Converting to Natural Gas for MATs Compliance

August 7, 2014

Presented by
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Background

- Many Power and Industrial Companies are Considering or in the Process of Converting from Coal or Oil to Natural Gas Firing
- Objectives Include Compliance with MATS Regulations, Simpler Operations, and Reduced O&M Costs
- Gas Conversions Require Evaluation of a Number of Issues that are Reviewed in this Webinar

Basic Requirements

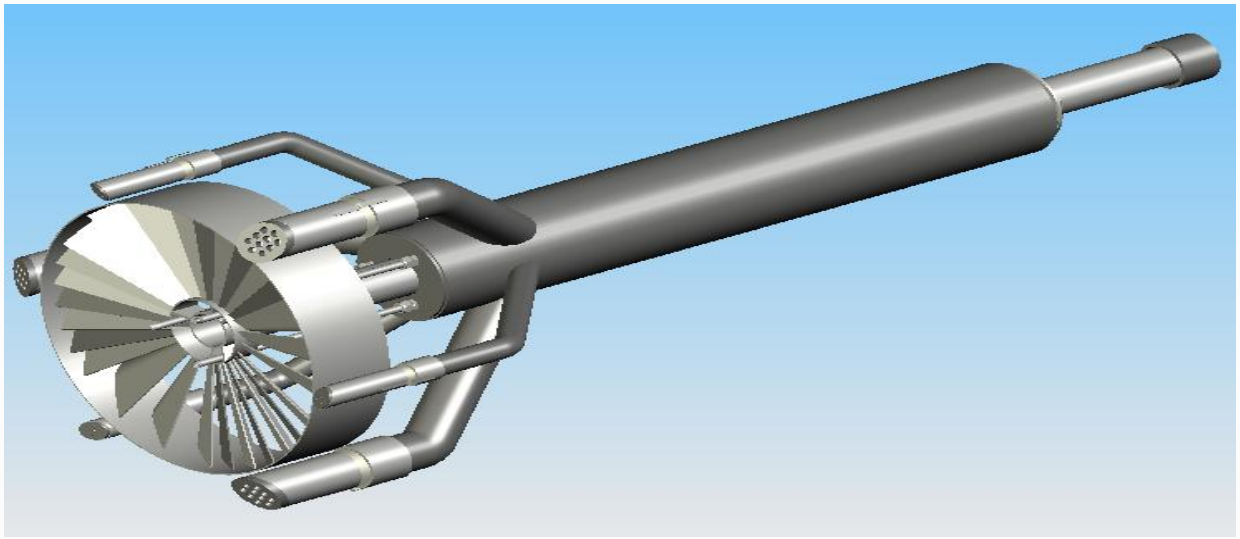
- Long Lead Items
  - Gas Supply
  - Boiler Study (Metal Temperatures & Circulation)
  - Outage Schedule
  - Air Permit
- Considerations for Gas Burners or Burner Modifications
  - Retain or Remove Oil/Coal
  - Added Emissions Controls
- Gas Valves
- Revised Burner Management System (BMS) and Approvals
- Revised Combustion Control (DCS)
- Boiler Changes if Required
- Will Higher Moisture Affect the Stack?
- Bypass or Remove Existing Particulate or Sulfur controls
- Review Fans and Auxiliaries

Basic Principles of Burning Natural Gas Low-NOx Burners or Modification

1. Safe & Stable flame
2. CFD can help Design for Unusual Cases
3. Good turndown 10:1 is typical
4. Fit the Furnace Cavity
5. Low NOx
6. Balanced Air and Fuel Flow to each Burner
7. Good Flame Detection
8. Reasonable Pressure Drop

Basic Principles of Burning Natural Gas
Low-NOx Burner Modifications

- Are the Air Registers in Good Condition?
- For Circular Burners, Remove the Center Fuel Assembly and Replace with the “Slide-In” Assembly shown below
- Balance Air Flow (CFD, Physical Model, Sleeve Damper)
- Add a Fuel Balancing Valve at each Burner



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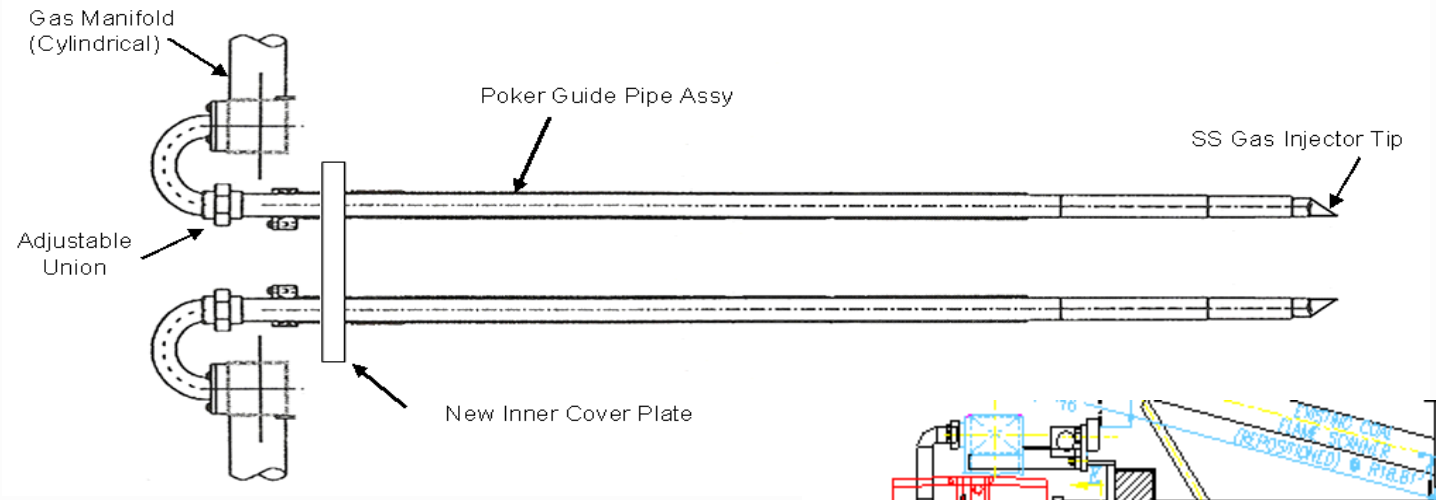
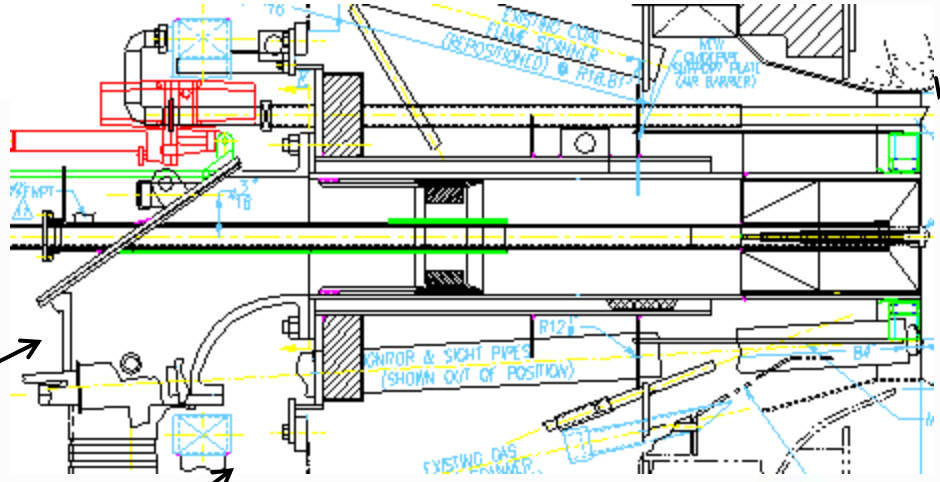
New Low-NOx Burners

Gas Retrofit to Coal Circular Burners

Retain Coal Pipe - Retrofit Gas Manifold and Poker Assembly “Around” Coal Pipe



Gas Pokers

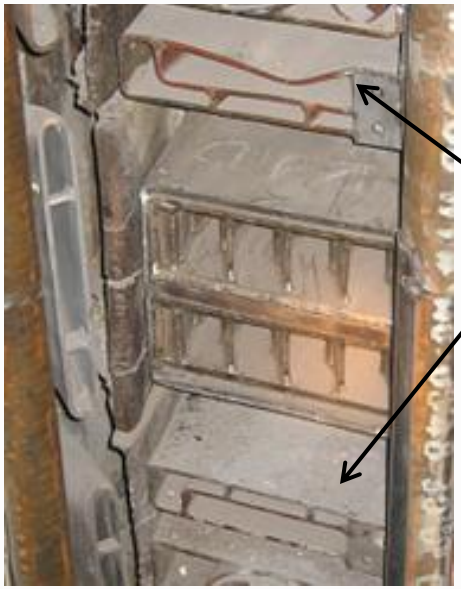


Coal Pipe (Existing

Gas Manifold

Gas Retrofit to Coal T-Fired Burners

Tilting Retrofit Low-NOx Gas Injectors Above & Below Coal



Retrofit Gas Injectors Behind Bucket

Low-NOx Gas Injectors

Flame Stabilizer

Typically 40% NOx Reduction with this Patented Approach

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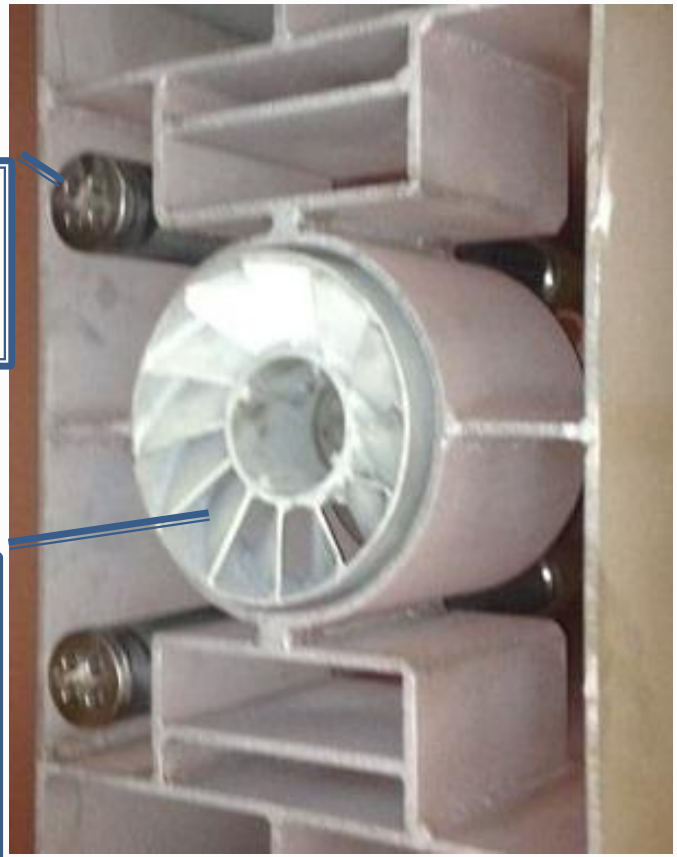
Tangent Firing Without Tilts

Low NOx Gas Injectors

Flame Stabilizer and Center Gas Injectors



Typically 40% NOx Reduction with this Patented Approach

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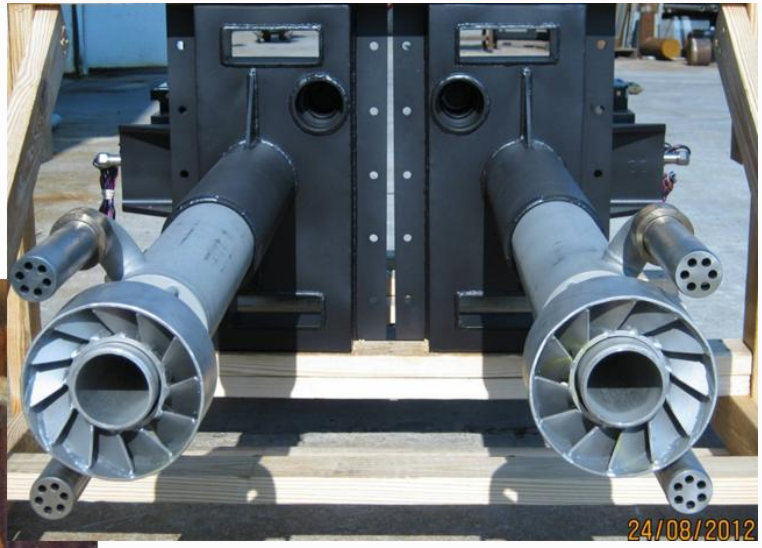
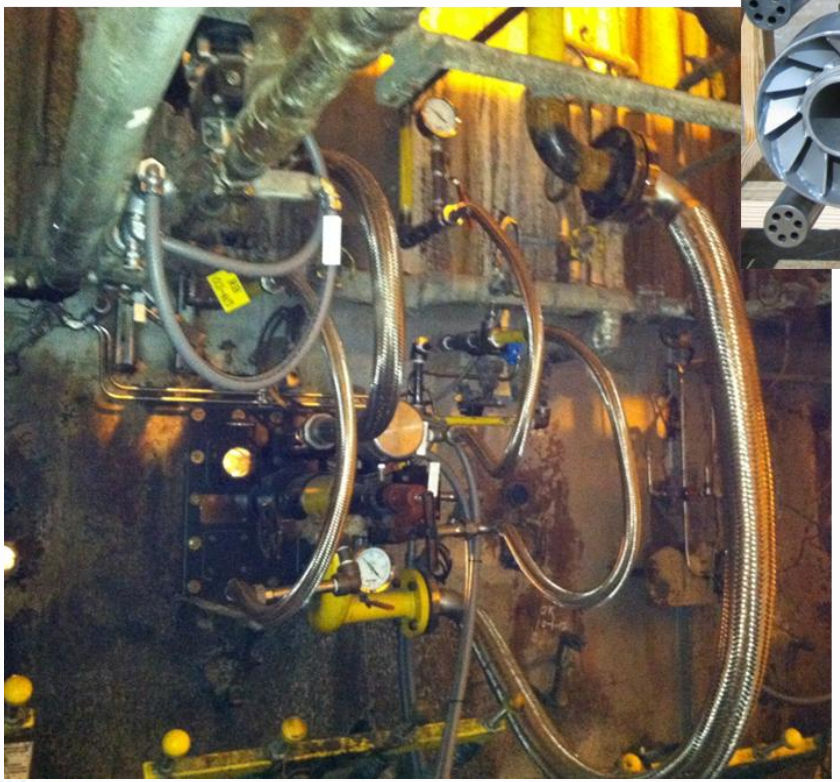
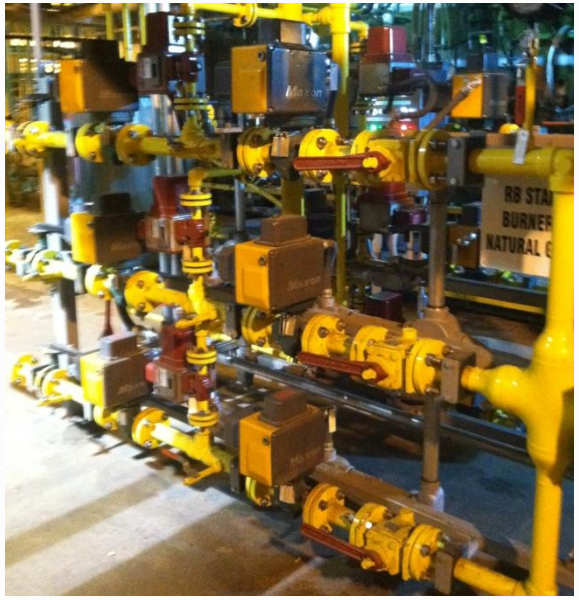
Recovery Boilers & Stokers





Valve Trains



Impacts on the Current Equipment

- Boiler Superheater, Reheater, Sprays and Headers
- FD and ID Fans
  - Gas requires more air then oil but less then coal, gas also needs about 4% more heat input then oil
- Stack and Flues
  - Gas has more moisture in the flue gas so the stack liner must be evaluated
  - Gas will have a visible water vapor plume on cold days
- Soot blowers won't be needed
- Clean your furnace
  - A good wash down will help
- Consider keeping a backup fuel - coal , #6 oil, or #2 oil
- Consider the recent price of gas this past winter
- DCS and BMS
- Sources of ignition near your gas path
- Windbox air flow correction
- Minimum boiler turndown can be lower

Standards for Safety and Controls

- The primary safety standards and codes are as follows:
  - NFPA 85
  - NFPA 54, ANSI B31.1 B31.3 or
  - NFPA 56
  - Factory Mutual (FM)
  - BLRBCK
- Not a comprehensive list!

Comparison of NOx Technologies

Reduction Method	NOx, % Reduction	Annualized Cost Factor NOx Removal	Boiler Impact
Low NOx Burner	25+%	Low	Low
OFA/BOOS	25+%	Low	Low
Water Injection	25-35%	Low	Moderate
FGR	25-75%	Moderate	Moderate to High
SOFA & FGR	50-80%	Moderate	Moderate to High
Ultra Low NOx Burners & FGR	90%	High	Package Boilers Only
SNCR*	10-30%	Moderate	Low
SCR	90+%	High	Low

* Often not appropriate for Gas unless other fuels are used

Permitting

- Start Early
- Engage a consultant to speak to the regulators
- Often the permit will allow gas to be added as long as the emissions are lower than other fuels

Comparison Of Natural Gas Combustion Properties

Fuel Type	HHV BTU/LBm	*Mass Air to Mass Fuel	% Excess Air	Total Air	Typical Boiler Efficiency
Natural Gas	≈ 21,000	17.23	7-12	117	82-84%
#6 Oil	≈ 18,100	13.63	10-15	116	85-88%
Coal	11,000-13,000	10.7	25-30	126	84-86%
Biomass	7,300-9,000	4.8	25-32	126	75-78%

* Stoichiometric

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Gas Conversions at Utility Field-Erected Wall, Cyclone and T-Fire Units

- Utility Boilers require precise regulation of superheat and reheat temperatures
- Coal to gas
  - Usually plenty of furnace size and fan capacity
  - Minor (if any) changes to steam or metal temperatures
- Oil to gas may require major changes to superheat and reheat surface or sprays (small furnace)
- BMS/DCS may be old and difficult to modify
- Cyclones boilers have very high NOx
- What to do with sulfur and particulate controls

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Industrial Field-Erected Wall, Cyclone and T-fired Units

- Coal or Hog to gas there is usually plenty of furnace size, fans may need to be upgraded
- BMS/DCS may be old and difficult to modify
- Space around the boiler may be limited for gas valves
- What to do with sulfur and particulate controls

Stokers, Recovery Boilers, Package Boilers

- **Stokers**
  - Can be up fired, wall fired, tangent fired or other
  - Grate may or may not need to be covered or removed
  - Fans need to be evaluated

- **Recovery Boilers**
  - Require very special burner
  - Flame detection requires a flame rod
  - Load burners and startup burners are different

- **Package Boilers**
  - Very narrow furnace width
  - Volumetric heat release is high
  - Combustion air is ambient in most cases
  - FGR or SCR are often easy to implement for larger NOx reductions
  - Single burners are easy to modify

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Options & Limitations Related to Keeping Your Current Fuel for use During Emergencies or During Fuel Price Volatility

1. You are subject to greater price volatility
2. Interruptible gas is lower cost
3. Many are converting to #2 oil as a back-up fuel
4. Once you remove coal it is difficult to go back
5. Gas can usually be added to an existing burner

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Issues to Consider when Converting from No. 6 to No. 2 Oil Firing
August 7, 2014

No. 2 Oil Firing Applications

- No. 6 Oil-to-Natural Gas Conversion Projects
  - No. 2 Oil Preferred Over No. 6 Oil as Backup Fuel for MATs Compliance
- No. 2 Oil Added as Backup Fuel for Coal-to-Natural Gas Conversion Projects
  - Less Infrastructure Required than Adding No. 6 Oil as Backup Fuel
  - MATs Compliance
- Misconception: No. 2 Oil Easier to Burn than No. 6 Oil Because it is a “Cleaner” Fuel

Issues with No. 2 Oil Firing

- Differences in Properties of No. 2 & No. 6 Oils that Can Affect Burner Operation
  - No. 2 Oil Viscosity Much Lower - Affects Performance of No. 6 Oil Pumps
  - ULSD has Low Lubricity – May Affect Pump Life
  - No. 2 Oil Not Heated - Temperature Typically Ranges from 30-70°F
  - No. 2 Oil HHV (Btu/gal) ~7% Less than No. 6 Oil – Higher Flow Capacity Atomizers Required
- Simply Replacing No. 6 Oil Atomizer with Higher Capacity Atomizer Not Only Consideration

No. 2 Oil Atomization

- Air Atomization Preferred for No. 2 Oil
  - High Compressed Air Requirement Generally Limits Air Atomization to Igniters & Single Burner Applications
- Steam Atomization of No. 2 Oil Required for Large Burners and Multiple-Burner Boilers
  - **Must Limit Contact of Steam with Relatively "Cold" No. 2 Oil to Prevent Steam Condensation**
  - Condensed Steam Can Adversely Affect Atomizer Capacity and Atomization Quality, Causing High Opacity (Visible Smoke) and High CO/UBC

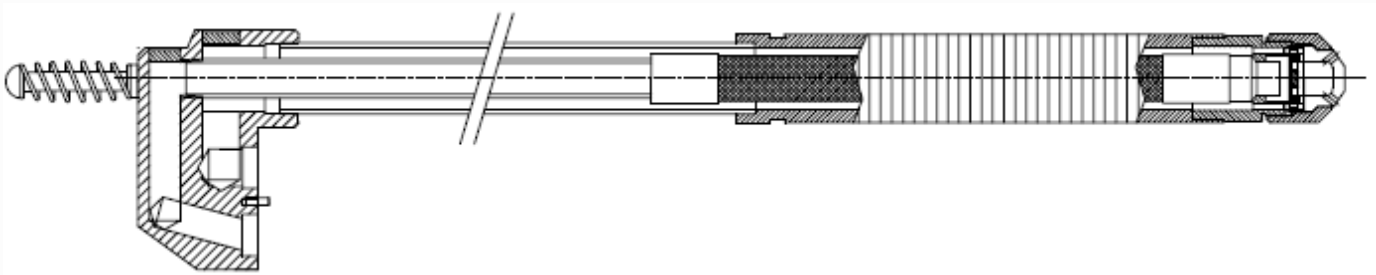
Steam Atomization of No. 2 Oil

- Steps to Minimize Condensation of Atomizing Steam by Cold No. 2 Oil
  - Selection of Oil Gun and Atomizer Design to Minimize Contact of Atomizing Steam and No. 2 Oil
  - High Atomizing Steam-to-Oil Mass Ratio
  - High Atomizing Steam Temperature
  - Increase No. 2 Oil Temperature

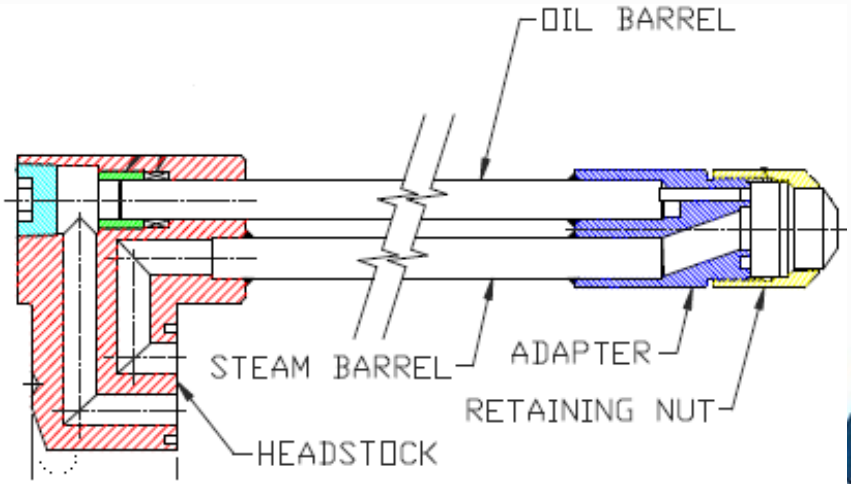
Steam Atomization of No. 2 Oil (cont)

OIL GUNS

- Avoid Coaxial Oil Guns which Maximize Contact of Atomizing Steam and Oil:



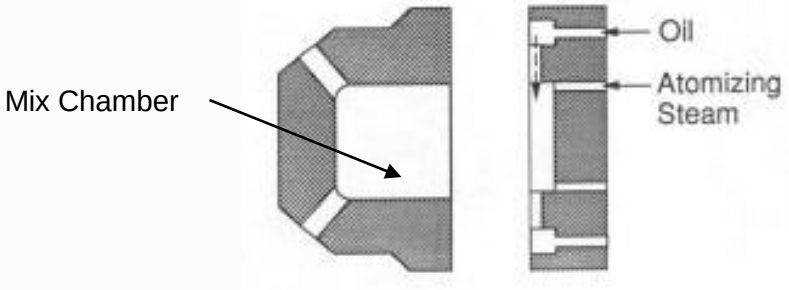
- Use Parallel Barrel Oil Guns to Minimize Oil-Steam Contact:



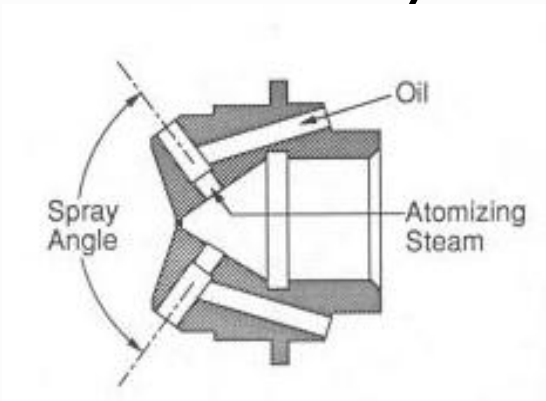
Steam Atomization of No. 2 Oil (cont)

ATOMIZERS

- Avoid Internal-Mix Atomizers that Maximize Oil-Atomizing Steam Contact:



- Use Y-Jet Atomizers that Minimize Oil-Steam Contact (No Mix Chamber):



Steam Atomization of No. 2 Oil (cont)

ATOMIZING STEAM & No. 2 OIL CONDITIONS

- Atomizing Steam-to-Oil Mass Ratio ≥15% (10% Typical for No. 6 Oil)
- Superheated Atomizing Steam
- Increase Temperature of No. 2 Oil to ~ 100°F (but Below Flash Point of ~ 125 °F)
- Atomizer Design Should be Confirmed by Laboratory Spray Tests Before Installation

Conclusions

Questions

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