

# How Dr. Heater<sup>®</sup> Reveals Design Flaw

## Case #1- Serious Erosion in VDU Heater



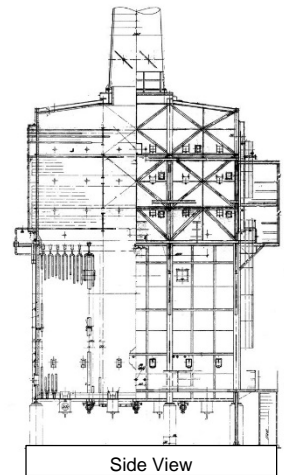
FHinfinity  
Showcase Material

### Introduction

A VDU heater experienced repeated tube failures due to severe erosion near the outlet, despite normal tube wall temperatures and no operational alarms. Traditional analysis couldn't explain the root cause until we applied **Dr. Heater<sup>®</sup>**, the FHinfinity's built-in diagnostic tool.

### Heater Specifications

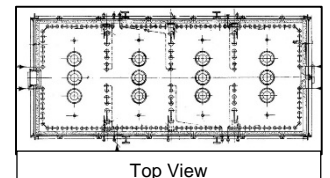
- **Firebox Type:** Box-shaped, Up-fired, Natural Draft
- **Number of Cell / Pass:** Four / Six
- **Number of Services:** Three (LPS, MPS, VDU Feed)
- **Tube Location:** Refractory-Backed / Central
- **Tube Diameter:** Varies across radiant section (4 different sizes)



Side View

### Simulation Validation by FHinfinity<sup>®</sup>

Parameter	Design Value	FHinfinity Result
Total Heat Absorption [kW]	25222	25420
Avg. Rad. Sec. Heat Flux Density [W/m <sup>2</sup> ]	29224	29444
Process Outlet Temperature [C]	412	411
Process Side Pressure Drop [bar]	0.5	0.7



Top View



*High agreement confirms model accuracy*



No Manual Cross-Checks. No Missed Warnings!

### Introducing Dr. Heater<sup>®</sup>

**Dr. Heater<sup>®</sup>** is an automated design validation module that checks your heater against industry standards (API, ASME, OEM guidelines) and best practices.

It flags potential flaws at 3 levels:



**Alarm:** Critical issue



**Caution:** Risk under certain conditions



**Note:** Design deviation worth reviewing

## Diagnosis: Sonic Velocity → Erosion

Dr. Heater© identified a critical flow anomaly:

● **"In some local point of heater, the process side velocity has exceeded 80% of Sonic velocity. This can cause vibration due to shock waves in the heater, as well as erosion of the heater tubes or transfer line and fluid fogging / entrainment, which can upset fractionation in the vacuum tower (if any)"**

**Dr. Heater (Input Data)**

Heater Section	Service
LPS-II	Steam (LP-MP-HP)
LPS-I	Steam (LP-MP-HP)
Process	Vacuum Unit Preheater
Firebox	Vacuum Unit Preheater

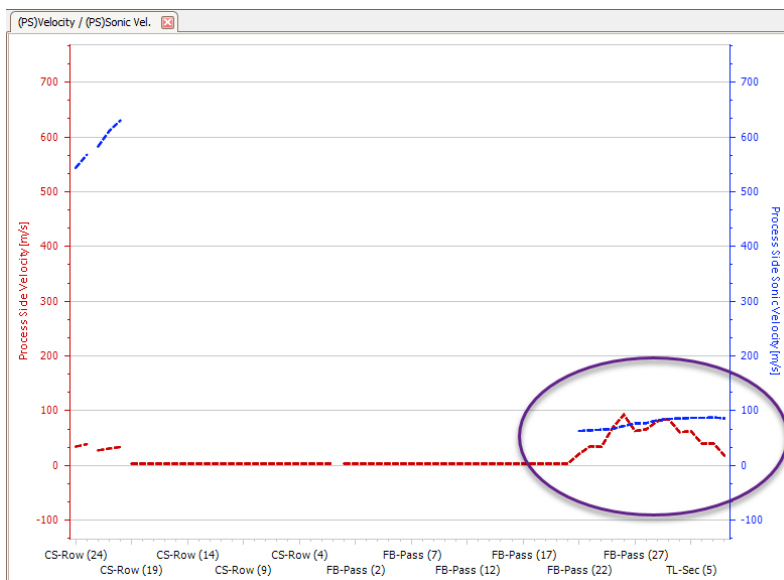
**Operational Data**

Item	Value	Unit
Draft at Arch	-0.2326	mbar
Draft at Damper	0.3037	mbar
Excess O2 At Arch	3.9439	Percent
Excess O2 At Damper	3.9439	Percent

**Dr. Heater (Results)**

- 9- Firebox casing temperature exceeded the recommended normal range in standards. Refractory type or its thickness should be revised.
- 10- Based on thermodynamic analysis and comparison of outlet flue gas temperature versus inlet feed temperature, this heater has potential for efficiency improvement. Consider evaluating practical measures to enhance performance.
- 11- Mist flow regime has been occurred in one or more tubes. In this regime, the heat transfer is directly from the tube wall to the vapor. The effect is a sudden reduction of the heat transfer coefficient and consequently, an increase in the tube wall temperature.
- 12- In some local point of heater, the process side velocity has exceeded 80% of Sonic velocity. This can cause vibration due to shock waves in the heater, as well as erosion of the heater tubes or transfer line and fluid fogging / entrainment, which can upset fractionation in the vacuum tower (if any).**
- 13- In one or more tubes of heater, degree of vaporization is higher than 5%. High vaporization rate may cause temperature peak in tubes which makes it difficult to control the heater operation.
- 14- Ratio of Flame length to Firebox height is high.
- 15- The Draft at the Firebox Roof is negative and acceptable. However, the temperature used in the Draft calculations is the same as the

**This explains the repeated erosion at the outlet header, a flaw hidden in conventional thermal analysis.**



### Velocity / Sonic Velocity Curve:

- X-axis: Tube length
- Y1-axis: Linear Velocity [m/s] (red curve)
- Y2-axis: Sonic Velocity [m/s] (blue curve)

## Engineering Insight

Erosion wasn't due to poor operation, it was a design-level flaw:

**Dr. Heater© caught what others missed.**

See more at [www.FHinfinty.com](http://www.FHinfinty.com)