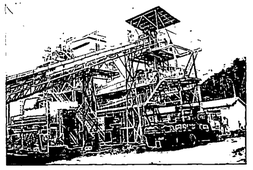
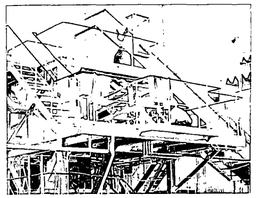
World Wide Operating O'Connor Combustor Plants

The first O'Connor Rotary Combustor was built in 1975 by Ishikawajima Harima Heavy Industries (IHI) under license from O'Connor Combustor Corporation. This 30 ton per day pilot plant unit was utilized for extensive systems evaluation and for testing the combustion of various types of municipal, industrial and agricultural solid waste products.

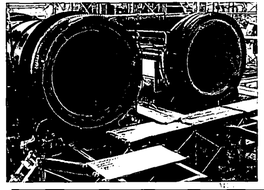
Following completion of this successful two-year "shake-down" and test evaluation program, the O'Connor Combustor technology was released for commercial availability in 1977. Since that time, a total of eight O'Connor Combustors have been built and are operating in five different plants in the U.S.A. and abroad.



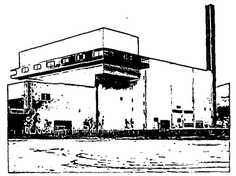
Industrial Waste to Energy - The Kanbara Tank Cleaning Service Company, Ltd. of Fukuyama, Japan has logged over 40,000 hours of operation on this 55 TPD, high BTU oil sludge to steam energy plant, since its start-up in 1977.



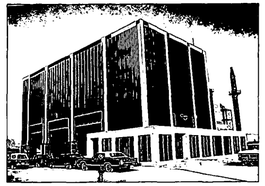
In the spring of 1978, IHI resized the pilot plant in Yokohama to 55 tons per day (TPD) to meet the growing needs of their Yokohama facility for the disposal of their industrial wastes and to support their ongoing evaluation and fuel testing programs.



***Agricultural Waste to Energy** - These two combustors, shown under construction, were placed in service in July 1977 in a 135 TPD plant owned by the Siam Kraft Paper Company, Ltd. in Ban Pong, Thailand. The plant consumes bagasse (sugar cane residue), pith, rice hulls and paper waste to produce steam for the paper making process.*



***Municipal Waste to Energy** - This 330 TPD municipal solid waste to energy facility is owned and operated by Kure City, Hiroshima Prefecture, Japan. The ultra-modern plant was placed in service in May 1980 and has achieved over 90% operational availability during its first year of commercial service.*



***Municipal Waste to Energy** - This 200 TPD municipal solid waste to energy plant is owned and operated by the Resource Authority in Sumner County, Tennessee. This facility, which began operation in January 1982, delivers 50,000 pounds of steam per hour to three local industries and generates electricity for the Tennessee Valley Authority.*

TYPICAL ROTARY COMBUSTOR/BOILER ESTIMATED PERFORMANCE

BASIS FOR PERFORMANCE

STEAM OUTLET PRESSURE	600 PSIG
STEAM OUTLET TEMPERATURE	600°F
FEEDWATER TEMPERATURE	250°F
AMBIENT AIR TEMPERATURE	70°F
A.H. EXIT GAS TEMPERATURE	400°F
EXCESS AIR	50%
RC-BLR EFFICIENCY	70%
ADIABATIC COMBUSTION TEMPERATURE	2940°F
FLUE GAS ENTERING BLR TEMPERATURE	2200°F
AIR SIDE Δp "W_C (O.C.C. EQUIP.)	8.5 "W_C
GAS SIDE Δp "W_C O.C.C. EQUIP.	5.0 "W_C

FUEL TYPE: MUNICIPAL SOLID WASTE

FUEL ANALYSIS - O.C.C. "STD." MSW
LBS/100 LBS FUEL AS FIRED

C	25.53
H_2	3.35
O_2	21.38
S	.16
MOISTURE	22.00
INERTS	27.58
	100 LBS.

BTU / LB HHV 4500

MODEL NUMBER	RC 60	RC 70	RC 80	RC 90	RC100	RC 110	RC 120	RC 130
CAPACITY 10^6 BTU / HR INPUT	22	32	42	52	65	80	95	110
CAPACITY FEED RATE, TPD	60	87	115	140	175	215	255	300
OUTLET STEAM FLOW, LBS/HR	14400	20900	27400	34000	42500	52300	62000	71900
COMBUSTION FLOW, SCFM	5160	7505	9850	12195	15245	18765	22280	25800
FLUE GAS FLOW ACFM, (400°F)	9900	14400	18895	23397	29246	35995	42744	49493
ASH, LBS/HR	1350	1960	2575	3190	3985	4900	5820	6750
FLUID FLOW THRU R.C., GPM	250	365	480	595	745	915	1085	1255

- ☐ ALL PERFORMANCE DATA IS BASED ON THE CAPACITY IN 10^6 BTU/HR INPUT.
- ☐ NO ALLOWANCE MADE IN AIR OR GAS FLOWS FOR LEAKAGE OR INFILTRATION.
- ☐ DO NOT USE THIS DATA AS FINAL FOR A SPECIFIC APPLICATION - REFER TO APPLICABLE CONTRACT DOCUMENTS FOR GUARANTEED AND EXPECTED PERFORMANCE.

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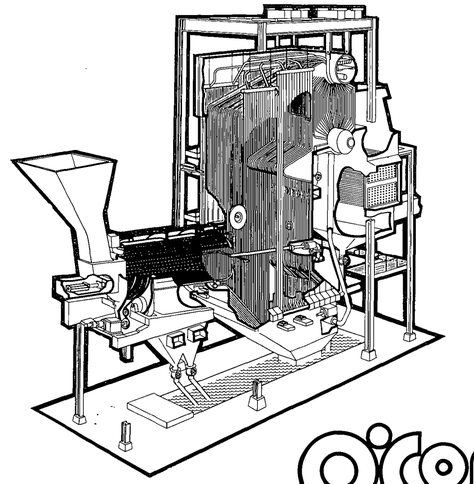
Efficient Conversion of Waste to Energy

O'Connor Water-Cooled Rotary Combustor

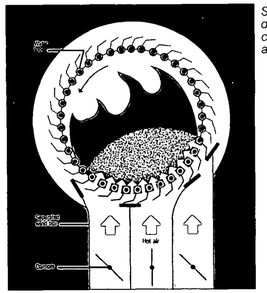
THE PROVEN SYSTEM



O'Connor COMBUSTOR CORP.

The O'Connor Water-Cooled Combustor

In a world where solid waste is both plentiful and hard to eliminate, and where energy is increasingly scarce and expensive, the integrated O'Connor™ Water-Cooled Rotary Combustor* and boiler system provides a practical solution for waste disposal and the generation of valuable energy.



Sectional view displays combustion air flow.

FEATURES OF THE SYSTEM

☐ **A simple, rotating cylinder** stirs and mixes the burning material. This continuous overturning and stirring completes combustion and eliminates clinker formation.

☐ **Heated forced air** promotes drying and burning of solid waste.

☐ **Water cooling** the combustor is provided by pumping boiler water through the combustor tubes. Refractories are not required.

☐ **High thermal efficiency** between 70 and 80 percent provides maximum energy recovery in the form of high pressure steam.

☐ **Simplified moving parts** assure ease of operation, maintenance and servicing, as well as minimal down time.

*U.S. Patent No. 3822651

THE COMBUSTOR / BOILER:

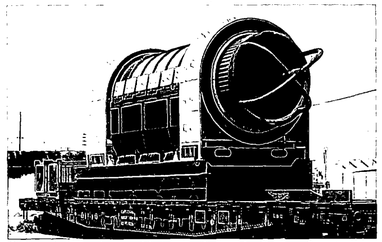
The O'Connor combustor is a hollow, water-cooled, steel cylinder made of alternating water tubes and fins welded between the tubes. The cylindrical combustor rotates on a slightly tilted axis at approximately 1/6 RPM. Fins are perforated to admit preheated combustion air. While solid waste burns, the combustor/boiler system recovers energy in the form of steam.

COMBUSTION:

Under forced draft, all air for combustion is preheated and fed through holes in the fins at sufficient velocity to penetrate the burning material. Solid waste is fed into the inlet at the upper end by a hydraulically-actuated feed system.

Dry material burns first, furnishing heat necessary to complete combustion. Wastes containing moisture are dried as they tumble down the inclined cylinder.

Ninety-five percent of combustible material is incinerated in the combustor. Remaining combustibles are consumed on a special water-cooled grate in the boiler where the ash collects. Air passing through holes in the grate penetrates the ash to complete combustion. Ash and inorganic materials, such as metals and glass, are intermittently steam-blown into the ash discharge section. Hot gasses enter the boiler.



Combustor barrel assembly leaving factory for Sumner County, Tenn.

STEAM GENERATION:

The closed-circuit, forced circulation system within the combustor generates approximately 30 percent of the steam. The remaining steam generation takes place in the boiler. Water from the boiler drum is pumped to the combustor's pressurized water circuit. The steam generated, mixed with the circulated water, returns to the steam drum. This circulation maintains combustor / boiler metal temperature at about-450 degrees Fahrenheit, depending on the pressure.

Advantages of The System

WEAR, EROSION AND CORROSION MINIMIZED:

The combustor's pressurized inlet water and saturated steam output remain at a constant temperature, minimizing thermal stress and reducing wear and erosion common to conventional incineration equipment. Forced draft, pre-heated combustion air distributed uniformly along the full length of the burning area provides maximum protection of the combustor walls.

LESS AIR REQUIRED:

Complete combustion is achieved using approximately one-third less air than conventional systems. Lower air requirements increase thermal efficiency, decrease power needed for operation, and permit use of smaller boilers, precipitators, fans and stacks.

EFFICIENT COMBUSTION & CONTROL ASSURED:

Since the combustor is water-cooled (not dependent on air for cooling grates) air flow can be controlled to optimize combustion at various waste feed rates.

ODORS ELIMINATED:

Waste odors are incinerated by channeling raw combustion air from covered trash pits and tipping floors.

DOWN-TIME & MAINTENANCE REDUCED:

The combustor offers lower maintenance costs by eliminating moving grates and refractories required by other incinerator systems.

WASTE PRE-TREATMENT ELIMINATED:

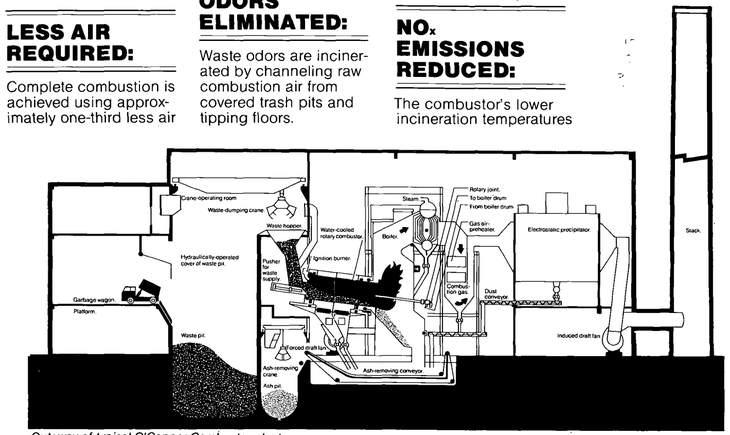
The combustor makes waste separation or predrying of refuse (with moisture content of up to 50%) unnecessary.

NO_x EMISSIONS REDUCED:

The combustor's lower incineration temperatures generate considerably less NO_x (oxides of nitrogen) than conventional incinerators.

GAS TEMPERATURE CONTROLS ELIMINATED:

Unlike conventional refractory incinerators, gas temperature controls are not required. Steel tubes in the combustor wall are water-cooled, protecting the entire wall from corrosion even in the presence of P.V.C.



Cutaway of typical O'Connor Combustor plant.

Waste to Energy Applications

The O'Connor Combustor is available in sizes ranging from 50 tons per day to 300 tons per day. Multiple units may be installed for all applications.

MUNICIPAL AND COMMERCIAL:

Municipal refuse and commercial solid waste are growing problems, with common methods of disposal being landfill, ocean dumping or incineration. Landfill near populated areas is becoming increasingly expensive. New laws, in many cases, now prohibit ocean dumping. Ordinary incineration reduces waste volume but reclaims little if any, energy and often cannot meet air pollution control standards.

The United States throws away 90 percent of waste that could be used to produce energy. This is no longer necessary, as solid waste incinerated in the O'Connor combustor recovers energy, reducing the need to burn other forms of diminishing fuels.

INDUSTRIAL:

The final residues of petroleum refining — sludge, residual oil, or refinery bottoms — are hard to dispose and ecologically dangerous. By burning this material in the combustor, energy content of the petroleum residue can be readily reclaimed.

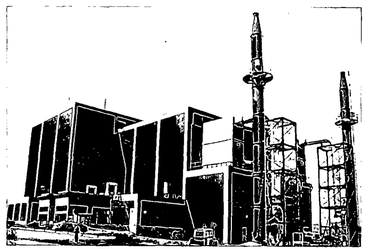
Many liquid or semi-solid process wastes as well as sewage sludge, can also be burned in the combustor.

FOOD PROCESSING AND AGRICULTURAL WASTES:

Many food / agricultural wastes can be burned in their primary residual form; others can be mixed with drier wastes to promote burning and energy recovery. Examples include nut shells, chicken processing refuse, feed lot garbage and manure, and bagasse (the waste left from sugar refining). Steam produced by the combustor can be used onsite in food processing plants, with electric power produced as an end product.

USE OF GENERATED STEAM:

The combustor's steam can be piped to users within any reasonable distance. Typically, high-pressure steam produced in the O'Connor system is utilized for process applications, to power turbine-driven electrical generators or to heat buildings, to power chillers for central cooling plants, or to heat water for distribution.



Rear view of 200 TPD plant at Gallatin, Sumner County, Tennessee

HISTORY OF THE O'CONNOR COMBUSTOR:

Chadwell O'Connor, president of O'Connor Combustor Corporation and founder of the parent company O'Connor Engineering Laboratories is the inventor of the patented O'Connor combustor. He has spent over 30 years specializing in design, engineering, and construction supervision of power-generating stations, large central heating and refinery equipment, refrigeration plants, water and waste treatment, and chemical plants.

During his two decades with the Pasadena Light & Power Department, a city-owned utility in California, Mr. O'Connor was responsible for design and construction of Broadway No. 3, a 75,000 KW, 2,000 PSI unit with 1,000 degrees fahrenheit steam and 1,000 degrees fahrenheit reheat capacity. That station was judged the most efficient steam-electric plant of its size in the United States.

He was also in charge of converting Pasadena's incinerator plant to steam energy recovery. This involved piping steam to generating stations to supplement their own steam production.

It was in this plant that Mr. O'Connor conceptualized many of the innovations which eventually led to his development of the O'Connor Water-Cooled Rotary Combustor and its associated systems.