Attachment

The following is provided in response to the information request in EPA letter dated April 9, 2013 for question nos. 2, 5, and 6. Each request for information is repeated below in bold italics followed by FPC TX response and supplemental information. To clarify the responses when responses are required for multiple sub-questions contained in EPA question, those sub-questions have been organized into the bullets below and responded to individually.

2. ***Beginning on page 27 of the permit application in the section entitled "Overall Energy-Efficient Design Philosophy", it is stated that FPC TX is incorporating several design strategies that will provide operating cost savings and the benefit of minimizing emissions of GHG throughout the plant. In this section there is a summary of the equipment selection and design attributes that include, but not limited to, the following:***

    - ***energy saving motors on applicable compressors,***
    - ***capacity control will be installed to reduce electric energy consumption,***
    - ***variable speed for blowers, pumps and compressors,***
    - ***use of cold box heat exchangers instead of shell and tube exchangers,***
    - ***Olefins 3 plant is designed to maximize cooling from process off-gas streams to minimize***
    - ***refrigerant requirements,***
    - ***Olefins 3 plant is designed to operate at lower pressure to allow easier separation of methane, which is estimated to reduce up to 10% required power for the binary compressor, requiring less refrigeration, and***
    - ***Ethylene fractionator's lower-reflux design.***

    Please provide supplemental technical benchmark data that compares the design selections to be employed to a similar or existing source in the industry. If possible, please provide the technical resources used to evaluate the design decisions and to support the assertions made in this section. If technical benchmark data is not available, then please provide information detailing or projecting the potential efficiency gains that are expected utilizing these design strategies. Please include the basis for the rationale and supporting calculations and resources for this information.

    FPC TX would like to clarify that, as stated in the application, the overall Olefins 3 and PDH unit energy-efficient design elements in Section 3.2.1 of the permit application were intended to provide a qualitative demonstration of the FPC TX energy efficiency design philosophy that is being used for this proposed project. This information was specifically presented separate from the five step BACT review (section 6.0 of the application) because it was provided for information purposes only and was not proposed as, or intended to be construed as BACT for individual GHG emission sources.

As stated in section 3.2.1 of the application, these design elements are intended to operate integrally to maximize energy efficiency; therefore, it is difficult to specifically quantify the effects of each individual energy-efficiency design element separately. Specifically the application states that:

Since the proposed energy efficiency design features represent an integrated energy efficiency strategy, it is difficult to identify and quantify the affect of each individual efficiency feature. However, some examples of the type of energy efficiency design features that are included in the Olefins Expansion design are described in this section below. Although not possible to individually quantify, the overall effect of the associated energy savings and GHG emissions are reflected in the emission calculations included later in this application.

FPC TX understands the requirement for benchmarking and quantifying proposed BACT, but these supplemental overall design elements are not being proposed as BACT nor have these elements been proposed as BACT or individually quantified by other permit applicants.

Although not related to BACT, FPC TX is providing more information, where available, in this response to satisfy EPA's request as much as possible. In this response, FPC TX is providing an additional discussion of each overall energy efficient design aspect that was presented in the permit application. When possible, qualitative benchmarking information or projected efficiency gains are discussed.

- ***energy saving motors on applicable compressors,***

  For the Olefins 3 and PDH units NEMA (National Electrical Manufacturers Associate) Premium, highest efficiency motors will be installed when possible, specifically when the design specification can be met using a premium motor and when the premium option is available from the motor vendor. An information sheet on NEMA Premium motors is attached.

- ***capacity control will be installed to reduce electric energy consumption,***

  For the 13.8kV power that will be supplied to the Olefins 3 and PDH units, capacitor banks will be installed to improve the power factor thus maximizing the electric energy efficiency of the unit. From current operating experience, the power factor measured with the use of the capacitor banks is approximately 0.98. Without the capacitor banks, this power factor drops in the range of 0.85. Based on the estimated daily power consumption (600 MW) that will be required by the Olefins 3 and PDH units (combined), the use of capacitor banks translates to an estimated energy savings of approximately 78 MW [calculated as: 600 MW x (0.98 – 0.85)].

- ***variable speed for blowers, pumps and compressors,***

In this response, FPC TX is providing examples of variable speed equipment (blowers, pumps and compressors) that are being specified for this project. This is not a comprehensive list.

Compressors: To take full advantage of the energy in the super high pressure (SHP) steam generated through flue gas heat recovery in the heaters, the process gas compressor will be driven using a high efficiency turbine (approximately 78% eff.). The expected power consumption for this turbine at full load is expected to be approximately 41,000 kW (55,000 HP). To improve the efficiency of the machine and prevent compressor surge, remote speed control will allow the DCS (distributed control system) operator to adjust the speed of the turbine to optimize turbine speed and steam consumption during periods of reduced process load. Since the turbine can be reduced to approximately 70% of its maximum load, the steam savings are substantial. The extraction and condensing steam rates have been optimized to take full advantage of the extraction steam for low steam pressure level users throughout the plant (reboilers, strippers, steam tracing etc.).

For benchmarking purposes, this design option is preferred in lieu of the “kickback” function, which takes compressed gas from the compressor discharge and lets it down to the compressor suction for recompression and to prevent compressor surge. During kickback, compressor efficiency is reduced due to the energy lost from the process gas pressure drop. The selected design option (variable speed turbine control) lowers the compressor speed and throughput which in turn eliminates the need for kickback.
Pumps: In addition to the major compressors described above, there are two sizeable process related pumps which will employ a steam turbine. The quench water circulation pump and the boiler feed water pumps contribute approximately 500 HP and 1,400 HP respectively. The turbine speeds will be controlled to meet supply header pressures as demanded by the process. Turndown for these turbines is also expected to be in the range of 70%.

Blowers/Fans: Cooling tower fan motors will be equipped with dual speed adjustment for improved efficiency. The approximate power settings of these two speeds will be 250 HP (high speed) and 69 HP (low speed). The fan speeds will be adjusted as necessary to meet the units cooling water temperature demand.

- ***use of cold box heat exchangers instead of shell and tube exchangers,***

Olefins plant designs normally incorporate kettle type exchangers to vaporize ethylene product, recycle ethane, and a portion of charge gas chilling. Heat leakage can be as much as 3%.

Aluminum brazed heat exchangers, also known as "cold boxes", will be employed in this expansion project to maximize refrigeration recovery of various cryogenic process streams thus reducing loads on refrigeration compressors (heat leakage is only about 1%). Aluminum is selected as the material for manufacture of compact exchangers (comprised of alternating layers of corrugated aluminum sheets, brazed together) because of its physical properties. These exchangers are capable of exchanging energy among various streams at a time and their design structure produces ideal countercurrent flow for optimum energy recovery. Aluminum is also much more conductive (over 10 times) as compared to stainless steel which is normally used for the construction of conventional shell and tube exchanger designs in extremely cold service.

Total energy exchanged in cold boxes is expected to be in the range of 600 MMBtu/hr. The 2% heat loss differential between traditional exchangers and the cold box accounts for approximately 12 MMbtu/hr of energy savings. These heat leakage estimates were derived from the technology provider's cold box specification sheet included in the basic design package, which is business confidential.

- ***Olefins 3 plant is designed to maximize cooling from process off-gas streams to minimize refrigerant requirements,***

To minimize refrigeration requirements, the cryogenic energy of the raw hydrogen and methane off-gas streams is recovered by heat exchange with the binary refrigerant and propylene refrigerant streams in the cold boxes. The energy recovery design basis is approximately 35 – 40 MMBtu/hr, which was obtained from the aforementioned cold box specification sheet.

- ***Olefins 3 plant is designed to operate at lower pressure to allow easier separation of methane, which is estimated to reduce up to 10% required power for the binary compressor, requiring less refrigeration, and***

The demethanizer tower in the Olefins 3 unit will operate at approximately 390 psig lower than other olefins processes. The lower pressure allows for easier separation of the methane from the heavier components and requires less refrigeration. These expected energy savings are the technology provider's best estimate derived through complex calculations, the use of leading edge software, and a team with vast experience. The Binary Compressor HP is currently estimated to be approximately 48,000 HP. This translates to approximately 3.6 MW in compressor steam savings based on the vendor's estimate of a 10% energy savings.

- ***Ethylene fractionator's lower-reflux design.***

Ethylene fractionator tray count and tangent to tangent length is based on (minimum) reflux rate. Higher reflux rate equals less trays and tower height. Lower reflux rate equals more trays and longer tower. The Olefins 3 ethylene fractionator tower will be designed to operate at a lower reflux ratio than other comparable units. For benchmarking purposes, typically most licensors design this tower to operate in the range of 7 - 10% above minimum reflux. Compared to conventional tower designs, FPC TX's design will only require approximately half the flow above minimum reflux. Even though the capital investment is higher for more trays and a taller tower, FPC TX prefers this design due to energy savings resulting from a lower reflux rate and the corresponding lower condenser heat duty.

5. On page 46 of the permit application, it states that "high efficiency burners, designed for optimum combustion of the hydrogen-rich fuel gas, will be installed in the firebox on both sides of the radiant tubes." Please provide any benchmark comparison for similarly designed burners that have been permitted by air permitting authorities nationwide.

For this project, FPC TX considered other burner designs and configurations and eliminated those that were not technically feasible or would not meet the design criteria. FPC TX has extensive experience and knowledge of ethylene cracking furnace burner design and operation after operating and installing these units at the Point Comfort Olefins plants since 1994 (almost twenty years). As such, FPC TX is providing internal benchmarking through discussion of the various burner design options considered for this project with an explanation of how the proposed burner design was selected, and is appropriate for this project.

FPC TX has operated, tested, and improved various pyrolysis furnace burner designs at its Point Comfort facility since the start-up of the Olefins 1 unit in 1994, Olefins 2 unit startup in 2001 and the three additional cracking furnaces installations in 2006-2007. FPC TX has relied on this pyrolysis burner experience and knowledge and input from the furnace licensor for the selection of the proposed Olefins 3 furnace burners as described in more detail below.

Pyrolysis furnace burner selection is a complex process which has to consider many variables. In addition to energy efficiency, FPC TX must ensure the burner selection is adequate for to maintaining compliance with applicable furnace permit conditions and emission limits (e.g., NO_X, CO) and maintaining safe, consistent and reliable furnace operation. Some burner designs and installations have proven to be detrimental to the performance of the furnace and therefore detrimental to energy efficiency. Improper burner selection, burner spacing, and installation can result in flame rollover, tube impingement, and uneven coking (which can increase the decoking frequency and associated GHG emissions). Safety is also a concern considering the firebox operating temperatures and radiant coil metallurgical limits.

Among the various burners that FPC TX has considered, are the use of all wall mounted lean premix wall burners (LPMW), a lean premix fuel floor mounted burner (LPMF), burners with steam injection, and staged fuel with flue gas recirculation (SFFR) floor mounted burners & wall burner (LPMW) combination. These burner types are discussed below.

The all wall mounted burner option (100% LPMW) is attractive in terms of minimizing NOx emissions. However, the wall burner capacity is very low, in the range of 1 MMbtu/hr/burner, and therefore would require hundreds of burners to provide the required heat input which is not an energy efficient configuration. As all burners operate at 10% excess air, the setting of air doors and combustion adjustment for these many burners would be problematic.

The LPMF utilizes venturis on one of two burner tip sets to inspirate air needed for combustion. As the air is drawn into the firebox it mixes with a small portion of the fuel creating what is known as a lean fuel mixture. This lean fuel then exits the venturi at a high velocity creating a stiff combustion zone. A second set of burner tips is designed to induce flue gas and supply the remainder of the fuel. The staged fueling and flue gas recirculation are designed to achieve a low NOx emission rate. The main issue with applying this technology to the Olefins 3 furnaces is that these burners require high fuel gas pressure (minimum of 50 psig at the burner as compared to 20-25 psig for more traditional burners). The higher pressure will ensure complete combustion and a stiff flame that will not cause flame rollover and tube impingement. However, the design of the Olefins 3 fuel gas system requires a fuel gas mix drum pressure of approximately 45 psig. The resulting pressure at the burners is limited to approximately 25-30 pounds after filtration, metering, and control losses. The 45 psig fuel gas pressure is set to allow the process to fully benefit from the refrigeration available in the fuel gas stream. The offgas sent to the fuel gas drum flows from the plant's cold box where the fuel gas portion is vaporized at low pressure to provide extreme low temperature refrigeration (needed to condense ethylene product from the cracked gas). Increasing the fuel gas pressure would drastically reduce the fuel gas refrigeration capability, and thus, is not a viable option. Installing a fuel gas compressor to boost fuel pressure will also be costly and require additional energy.

Steam injection is also a common means for reducing NO_x emissions. This practice involves the injection of steam directly into the burner combustion zones to achieve lower flame temperatures thus reducing NO_x emissions. A disadvantage is that the steam reduces the required process temperature which increases the firing demand to the furnace by approximately 2%. GHG emissions are also increased further upstream as a result of producing the injection steam.

The SFFR burner was also a design considered for the Olefins 3 furnaces. This technology works very similar to the LPMF burner (previously discussed); however, it differs in that it uses a venturi design to inspirate mainly fuel gas, instead of combustion air, and requires a much lower fuel gas pressure.

In addition to the floor mounted SFFR burner, FPC TX has identified benefits of including various arrangements of wall mounted burners (LPMW) to work in conjunction with the SFFR burner. This arrangement aids in spreading out the heat necessary for the cracking operation thus reducing the flame temperature and associated thermal NO_x. This combination is also effective at providing instant and complete combustion due to its uniform burner and fuel gas distribution. This combination of burner designs is proven and currently applied in commercial pyrolysis furnace service. FPC TX has selected this proposed burner technology combination for the Olefins 3 furnaces. Please see the attached brochure from John Zink Combustion Group for more information on the proposed burner technology.

In summary, the final burner design (floor mounted and wall mounted burners) was selected because it will provide even heat flux distribution to the radiant coils to maximize feed conversion and therefore maximize energy efficiency while still achieving all the other environmental performance requirements.

6. ***Please provide supporting calculations, technical information and a basis for the rationale used to calculate the energy that will be recovered from the "Energy Efficient Design Elements" proposed for the cracking furnace on page 48 of the permit application.***

The attached furnace efficiency diagram summarizes the non-confidential information related to the design elements that were presented in the permit application. The details used to quantify the energy recovery (MMBtu/hr) for each design element were based on the following types of design parameters: stream mass flow rates, stream heat capacities and stream inlet and outlet temperatures, which were provided by the furnace licensor on design specification sheets marked as business confidential.

3-Phase Motor NEMA Premium™ Information Guide

National Electrical Manufacturers Association (NEMA), in conjunction with the US electric motor industry, has established NEMA Premium Efficiency standards as the highest nominal efficiencies to date, and is endorsed by the Consortium for Energy Efficiency (CEE). CEE members include electric utilities, administrators of state and regional efficiency programs, and environmental and research groups. CEE's motor specifications are used as a basis for public motor efficiency programs, which may include rebates or financing.

3-PHASE MOTORS AND NEW ENERGY LEGISLATION (EISA)

The Energy Independence and Security Act (EISA) of 2007 was signed into law in December of 2007. While the policy covers several areas of promoting energy efficiency, its primary focus is to conserve domestic resources, limit dependence on foreign oil, and reduce toxic emissions. The production of energy is one of the largest contributors to the decline of natural resources as well as pollution of the environment. Motors consume approximately 60% of the electricity used in the United States; therefore, motors were targeted to raise the bar in minimum efficiency levels to help drive this initiative. While the law was signed in 2007, the real action will take place on December 19th of 2010. Motor manufacturers will only be able to manufacture motors covered by the legislation meeting the newer, higher efficiency levels after that date.

ENERGY LEGISLATION COVERAGE

The EPAct 2007 legislation separates the motors covered by the policy into 2 groups: Subtype 1 and Subtype 2. These are defined as follows.

SUBTYPE 1

- General Purpose 3-Phase Motors
- 1 to 200 HP
- NEMA frame 143T and larger
- C-Face Motors with Base Mount

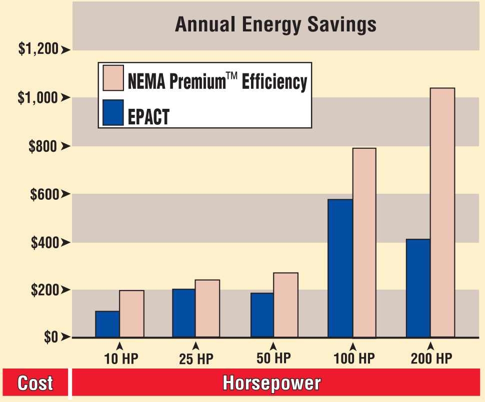
Motors previously covered under EPAct 1992 will now be required to meet NEMA Premium Efficient levels (NEMA MG1 Table 12-12).

SUBTYPE 2

- General Purpose and Definite Purpose 3-Phase Motors
- 1 to 200 HP
- NEMA frame 143T and larger
- U Frame Motor Designs
- NEMA Design C Torque
- Close-Coupled Pump
- Metric IEC
- Fire Pump
- Footless Design, C-Face without Base
- Vertical Solid Shaft Normal Thrust
- 8 Pole General Purpose Design up to 600V
- NEMA Design B General Purpose 201 to 500 HP

3-Phase motors not covered under EPAct 1996 and meeting the following requirements, will now be required to meet old EPAct 1996 minimum efficiency standards (NEMA MG1 Table 12-11).

Note: NEMA Premium is a registered trademark of the National Electrical Manufacturers Association and may only be used on products covered by a memorandum of understanding between the manufacturer and NEMA.

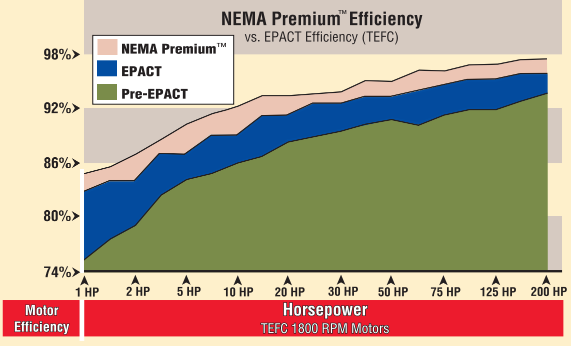


ANNUAL ENERGY SAVINGS

NEMA Premium™ Efficiency motors will save you significant energy costs, resulting in a faster payback on your purchase.

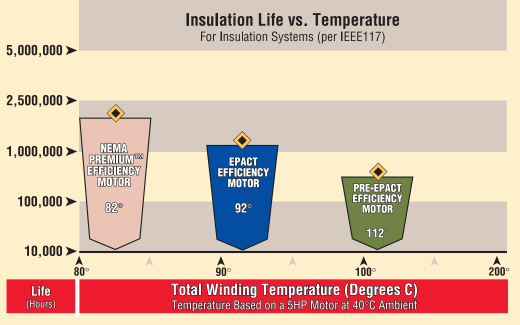
Comparisons are based on industry average efficiency standards. Based on a Dayton TEFC motor, 1800 rpm, 0.07/KWH @ 4400 hours.

Motor HP	NEMA EPACT Nominal Full-Load Efficiency: Open Motors rpm 1200	1800	3600	Enclosed Motors rpm 1200	1800	3600	NEMA Premium Nominal Full-Load Efficiency: Open Motors rpm 1200	1800	3600	Enclosed Motors rpm 1200	1800	3600
1	80	82.5	—	80	82.5	75.5	82.5	85.5	77.0	82.5	85.5	77.0
1½	84	84	82.5	85.5	84	82.5	86.5	86.5	84.0	87.5	86.5	84.0
2	85.5	84	84	86.5	84	84	87.5	86.5	85.5	88.5	86.5	85.5
3	86.5	86.5	84	87.5	87.5	85.5	88.5	89.5	85.5	89.5	89.5	86.5
5	87.5	87.5	85.5	87.5	87.5	87.5	89.5	89.5	86.5	89.5	89.5	88.5
7½	88.5	88.5	87.5	89.5	89.5	88.5	90.2	91.0	88.5	91.0	91.7	89.5
10	90.2	89.5	88.5	89.5	89.5	89.5	91.7	91.7	89.5	91.0	91.7	90.2
15	90.2	91	89.5	90.2	91	90.2	91.7	93.0	90.2	91.7	92.4	91.0
20	91	91	90.2	90.2	91	90.2	92.4	93.0	91.0	91.7	93.0	91.0
25	91.7	91.7	91	91.7	92.4	91	93.0	93.6	91.7	93.0	93.6	91.7
30	92.4	92.4	91	91.7	92.4	91	93.6	94.1	91.7	93.0	93.6	91.7
40	93	93	91.7	93	93	91.7	94.1	94.1	92.4	94.1	94.1	92.4
50	93	93	92.4	93	93	92.4	94.1	94.5	93.0	94.1	94.5	93.0
60	93.6	93.6	93	93.6	93.6	93	94.5	95.0	93.6	94.5	95.0	93.6
75	93.6	94.1	93	93.6	94.1	93	94.5	95.0	93.6	94.5	95.4	93.6
100	94.1	94.1	93	94.1	94.5	93.6	95.0	95.4	93.6	95.0	95.4	94.1
125	94.1	94.5	93.6	94.1	94.5	94.5	95.0	95.4	94.1	95.0	95.4	95.0
150	94.5	95	93.6	95	95	94.5	95.4	95.8	94.1	95.8	95.8	95.0
200	94.5	95	94.5	95	95	95	95.4	95.8	95.0	95.8	96.2	95.4
250	—	—	—	—	—	—	95.4	95.8	95.0	95.8	96.2	95.8
300	—	—	—	—	—	—	95.4	95.8	95.4	95.8	96.2	95.8
350	—	—	—	—	—	—	95.4	95.8	95.4	95.8	96.2	95.8
400	—	—	—	—	—	—	95.8	95.8	95.8	95.8	96.2	95.8
450	—	—	—	—	—	—	96.2	96.2	95.8	95.8	96.2	95.8
500	—	—	—	—	—	—	96.2	96.2	95.8	95.8	96.2	95.8



EFFICIENCY COMPARISONS

Grainger carries a complete line of 1 to 200 HP NEMA Premium™ Efficiency motors.



INSULATION LIFE VS. TEMPERATURE

NEMA Premium™ Efficiency motors run cooler and operate at a lower temperature rise which increases insulation life, grease life, and ultimately the life of the motor.

You'll enjoy lower maintenance and air conditioning costs with less downtime.

JOHN ZINK HAMWORTHY COMBUSTION

2013 Burner Products

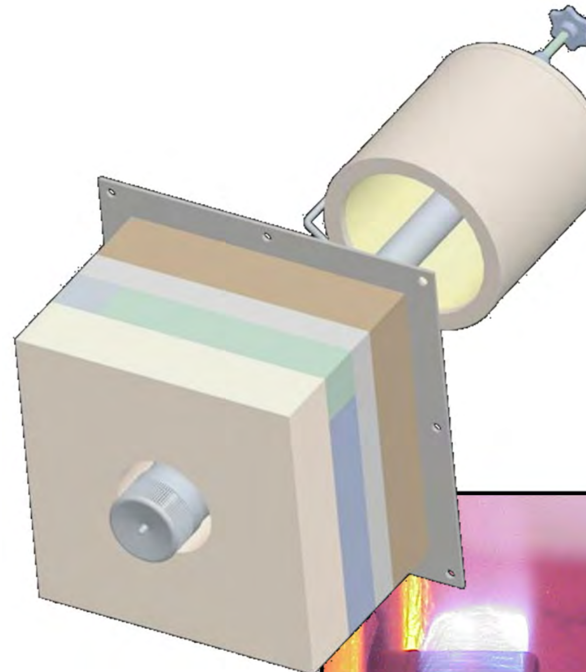
Ultra LoNOx® Burners for Ethylene

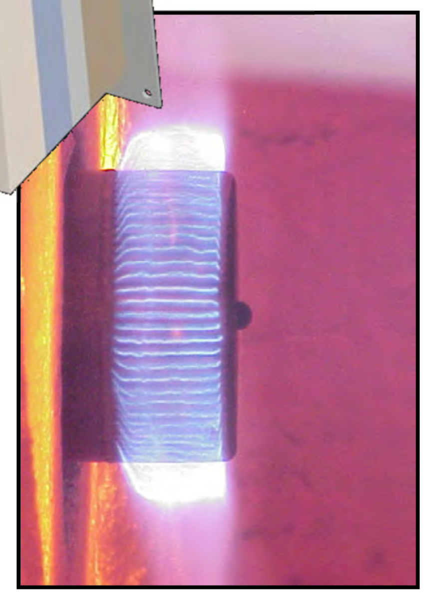
February, 2013

JOHN ZINK HAMWORTHY COMBUSTION

LPMW Burner

- Radiant Wall – Ultra-Low NOx Burner
  - Ethylene cracking and reforming furnaces (hydrogen, ammonia)
  - On the market since 2002
  - Over 7,500 burners in the field
  - Leading edge lean pre-mix / staged fuel technology
  - JZ's best available radiant wall burner for low NOx emissions
  - All stainless insert
  - Slide-N-Lock™ air control



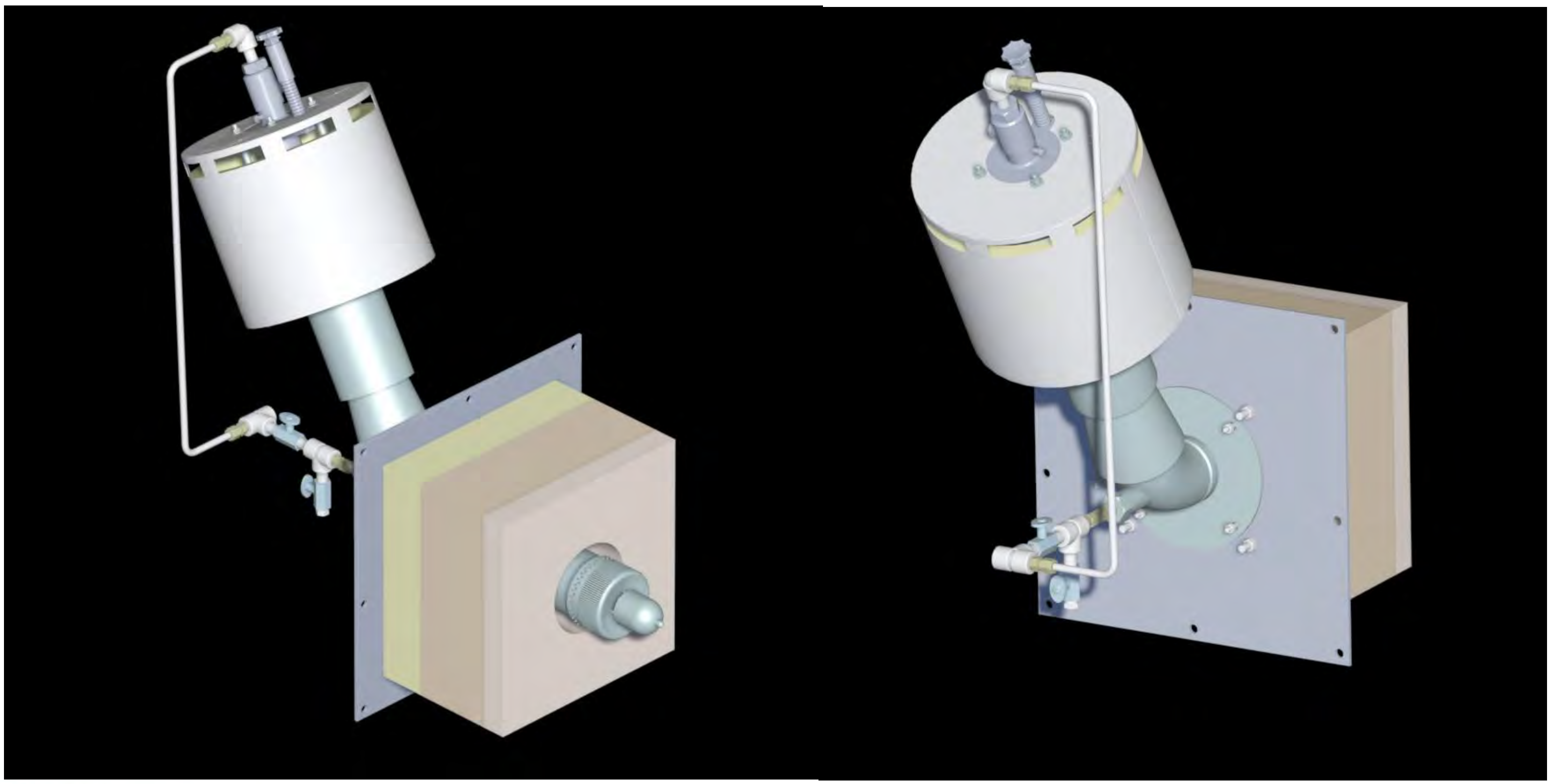


Patented

US Patent No. 5180302 and other countries

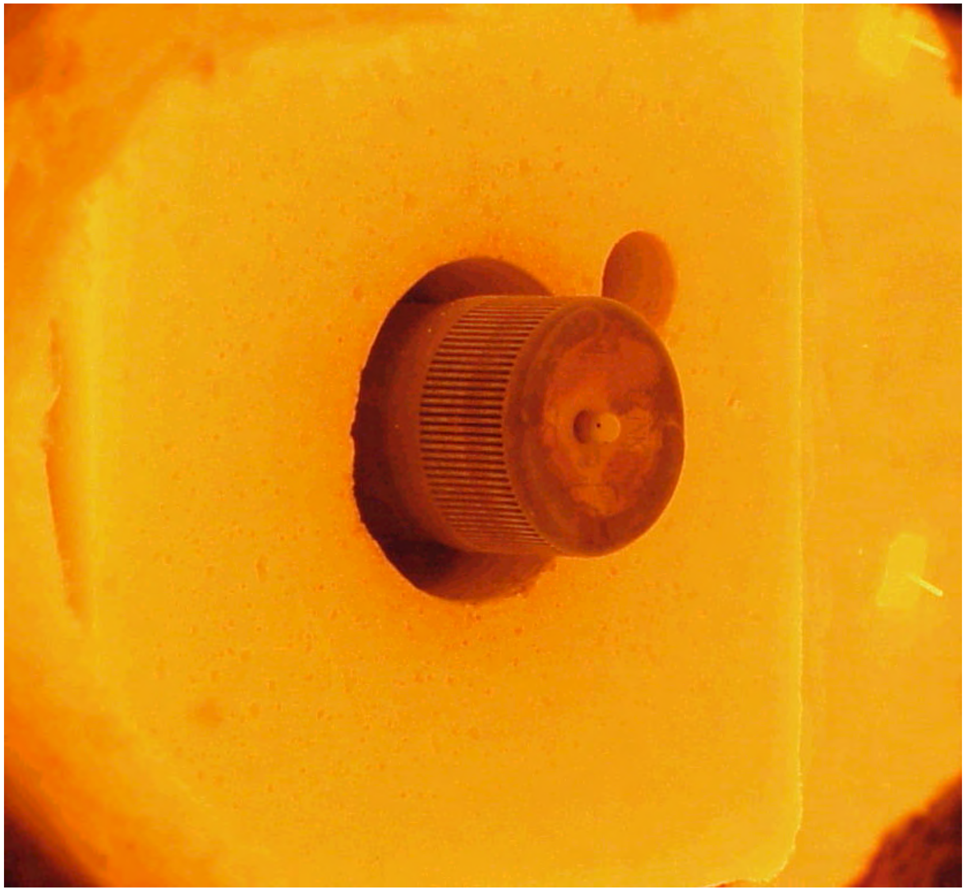
JOHN ZINK HAMWORTHY COMBUSTION

Lean Premix Wall burner



LPMW Lean Premix Wall Burner

- Single burner test
  - BWT: 1200 °C
  - NOx: ~30 mg/Nm3



Typical NOx Performance

JOHN ZINK HAMWORTHY COMBUSTION

INFURNOx Technology

Burner Style	Test Data*	Field Data*
PSMR	80 mg/Nm^3	100 mg/Nm^3
PXMR	80 mg/Nm^3	120 mg/Nm^3
PLSFFR	80 mg/Nm^3	100 mg/Nm^3

Lean Premix Technology

Burner Style	Test Data*	Field Data*
LPMW	30 mg/Nm^3	45-60 mg/Nm^3

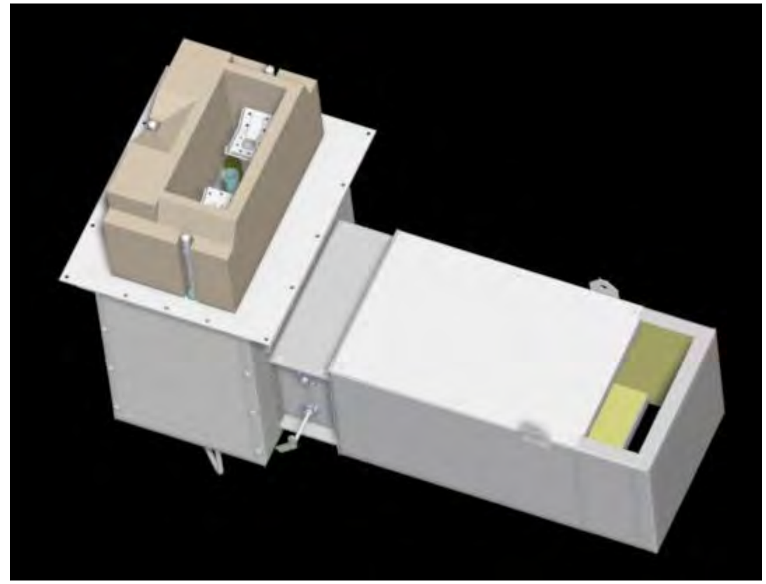
*1200 °C furnace temperature, 20% H_2 with 80% CH_4 fuel and 10% excess air

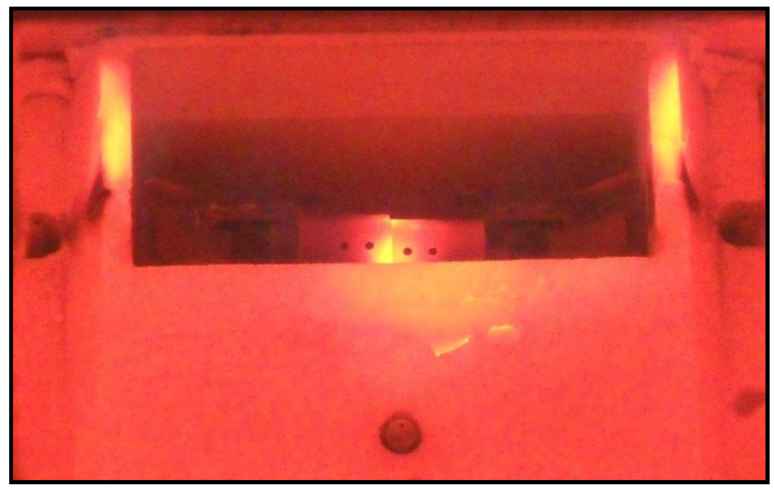
PLSFFR Burner

- Flat Flame – Ultra-Low NOx
  - Ethylene cracking furnaces
  - On the market since 1990
    - More than 6,000 in the field
  - Staged fuel / diluted primary
  - Wall fired
  - Time proven Ultra-Low NOx design
  - Engineered heat flux profile
  - Flame adherence to wall

Patented

US Patent No. 5344307





Typical NOx Performance

Low NOx Technology

Burner Style	Test Data*	Field Data*
PSFFG	65 ppmv(d)	65 ppmv(d)

INFURNOx™ Technology

Burner Style	Test Data*	Field Data*
PSMR	40-45 ppmv(d)	50 ppmv(d)
PLSFFR	40-45 ppmv(d)	50 ppmv(d)

*1200 °C furnace temperature, 20% H_2 with 80% CH_4 fuel and 10% excess air

Formosa Plastics Corporation
Point Comfort, Texas
Olefins Expansion

OL3 HEATER - Efficiency Diagram