corporation has invested more than three million dollars in the redevelopment and testing of the Riley-Morgan Gas Producer. The installation shown in Figure 1 is located at our R&D Center in Worcester, Mass. It houses a full scale commercial-size gas producer, Figure 2. The installation was completed in December of 1974 and has operated on a number of eastern coals including anthracite and caking and non-caking bituminous coals. Based on predictions that a large market for gas producers would develop about 1976, Riley established a very elaborate program to test most major types of coals on both air and oxygen. However, as the prospects for this market development fades further into the future, we have suspended any further Company-sponsored tests and have instead undertaken test programs for individual companies on specific fuels.

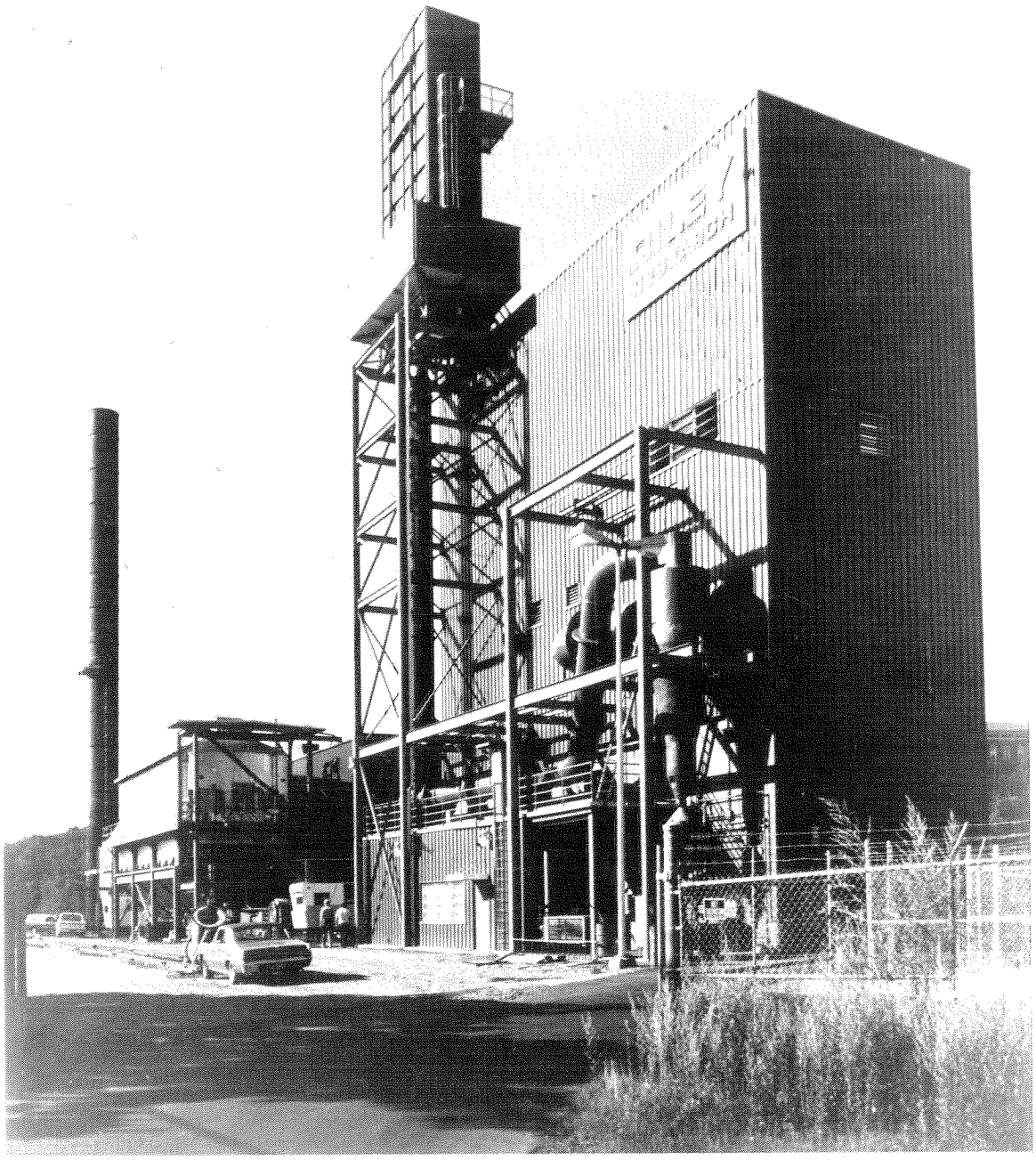

Figure 1. Demonstration Plant

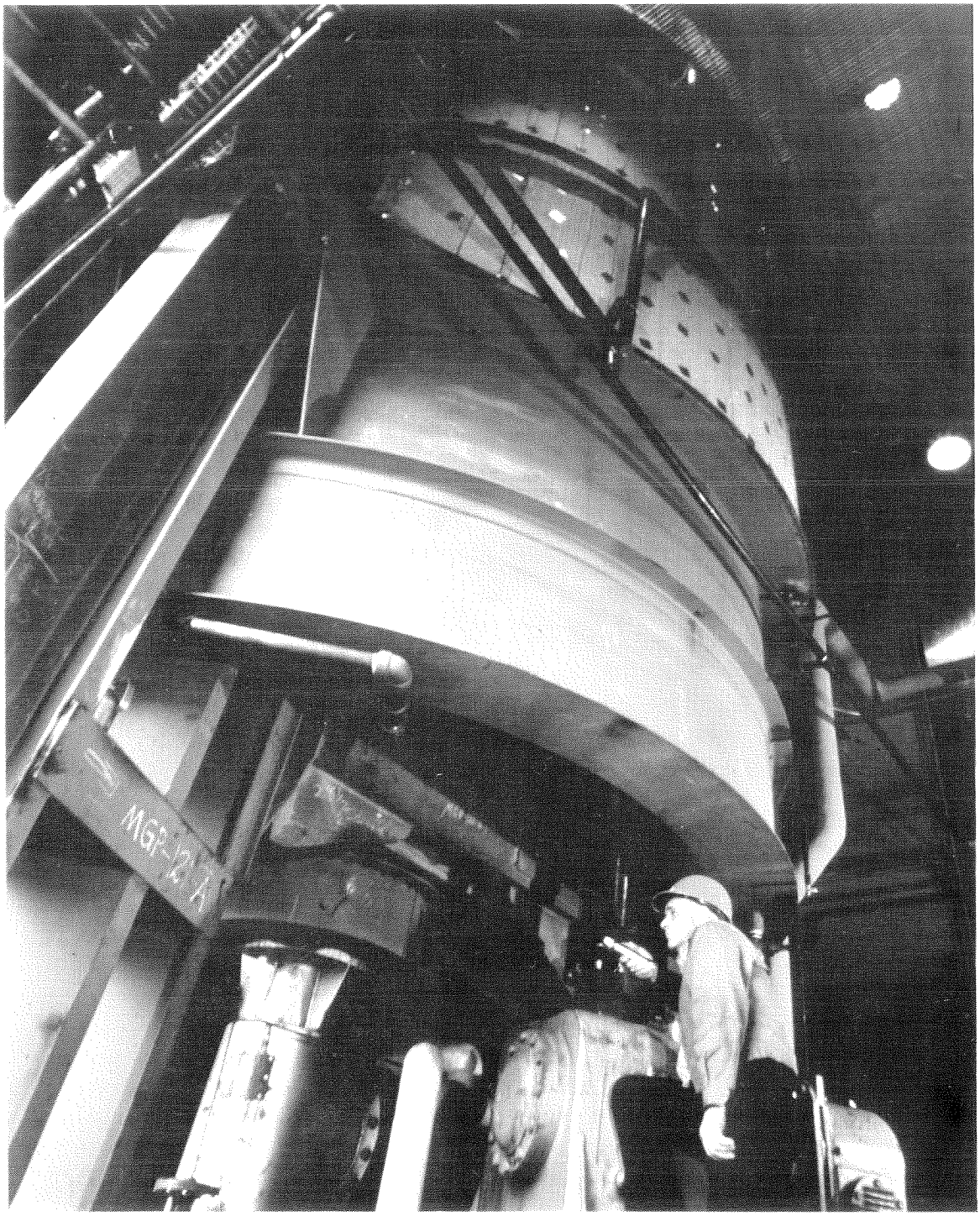

Figure 2. Completed Gas Producer

During the past year, we have received numerous inquiries from people who were excited by some of the optimistic costs quoted by various sources for low BTU gas. Unfortunately most of these figures are based on 100% load factors which rarely exist in real life. I would like to develop a few rules of thumb for the application of low BTU producer gas by listing a few simple cases.

CASES AND APPLICATIONS

Case I - Producer Gas versus Direct Fired Pulverized Coal

We have received a number of inquiries from people interested in firing producer gas in coal fired boilers rather than adding an SO_2 system to the boiler. Let's look at some of the economics associated with such a substitution. Consider a typical 450 MW coal fired utility boiler which is base loaded. The efficiency of this unit is about 89.5% and it will fire 372,000 lbs. of coal per hour. The average availability is 85%. The yearly consumption of coal is 1,385,000 tons. At $20 per ton the annual cost of fuel is $27,700,000.

If we modify the boiler to produce maximum continuous rating (MCR) on low BTU gas (150 Btu/SCF), we find that the boiler efficiency is reduced to 81%. The efficiency of the gas producer and cleanup train is about 68%. Therefore, our new fuel requirement is 2,250,000 tons per year at a cost of $45,000,000. The additional fuel cost per year is $17,300,000, while the cost of the boiler modification may run up to $20 per KW.

Rule 1 - Fire coal directly whenever possible.

Case II - Effect of Load Factor on Cost of Gas

A number of inquiries have been received for the application of low BTU gas as the sole source of process and heating fuel for small industrial parks. Let's investigate this application. The parks operate 10 hours a day 5 days a week for a load factor of about 30%. The cost of the plant including gasifier, cleanup system, land, utilities, interest during construction, startup and cost and inventory is shown in Table I. The plant will generate 631,626 million BTU's per year at 100% load factor. At a 30% load factor the cost of gas will more than double due to the fixed capital cost and wages.

Rule II - Low BTU Gas is economical only if there is a high load factor.

Case III - Application of Low BTU Gas to Existing Oil and Gas Fired Boilers.

Figure 3 illustrates four different types of boilers including a large utility type boiler, two intermediate size field erected industry boilers, and a shop assembled package boiler.

Our investigations show that producer gas with a BTU value of approximately 300 BTU/SCF has the same general characteristics as natural gas and can be fired in all types of boilers with only minor modifications to the burners. However, for commercially available gasification units to produce this type of gas, a source of oxygen is required. The gas from an air-blown unit is approximately 150 BTU/SCF with bituminous coal. Since oxygen plants can be justified for only the very large units, we will limit our discussion to air-blown gasifiers and 150 BTU gas.

The utility boiler shown is a 600 MW unit designed for crude oil firing. With low BTU gas this unit would either have to be derated to 65% of MCR, or would require a major modification due to problems associated with the increased mass flow through the unit. In this case an oxygen blown system may be justified.

The industrial unit is rated at 600,000 lbs. of steam per hour and was designed for oil firing. With low Btu producer gas this unit would make full rating but would be 40° F low in superheat and 8% lower efficiency. While no modification need be made to pressure parts, the burners, windbox, and airheater would have to be modified along with the I.D. fan and ductwork.

TABLE I

Total Plant Investment

Coal Gasification and Ash Removal System	$1,250,000
Cleanup Train (Tar and Sulfur)	3,000,000
Utilities	500,000
Engineering fees	500,000
Subtotal	$5,250,000
Contingency 15%	787,500
Total Plant Investment	$6,037,500
Interest during Construction, Coal Inventory and Startup Cost 20%	1,207,500
Total Capital Requirements	$7,245,000

Owning and Operating Cost

		Cost/Million BTU's	
	$/Year	100% Load	30% Load
Investment Cost (15.2% of total capital requirements. This is based on 30 year life, 3.2% straight line depreciation, federal and local taxes and insurance)	$1,101,240	1.744	5.812
Fuel Cost (32,850/9855 tons @ $25/ton	$ 821,250/ 246,375	1.300	1.300
Maintenance Cost (3% of total Capital Requirements	$ 217,350	0.344	0.344
Operating Cost/5 Shifts 1 man per shift @ $9.00 hr.)	73,600	0.145	0.493
Other operating costs	62,800/ 18,840	0.099	0.099
		3.632	8.048

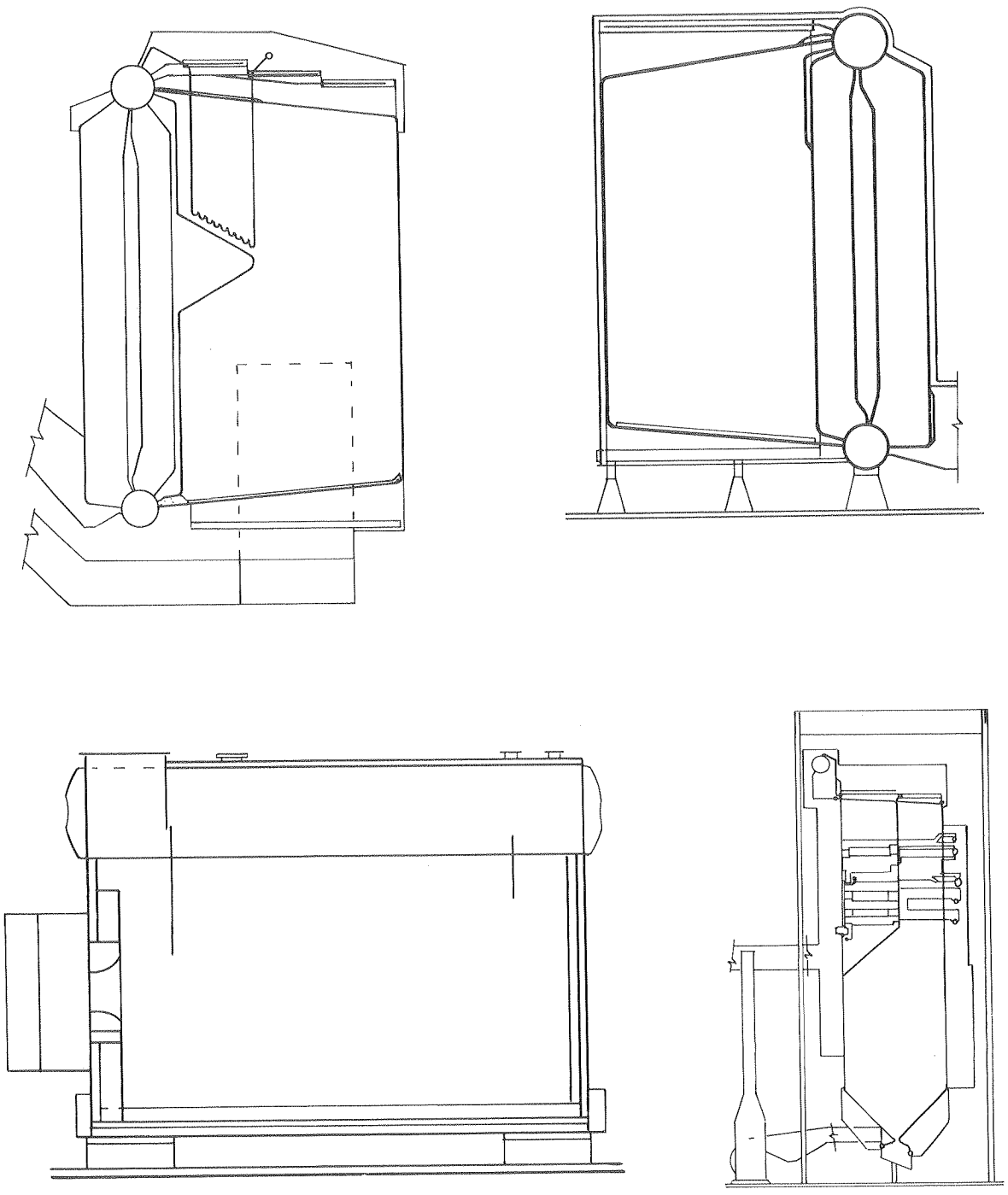

Figure 3. Four Types of Boilers

The smaller industrial unit is rated at 180,000 lbs. of steam per hour and designed for natural gas firing. It can make full rating with low BTU gas but will require modification to the burners, windbox, and will suffer a loss of about 3% in I.D. fan efficiency.

The package boiler is rated at 60,000 lbs. of steam per hour and is designed for natural gas firing. This unit will make full rating on low BTU gas after modification of the burner and windbox, but fan performance is marginal. This unit will also suffer a loss of about 2% in efficiency. While this unit can make full rating on producer gas, note the size of the producer installation as compared to the package boiler (Figure 4). If a cleanup train is required it would require about three times as much space as the gas producer.

Rule III - Don't assume that producer gas can be substituted for natural gas in a boiler without checking with the boiler manufacturer.

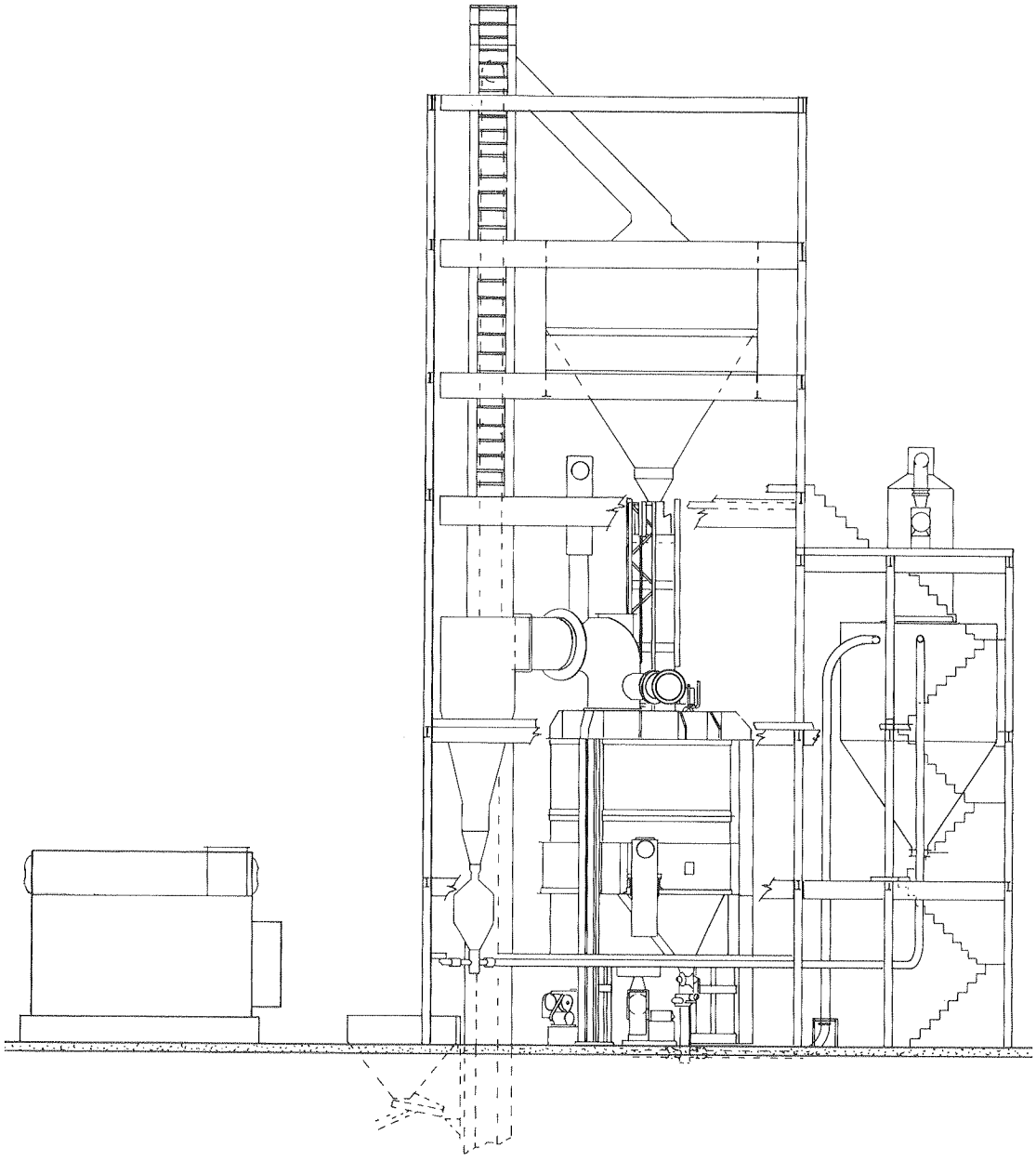

Figure 4. Comparison - Gas Producer to a Packaged Boiler

EQUIPMENT MUST BE DEMONSTRATED

The commercially available gas producers and clean up trains have years of operating experience behind them, but unfortunately not as an integrated system. It is this combination of equipment which ERDA is attempting to demonstrate through their Program Opportunity Notes (PON's) and Request for Programs (RFP's). At the present time contracts for six industrial demonstration plants have been signed: one will provide gas for a brick kiln, one will provide fuel gas for iron ore pellitizing and another will provide gas for a zinc smelter operation. All should have high load factors and appear to be excellent applications for producer gas. The remaining three contracts are boiler applications. One is for space heating and for food drying in a processing plant; one is for space heating and cooling of a residential/industrial complex and the last is for space heating of a college campus. It will be interesting to follow the development of these projects to see if the economics can justify these applications.

Unfortunately, the small group of contracts mentioned above are all government supported. The large industrial market for gas producers has just not developed and even if orders were placed now it is doubtful that many would be in place for the winter of 1978-79 let alone this coming winter. Recent forecasts predict that even less natural gas will be available this winter than last; so for the sake of the economy let's hope for a string of mild winters.

In the meantime, manufacturers of gas producers stand ready to serve, but it appears that they also serve who only stand and wait.