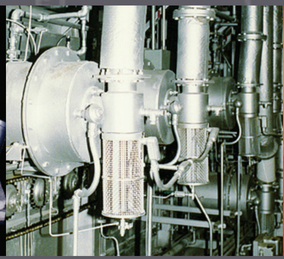
RECUPERATIVE RADIANT TUBE BURNER

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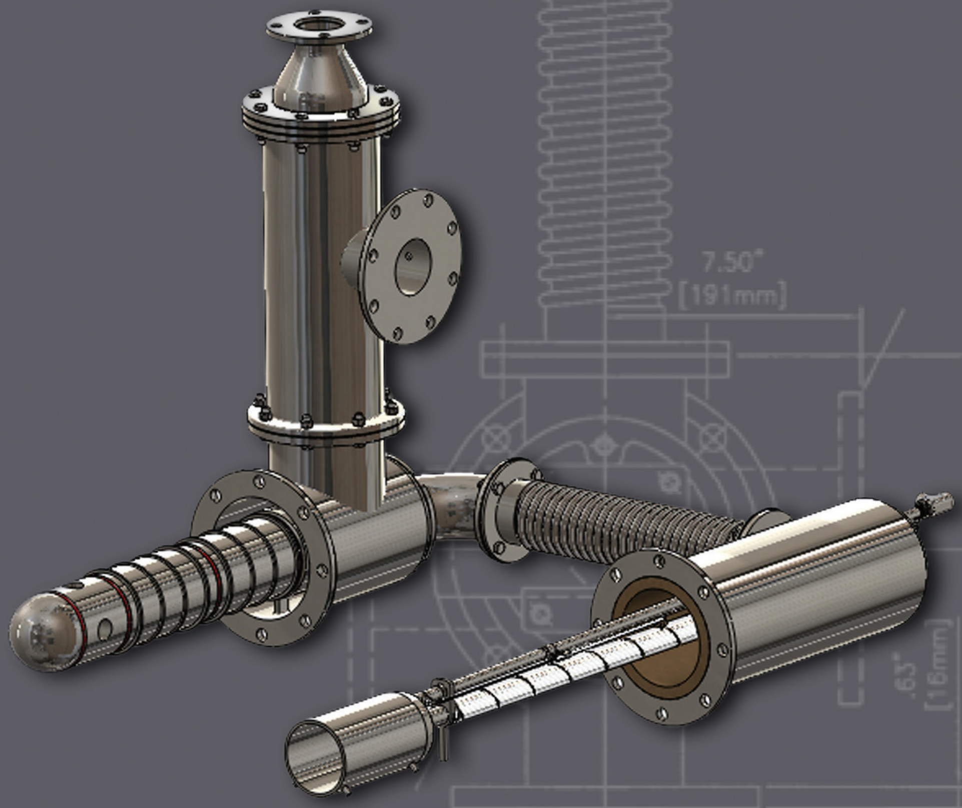


The purpose of radiant tube combustion is to apply fuel fired heating, with the products of combustion isolated and separated from the furnace atmosphere. This will allow control of the furnace atmosphere to protect or modify the surface of the material being heated. When utilizing radiant tube combustion, attention must be paid to the following factors:

- Thermal efficiency of the combustion process
- Environmental emissions from the combustion process
- Effect of the combustion process on the life of the radiant tube
- Reliability of the combustion equipment itself

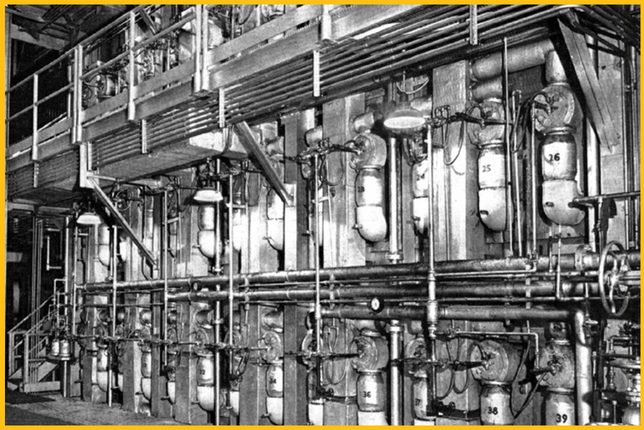
APPLICATIONS

- Continuous Annealing Lines (CAL)
- Continuous Galvanizing Line (CGL)
- Continuous Silicon Lines
- Heat Treating Systems
- Roller Hearth Systems
- Aluminium Process Furnaces

FEATURES

- Flexible “Retention Nozzle” burner design
- Engineered NOx Emissions
- Custom Engineered design
- Laboratory verification of designs
- Maximum combustion efficiency
- Tube temperature uniformity
- Rugged experience-based construction
- 15,000 burners in operation
- 55 years applications experience
- Family of burner types available to suit application
- World-wide manufacturing and service network

Bloom has been building radiant tube burners for over 55 years, with more than 15,000 radiant tube burners in operation. We were instrumental in the application of the design incorporating an internal recuperator inserted within the radiant tube. This long experience coupled with our R&D capabilities and engineering programs of continuous design improvement, puts us in a position to be the burner supplier of choice for radiant tube combustion applications.



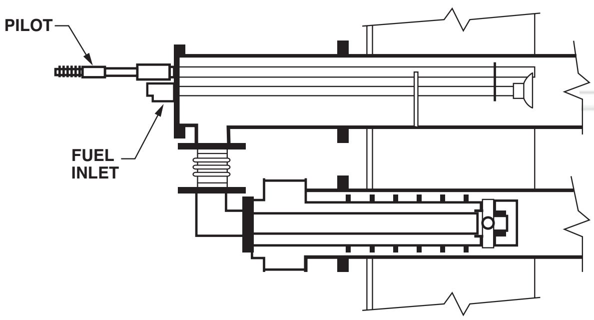
EFFICIENCY

Burner combustion efficiency is achieved, first, by transferring as much of the heat, from the combustion process, directly into the process as possible. Tube configuration is a large factor in this heat transfer with the longer W and recirculating (double P) tubes allowing a greater heat transfer vs the shorter U and straight thru tubes. Burner efficiency is further enhanced by recovering the waste sensible heat from the products of combustion and preheating the incoming combustion air. Recuperation and regeneration are the two primary techniques for recovering the sensible heat. Regenerative heat recovery offers a greater efficiency but at a greater capital cost than recuperation. Overall system efficiency is further enhanced by utilizing the remaining sensible heat, in the products of combustion, in accompanying system processes, such as heating rinse water. Bloom has the capability to engineer temperature of the products of combustion to optimize the integration with the rest of the system.

EMISSIONS

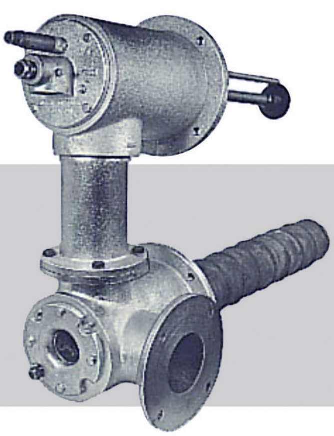
Within the restricted combustion environment of a radiant tube, NOx emissions can be relatively high. The paradox of NOx relative to combustion efficiency is that the higher the combustion air temperature preheat (ie better efficiency) the disproportionately higher is the emissions of NOx. Bloom uses its “Retention Nozzle” design, air-staged combustion and exclusive type “F” exhaust gas recirculation technique to reduce NOx. Recirculating tubes (such as P and double P) can be inherently low in NOx. Bloom’s “retention Nozzle” and air-staged combustion techniques further reduce these emissions. With these multiple techniques, NOx emissions do not need to be predicted from guesswork. The emissions can be engineered to create the proper levels to meet a given requirement.

TYPE “F” ULTRA LOW NOx

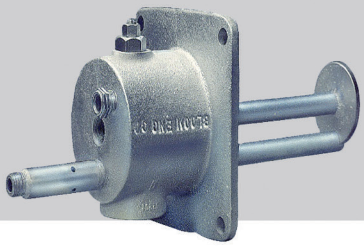


U.S. Patent No.5, 775, 317

REGENERATIVE BURNER



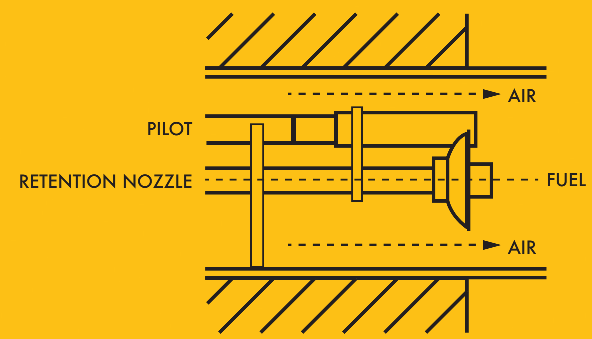
RECUPERATIVE BURNER



COLD AIR BURNER

A unique and fundamental feature of a typical Bloom radiant tube burner design is the "Retention Nozzle" fuel nozzle. Quiet stable operation and uniform tube temperatures are obtained by utilizing this patented nozzle design. The nozzle distributes the air uniformly around the (center) gas stream while creating a partial vacuum between the two streams. This allows for a controlled mixing of the fuel and air, promoting flame stability and safe, reliable burner operation.

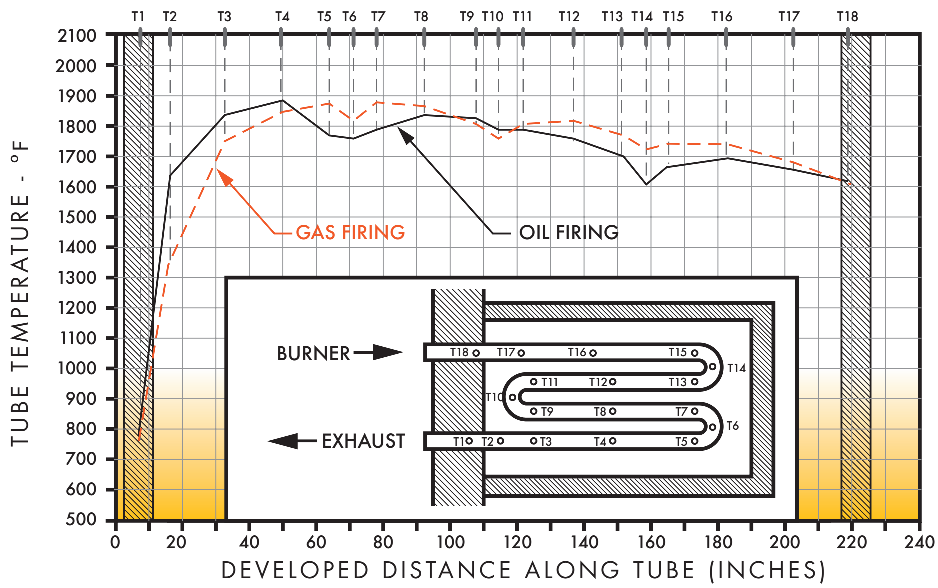
"RETENTION NOZZLE"



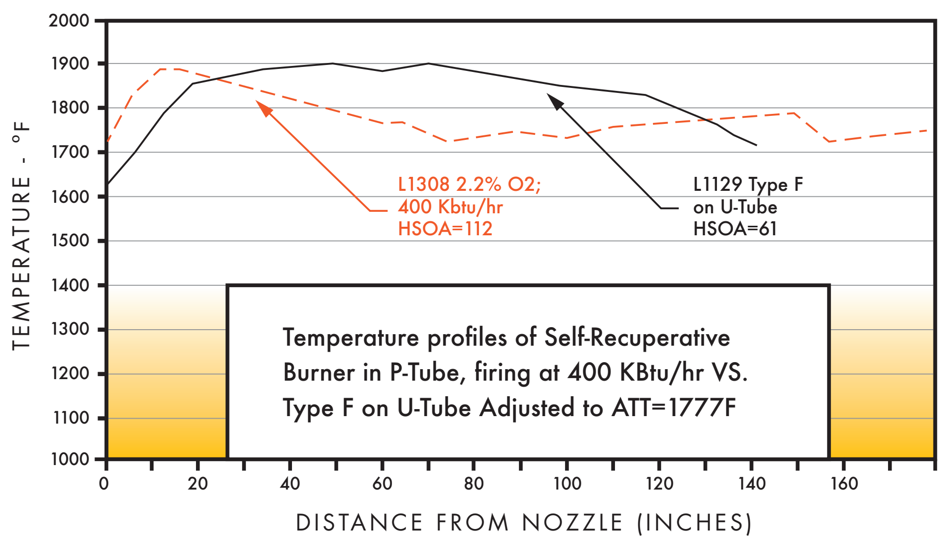
RADIANT TUBE LIFE

For proper radiant tube life, the maximum operating temperature at any point along the tube must not exceed the design working temperature for the tube material. Tube life can thus be predicted, to a large extent, by its temperature uniformity. A measure of temperature uniformity is expressed as the Hot Spot Over Average (HOSA) temperature. The HSOA is the difference between the peak high (or low) tube temperature and the average tube operating temperature within the operating range of the burner. A low HSOA is an indication of low peak tube temperature. A low HSOA will cause the tube to have minimal thermal stresses, enhancing tube life. A low HSOA will also create a better heating quality within the furnace. Due to the design flexibility of Bloom's "Retention Nozzle", the burner flame can be engineered to a customer's specific radiant tube, achieving minimal HSOA.

THERMOCOUPLE NUMBER AND LOCATION

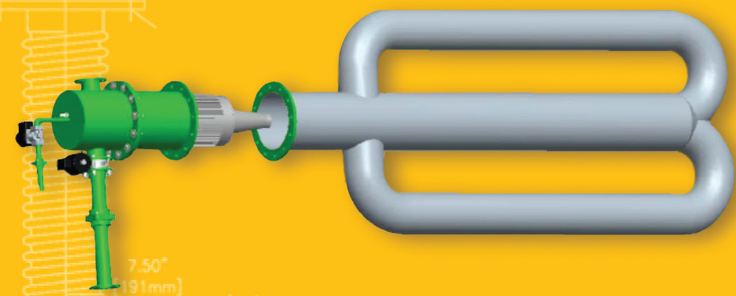


TEMPERATURE DISTRIBUTION COMPARISON



In the application of the burners, a variety of control techniques can be employed. The final choice would depend on such considerations as: system configuration, fuels utilized, environmental considerations and product mix. Typical alternative considerations include:

- **Suction, Forced Draft or Push/Pull**
- **High/Low, On/Off or Modulating**
- **Mass Flow, Pressure Balance or Pulse Firing**



RELIABILITY

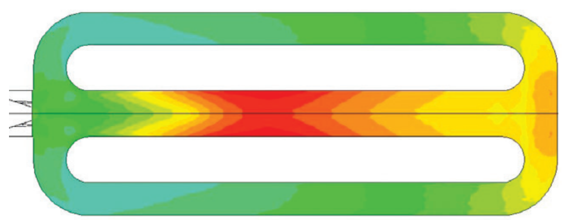
Bloom burners are designed for continuous operation in demanding environments. The burners are manufactured from heavy alloy castings. Bloom burner designs are based on 50 years experience and backed up by the latest design techniques including computational fluid dynamics (CFD). Laboratory testing ensures the optimization of the specific application. Additionally, customer feedback and laboratory-based research provides a source of continuous improvement of the fundamental designs. All of these characteristics are what to expect from an engineering based company. As such, reliability is not an unknown but an engineered process to achieve the maximum service life. Service lives in-excess of twenty-five years have been documented.

LABORATORY CAPABILITIES

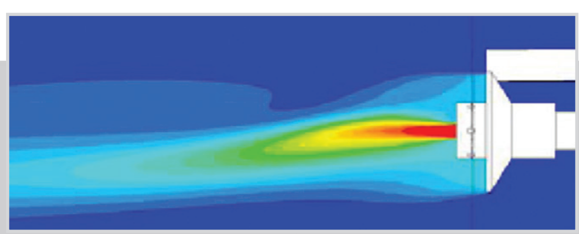
Bloom operates one of the largest and most advanced private, applied combustion labs in North America. The lab occupies 20,000 ft2 (2,000 M2). It has twenty fully instrumented furnaces of varying configurations to suit the range of industrial combustion applications. Additionally, the lab has a dedicated staff of engineers and technicians. Lab activities include: new burner development, burner upgrades, production performance testing and emissions verification Bloom's computational fluid dynamics (CFD) capabilities are fully integrated into the laboratory activities.

BLOOM COMBUSTION LABORATORY - DOUBLE P TUBE

CFD TEMPERATURE PROFILE OF A DOUBLE P TUBE



CFD STUDY FOR "RETENTION NOZZLE" DESIGN



CAPABILITIES

Quiet, stable operation across a wide range of parameters
Exclusive "Retention Nozzle"
Easy conversion of older designs to low NOx operation
Easy conversion of existing design to multi-fuel operation
3" ID tubes and largerRugged cast/machined alloy construction
Operating temperatures up to 1950°F (1065°C)
Operating efficiencies up to 80% (LHV)

BURNER OPTIONS

Radiant Tube Types

- A U tube
- B W tube
- C Straight thru
- C Single ended
- D P tube
- E Double P tube

Piping Configuration

- A Suction (pull)
- B Forced draft (push)
- C Push/pull

Control

- A Modulating high/low
- B Modulating high/off
- C Pulse high/low
- D Pulse on/off
- E Tempered flame

Burner Ignition

- A Glow pilot
- B Lance pilot
- C Direct spark ignition

Fuels

- A Natural gas
- B Coke oven gas
- C Propane
- D Butane
- F Any mixed gas above 176 Btu/Ft3 (HHV), (6.9 Mj/nM3) (HHV)
- E #2 fuel oil (nominally 20% excess air is required)

Tube Diameter

3in (76mm) to 10in (254MM) ID

Operating Temperature Range

400°F (200°C) to 1950°F (1065°C)

Flame Monitoring

- A U/V detector
- B Flame rod

RADIANT TUBE BURNER MODELS

Today our customers can choose from the following burner types as best fits their applications:

- 2300 Cold air, forced draft
- 2310 Type "R" Cold air, suction
- 2320 Recuperated, suction and push-pull * #
- 2350 Recuperated, forced draft * #
- 2370 Type "F" Ultra low NOx *
- 2301 Single ended tube, recuperated
- 2390 Regenerative
- 2450 Recuperative P
- 2460 Recuperative double P
- 2470 Regenerative double P

*Type "L"
Improved recuperated enhancement available as option

#Air Staged – Available as low NOx option

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BURNER SELECTION TABLE TYPICAL (Natural Gas Fuel)

Burner Model	Type	Available Heat (LHV)	NOx	Piping Configuration
2301	Recuperated	55-60	Low	Push/Pull
2300	Cold Air	39-46	Low	Forced Draft
2310	Cold Air	39-46	Low	Suction
2320	Recuperated	61-66	Low	Suction, Push/Pull
2320-Air Staged	Recuperated	61-66	Very Low	Suction, Push/Pull
2320-L	Recuperated	68-77	Low	Suction, Push/Pull
2320-L, Air Staged	Recuperated	68-77	Very Low	Suction, Push/Pull
2350	Recuperated	61-66	Low	Forced Draft
2350-Air Staged	Recuperated	61-66	Very Low	Forced Draft
2350-L	Recuperated	68-77	Low	Forced Draft
2350-L, Air Staged	Recuperated	68-77	Very Low	Forced Draft
2370	Recuperated	61-66	Ultra-Low	Push/Pull or F-D
2370-L	Recuperated	68-77	Ultra-Low	Push/Pull or F-D
2390	Regenerative	77-83	Ultra-Low	Push/Pull
2450-P	Recuperated	61-66	Ultra-Low	Push/Pull or F-D
2460-PP	Recuperated	63-73	Ultra-Low	Push/Pull or F-D
2470-PP	Regenerative	77-82	Ultra-Low	Push/Pull

For your specific application, a Bloom engineer can assist with the selection process.