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KvX

Fuel Saving Solutions

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Technologies That Deliver Measurable Energy Savings

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- **KvX Systems**
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Introduction

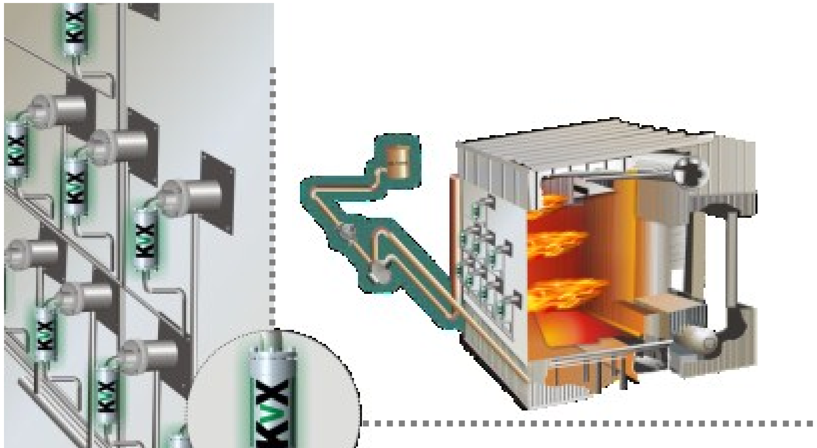
- KvX is a fuel treatment system, that delivers substantial fuel savings (>5%), reduced maintenance costs, and lower harmful pollutants

- KvX Systems are optimized to treat all combustible fluids including Gas (NG, LNG, LPG), Diesel (LDO, HSD), and Heavy Oil (Furnace, LSHS, Bunker)

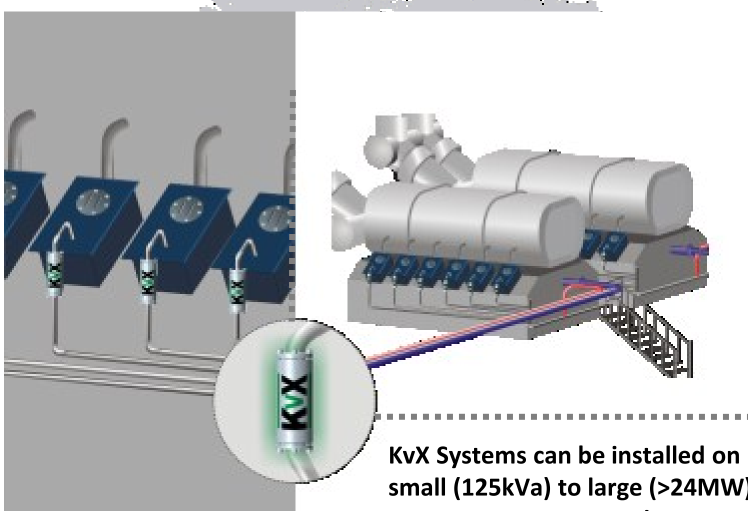
- KvX Systems are compatible with a wide range of large, industrial energy conversion equipment; Boilers, Dryers, Furnaces, Gas Turbines, Kilns, Marine & Diesel Engines, Ovens, Power Generators, Reformers, and Thermic Fluid Heaters

- KvX Systems can be easily installed with minimal disruption to plant geometry and function in a very short period of time; typical installations are in-line, require flanged or threaded connections to existing fuel lines close to points of combustion, and do not alter fuel flow pattern

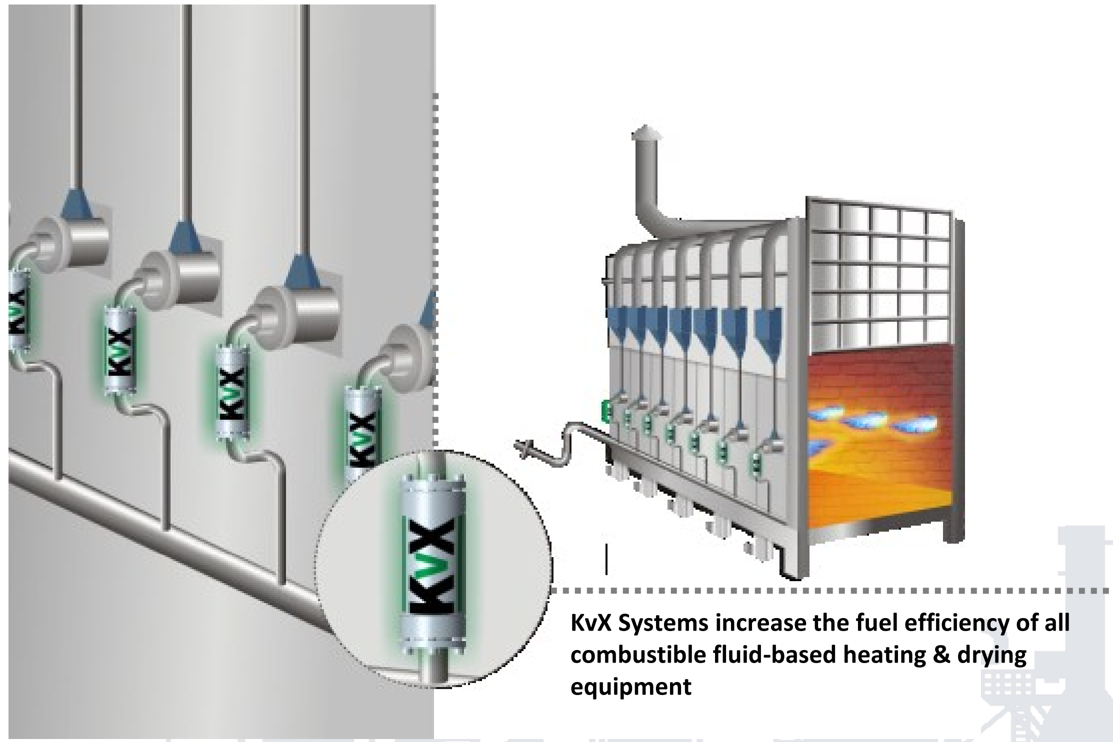
Typical Installation



KvX Systems are compatible with all types of boilers with single/multiple burners running on gas & liquid fuels



KvX Systems can be installed on small (125kVa) to large (>24MW) power generators running on gas & liquid fuels



KvX Systems increase the fuel efficiency of all combustible fluid-based heating & drying equipment

Introduction

- Patented Technology; Designed & Manufactured in Austria
- Treats all combustible fluids including Gas (NG, LNG, LPG), Diesel (LDO, HSD), and Heavy Oil (Furnace, LSHS, Bunker)
- Compatible with a wide range of large, industrial energy conversion equipment; Boilers, Dryers, Furnaces, Gas Turbines, Kilns, Marine & Diesel Engines, Ovens, Power Generators, Reformers, and Thermic Fluid Heaters
- Broad product portfolio; ⅜", ½", 1", 2", 3", 4" & 6"
- Mechanical arrangement; no internal moving parts
- Typical installations are in-line, require flanged or threaded connections to existing fuel lines close to points of combustion, and do not alter fuel flow pattern
- TÜV-Überprüfung - 13-TAAP-2936/TÖP
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Technology Overview

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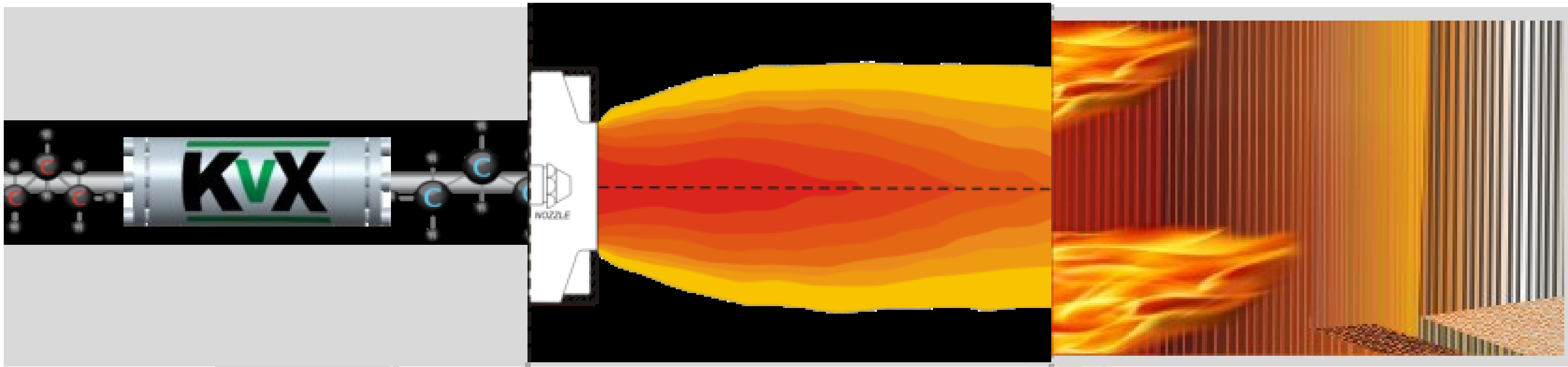
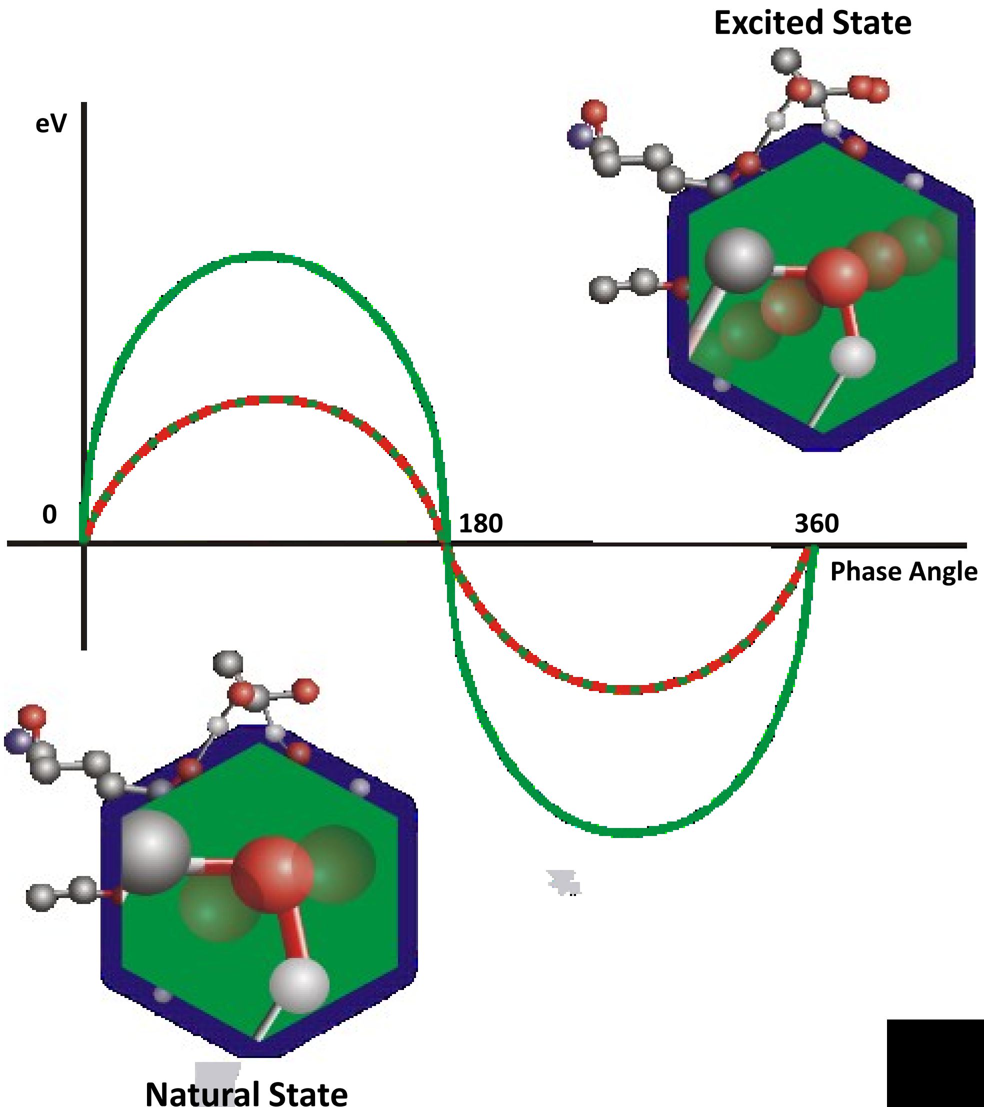


KvX System
- Superimposition of natural resonance frequency on C
- Elevation of valence electrons to higher energy state
- Weakens the covalent bonds between C–H and C–C
- Decrease in viscosity

Burner/Injector
- Better atomization
- Rapid combustion
- Higher flame temperature
- Reduction in un-burnt carbon
- Lower CO formation

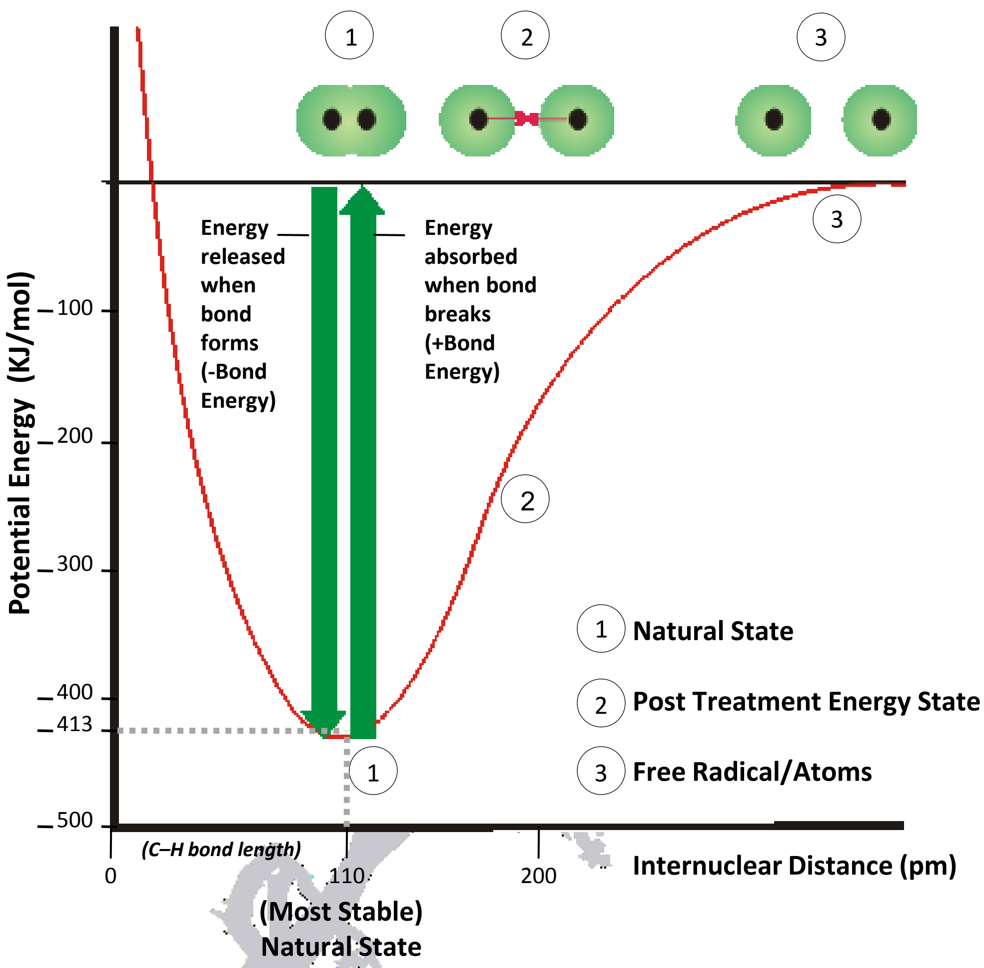
Heat Transfer Zone
- Increase in radiant heat (or torque) throughput
- Reduction in surface soot build-up
- Lower emission of harmful pollutants

Radicalization of Carbon



- KvX Systems ***superimpose natural resonance frequency on carbon***
- Enabling the carbon atom to resonate at a higher amplitude
- Allowing valence electrons to attain a higher energy level
- Resulting into the radicalization of carbon
- Gain in amplitude by hydrocarbon molecule decreases inter-molecular forces ***resulting in*** [redacted]

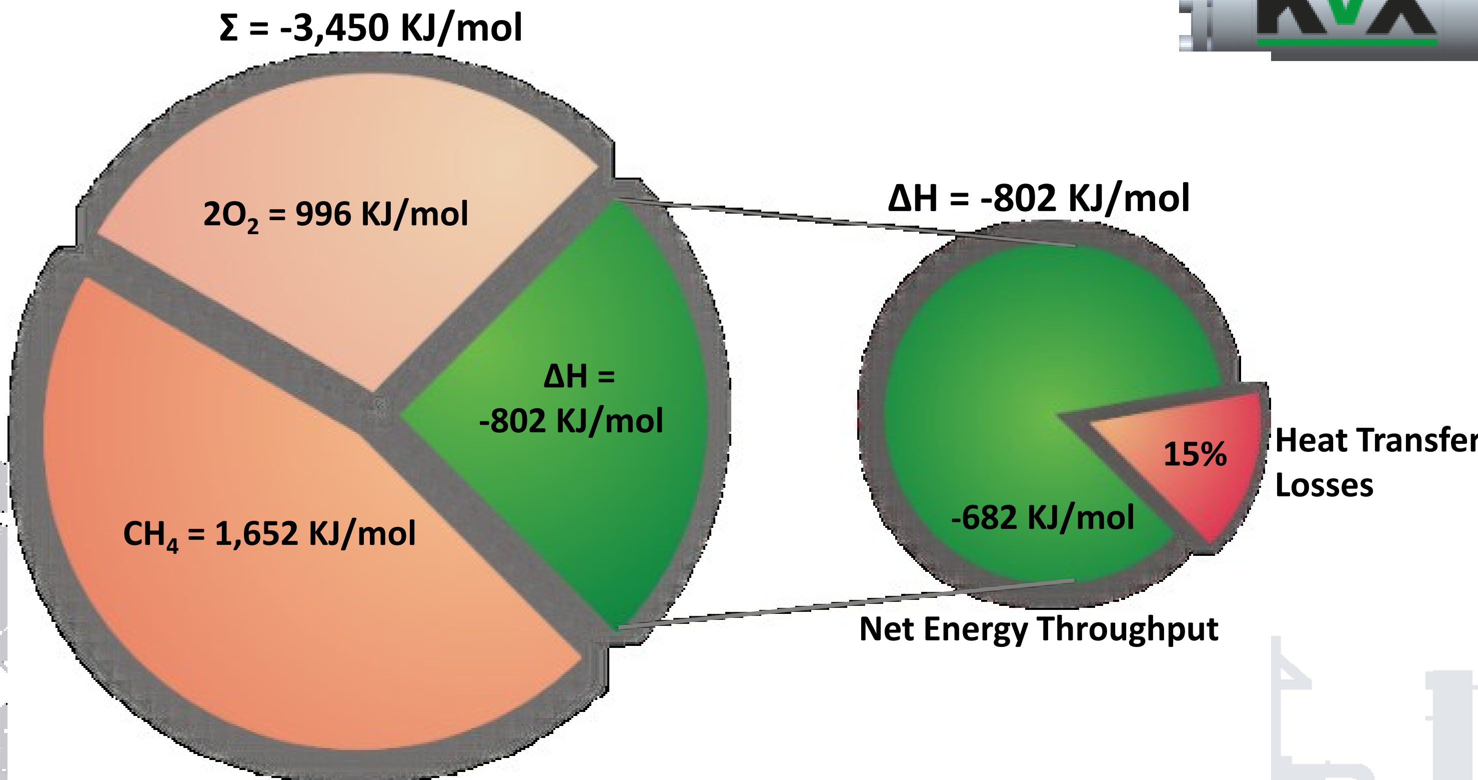
Weakened Covalent Bonds



- Ground state hydrocarbons have strong hydrogen and carbon bonds, which are characterized by negatively doped carbon
- KvX Systems allow valence electrons to achieve a higher energy state thus positively endowing carbon atoms
- During combustion ***positively doped carbon atoms combine with oxygen more rapidly*** resulting in lower unburned carbon and CO emission levels
- Optimized combustion results in an increase in the release of

Savings of Weakened Covalent Bonds (Methane)

Bond	Bond Energy (KJ/mol)
C-C	348
C-H	413
C-O	358
C=0	799
O=O	498
O-H	463
CH_4	1,652
$2O_2$	996
$2H_2O$	1,598
CO_2	1,852



Endothermic Energy = 2,648 KJ/mol

$CH_4 + 2O_2 \rightarrow 2H_2O + CO_2 + \Delta H$

$\Delta H = (1{,}652 + 996) - (1{,}598 + 1{,}852) = 2{,}648 - 3{,}450 = -802$ KJ/mol

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KvX Installation in Glass Furnaces

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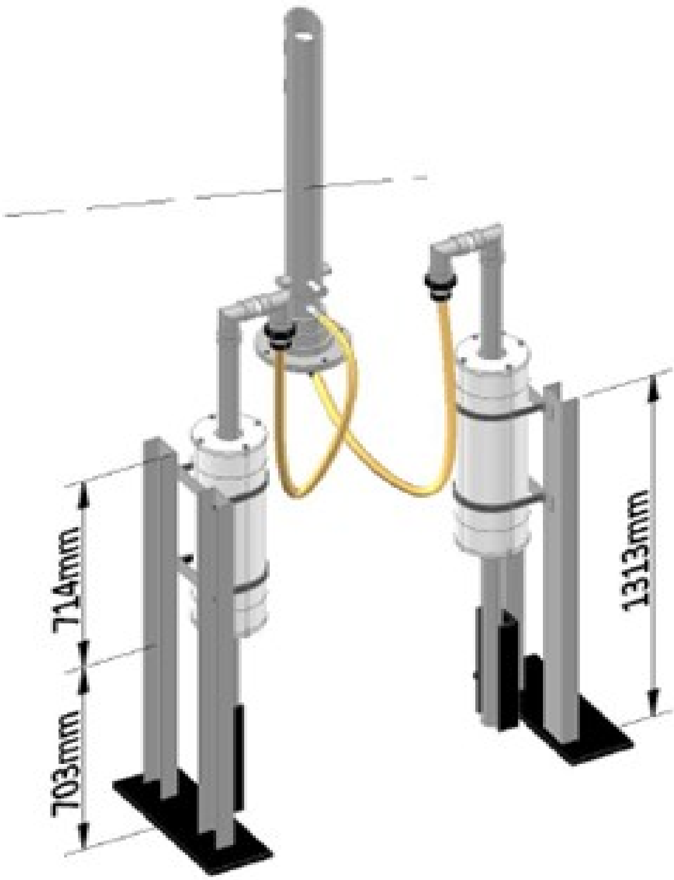
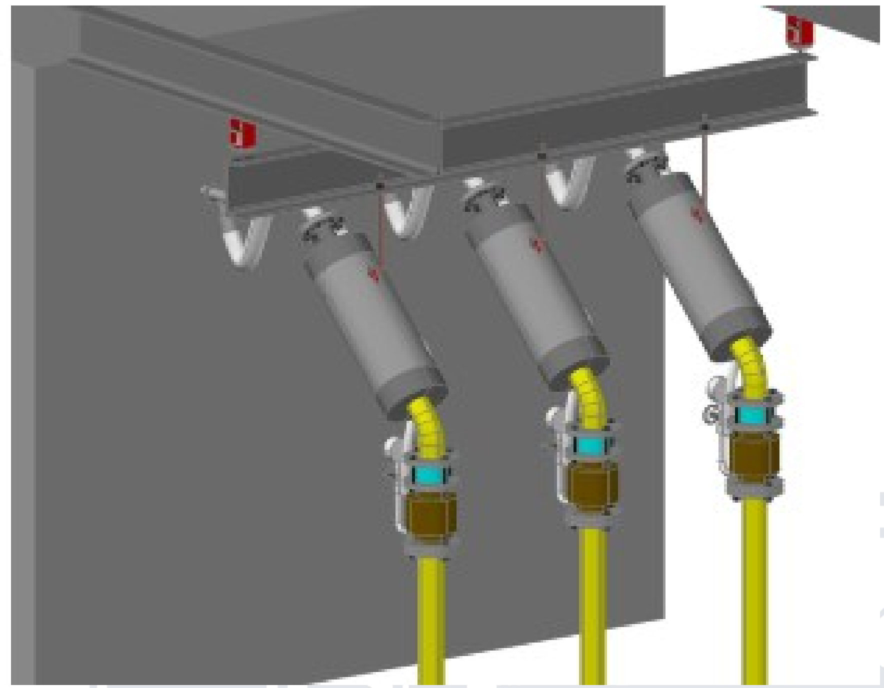
KvX Installation done in various Glass Furnaces

Float glass : Cross fired

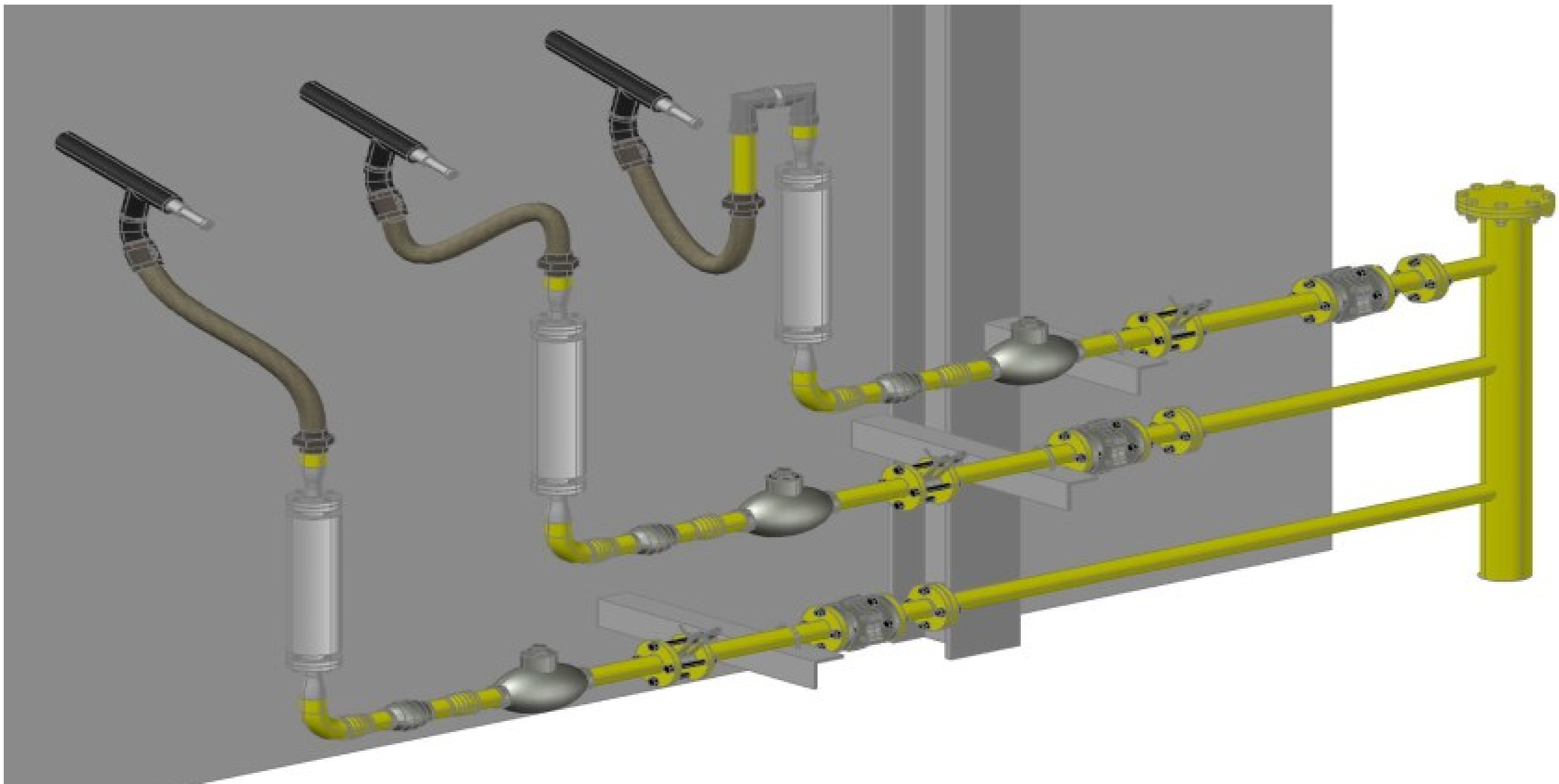


Flint bottle glass : End fired



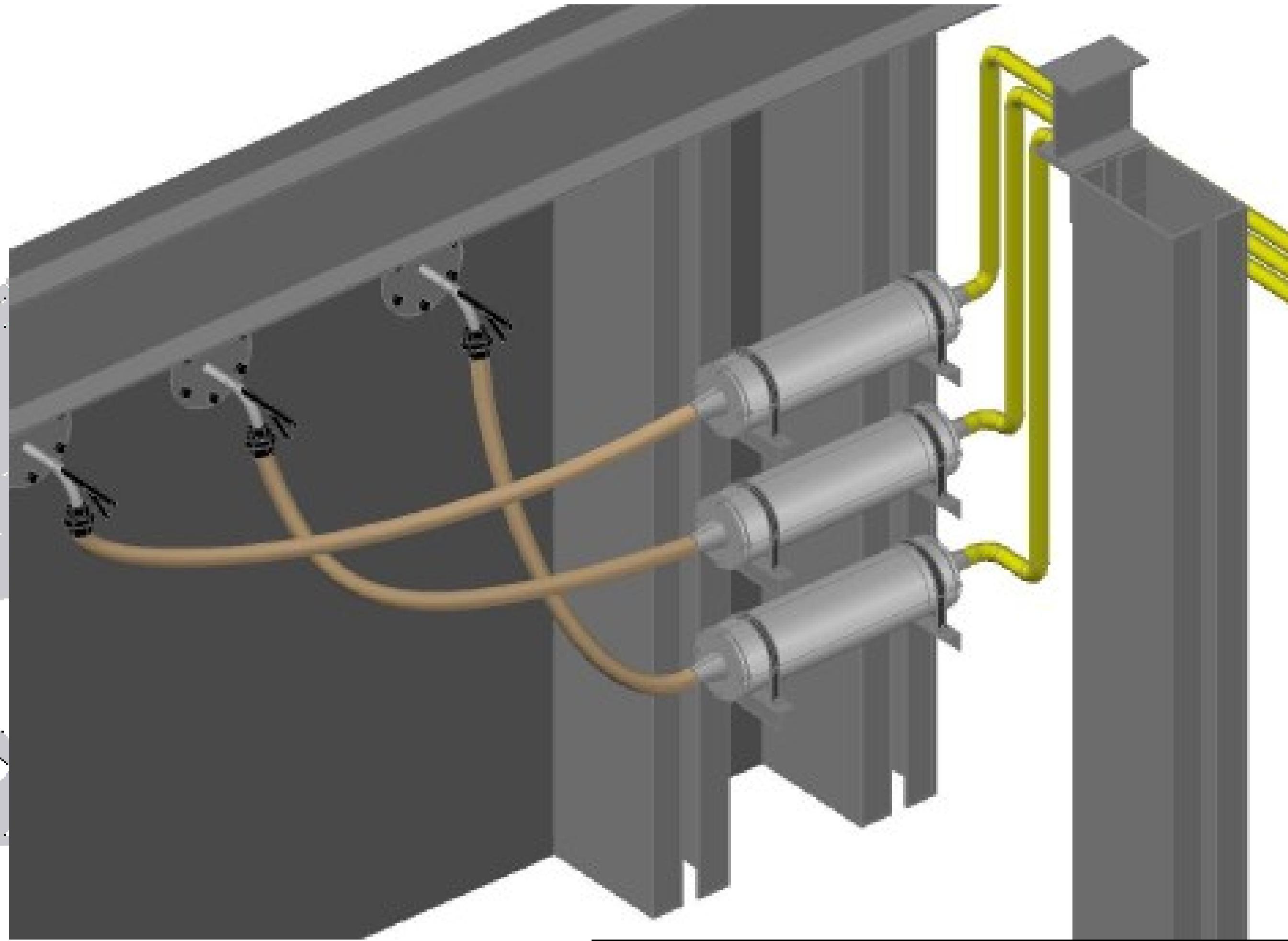
KvX Installation done in various Glass Furnaces

Lead glass : End fired



KvX Installation done in various Glass Furnaces

Amber glass bottle : End fired



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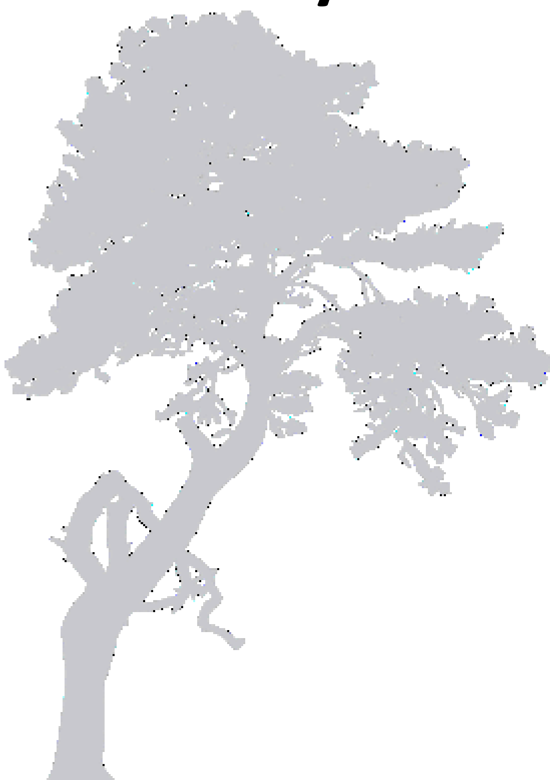

Technologies That Deliver Measurable Energy Savings

Introduction

Customer :

Leading glass bottle manufacturer for pharmaceutical customers around the world.

Furnace :

- Amber bottle glass furnace
- Capacity : 150 TPD
- Regenerative furnace
- End fired furnace
- No. of Burners : 3+3
- Year of commissioning : 2009
- KvX Installation done on : 10th Nov 2013
- Primary fuel : Natural gas

Ratio Analysis : Gas to Glass Pull (Nm^3/T)

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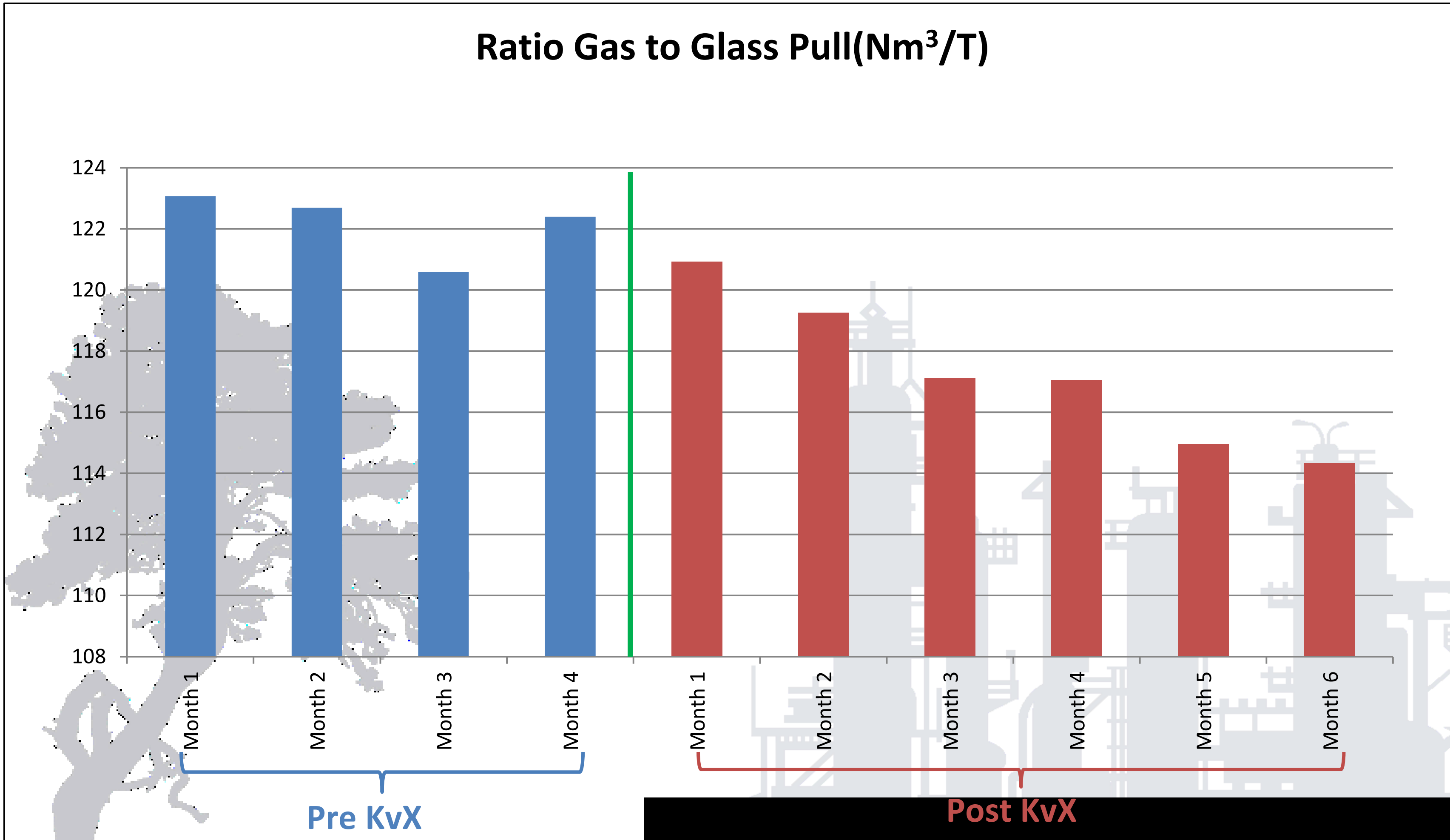
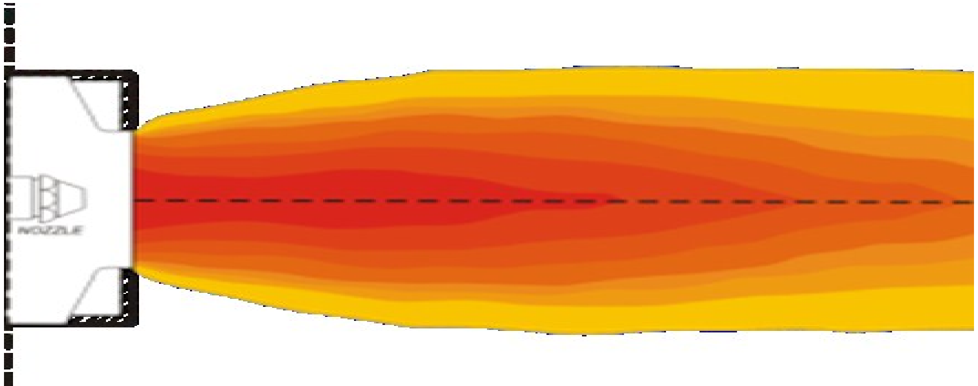


Stage 1



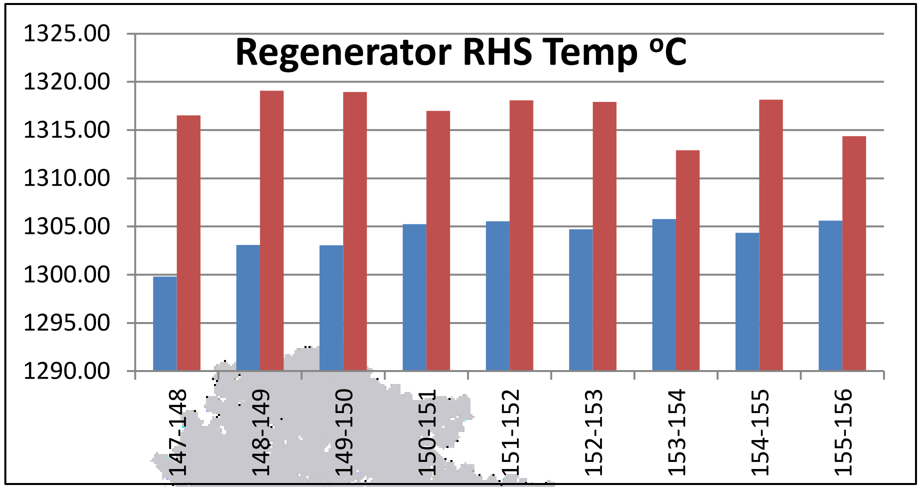
Burner/Injector

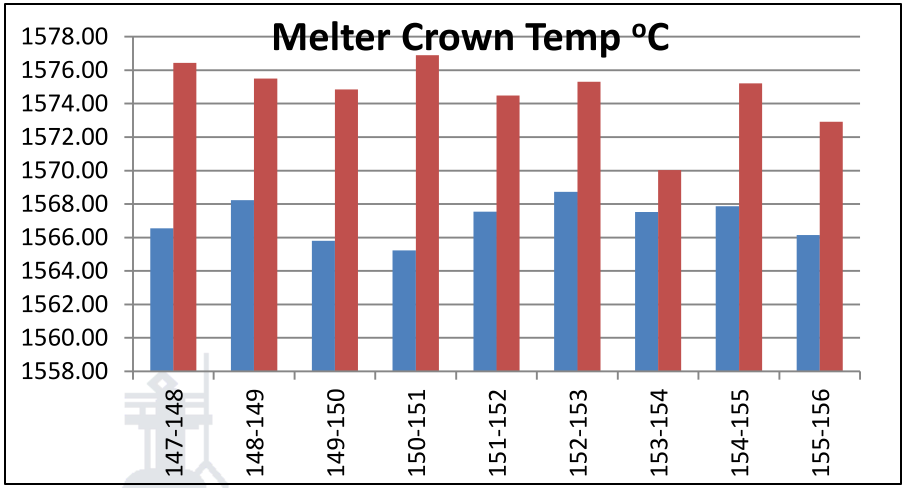
- Rapid combustion
- Higher flame temperature
- Reduction in un-burnt carbon
- Lower CO formation

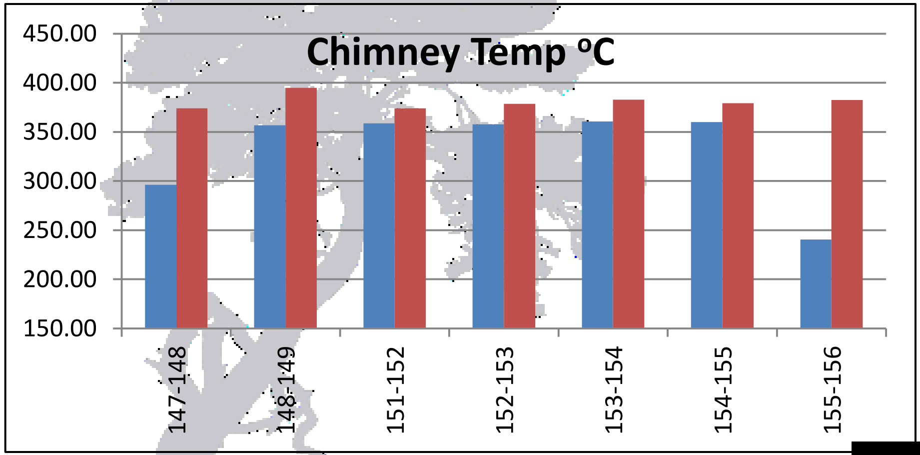
Events	Observations	Explanation	Adjustments
Installation of KvX	Brighter blue flame		Nil
	Visible flame length reduced by about 20%	This is due to radicalization of carbon atom which enables faster burning	Nil
	Reduction of CO from 200 PPM to zero at same air ratio of 10.6 compared to prior KvX	Near complete combustion	Nil
Stabilization of furnace	Increase in stack/ regenerator temperature	[redacted]	

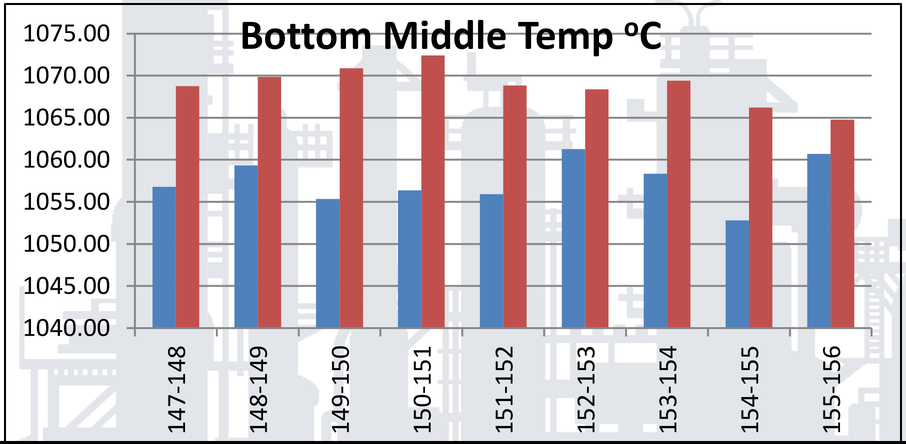
Temperature comparison to pre and post KvX at various load per day

Pre KvX   Post KvX







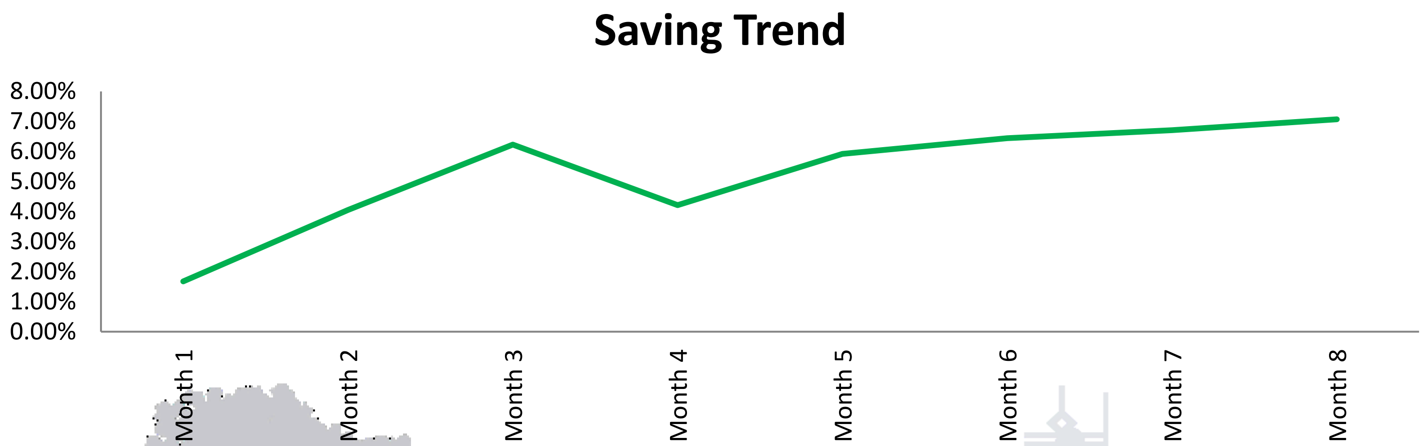


Stage 2

Heat Transfer Zone

- Increase in radiant heat throughput
- Lower emission of harmful pollutants

Events	Observations	Explanation	Reason For Adjustment
Air Fuel Ratio reduced from 10.6 to 9.4	CO ppm maintained below 50 PPPM.	This was made possible due to complete combustion indicated above	This was done for minimize the loss through stack and to improve heat retention in the furnace.
During reversal ensuring positive pressure in furnace	Drop in furnace temp during reversal	Less temp air from surrounding being sucked into hot furnace	Drop in furnace temp during reversal
Burner angle vertical and horizontal adjustments made	Mixing of flames was negated	Done by customer to improve heat distribution in melter zone	This was done to capitalize on improved heat available in furnace



Events	Observations	Explanation	Reason For Adjustment
Stabilization of furnace	Improved bottom and crown temperature (Please refer to graph)	Utilization of extra heat provided by KvX	
Flame length adjustments done	Shorter flame not reaching control temp measurement location	The bottom and crown temp before control zone were higher	Reduction in fuel and air flow
	Improved ratio of production to fuel ratio		

Conclusions

- KvX installation done with minimal disruption to plant operation.
- Extra heat provided by KvX was clearly available for utilization within the furnace. Can be achieved through various mode
  - Reduction in combustion air.
  - Minor adjustments to burner.
- Proven savings in fuel consumption >5%.
- Stabilization period vary from furnace to furnace, depending upon inherent operational characteristics like changes in
    - Production.
    - Cullet ratio.
    - Ambient temperature.
- Availability of bubblers/ electrical heater help improved capture of additional heat provided by KvX.

Summary

- KvX is an in-line, retrofit, fuel treatment system
  - suitable for all combustible liquid and gas
  - used in a wide range of large, industrial energy conversion equipment including boilers, furnaces, gas turbines, marine & diesel engines, and power generators
- KvX Systems radicalize carbon in the hydrocarbon chain
  - intra-molecularly
  - pro tem
  - to improve the kinetics of the fuel
- This radicalized fuel is characterized by
  - weakened covalent bonds between C-H and C-C, and
  - decreased viscosity
  - which enable better atomization and rapid combustion
  - leading to optimized oxidation
- The consequent increase in
  - radiant heat (or torque) throughput, and
  - reduction in un-burnt carbon and CO emission
  - results in **substantial fuel savings, reduced maintenance costs**, and **lower harmful pollutants**

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