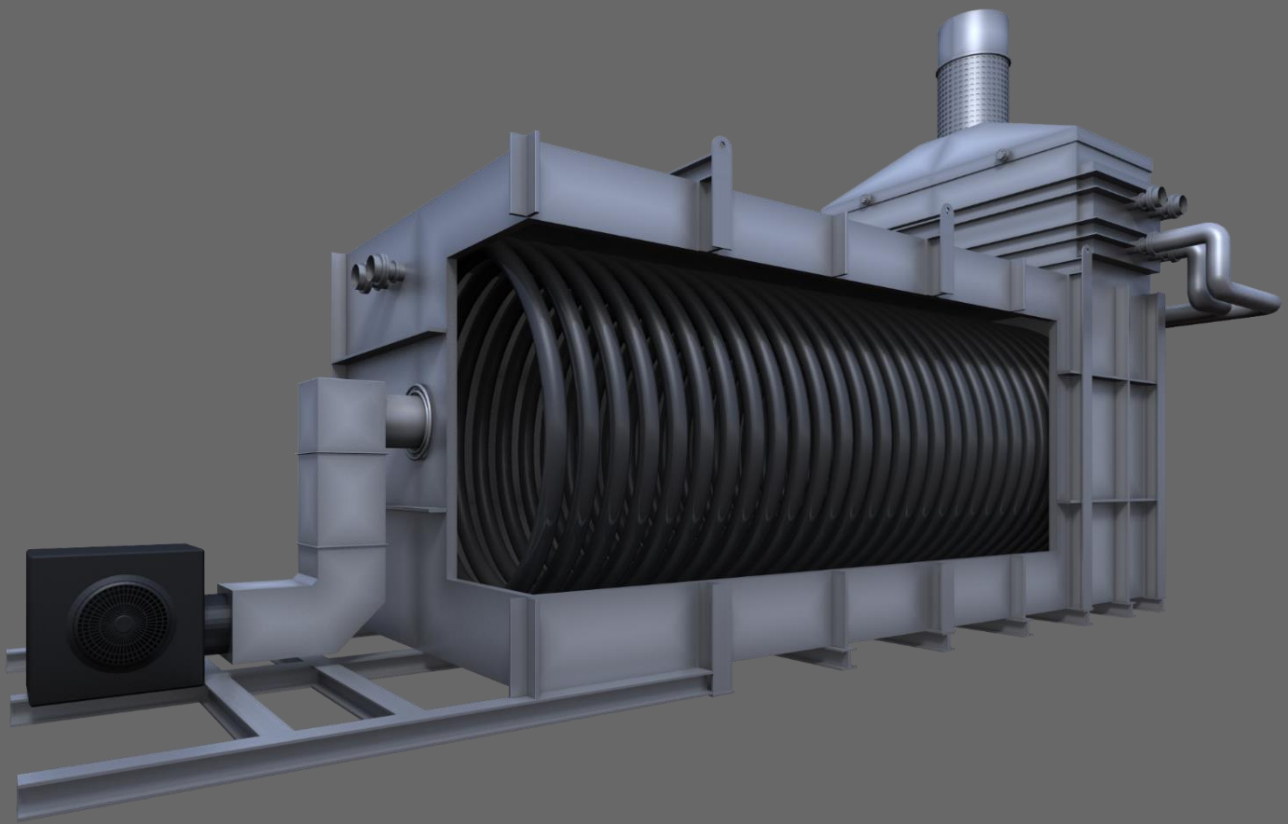


Beginners Guide to Fired Heaters

The 10-minute guide to learning the basics of fired heaters.

THM TULSA HEATERS MIDSTREAM

Contents

Are you responsible for purchasing or evaluating a fired heater, but not really sure where to start? We can relate because we were in your shoes once. And there are many more out there feeling the same way. Fired heaters just isn't one of those topics that gets covered in school, or talked about around the water cooler (do people still do that?). So we created this quick guide to kick start your learning.

OUR GOAL

Our goal is to give you a base set of knowledge so that you can have a "5th grade" conversation about fired heaters. We can't teach you everything in this short guide, but its enough to get you started. If you are looking for something more in-depth, make sure to check out the "Resources" page on our website for additional tools.

THIS GUIDE

This guide is based on API 560, the industry standard for designing fired heaters in many industries, including refining and petrochemicals. We'll cover various topics using the terms from the specification, including:

- Mechanical components of the heater
- Process design terms
- Heater draft configurations

Let's get started!

Introduction: What is a fired heater?

A fired heater is an insulated enclosure that uses the heat created by the combustion of fuels to heat fluids contained inside coils. The type of heater is normally described by the:

- structural configuration,
- radiant tube coil configuration and
- burner arrangement.

Some examples of structural configurations are cylindrical, box, cabin and multi-cell box. Examples of radiant-tube coil configurations include:

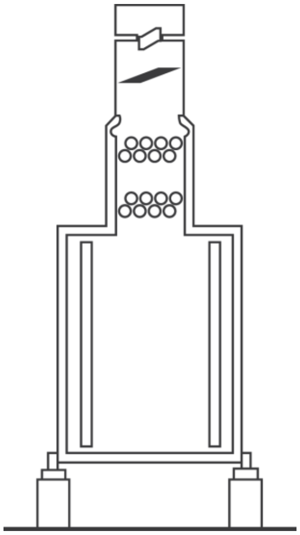
- vertical
- horizontal
- helical
- arbor

These examples can be seen in API 560, section 4 (figure 1). Examples of burner arrangements include:

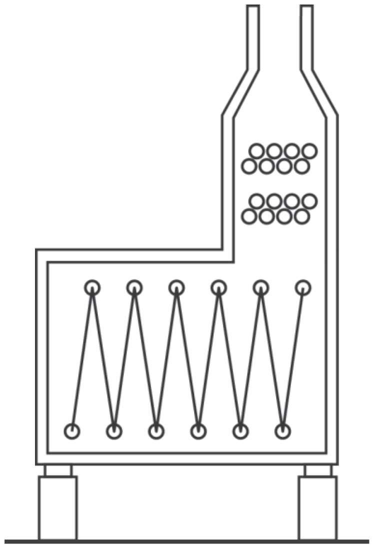
- up-fired
- down-fired
- wall-fired

The wall-fired arrangement can be further classified as sidewall, endwall and multilevel.

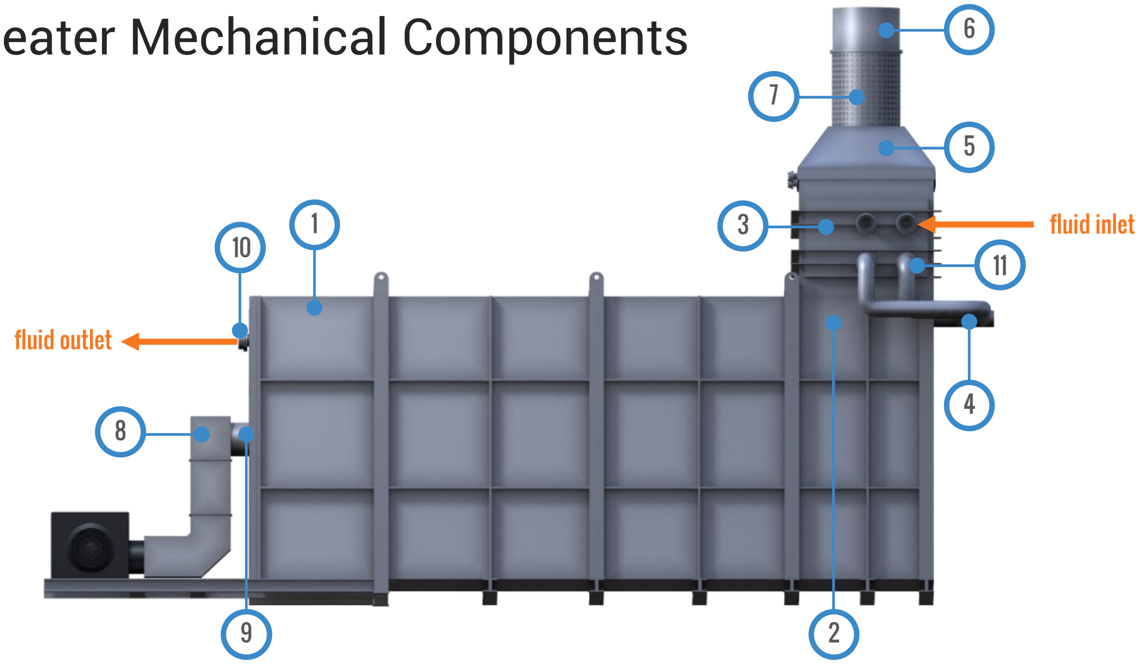
Throughout this guide, we will be using a horizontal box type heater, with a helical coil, and endwall fired burner as our example.



There are many different heater and coil configuration combinations. Heater and coil configurations vary widely by industry, application, and heater designer. Many heater designers have patents on specific combinations of structural and coil configurations for important applications.



Heater Mechanical Components



1 **radiant section** – portion of the heater in which heat is transferred to the tubes primarily by radiation

2 **arch** – flat or sloped portion of the heater radiant section opposite the floor

3 **convection section** – portion of the heater in which the heat is transferred to the tubes primarily by convection

4 **crossover** – inter-connecting piping between any two heater-coil sections

5 **breeching** – heater section where flue gases are collected after the last convection coil for transmission to the stack or the outlet ductwork

6 **stack** – vertical conduit used to discharge flue gas to the atmosphere

7 **damper** – device for introducing a variable resistance in order to regulate the flow of flue gas or air
NOTE: In some cases, like smaller forced-draft systems, a damper is not used.

8 **burner** – device that introduces fuel and air into a heater at the desired velocities, turbulence and concentration to establish and maintain proper ignition and combustion
NOTE: Burners are classified by the type of fuel fired, such as oil, gas, or combination (also called dual fuel).

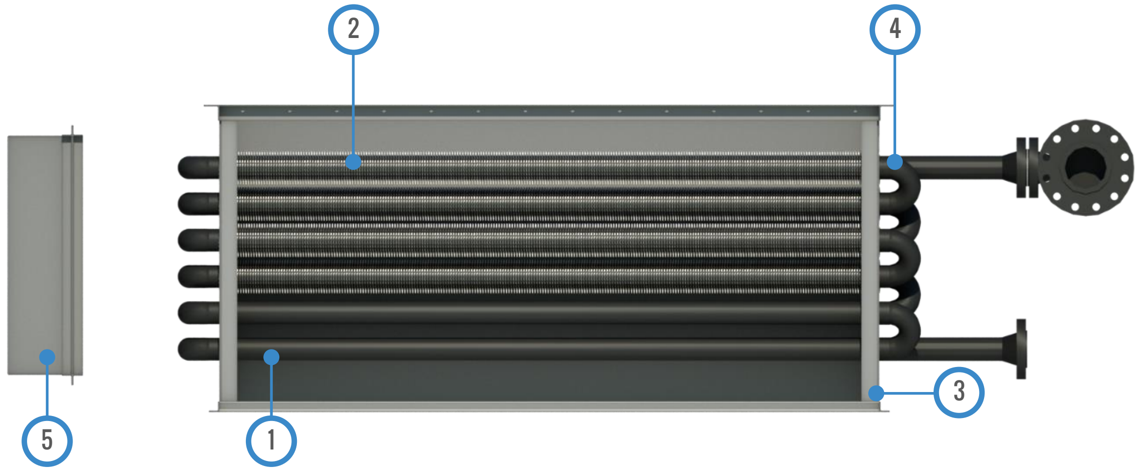
9 **pilot** – small burner that provides ignition energy to light the main burner

10 **terminal** – flanged or welded connection to or from the coil providing for inlet and outlet of fluids

11 **pass/stream** – flow circuit consisting of one or more tubes in series

Heater Mechanical Components

Convection Section



1. **shield section/shock section** – tubes that shield the remaining convection-section tubes from direct radiation
2. **extended surface** – heat-transfer surface in the form of fins or studs attached to the heat-absorbing surface
3. **tube support/tube sheet** – device used to support tubes
4. **header (return bend)** – cast or wrought fitting shaped in a 180° bend and used to connect two or more tubes
5. **header box** – internally insulated structural compartment, separated from the flue-gas stream, which is used to enclose a number of headers or manifolds

Heater Mechanical Components

Refractory

Refractory is used throughout the inside of the heater to shield the heater casing from excess temperatures. It is typically designed to reduce the outside temperature of the metal casing to 180° F (per API 560 specification). There are many different types of refractory, but the most common types are castable and ceramic fiber.

1 **ceramic fiber** – fibrous refractory insulation which can be in the form of refractory ceramic fiber (RCF) or man-made vitreous fiber (MMVF)

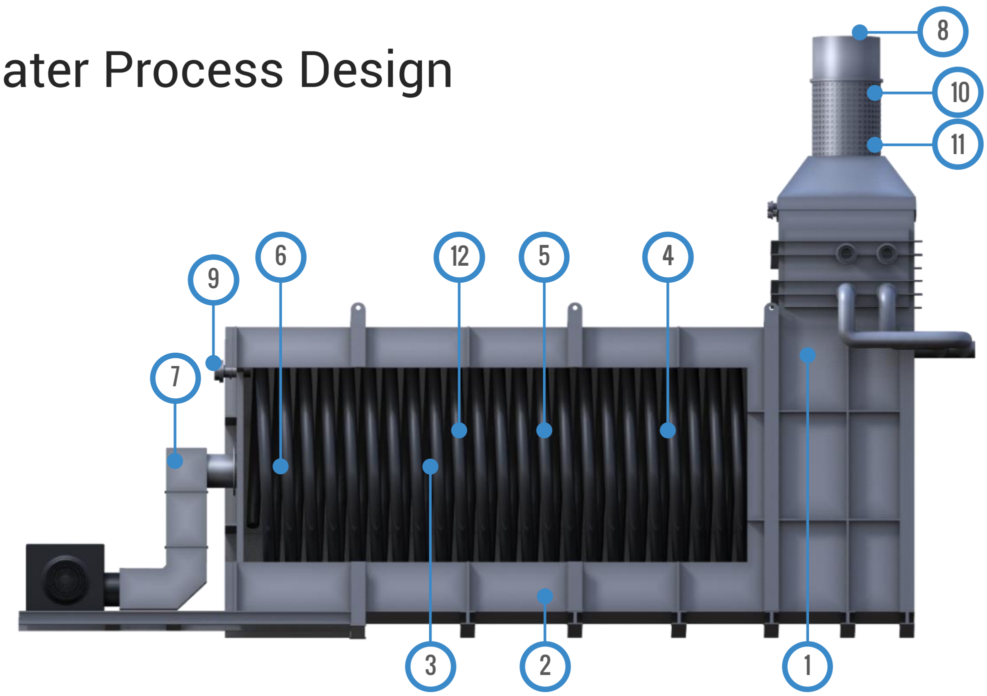
NOTE: Common forms include bulk, blanket, board, and modules.

2 **castable** – insulating concrete poured or gunned in place to form a rigid refractory shape or structure

multi-component lining – refractory system consisting of two or more layers of different refractory types

hot-face layer – refractory layer exposed to the highest temperatures in a multilayer or multi-component lining

Heater Process Design



1 **bridgewall temperature** – temperature of flue gas leaving the radiant section

2 **radiation loss/setting loss** – heat lost to the surroundings from the casing of the heater and ducts and auxiliary equipment

3 **volumetric heat release** – heat released divided by the net volume of the radiant section, excluding the coils and refractory dividing walls

4 **heat absorption** – total heat absorbed by the coils, excluding any combustion-air preheat

5 **fouling resistance** – factor used to calculate the overall heat transfer coefficient

6 **total heat release** – heat liberated from the specified fuel, using the lower heating value of the fuel

7 **excess air** – amount of air above the stoichiometric requirement for complete combustion (expressed as a %)

8 **flue gas** – gaseous product of combustion including excess air

9 **pressure drop** – difference between the inlet and the outlet static pressures between termination points, excluding the static differential head

10 **fuel efficiency** – total heat absorbed divided by the total input of heat derived from the combustion of fuel only (lower heating value basis)

11 **thermal efficiency** – total heat absorbed divided by the total input of heat derived from the combustion of fuel plus sensible heats from air, fuel and any atomizing medium

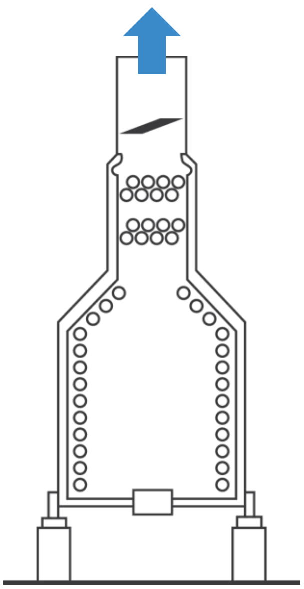
12 **average heat flux density** – heat absorbed divided by the exposed surface of the coil section

Heater Process Design

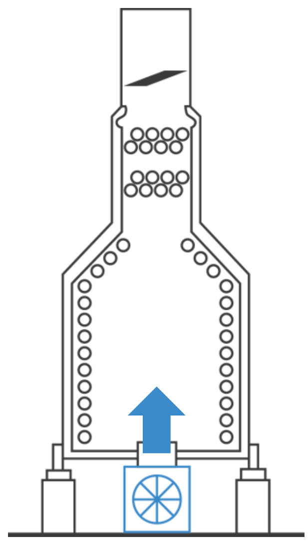
Draft

There are several methods in heater design for supplying the necessary air for combustion and removing the flue gases. The API 560 specification notes that draft should be -0.1 inches H_2O at the arch of the heater. Some forced draft systems will take exception to this requirement.

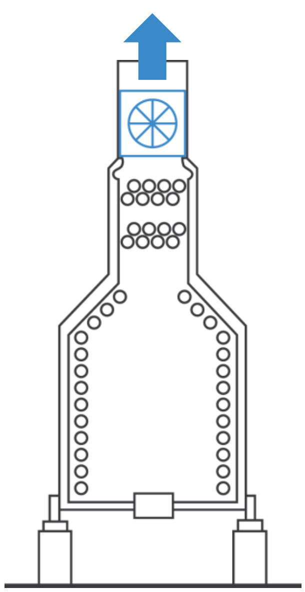
draft – negative pressure (vacuum) of the air and/or flue gas measured at any point in the heater



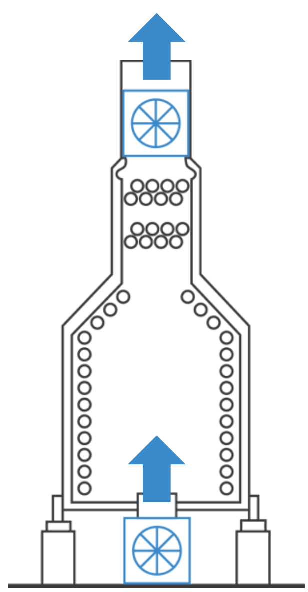
natural draft – heater in which a stack effect induces the combustion air and removes the flue gases



forced-draft – heater for which combustion air is supplied by a fan or other mechanical means



induced-draft – heater that uses a fan to remove flue gases and to maintain negative pressure in the heater to induce combustion air without a forced-draft fan



balanced draft – heater that uses forced-draft fans to supply combustion air and uses induced draft fans to remove the flue gases

Tulsa Heaters Midstream

Founded in 2014, Tulsa Heaters Midstream is a spin-off from Tulsa Heater Inc. Our original product line, the SHO heater line, was created by THI in 2010 to help service the growing gas processing industry. As the product continued to grow, it was decided that a dedicated team was necessary to best support our customers. Our background in the demanding refining and petro-chemical sector is an advantage, and gives our products a true differentiation. Our heaters provide users the opportunity to get their project off the ground quickly and affordably.

WHO WE ARE

Behind every product is a person. In our case, there is a team of people - all ready to serve. THM's growing team is built to scale along with its customers. As a privately owned, founder-led company, we're able to work fast and respond to our customers' needs without anything getting in our way. We invest in engineering, customer support, and great design.

WHAT WE DO

Tulsa Heaters Midstream's business is based on our belief in a servant mindset. We serve:

OUR CUSTOMERS *by being the most reachable and responsive supplier, with an almost obsessive focus on quality customer experiences – from product design and delivery to daily communications.*

OUR TEAM MEMBERS *by providing a fun, engaging, and family focused place to work and grow.*

OUR COMMUNITY *by supporting and giving to local organizations that lift and empower families and neighborhoods.*

In depth knowledge of heater design can take years to obtain. As with many other areas of study, the more time you spend working with it, the more you figure out how much you don't know. This guide was created as a first step on the path to better understanding fired heaters. The terms and concepts learned will apply to fired heaters in a variety of applications and industries, including:

- Refinery heaters
- Petrochemical heaters
- Hot oil heaters
- Regen gas heaters

For even more terms and details about fired heater design, we recommend the API 560 standard. We have also created several other guides, all of which are available on the Resources page of our website.

What to do with this guide:

- Keep it as a reference for future use
- Give a copy to new hires or colleagues that you think need to understand fired heater basics
- Share a copy with your spouse so that they can learn what you do at work
- Start using what you learned!

We hope you found this guide helpful. If you are interested in learning a lot more about heaters, contact us about attending our Heater School course in Tulsa.

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