# Worldwide Pollution Control Association

WPCA-

Southern Company

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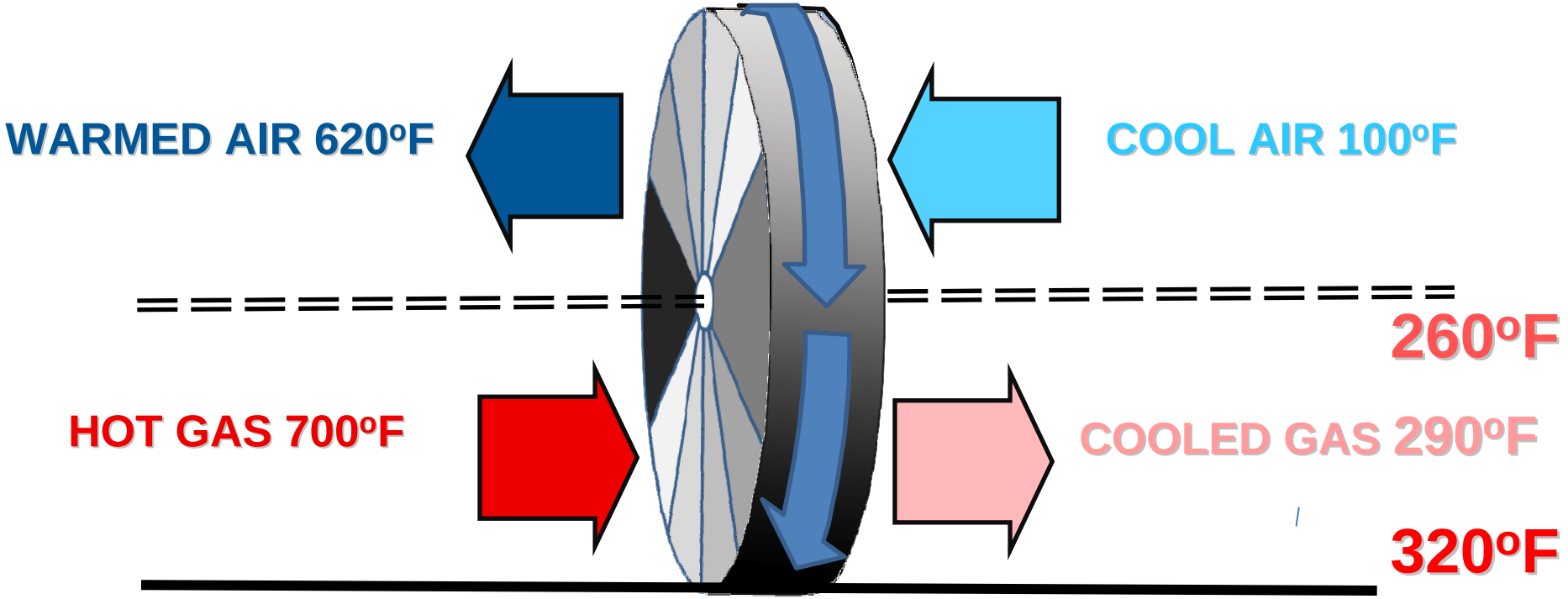
# MERCURY OXIDATION ACROSS THE AIR HEATER

John Guffre
Paragon Airheater Technologies
WWW.PARAGONAIRHEATER.COM

# Function of an Air Heater

- Extracts Waste Heat From Exhaust Gases
- Recycles That Heat to the Incoming Air



# Gas Outlet Temperature

- **ESTABLISHED STANDARD :**
  - **A 10°F Increase In Gas Outlet Temperature Decreases Boiler Efficiency By 0.25%**
  - **10°F Increases Fuel Cost By $ 7500,000$^{+}$/Yr**

# Gas Outlet Temperature

## GOAL:

**Operate At Lowest Practical Gas Outlet Temperature**

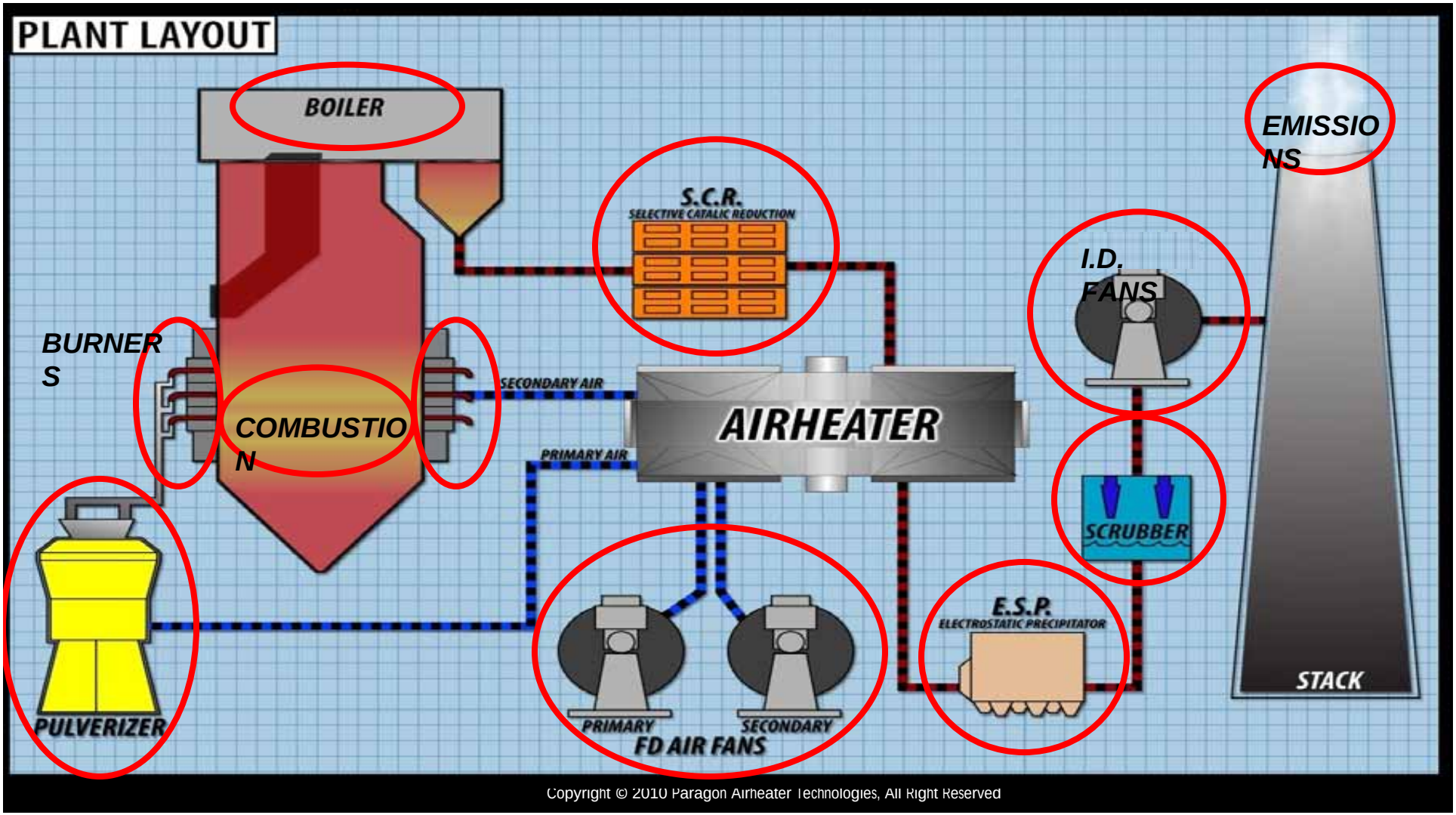
## OBSTACLES:

**Condensables**

**Effects of Gas Temperature on Equipment**

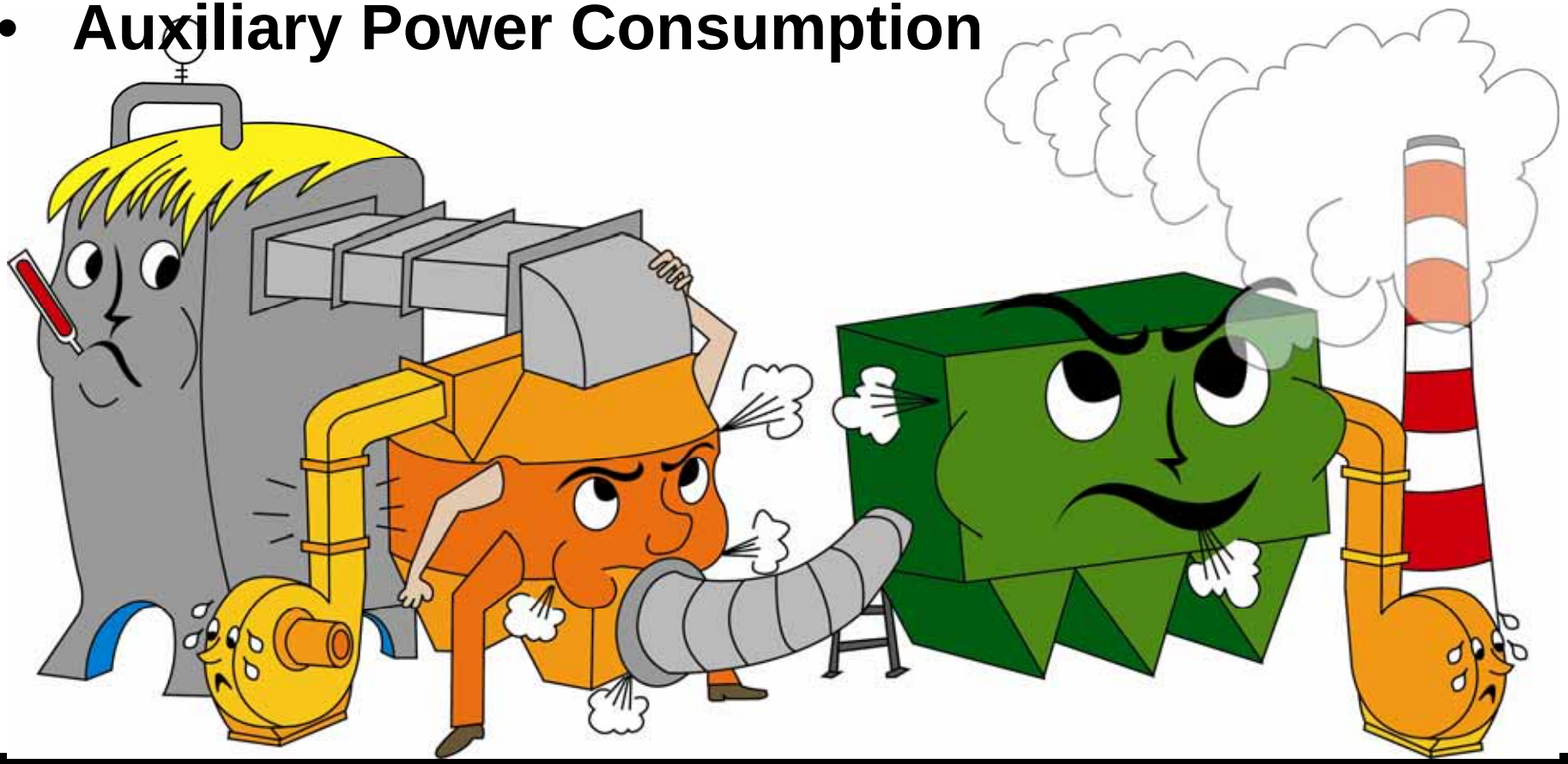
# The SCR Impacts the Air Heater

## The Air Heater Impacts Combustion and APC Equipment



# Inter-Relationships

- **Combustion Performance**
- **APH performance**
- **Environmental Control Equipment**
- **Auxiliary Power Consumption**



# AH DETERIORATION

# BROMINE PAC PROBLEM?

## RAPID CORROSION OF AIR HEATER ELEMENT

# BROMIDE ACI CORROSION

- ACI INJECTION ON HOT SIDE  6 TO 25 FEET FROM INLET TO AH
- DETERIORATION OCCURRED IN THE COLD END BASKETS ONLY
- DETERIORATION USING AMMONIATED BROMIDE PAC  OR GASEOUS BROMIDE IMPREGNATION
- NO DETERIORATION OBSERVED WITH SODIUM BROMIDE PAC

# ROOT CAUSE DETERMINATION

**INITIAL INVESTIGATION**

- **SUSPECTED SOOTBLOWER EROSION BUT METALLURGICAL AND CHEMICAL ANALYSIS OF FAILED SECTIONS CONFIRMED CORROSIVE MECHANISM**

- **CONSULTATION WITH INDUSTRY EXPERTS (EPRI, LEHIGH UNIVERSITY) SUGGESTED AN AMMONIA LINK**

- **AMMONIA ODOR DETECTED IN FLYASH WHEN WET. THIS WAS PRIOR TO SNCR OPERATION.**

- **CORROSION NOTICED USING AMMONIATED BROMIDE AND GASEOUS DIFFUSED BROMIDE PAC. NO CORROSION OBSERVED USING SODIUM BROMIDE PACS**

# ROOT CAUSE DETERMINATION

- **DIFFERENT VOLATILITY LEVELS OF DIFFERING PAC BROMIDING TECHNIQUES**

| *BROMIDING TECHNIQUE* | *PURE SUBSTANCE VAPORIZING TEMP* |
|---|---|
| **GASEOUS DIFFUSED** | **-56 deg f** |
| **$NH_4$ Br** | **388 deg F** |
| **KBr** | **1463 deg F** |
| **NaBr** | **1483 deg F** |

- **BROMIDE CONCENTRATIONS IN THE CARBON CAUSING DETERIORATION WERE FROM 5.5 TO 8.0 PERCENT**
- **CONCENTRATIONS FROM THE NON DETERIORATION PACS WERE BETWEEN 4-5 PERCENT**
- **OBSERVED DETERIORATION PRIMARILY A FUNCTION OF BROMIDING TECHNIQUE, LESSER OF BROMINE CONCENTRATION AND DEW POINT**

# ACID RESISTANT COATINGS

# Downstream Corrosion

**HgS Cinnabar Ore**

$Hg^0$

$Hg^{2+}$

$Hg_p$

# COMBUSTION CHEMISTRY

- **SCIENCE CONCERNING THE COMBUSTION CHEMISTRY OF MERCURY WAS VIRTUALLY UNKNOWN BEFORE 2000**

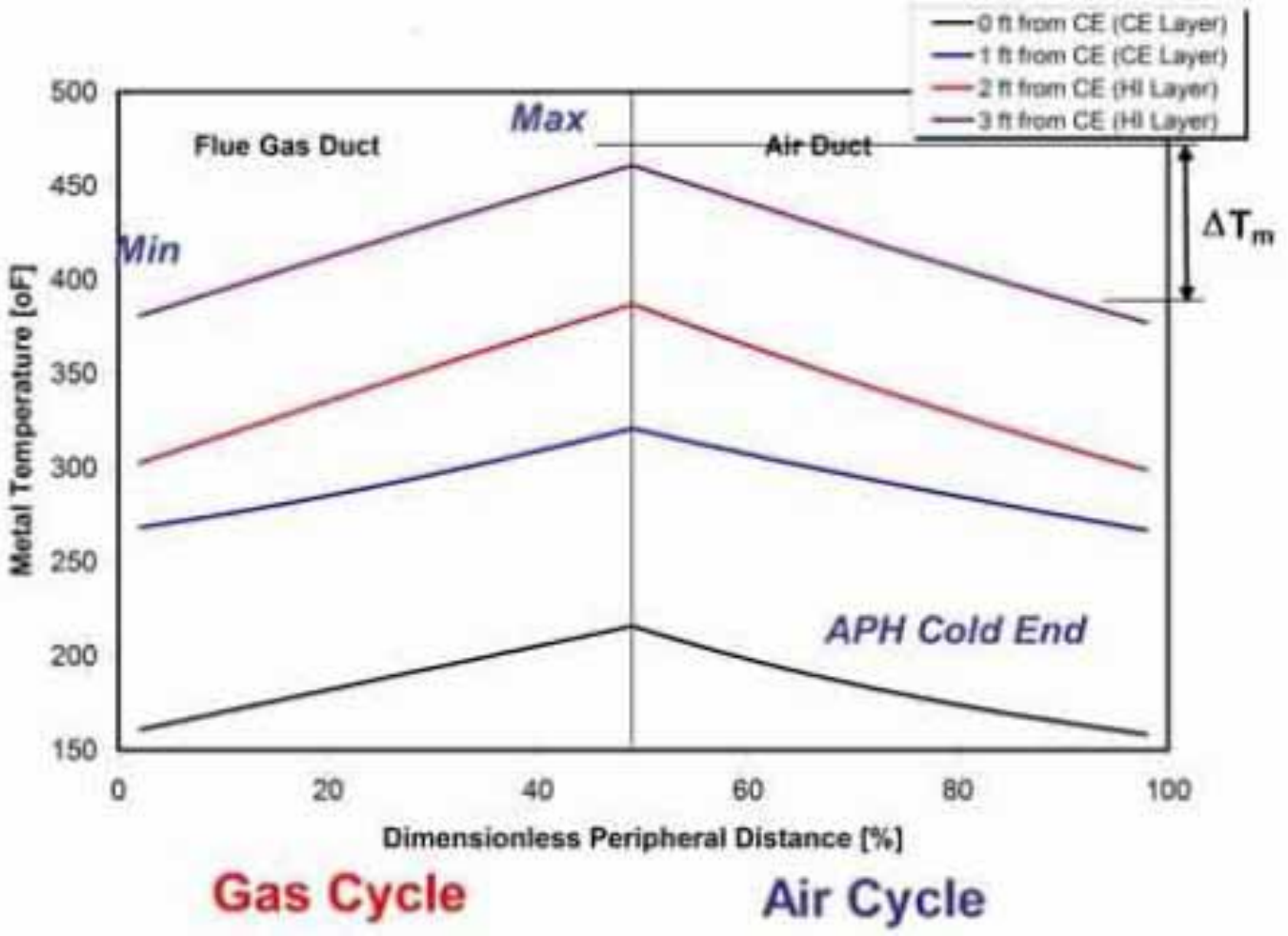
- **ASSUMPTION HAS BEEN THAT ADDITIVES ARE REQUIRED FOR OXIDATION OF Hg**

# NON-CATALYTIC Hg OXIDATION

## HETEROGENEOUS CHEMISTRY ON ANY AVAILABLE SURFACE

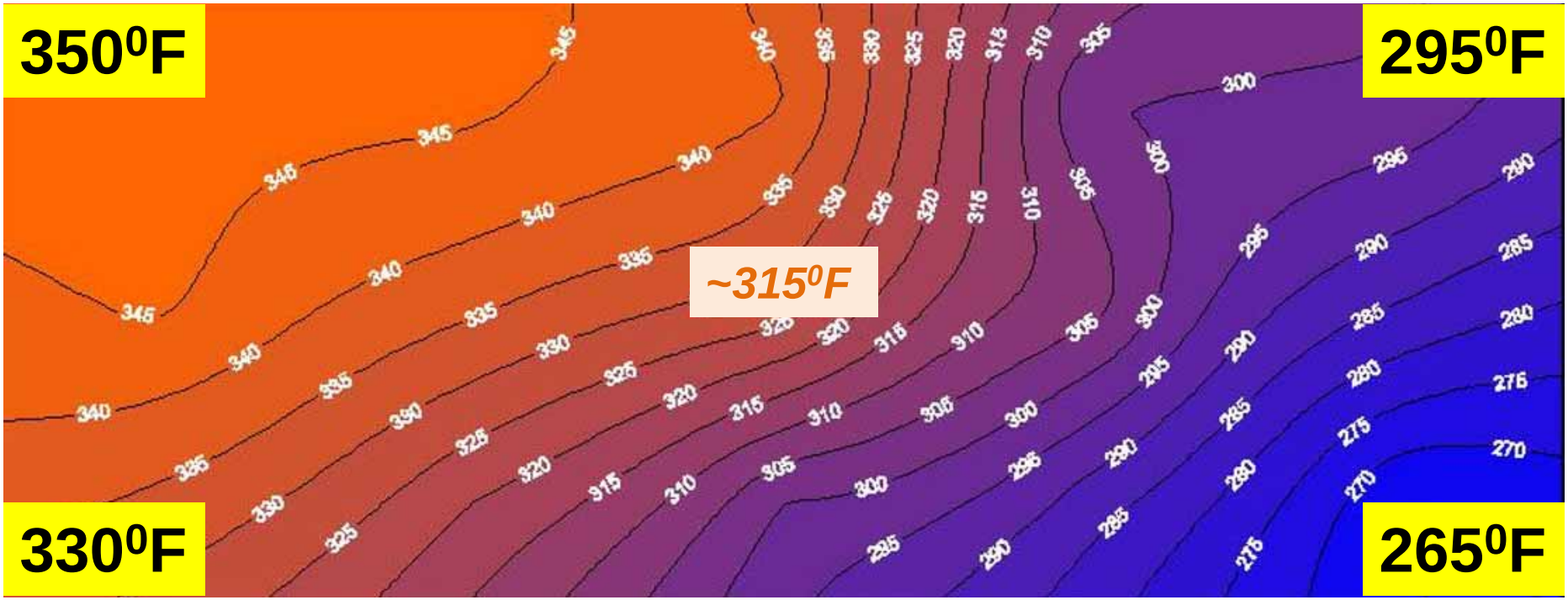
- **SURFACE TEMPERATURE 450°F ± 50°F**
- **$Hg_{(g)} + SO_x + O_2 \leftrightarrow HgSO_{4\,(s)}$ MERCURIC SULFATE**
- **$HgSO_{4\,(s)} + 2HCl_{(g)} \rightarrow HgCl_{2\,(s)}$ MERCURIC CHLORIDE**
- **$HgCl_{2\,(s)} \rightarrow HgCl_{2\,(g)}$ SUBLIMATION**

# AH METAL TEMPERATURE

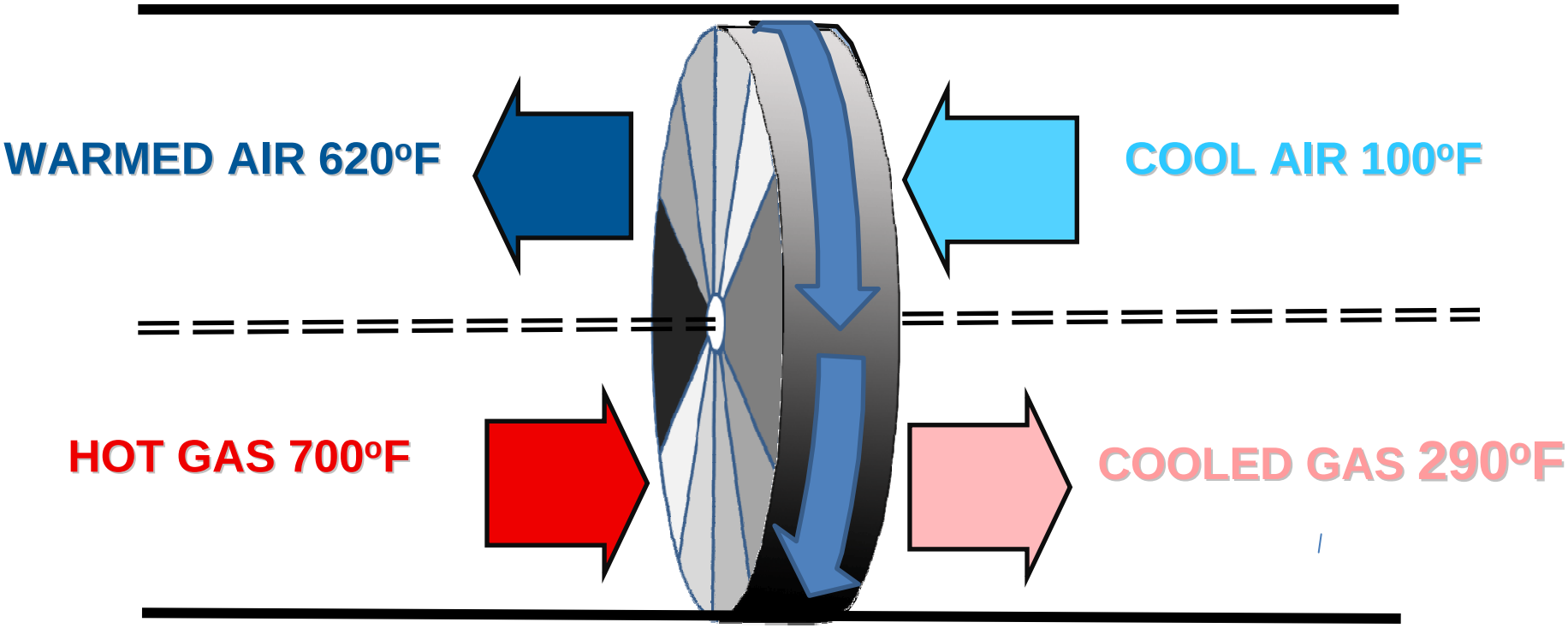



**12" ACTIVE SURFACE**

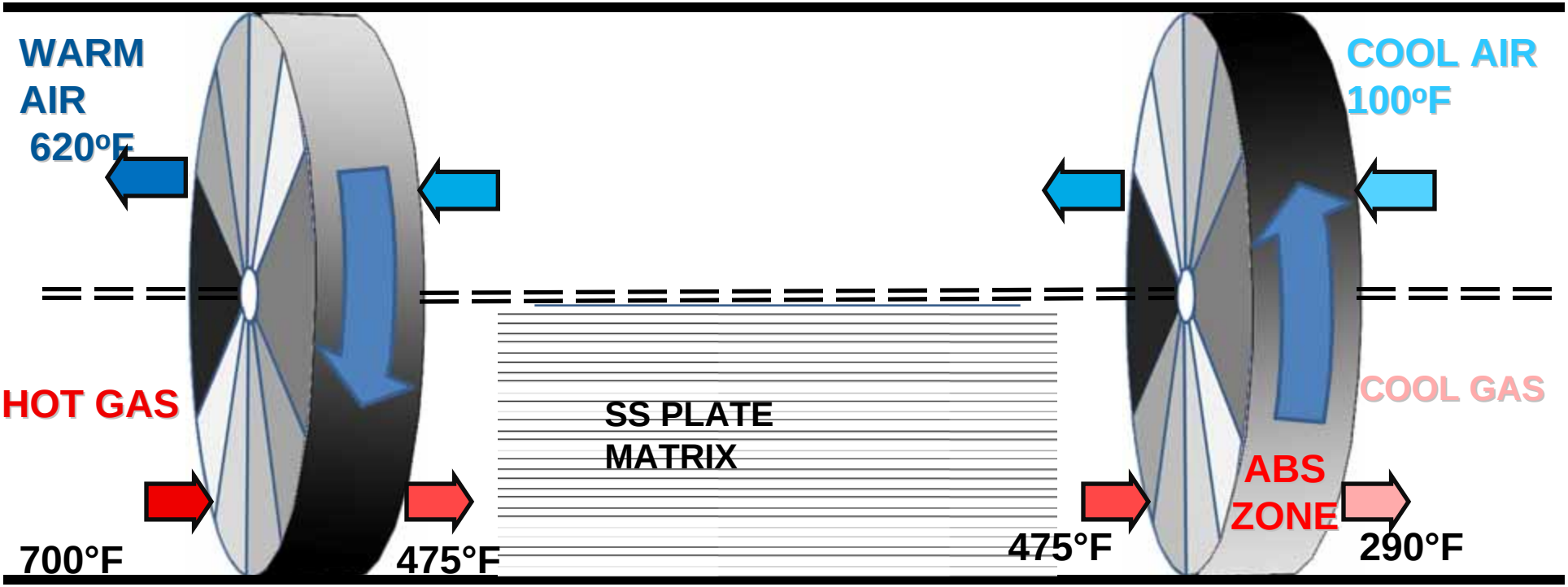
# GAS TEMPERATURE PROFILE



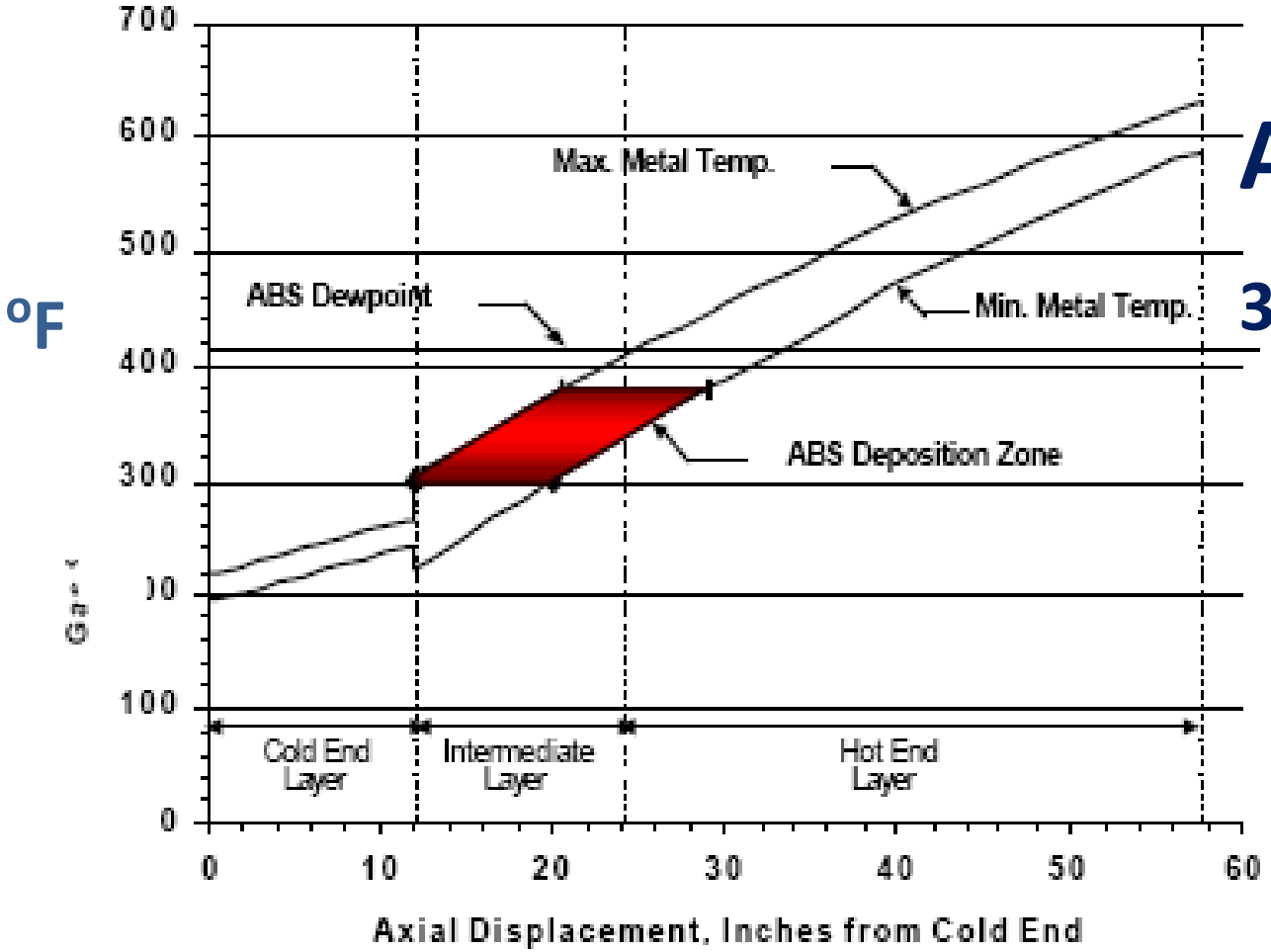
# SINGLE AIR HEATER



# Hg OXIDATION AH ARRANGEMENT



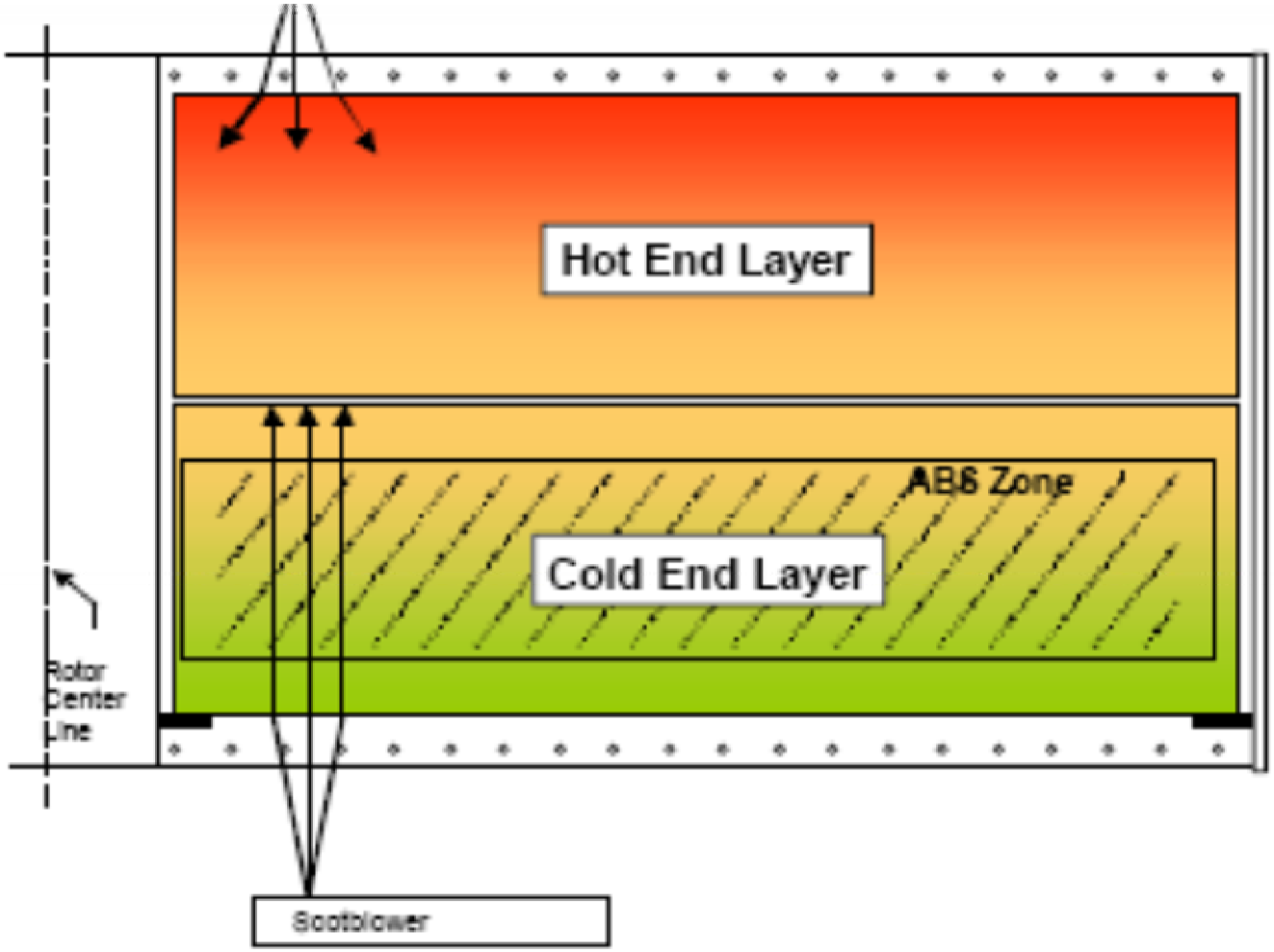
# ABS Deposition Temperature



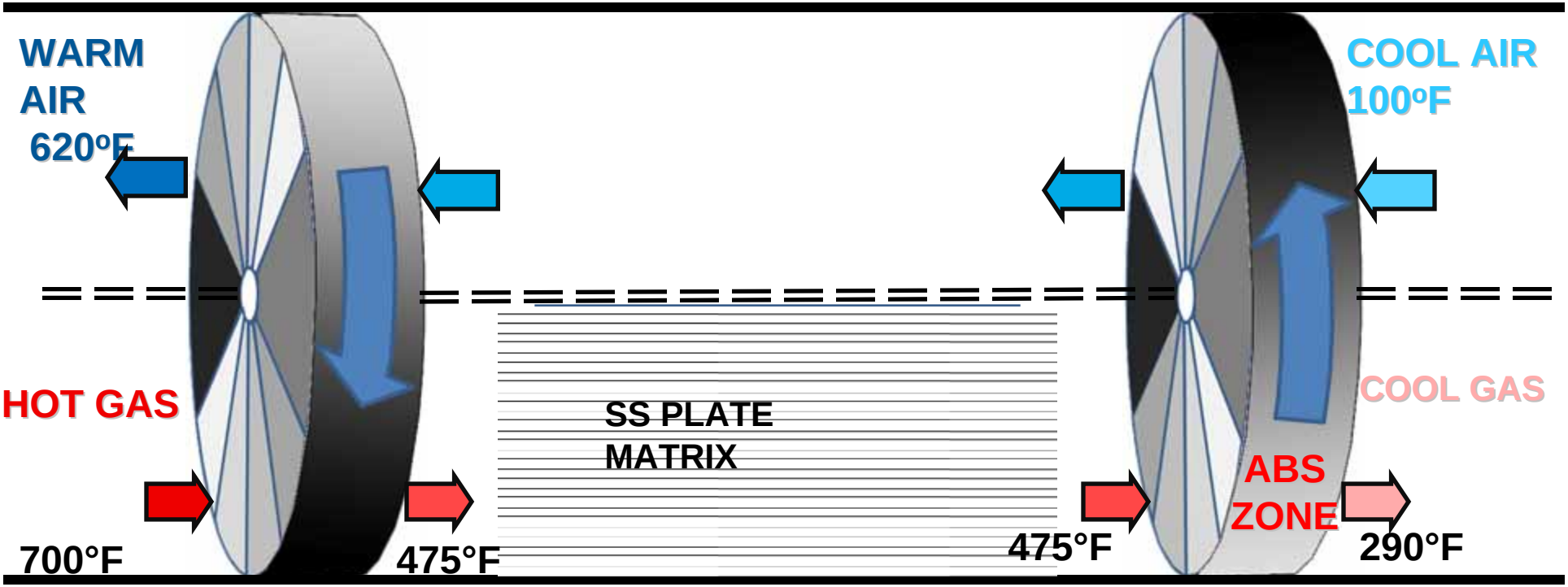

**ABS**

**300°F TO 390°F**

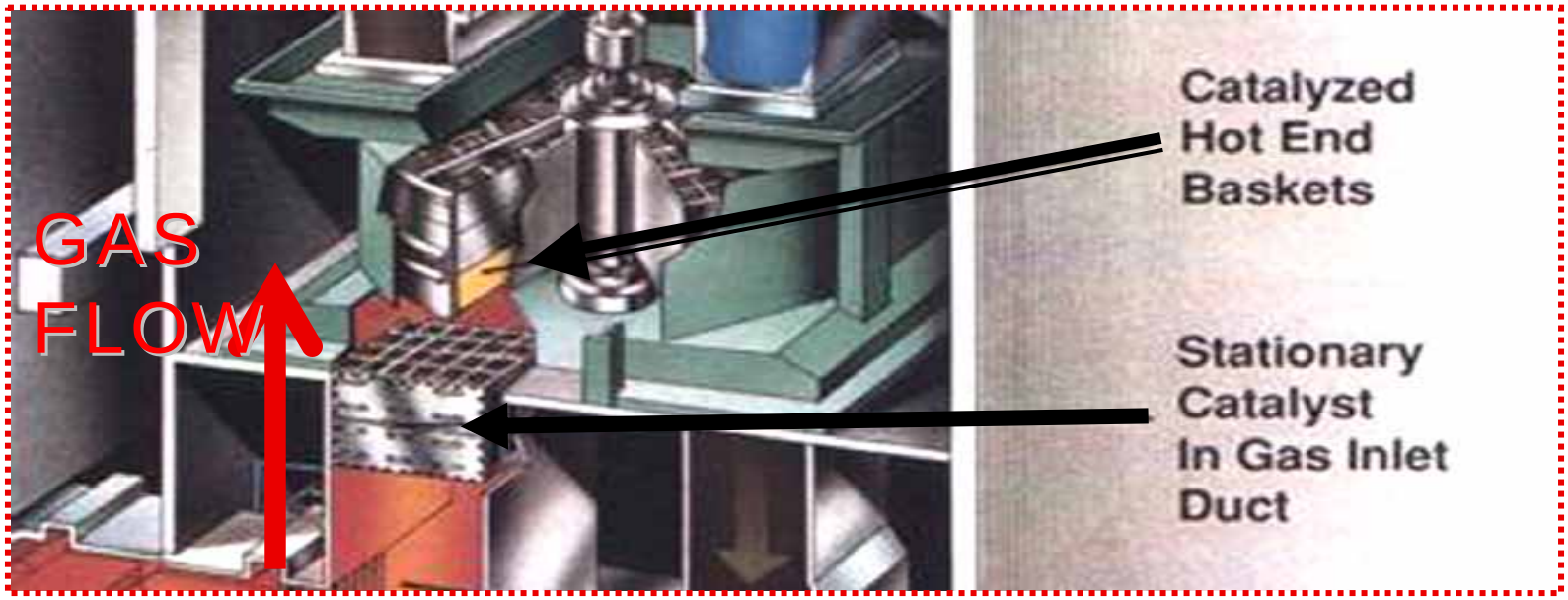
# ABS Zone - Two Layer



# Hg OXIDATION AH ARRANGEMENT



# Catalyst in Airheaters



# $SO_3$ EXIT CONCENTRATION

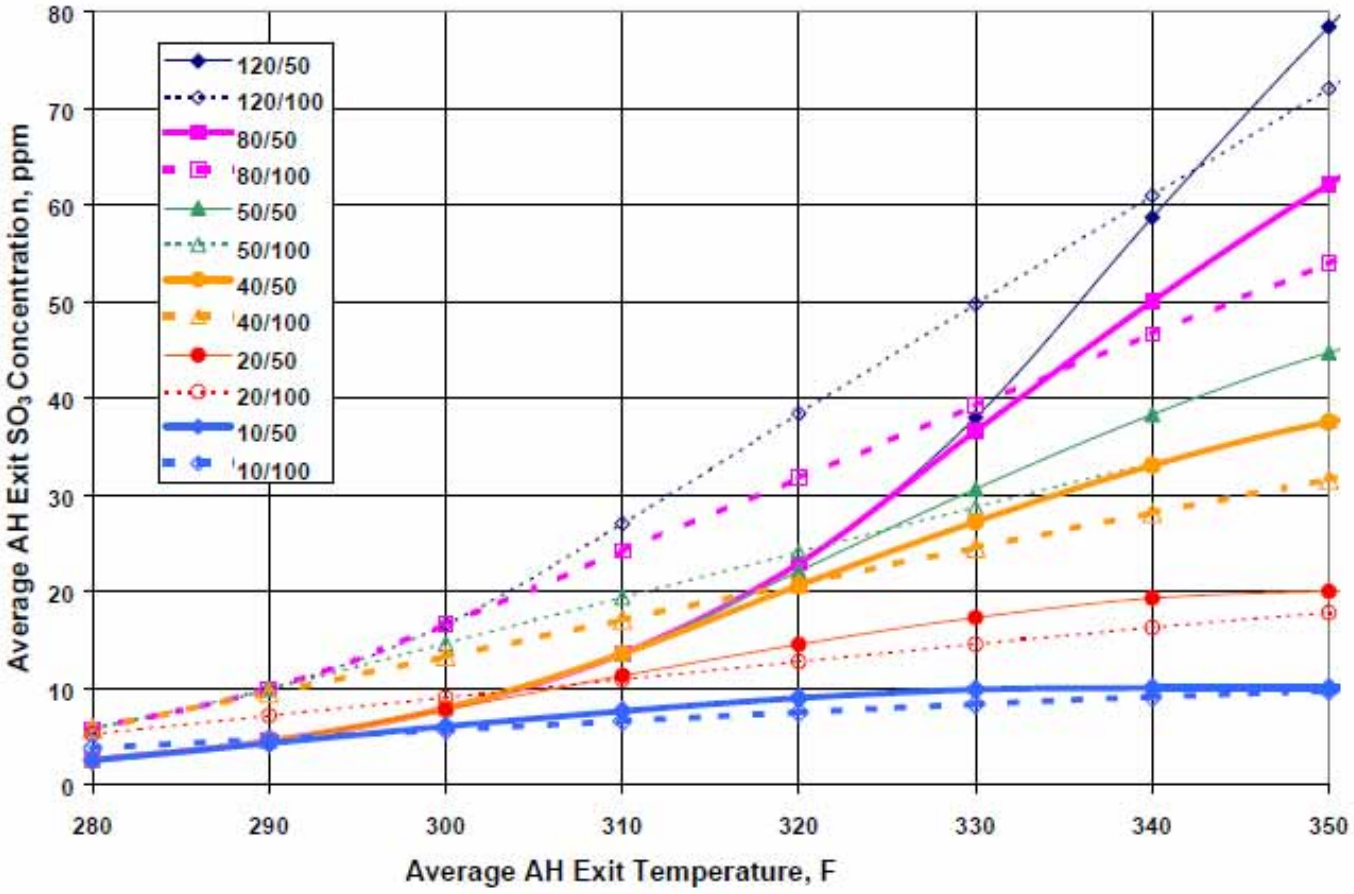



**Figure 6.2.** Estimated air preheater exit $SO_3/H_2SO_4$ concentration versus average air preheater exit temperature for a temperature offset of 35 °F. The first value of each pair in the legend is the preheater inlet $SO_3/H_2SO_4$ concentration in ppm and the second value of the pair is the spread in exit gas temperature between the cold side and the hot side of the preheater exit.

# $SO_3$ Exiting the Air Heater

SO3 at AH Gas Inlet

Metal Temperature

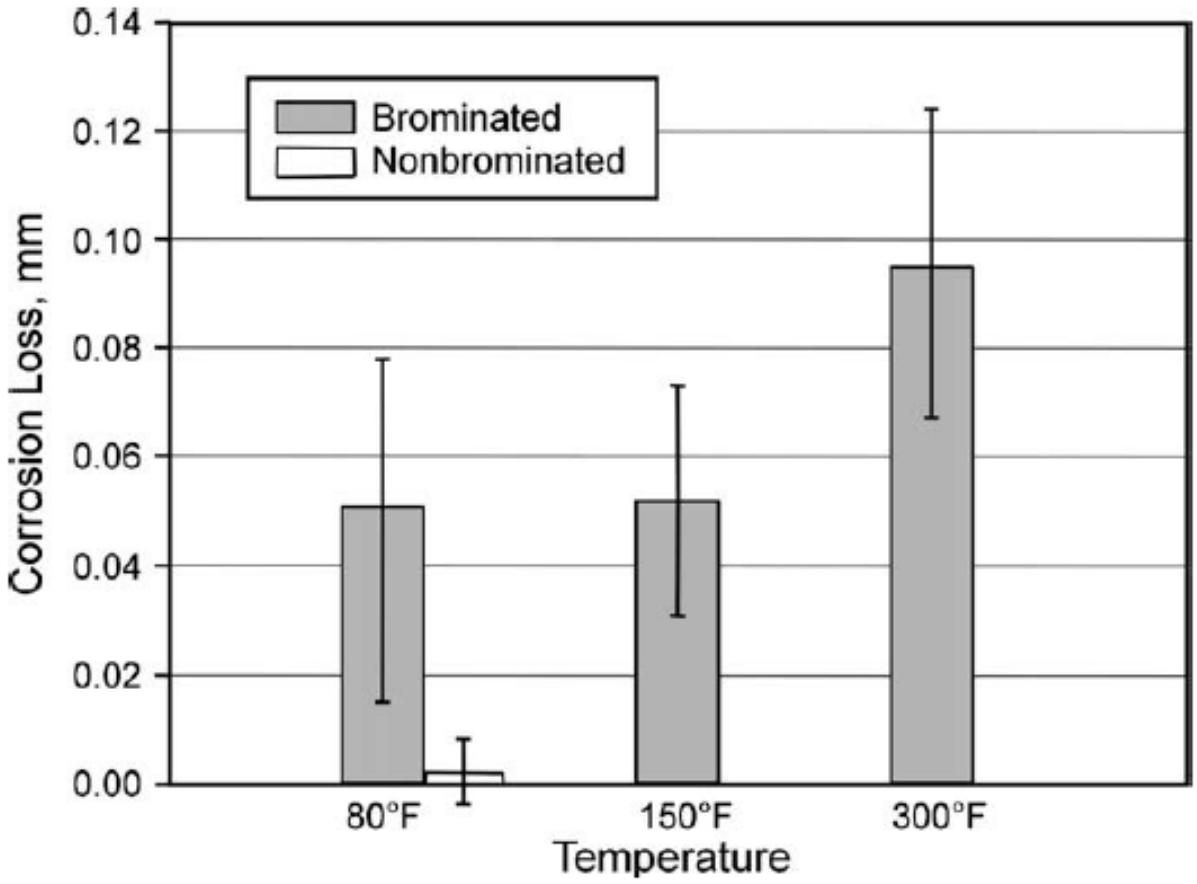
Gas Temperature

Ash Quantity

Ash Alkalinity

PM 2.5

# $Br_2$ GAS PHASE OXIDATION

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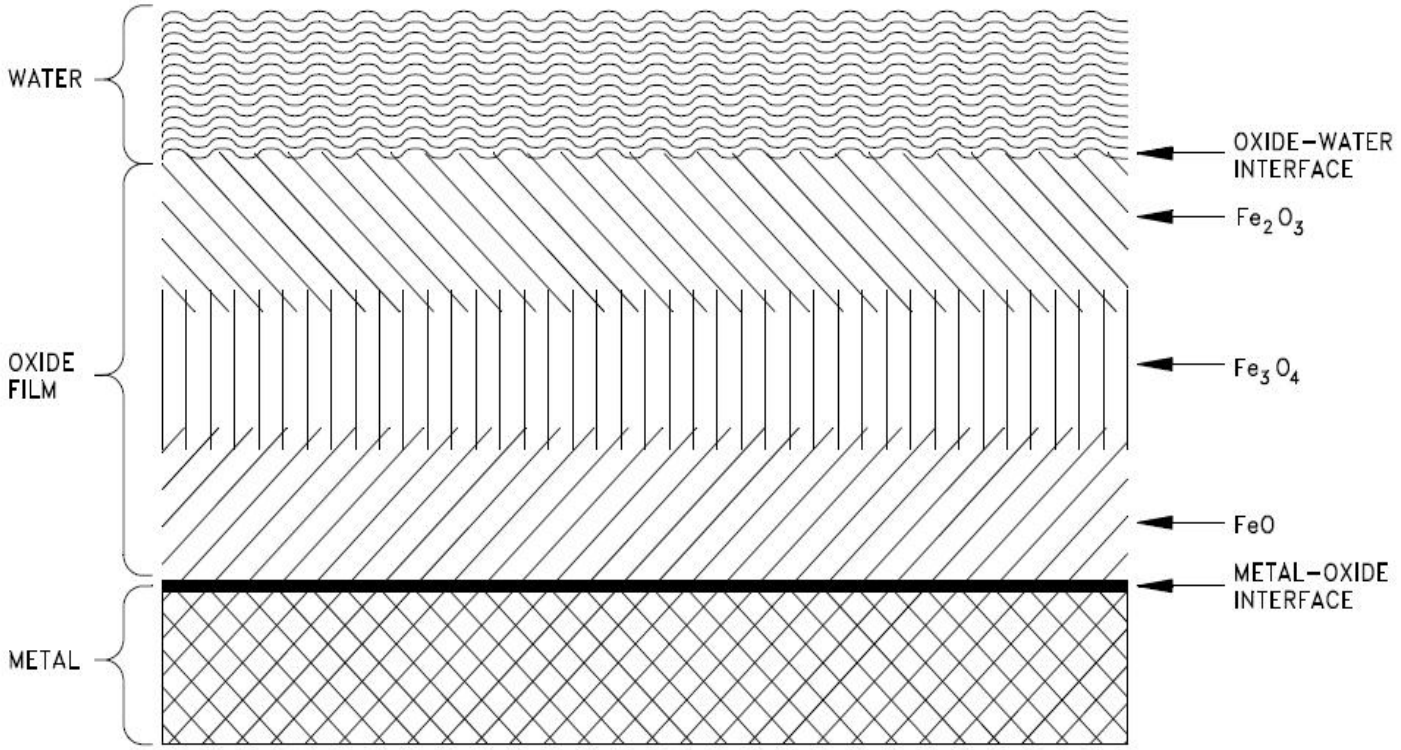
# PROTECTIVE OXIDE LAYER

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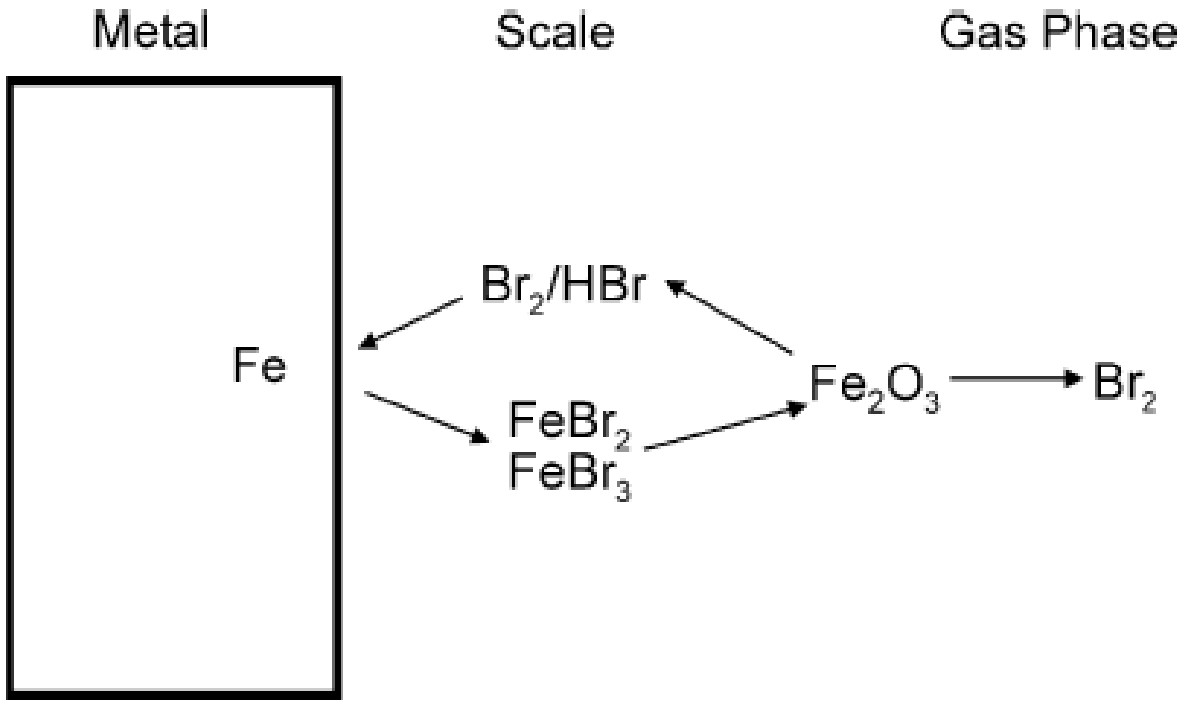
# $BR_2$ GAS PHASE OXIDATION

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