# *Vertical Vacuum Heat Treatment of Metals*

*AeroMat 2023, Emerging Materials & Processes*
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REX HEAT TREAT

# Vertical Vacuum Furnace

# Key Terms

- ***Heat Treat* – thermal processing of metals**
- ***Harden* – high-temperature thermal process**
- ***Quench* – rapid cooling of metal from a high temperature**
- ***Temper* – low-temperature thermal process**
- ***Decarb/Carburization* – the act of removing or adding carbon to a metal via heat treatment**

# Agenda

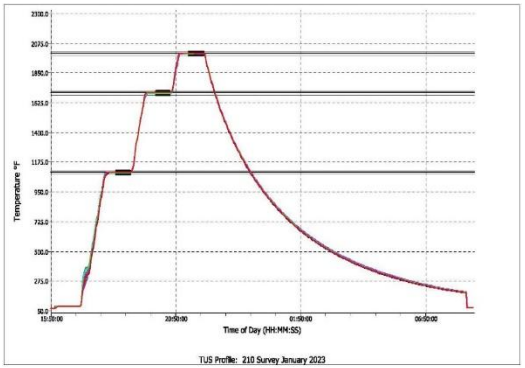
- Why the Vertical Vacuum Furnace?
- Vertical Vacuum Furnace
- Automation
- Advantages of Vertical Vacuum Processing
- Considerations

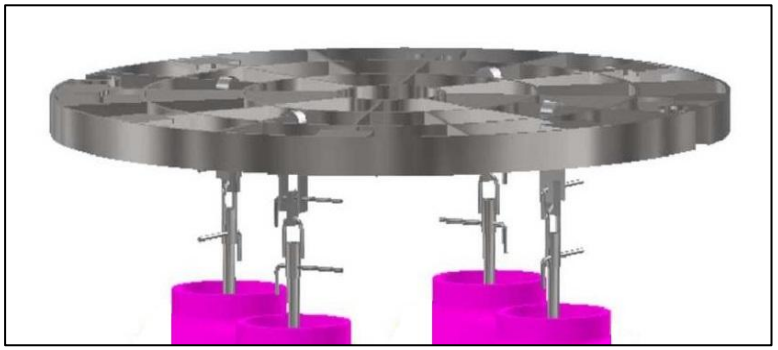
# Why the Vertical Vacuum Furnace?

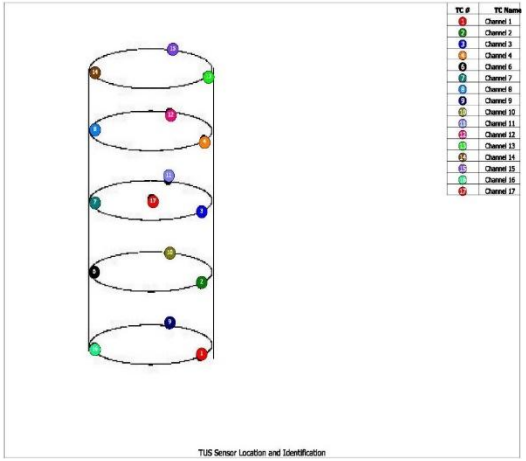
- Advances in heat treatment
- Standards have risen


# Why the Vertical Vacuum Furnace?

- Technological and engineering progress
- Quality emphasis





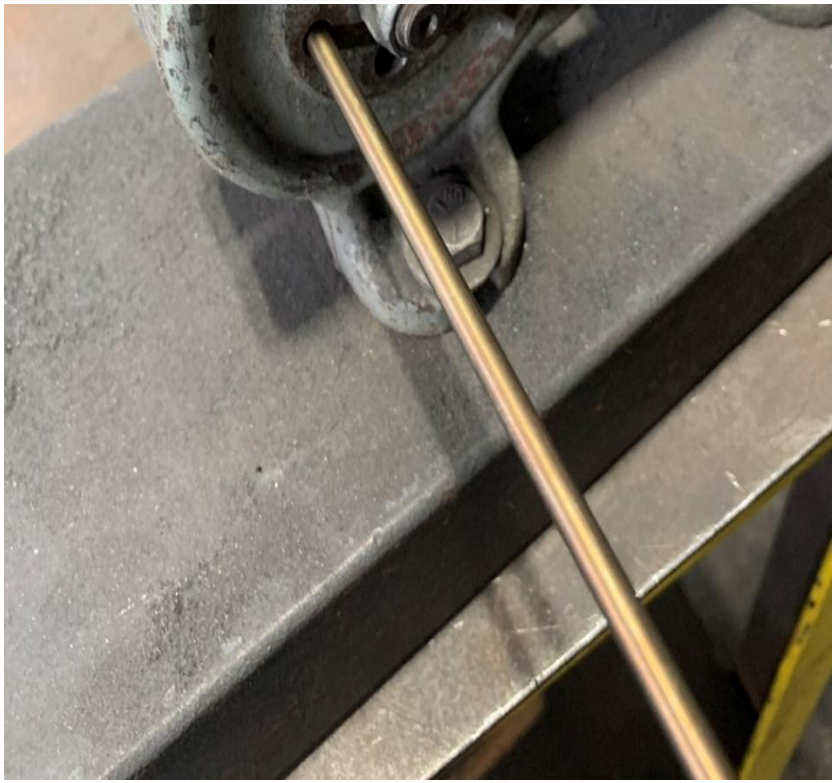

# Why the Vertical Vacuum Furnace?

## Vacuum Furnaces

- Cleaner surface
- Higher temperature capabilities

Atmosphere

Vacuum



# Why the Vertical Vacuum Furnace?

## Vertical Furnaces

- Distortion control
- Variety

# *Vertical Vacuum Furnace*

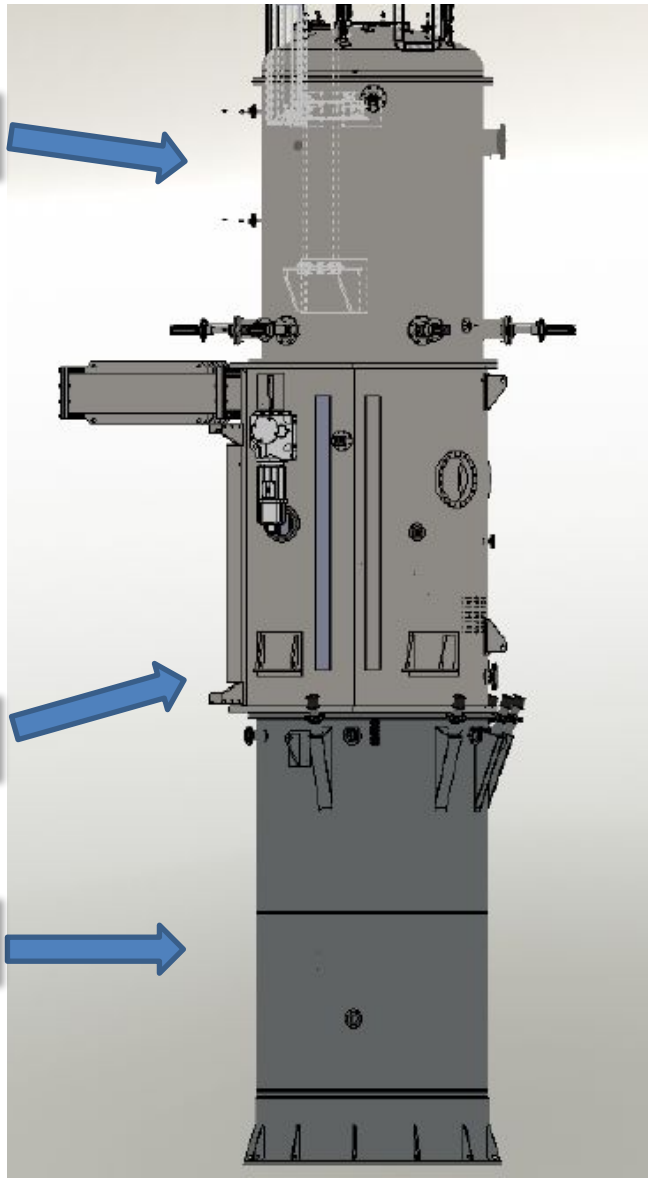
- Construction
- Design
- Processing Parameters

# *Vertical Vacuum Furnace Construction*

- **From construction to production, about 2 years**

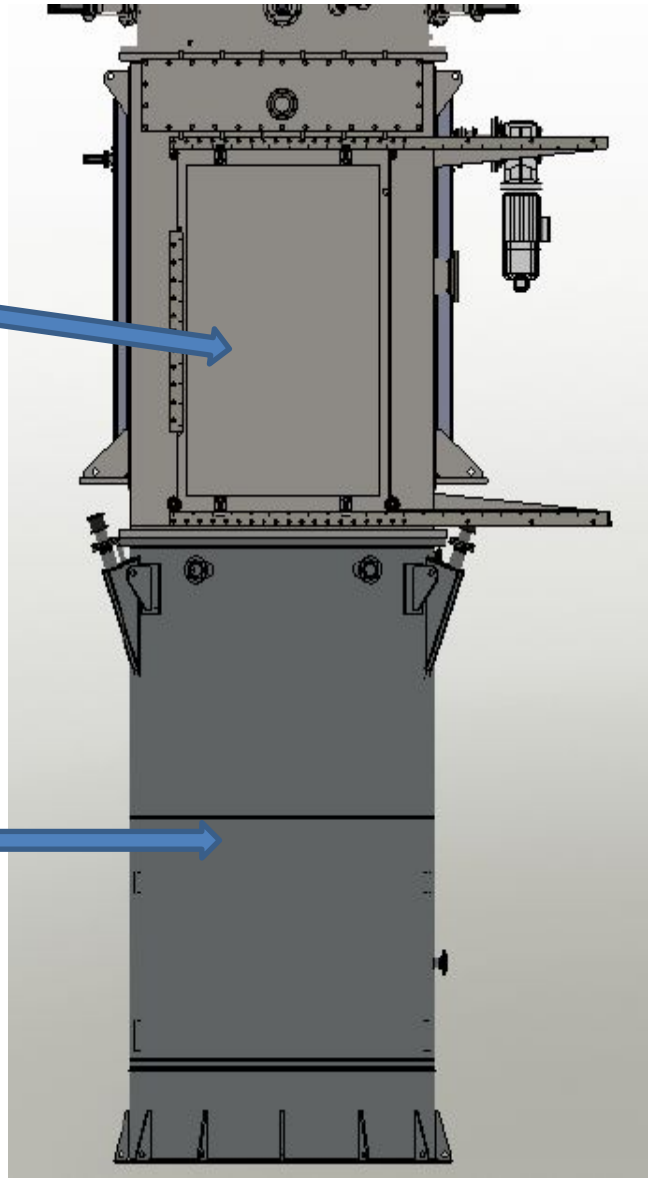
# *Vertical Vacuum Furnace Design – Multi-Chamber*

- Three vertical chambers
  - Upper chamber – hot zone
  - Middle chamber – upper vestibule
  - Bottom chamber – lower vestibule



# *Vertical Vacuum Furnace Design – Vestibule and Quench Tank*

- Door and Gas Quench Vestibule
  - Loading
  - Quenching
- Oil Quench Pit



# Vertical Vacuum Furnace Design – Bell Furnaces


- Nitrogen tank
- Wash tank
- Bell
- Bell

# *Vertical Vacuum Furnace Processing Parameters*

- Max weight of up to 7000 LBs top or bottom supported
- Work zone of 14.5’ Length x 6’ Diameter
- 1100°F – 2200°F
  - ±15°F
- Oil can be set at 100°F to 200°F
- 300°F – 1400°F
  - ±10°F

- Max gas quenching pressure is 1.50 bar (1125 torr)
- Standard operating Vacuum level is 70 microns (0.10 millibar)
- Equipment capable of submicron Vacuum levels
- Partial pressure heating up to 7500 microns (10 millibar)

# Automation

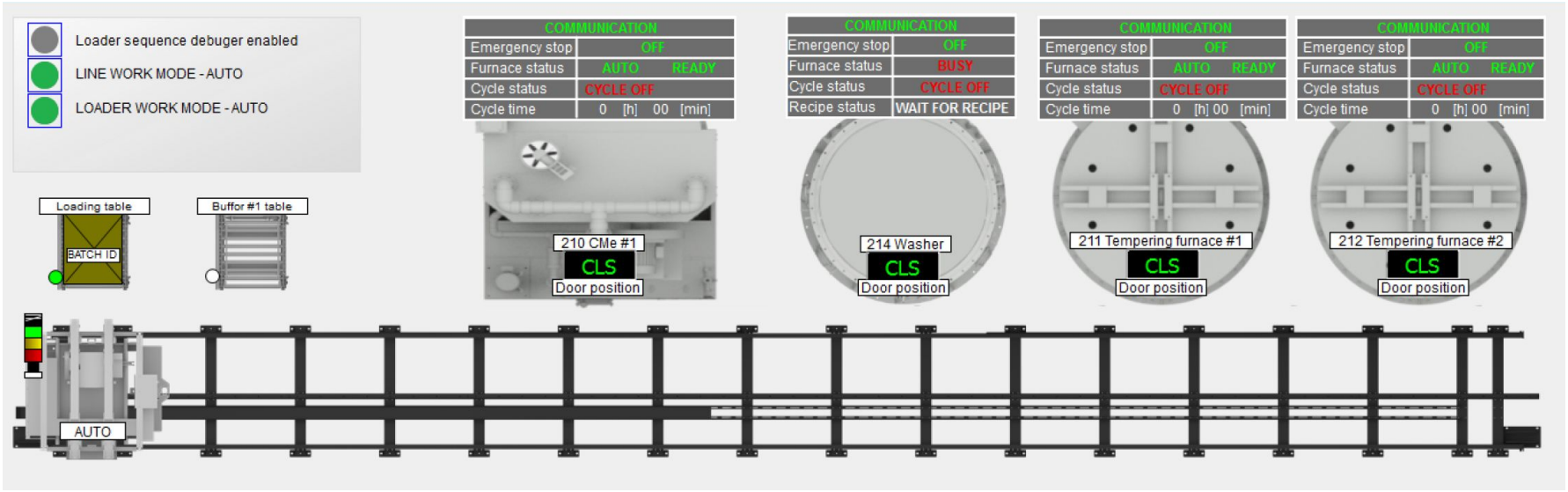
- Load Tables

- Loader

# Recipe is written for the entire program

RECIPE MANAGER STAGES

| No. | Recipe no. | Recipe name | Creation date | Revision date |
|---|---|---|---|---|
| 0001 | 47 | Tempering | 8/9/2019 10:11:23 AM | 3/1/2023 1:48:59 PM |
| 0002 | 47 | CMe | 8/9/2019 10:13:08 AM | 3/2/2023 10:14:36 AM |
| 0003 | 47 | Tempering | 12/29/2021 9:46:27 AM | 3/2/2023 10:13:52 AM |
| 0004 | 47 | CMe | 5/4/2021 11:34:52 AM | 3/1/2023 8:52:53 AM |
| 0005 | 47 | Washing | 8/9/2019 10:16:56 AM | 1/27/2023 8:07:07 AM |
| 0006 | 47 | Control | 5/4/2021 11:58:15 AM | 3/1/2023 9:51:06 AM |
| 0007 | 47 | Tempering | 8/9/2019 10:17:08 AM | 9/21/2022 4:03:29 PM |
| 0008 | 47 | End | 8/4/2019 12:56:53 PM | 12/29/2022 10:33:10 AM |

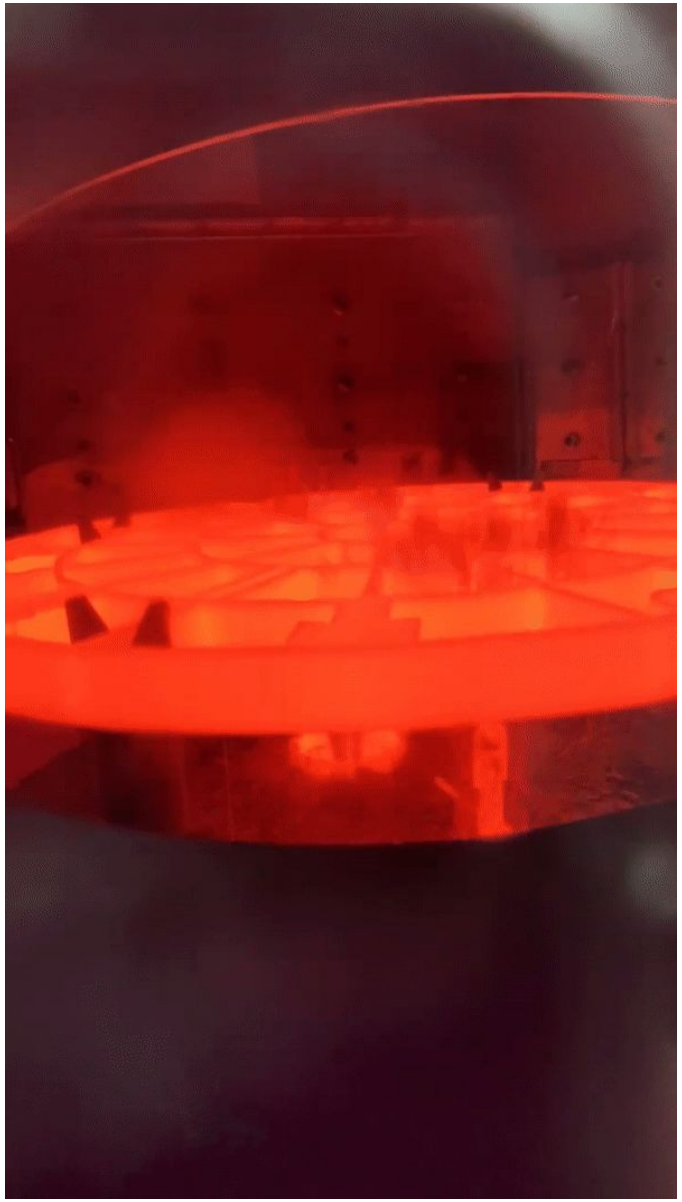


# Advantages of Vertical Vacuum Processing

- Tooling lifespan
- Direct feedback
- Distortion control
- Furnace conditioning
- Zero surface contamination
- Reduction of human interaction
- Physical and environmental safety

# *Advantages of Vertical Vacuum Processing*
## Physical and environmental safety

- Quench in Atmosphere vs Vacuum



# Considerations

- Risk is pushed upstream
- Less severe quench
- Contact (load) thermocouples

- Door closes during heat treat

# *QUESTIONS?*

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