College of Engineering
LAMAR UNIVERSITY

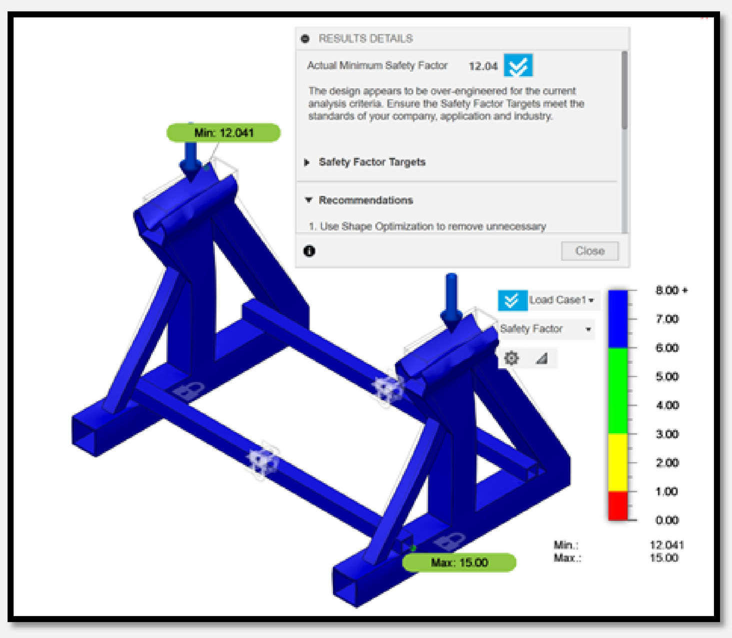
Tilt Furnace for Iron Pour

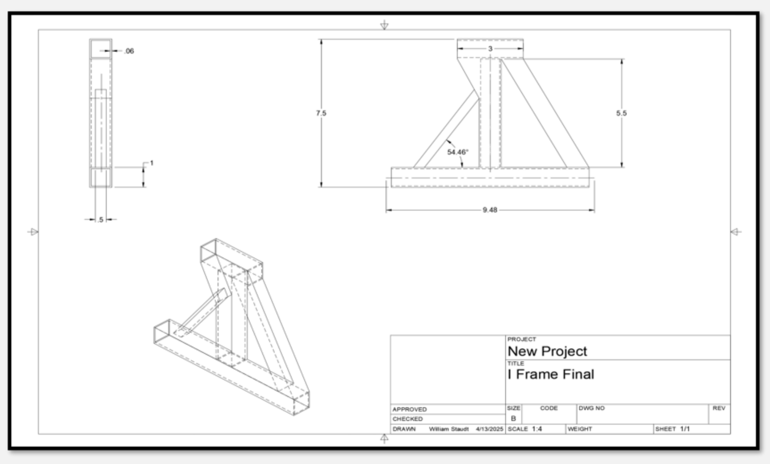
What is a Tilt Furnace?

The project involves the action of a tilting furnace, a mechanism that allows the furnace to tilt to melt and pour molten metals into molds or trays.
Process Design: Forming a frame to stabilize the furnace and establishing effective safety procedures for working on it.
Process Control: Atmosphere within Furnace, Frame Structure, Safety Features
Process Operations: Simulations, weekly process development, fail-safe mechanisms

I-Frame Design for the Tilt Furnace

The I-frame design allows for a successful pour free of obstruction, furnace is mounted and suspended in the air. It is composed of three major parts, a 36” bottom base beam, 24” center beam, and 13” top beam. Our design verification tested the frame’s structural integrity by ensuring that it should securely hold the weight of 1,000 lbs. Using Auto Fusion 360 programmed safety factors were used to determine weight capacity. A ¼ scale model was created and a static force test was performed to ensure motion is stable when performing a pour. We achieved an overall safety factor of 12.04 with a minimum requirement for passing at 4. Reducing risk of accidents, injuries, and damages at an early stage of the frame’s development.



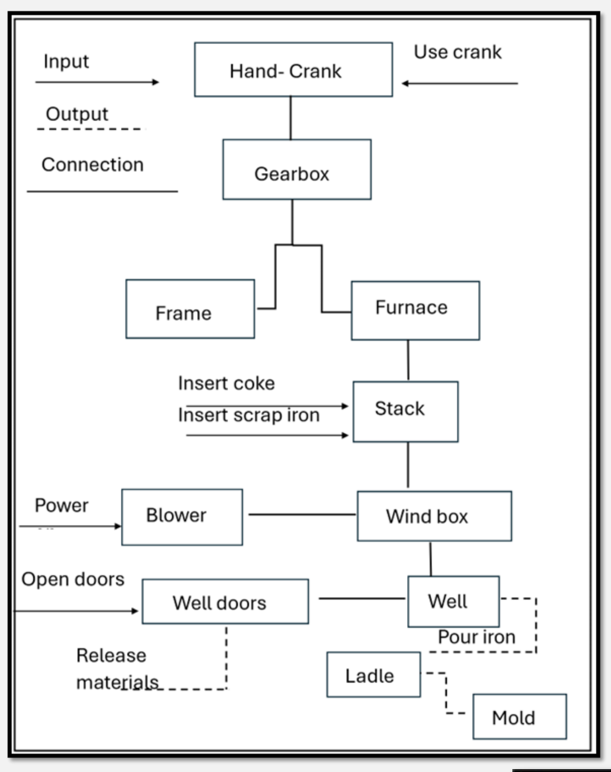


Castable Refractory Efficient Heat Use

An environmental factor was producing low heat loss. To reduce heat loss through a 3-inch castable refractory lining, with steady-state losses calculated at approximately 16.4 kW based on conduction analysis. Assuming ideal conditions, a continuous coke consumption rate of roughly 0.000555 kg/s (0.555 grams per second) would be required to offset this heat loss. In practice, fuel use would be higher due to melting energy requirements, exhaust losses, and combustion inefficiencies. These results underscore the importance of thick, high-quality insulation for maximizing energy efficiency and maintaining safe furnace operation.

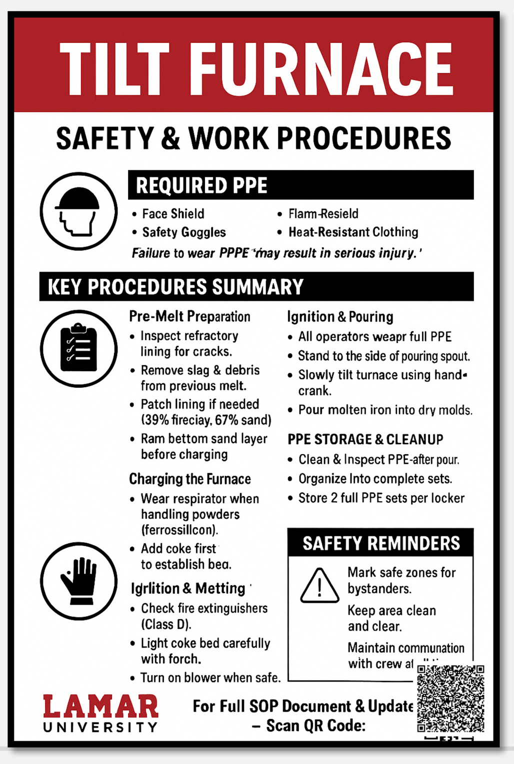
Process Control of a Tilt Furnace Pour

The key components shown include the gearbox, the furnace, and the individual parts that make up the system, such as the frame and the blower. The hand crank is a subcomponent of the gearbox, playing a crucial role in its operation. The well doors serve as another subcomponent of the furnace, facilitating the removal of excess material upon completion of operations. As depicted in the diagram, the hand crank is connected to the gearbox, which is, in turn, linked to both the furnace and the frame. The frame is attached to the furnace, which encompasses its primary components: the well, connected to the well doors, and the wind box, which is linked to the blower. User interaction with the system primarily involves turning the hand crank of the gearbox to tilt the furnace. Additionally, inputs into the system include the insertion of coke and scrap iron into the furnace, powering the blower, and opening the well doors. The system outputs consist of the release of excess materials from the well through the well doors and the melted iron poured into a ladle for subsequent transport to a mold.



Operations Safety Procedures

Our design input consisted of a safety and operations guide. The goal is to create the safest work environment for furnace operations. We used OSHA and NFPA codes to guide us and have reference. The team identified hazards in the workplace and created a set of safety regulations. We calculated the zone around the furnace where PPE would be required to be worn. Developed a set of safety and procedural standards that must be followed to operate the equipment in a manner that is both secure and adequate. It also contains specific information regarding the procedures that operators need to follow to ensure compliance with safety rules and to reduce the likelihood of accidents occurring.



Radiative Heat Loss (Q) was calculated as approximately 537,868 Watts (537.9 kW) using the formula:
$Q = \varepsilon \times \sigma \times A \times (T\_inside^4 - T\_outside^4)$
Where:
ε = Emissivity of castable refractory (0.85)
σ = Stefan-Boltzmann constant (5.67×10^{-8} W/m^2K^4)
A = Surface area (1.038 m^2)
T_inside = 1,811 K
T_outside = 303 K

Using the inverse square law of radiative heat dispersion:
$q = Q / (4 \times \pi \times r^2)$

Rearranging for distance (r):
$r = sqrt(Q / (4 \times \pi \times q))$

Using NFPA 86 standard Heatflux(q) = 1000W/m^2 we get r≈ 7m ≈ 23ft

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