Introduction to INDUSTRIAL HEATING

flagro . . . More Than Just Heat

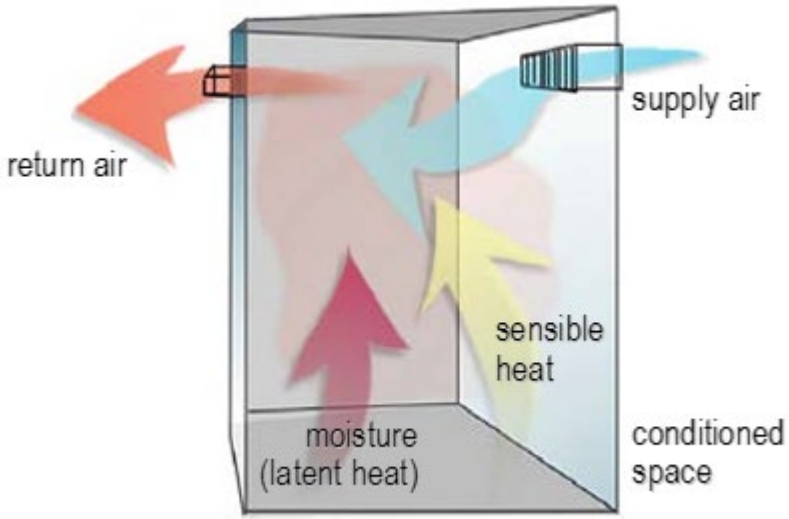
EST. 1978

Requirements for Indoor Comfort

- 68°F-76°F Temperature
- Humidity below 65%
- Minimum of Three (3) Air Changeovers/Hour in the Space
- Conditioned Air Free of Contaminants and Odors

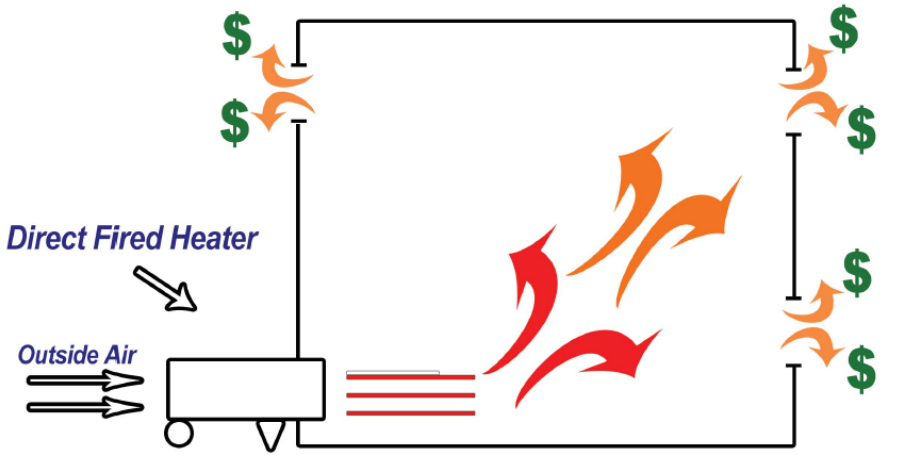
Creating a Comfortable, Conditioned Space

- To maintain the dry-bulb temperature in the conditioned space, HEAT (referred to as **sensible heat**) must be added or removed at the same rate as it leaves or enters the space
- In order to maintain the humidity level in the space, MOISTURE (sometimes referred to as **latent heat**) must be added or removed at the same rate as it leaves or enters the space



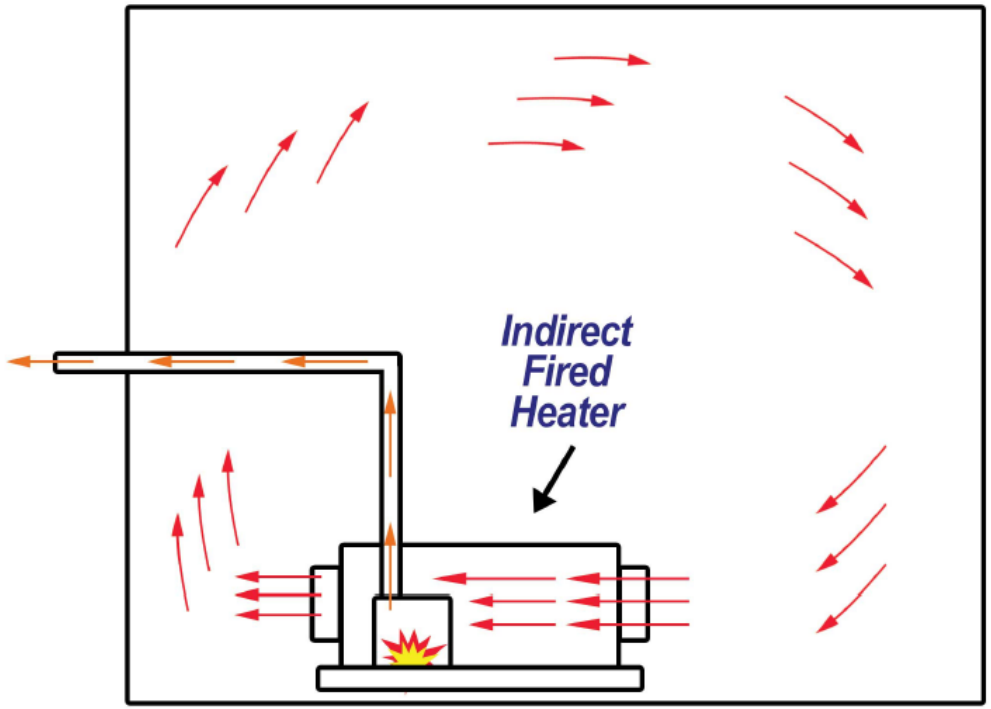
100% Make-Up Air (Pressurization)

- Controlled Mechanical Ventilation System
- Helps prevent negative pressure in buildings
- Prevents the build-up of indoor air contaminants
- Minimizes the potential for back-drafting of non-sealed combustion appliances such as water heaters and furnaces
- Maintains comfortable interior temperatures and proper airflow balance within a building
- Controls the amount of CO2, humidity, and air contaminar levels inside the building
- Provides optimal temperature and humidity comfort levels
- Essential to ensure a healthy and comfortable indoor environment



100% Recirculated Air

- Heater is placed inside the space
- Leads to Heat Stratification at the ceiling
- Fans required to circulate heat/air within the space
- Takes longer to heat space

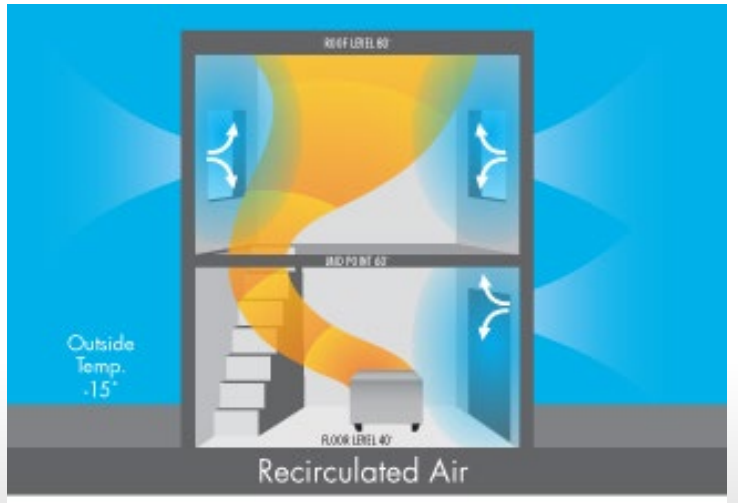


Combined Air Supply

Air should be introduced in a controlled manner, through proper air handling equipment, rather than just drawing it in through any windows, doors, or other leakage spots. There are three possible sources of interior air:

- 100% Make-up air (outdoor air)
- Combination of make-up air and recirculated air
- 100% Recirculated air within the space (not with Direct-Fired Heaters)

Volume should keep area under a slight positive pressure to ensure that uncontrolled infiltration does not occur, which adversely impacts occupant comfort levels and indoor humidity



Moisture Comes with Heat

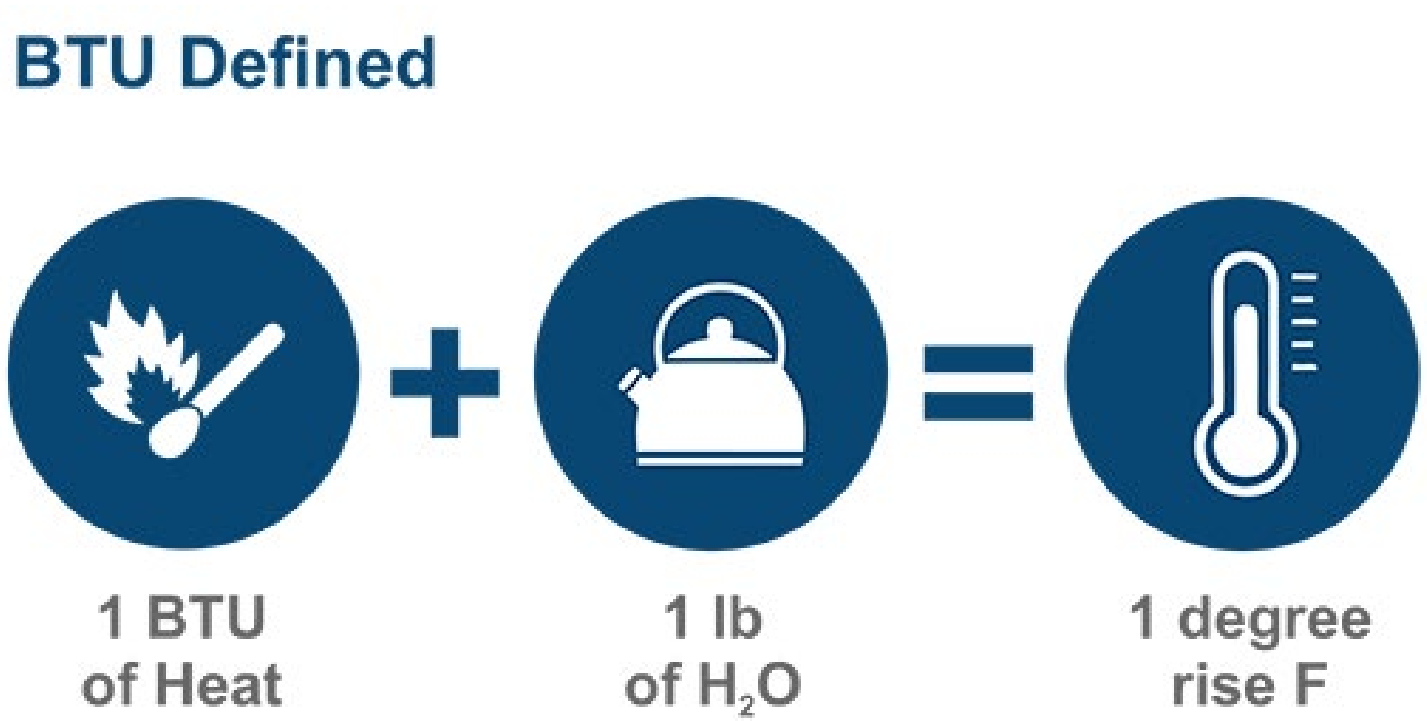
Sources of Moisture in the Air (Humidity) include:

- Ambient weather
- Construction processes
- 9.72 gallons of water produced per hour when burning 1 million BTUs of propane gas
- 11.76 gallons of water produced per hour when burning 1 million BTUs of natural gas
- 6 gallons of water produced by curing 1 cubic yard of concrete

What is a BTU anyway?

British Thermal Unit

- 1 BTU is required to raise the temperature of 1 pound of water 1°F.
- 1 CFH = 1,000 BTUs.



Winter Temperatures Require HEAT

Three Types of HEAT:

Convection: Causes hot air to rise and cool air to fall (relies on gravity, there is no convection on the orbiting International Space Station)
> Hot air rising above a fire, ice melting, sea breeze

Conduction: Transfer of energy as heat through direct physical contact between matter or particles of matter
> Touching the hot stovetop or burning your feet on hot sand

Radiation: A hot body emits electromagnetic waves that are absorbed by our skin; no medium is required for electromagnetic waves to propagate
> Warmth of sunlight, heat of hot oven as pass by

Most of the heat transfer from this fire to the observers is through infrared radiation. The visible light, although dramatic, transfers relatively little thermal energy. Convection transfers energy away from the observers as hot air rises, while conduction is negligibly slow here. Skin is very sensitive to infrared radiation, so that you can sense the presence of a fire without looking at it directly.

Heating a Space

Heating systems raise the temperature of cold spaces to keep occupants warm and cozy! Fireplaces are some of the oldest and most simple heating systems.

Natural flow of heat from hot to cold spaces. Air only knows one thing – to equalize itself with the ambient air temperature.

Main COMPONENTS of a modern HVAC heating system:

- Thermostat
- Heat Source
- Burner System
- Heat Distribution System

Thermostat

- The THERMOSTAT controls the temperature of the conditioned space by regulating the amount of heat created by the heater
- If the thermostat does not call for HEAT, the heater will not produce heat
- Without a thermostat monitoring and controlling the heater output, the heater will operate on low-fire continuously

Heat Sources (Fuel)

Common HEAT SOURCES include:

- Natural Gas
- Fuel Oil/Diesel
- Propane/LP Gas
- Electricity

Natural Gas

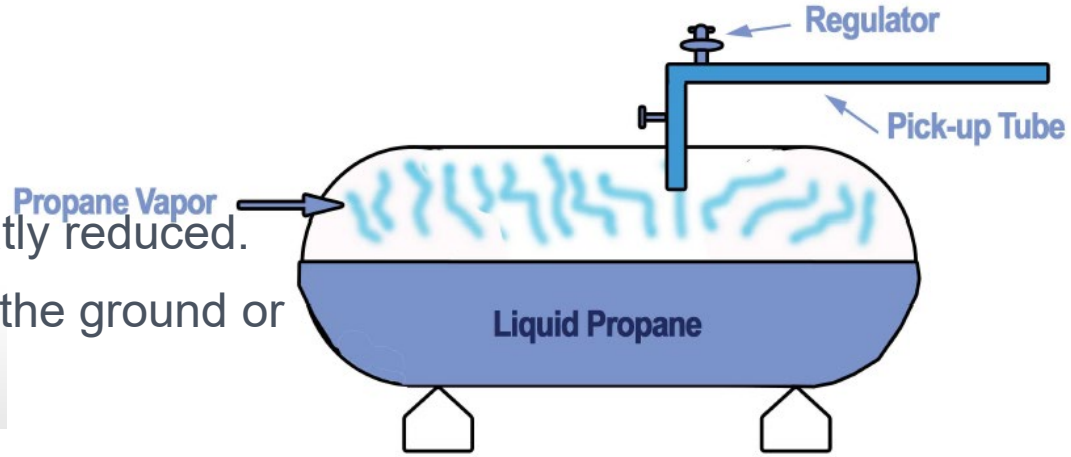
- Discovered in 1821 in Fredonia, New York as a by-product of oil production. From the start, the market for natural gas was limited by pipeline technology, the gas for Fredonia, New York in 1821 was supplied through wooden pipes.
- Currently delivered via pipeline
- Narrow range of flammability, making accidental combustion unlikely
- Gas rises and dissipates rapidly into the air, which also makes accidental combustion unlikely
- Less efficient than propane, but cheaper
- 1,030 BTUs per cubic foot

Fuel Oil/Diesel

- Delivered in liquid form, stored in a tank
- Will not release flammable vapors in its liquid state, with these flash points:
  - #2 below 125°F
  - #1 below 100°F
- Leaks in the system are easily identifiable by
  smell and by smoke
- Optimum efficiency levels of 85-95%
- Very cost-effective
- 138,500 BTUs per gallon

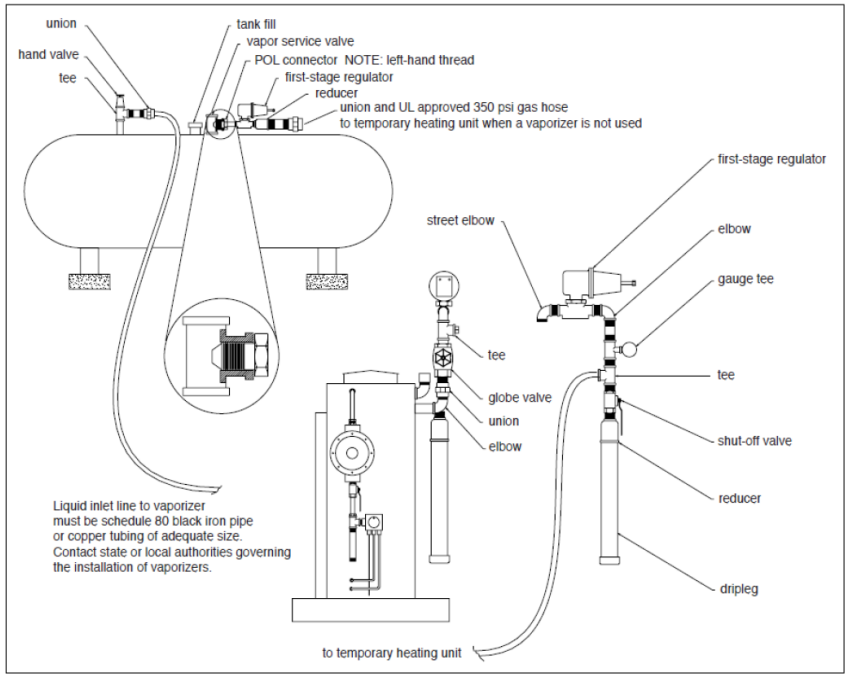
Propane/LP Gas (Vapor)

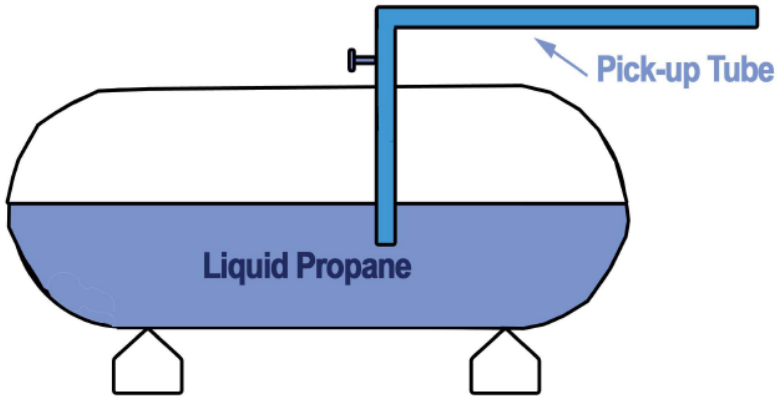
- By-product of natural gas processing and petroleum refining and burns more cleanly than gasoline and coal
- Delivered in liquid form, stored in a tank
- Vaporizes in the tank to supply your heater as a gas through tubing
- Pressure of the gas is regulated to a usable level by a regulator at the tank or at the wall
- Available energy load dependent on tank size and ambient temperature
- Require regular inspection and certification
- 2,516 BTUs per cubic foot
- Available for remote sites
- If tank is covered with ice and/or snow, vapor will be greatly reduced.
- **WARNING**: Vapors are heavier than air and settle low to the ground or in low areas like basements



Propane/LP Gas (Liquid)

- Requires use of a VAPORIZER to convert the liquid propane to the vapor needed by the heater
- Used with large direct-fired heaters (2M BTUs/hr. on larger), but this is dependent on geographic region as ambient temperature can greatly affect natural propane vaporization (propane boils to a vapor at -44°F)
- Can deliver large amounts of fuel without being affected by temperature or vaporization rates

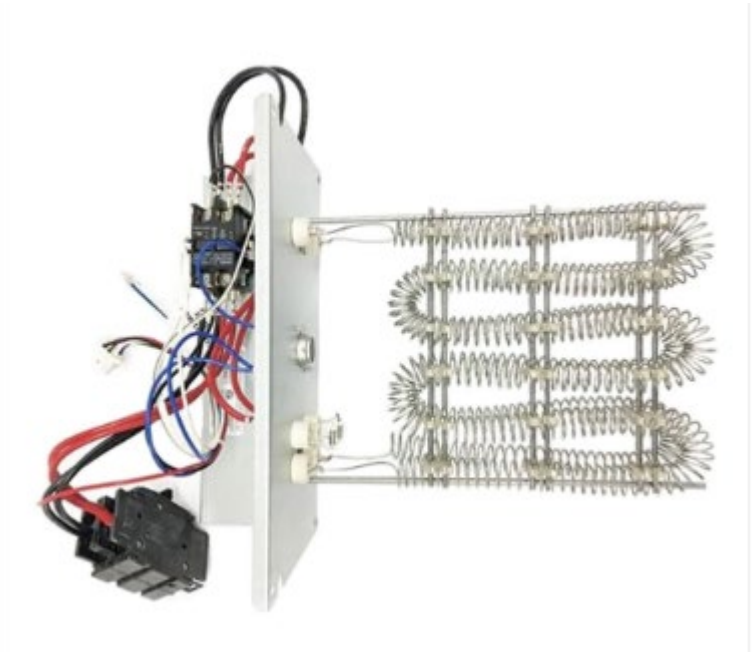




Electric

Resistance Heating: heat is created when electricity flows through a resistor: the electric heating element

- Requires no external venting
- Essentially 100% efficient
- Cost higher than with gas or oil



Heater Fuel Supply Review

- Which creates more BTUs? Fuel Oil > Propane > Natural Gas
- Most economical? Natural Gas
- Most efficient heater? Electric, but expensive to operate
- Easiest to maintain supply? Natural Gas, via pipeline

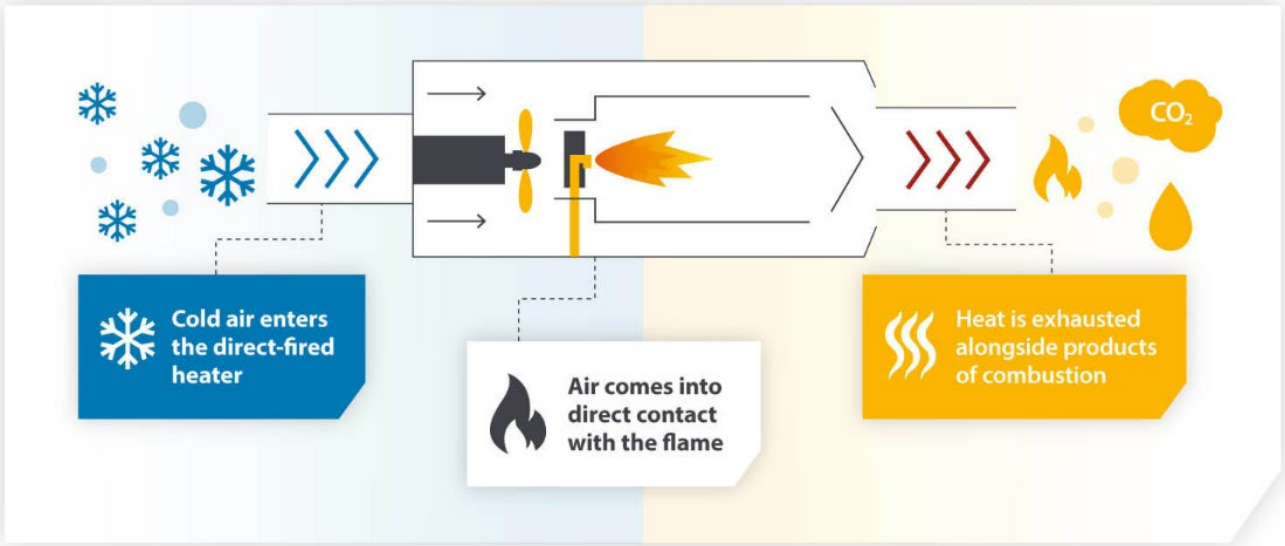
Burner System

In order to create heat, the HEAT SOURCE is sparked in the presence of OXYGEN to create COMBUSTION. Two common BURNER SYSTEMS we use:

- Direct-Fired Heaters
- Indirect-Fired Heaters

Direct-Fired Heater

An open flame inside the unit warms incoming air before it is passed into a space, delivering a vast amount of heat output quickly (with moisture)



The GOOD

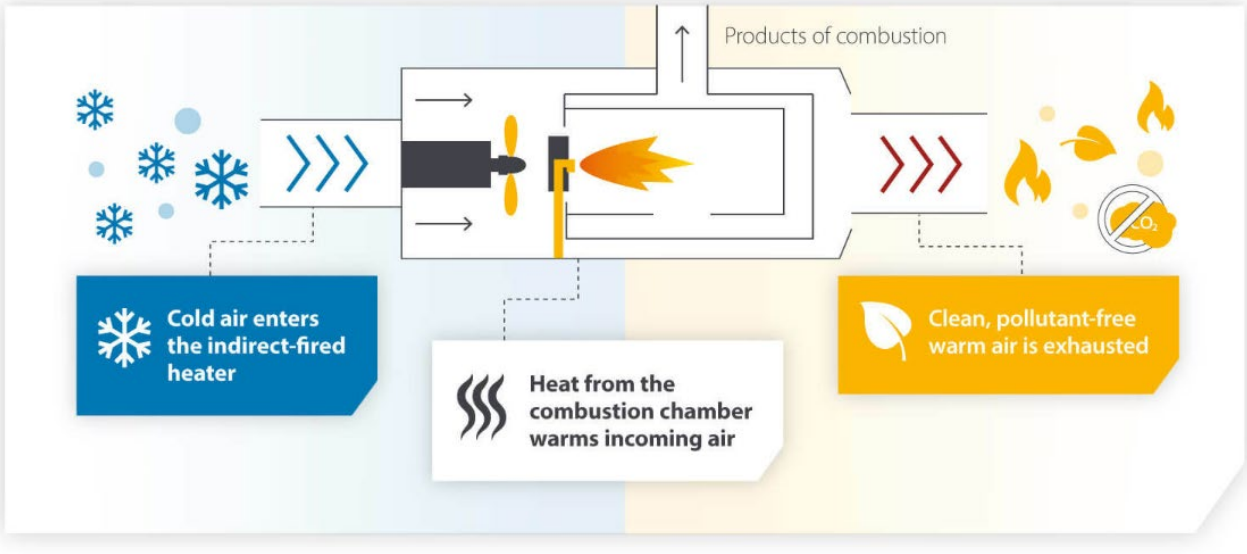
- Almost 100% efficient
- High discharge temp rise (170°F + ambient)
- Deliver large volume of make-up air for more frequent air changeovers
- Portable
- Easier to service
- Longer life expectancy

The BAD

- Can produce low levels of CO, CO_2, and NO_2 when recirculated
- Produces humidity (mold potential when recirculated)
- 100% fresh air intake

Indirect-Fired Heater

The flame is enclosed within a sealed combustion chamber and the heat inside this chamber is transferred to the air passing through the chamber via a heat exchanger



The GOOD

- Delivers warm, clean air
- Low discharge temp rise (100°F + return air temp)
- Use indoors and outdoors
- Can recirculate 100% of air
- For use in human/animal or flammable environments

The BAD

- Not as efficient (80%)
- Requires a chimney
- Maintenance costs higher
- Not a good make-up air unit
- Shorter life expectancy

Heat Distribution System

Heat must be MOVED from the heating unit to the space that needs to be heated, which can be done by:

- Ductwork (vinyl spiral, smart snap duct, lay-flat fabric)
- Duct-Less (heater inside conditioned space)