

## Erosion

Industrial power plants that utilize tubular air heaters often have erosion problems at the inlet sections of the air heater. The tubular air heater is designed to exchange heat through thin tubes. One of the drawbacks the tubular air heater is the establishment of laminar flow into these tubes. Turning veins and diffusor plates have been used to try to eliminate the erosion phenomenon with limited success.

Paragon is proud to offer the following solutions to the erosion problem found in tubular air heaters within the boiler industry.

## Sleeves

### Expandable Sleeves

Internal sleeves (tubes that fit into the inside diameter than the parent tube) are designed to repair the localized damage mechanism. These sleeves need to be expanded at the far end of the sleeve and at the tubesheet to ensure an air tight seal. Typical repairs are dependent on the failure mechanism but can last up to 10 years.

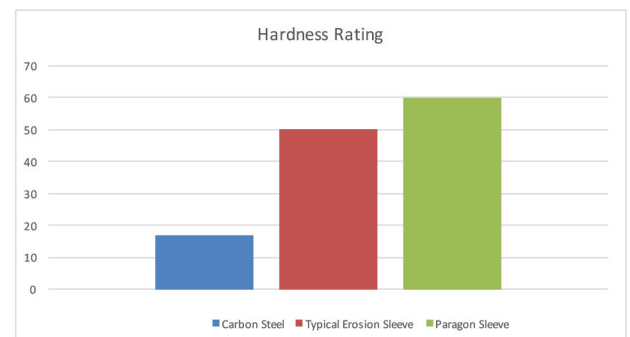
- Short term fix
- Need a tool and a supervisor to install.
- Need to be expanded into a tube with a hole or the potential of failing
- Types of damage that would need a sleeve:
  - Erosion
  - External corrosion
  - Soot blower damage



### Erosion Sleeves

An internal sleeve is designed for erosion protection. Most erosion protection sleeves are hardened to a Rockwell 40-50c. The Paragon Erosion sleeve is hardened to 60c, achieving 20% greater protection from erosion than typical sleeves.

- Long term fix
- Ease of installation – no supervisor needed
- Protection for new installations
- Damage protection for:
  - Erosion
  - Soot blower damage
  - Expansion joint failure
  - Mechanical damage



## Plugs

(Efficiency improvement)

When an air heater leaks the whole boiler is affected. Leakage lowers the exit gas temperature, causes the FD and ID fan to work harder thereby creating lower combustion efficiency. Plugging the tubes of a tubular air heater is a fast, economical way to regain control of leakage while preparing for a fix at the outage. Plugs can also be used to decrease the amount of surface area on the tubular air heater. This allows the air heater to run hotter and reduced the problems often associated with dew point corrosion.

- Specifically designed for a tubular air heater
- Ease of installation
- Ease of removal for a tube replacement.

### Plugs (Maintenance)

One of the normal maintenance requirements of tubular air heaters is plugging of failed tubes. In the past many plants used plugs designed for steam generator tubes. These tapered plugs are not designed for this application and are typically expensive. The Paragon Plug is specifically designed for a tubular air heater. Ease of installation allows the regular maintenance team to install the plugs or the onsite mechanical contractor. Paragon plugs can also be easily removed when necessary.

## Couplers

The current configuration of tubular air heaters does not always allow the replacement of a single, full tube section. The multiple tube section or the partial tube replacement is a necessity in today's market. The Paragon coupler allows tubes to be connected together with Paragon tooling. The couplers can be attached to the existing tube or to new tube sections on the inside (ID) or the outside (OD) of the tube. Some companies choose to couple the tubes on the inside because of ease of installation and no issues with pressure drop. Some companies will use the OD coupler because of a need to prevent ID tube disruption with laminar flow. Either way, with the OD or the ID coupler the connection allows an air tight, mechanically sound connection every time.

The coupler can come in many different material types and sizes depending on the application.

### Tubular Air Heater / Air to Air Exchanger Tubing

Specific tubing for tubular air heaters has been a trial and error process. Paragon recommends a specific type of tubing based on your damage mechanism. Many times the wrong material is used in the wrong application. There are times when carbon steel can be used and there are times when a higher corrosion resistant material is needed. Moreover, there can be a time when you want to use a hybrid tube of a higher corrosion resistant tube in one part and the balance in carbon steel.

## Carbon Steel

If the tube has been in service for years and the damage mechanism and deterioration rate in your air heater tube is below .02 mills per year, there is no reason to upgrade your material.

Carbon steel has been and can be used in the hotter section of the air heater. Carbon steel is a lower cost option and should be considered in the right situation and if the rate of deterioration is small or can be stopped/easily prevented.

## CR50

Many in the industry have been advertising CR50 as the correct choice for air heater tubing. When looking at the chemical composition of the two side by side the numbers tell a different story. Corten has more corrosion resistant elements making it the better choice for tubing in a highly corrosive environment.

	CR50	Corten	% difference
Chemical			
CARBON	0.06	0.05	17%
MANGANESE	0.87	0.94	8%
PHOSPHORUS	0.013	0.01	23%
NICKEL	0.16	0.26	63%
CHROMIUM	0.48	0.63	31%
MOLYBDENUM	0.02	0.02	0%
COPPER	0.31	0.36	16%
ALUMINUM	0.019	0.03	58%

## Paragon 2205

Paragon 2205 is currently the best available tube material for corrosion protection in the industry. It has identical thermal conductivity as carbon steel so there is no differential of thermal expansion. The material is a single layer of tubing and not a double layer of tubing which can often increase pressure drop. Further, there is no decrease in heat rate to the boiler. When you use a double wall or double layer of tubing you typically have a decrease in heat rate which can decrease operational efficiency.

Material type	Dew point corrosion (Slight)	Dew point corrosion (Moderate)	Dew point corrosion (Severe)	Erosion
Carbon steel	X	X		X -OD coupler
Stainless steel (300 series)		X	X	
Corten		X	X	
Stainless 2205			X	