



Firetube Turbulator

FIRETUBE HEAT TRANSFER

A typical firetube is constructed in a 'U' shape to be inserted in the lower half of a heater shell. The shell is filled with a bath fluid such as water, water/glycol mixture, glycol or eutectic salts. The burner side of the firetube transfers up to 40 % of the heat released by the burner into the surrounding bath while the stack side of the firetube only transfers 25 % of the heat released. As much as 35% of the available heat remains in the flue gases and exits the stack. This heat (and fuel) is wasted because of the poor transfer coefficient within the firetube.

The poor heat transfer on the stack side of the firetube is caused by the slower, less turbulent flue gas and the stratification of the warmer and cooler gases within the tube. By design the NATCO Turbulator creates turbulence within the flue gases creating a balanced heat distribution around the entire 360° of the tube at a minimum pressure drop.

TURBULATOR DESIGN

The Turbulator is designed with multiple faces, angles, and metal widths to obtain maximum turbulence of the flue gases through the tube. The scrubbing action against the tube raises the heat transfer coefficient significantly to increase the heat transfer to the bath and reduce the fuel usage. The additional turbulence created in the stack side of the firetube can increase the heat transfer rate from 25% to 30%. This increased transfer rate

can result in a 250 F reduction of the stack gas temperature.

TURBUATOR APPLICATION

To function properly, the Turbulator is sized specifically for the BTU input and firetube size. The heat transfer is maximized with minimum pressure drop through the use of appropriate metal width, impingement angle and turbulence length. It is designed to be inserted into the stack side of the tube where exhaust temperatures are usually 1000° F. or less and there is no flame impingement on the turbulator.

NATCO Turbulators will improve the life of firetubes by reducing local temperature differences that cause thermal stress. When properly applied the NATCO Turbulator will last 5 years without cleaning or replacement necessary. After installation the burner system should be properly adjusted so there will be no "burn out", carbon deposit, oxidation or any other problem arising from the use of the turbulator. NATCO Turbulators improve combustion by causing fuel to burn more completely forming less soot. Firetube cleaning may be significantly reduced.

Typically, when all other factors such as weather, temperatures, bath temperature, wind speed, etc. are constant, the Turbulator will reduce the cost of heating by 5 to 15%

FUEL SAVINGS

Fuel savings exceeding 15% are possible on oil and gas field applications. Several factors including increased turbulence will contribute to the overall fuel reduction. These additional benefits include reduced excess air caused by the slight pressure drop across the turbulator and the lower stack gas temperature, longer residence time for the flue gas caused by lower heat release rates and efficient response to changing process conditions.

At an average gas price of \$5 per therm, the turbulator will save enough fuel to pay for itself in 3 to 6 months. For example, a 1 MM Btu/hr seasonal heater operating 5000 hours per year has an annual fuel cost without a turbulator of about \$38,461. With a turbulator installed and the burner readjusted to maximize the firetube efficiency, the annual fuel cost will be reduced to \$35,714. The annual cost savings will be \$2,747.

TURBULATOR SIZING

For proper turbulator sizing, NATCO requires the firetube diameter (D) and the firetube length (L). The turbulator diameter is approximately 70% of the firetube diameter (D). The turbulator length (T) is determined by multiplying (L) by the factor (F) below.

- a. Atmospheric burner below 4000°:
F = 0.75
- b. Atmospheric burner above 4000°:
F = 0.55



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- c. Power burner at any altitude:
F = 0.8

5% to 10%. The additional annual fuel gas savings for a 1 MM Btu/hr can be as much as \$3,846.

Firetube Efficiency = 76.1 %
Stack O₂ = 5.7 %
Stack Gas temperature = 460° F

INSTALLATION / OPERATION TIPS

1. The NATCO turbulator must be inserted in the firetube and positioned nearest the stack. There should never be actual flame impingement on the turbulator.
2. To determine the performance improvement measure the stack O₂ and stack temperature prior to and after inserting the turbulator. Assuming no other burner changes are made, the O₂ measured in the stack will decrease due to the reduced draft caused by the pressure drop across the turbulator. On atmospheric burner applications the O₂ should be maintained between 3% to 4% at high fire in order to ensure complete combustion.
3. The turbulator pressure drop will reduce the natural draft of the stack between 0.02 to 0.08 inches W.C. depending on turbulator length, stack height, stack diameter and firing rate. To maximum turbulator performance, the burner heat input should be reduced by approximately 20% upon installation of the turbulator.
4. For typical atmospheric burners, the fuel gas pressure should be regulated so the burner is "ON" approximately 90% of the time during the coldest winter days. This maximizes the firetube efficiency and reduces the annual fuel input an additional

CASE HISTORY

Case #1

One 36" OD x 12' S/S indirect heater with a 10" diameter x 22'9" long firetube with a 100" turbulator.

Base Conditions:

Fuel rate = 7.62 MCFD
Firetube Efficiency = 60%
Stack O₂ = 4.7 %
Stack Gas temperature = 1112° F

Turbulator conditions (same process rates):

Fuel rate = 5.6 MCFD
Firetube Efficiency = 75.5%
Stack O₂ = 4.9%
Stack Gas Temperature = 543° F

Based on a gas cost of \$5.00 per therm, a turbulator cost of \$250 and an installation cost of \$300, the fuel savings of \$10.10 per day yields a net payback of 55 days.

Case #2

One 54" OD x 27' S/S steam generator with an 18" diameter x 51' 3" long firetube with a 22' turbulator.

Base Conditions:

Fuel rate = 22.45 MCFD

With Turbulator conditions:

Fuel rate = 12.61 MCFD
Firetube Efficiency = 81.8%
Stack O₂ = 5.1%
Stack Gas Temperature = 260° F.

Fuel saved per day equals 9.8 MCFD at \$5 per therm for a savings of \$49.20 per day. A turbulator cost of \$1,900 plus \$450 installation resulted in total installed price of \$2,350. Payback was realized in 48 days.

NATCO CONTACTS

For more information and pricing on NATCO turbulators and other energy savings equipment, please contact the nearest NATCO branch or our Corporate offices located at

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