ROSA OPERATING LLC

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Firetube boilers with X-ID® Tubes

Today's firetube boilers are direct descendants of the Scotch Marine boiler, suited for stationary service. Improvements have been made to the basic design over the years in the burner design and controls, materials and design standards and other areas. A fair bit of conservatism is still carried over due to industry-prevalent rules of thumb dictating fireside surface needed per Boiler Horse-power, the current rule of thumb being 5 sq.ft/BHP. This number can easily be lower, while having proven and reliable boiler performance, with advanced enhanced heat transfer boiler tubes like the X-ID®

X-ID® tubes have been produced for the past fifteen years. X-ID® tubes are internally augmented/enhanced tubes that significantly increase the heat transfer for gas flowing inside the tube compared to an equivalent plain tube. This heat transfer enhancement is provided by the helical ribs that are embossed on the inside of the tube. Heat transfer enhancement in X-ID® tubes is not only due to a surface area increase, but more importantly due to a complex boundary layer separation-reattachment phenomenon

In a typical tube in the convection section of a firetube boiler, 90% of the resistance to heat transfer from the flue gas to the water on the shell side, is on the inside of the tubes. Decreasing this resistance (i.e. increasing inside heat transfer coefficient) by using X-ID® tubes significantly increases the overall heat transfer in the convection section. Tube-side heat transfer in X-ID® tubes is 85% more than a comparable plain tube.

X-ID® performance has been extensively researched both at the Fintube Test Facility and through research performed at the University of Tulsa. Performance has been independently tested by other agencies as well. More importantly the success of the X-ID® firetube boiler offered by most OEMs speaks to the efficiency of this tube.

Advantages of X-ID® tubes in Firetube Boilers

- The foot-print and space requirements for an X-ID® unit are less than those of an equivalent unit equipped with plain tubes. X-ID® boilers rated at 700 BHP have been built on the frame of a unit previously sized for a 350 BHP design.

- The lower tube counts required by X-ID® boilers has allowed for larger furnaces which are very beneficial in NOx reduction.

- Surface area limited boilers like Ohio Specials can benefit greatly by X-ID® tubes, since the thermal performance goes up a lot more than the surface area goes up. (i.e. ~ 85% increase in convective heat transfer with a fire-side surface area increase of ~ 25% due to the ribs). This means that for Ohio Special boilers, X-ID® tubes allow for much higher boiler heat transfer and efficiencies than plain tube boilers that have the total 359 sq. ft allowed in such boilers.

- Due to the increased heat transfer from X-ID® tubes, X-ID® boilers are more efficient than plain tube boilers producing the same output leading to significant fuel savings. Lower fuel consumption also results in lower emissions of NOx and other pollutants.

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A couple of examples of higher performance obtained with X-ID® tubes are attached :

Fuel saving by re-tubing 2nd pass with X-ID® in a 2-pass Dryback Boiler

	Bare tubes	X-ID®
Boiler HP	600	600
Type	Dryback	Dryback
Tube o.d.	2.5"	2.5"
Operating pressure	100 psig	100 psig
Excess air (v/v)	15 %	15%
Shell I.D.	100.0"	100.0"
Morrison tube diameter	46.0"	46.0"
# tubes second pass	290	290
Temp. exit second pass (F)	560.6	392.6
Boiler efficiency	76.7 %	80.8%
Total pressure drop (in. H20)	0.47	0.83
Total btu/hr lost	6,091,643	4,777,990
Energy savings	**1,313,653 btu/hr**	
@ $6.00/thousand ft3 natural gas	**Cost savings = $8.13 per operating hour**	

Fuel saving by re-tubing 2nd pass of a 3-pass wetback boiler with X-ID® tubes

Boiler HP	600	600
Tube o.d.	2.5"	2.5"
Operating pressure	125 psig	125 psig
Excess air (v/v)	15.00 %	15.00 %
Shell I.D.	90.0"	90.0"
Morrison tube diameter	37.75"	37.75"
# tubes second pass	198	198
# tubes third pass	134	134
Temp. exit second pass (F)	779.8	510.
Temp. exit third pass (F)	470.6	400.6
Boiler efficiency	79.0 %	80.71%
Total pressure drop (in. H20)	1.52	2.04
Energy savings	**531,815 btu/hr**	
@ $6.00/thousand ft3 natural gas	**Cost savings = $3.29 per operating hour**	

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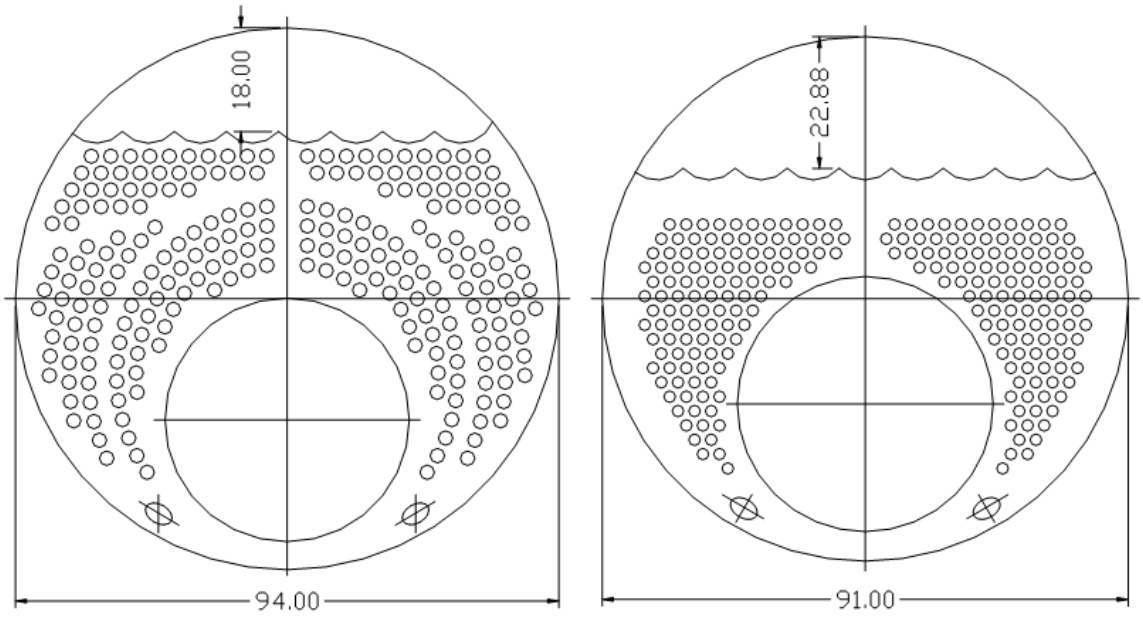
- Due to the additional turbulence created near the wall, X-ID® tubes are self-cleaning to a great extent and have been shown to foul less than plain tubes, even with particulate laden flue gas inside tubes. Regular tube brushes can be used to clean X-ID® tubes. Our most recent feed-back from a firetube boiler installation with heavy oil as the fuel was that X-ID® tubes stayed clean.

- Alternately, an X-ID® boiler can be designed with the same shell size as a plain tube boiler, resulting in significantly larger steam space and disengagement heights. This is important in processes that require rapid ramp-up to full production or need high quality steam even with rapidly varying loads.



	4-pass bare tube	**2 pass X-**
Tube count	232 x 2.5" o.d.	**ID®** 224 x
Heating surface, sq.ft	2558	2.0" o.d. 2126
Heating surface / BHP	5.0	4.25
Steam volume (ft3)	95.36	155.6
Boiler efficiency	82.4%	81.2%
Boiler pressure drop, in w.c.	6.0	**2.5**

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- The X-ID® tube is manufactured and tested to the same specification as the plain boiler tube and is certified as a SA-178A grade tube.

- Rolling X-ID® tubes is no different than rolling plain tubes. No special tools are needed nor is the wear and tear on the roller-expanders any different than for plain tubes. The ribs roll off and the tube acts like a plain tube. X-ID® tubes can rolled and expanded, flared, beaded and seal welded.

Re-tubing an existing boiler with X-ID® will also offer significant improvements in efficiency for minimal added pressure drop. Our experience has shown that the existing fans can handle the added pressure drop load.

If you have any questions, please feel free to contact us.