80 YEARS SERVING THE OILHEATING INDUSTRY

Oilheating

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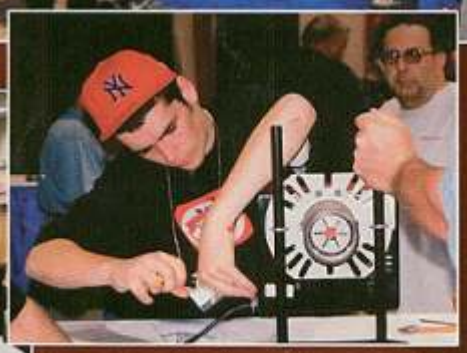

SERVICE MANAGERS MEET IN HARTFORD

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2002 Buyers Guide

The inner chamber...

The refractory material that makes up a combustion chamber has to withstand temperatures as high as 4700° F. Inspection and preventative maintenance are essential for proper operation and safety.

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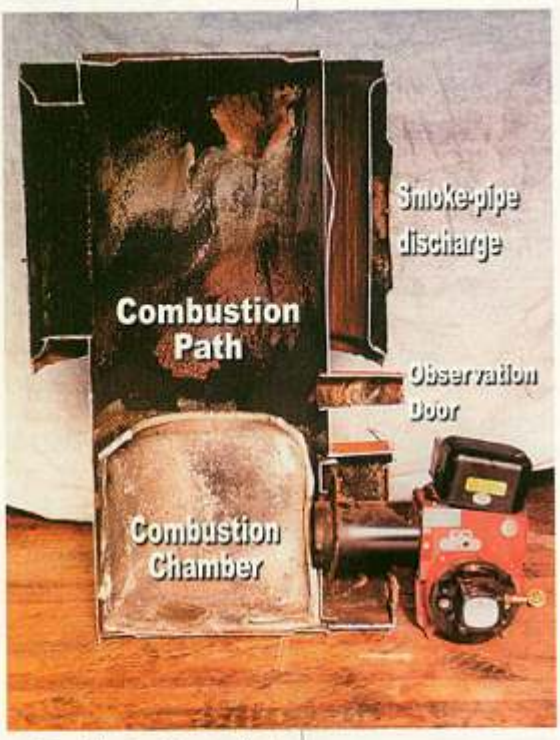
Boilers and furnaces are constructed with a high temperature insulation known as *refractory*; this material insulates the area in these appliances that is exposed to the burner flame.

Refractory is necessary because the temperatures developed in combustion can exceed the melting point of steel*. Without this refractory in its proper place, overheating of the metal of the heat exchanger or boiler components can result in damage to the system.

In addition, soot production and interference with combustion product flow often result due to fallen or improperly positioned refractory.



The bisected forced hot air furnace shows placement of combustion chamber refractory in heat exchanger.

Reactive and Preventative Maintenance

An oil company's service plans include many maintenance actions. These maintenance activities are designed to make sure that a combustion appliance operates safely and efficiently and for as long as possible.

Reactive Maintenance is maintenance that is performed after a failure occurs. Examples of this include clearing a boiler that has plugged with soot or fixing a leaking gasket.

Preventative Maintenance is maintenance that is performed to avoid a more serious catastrophic failure. An example of this would be the replacement of oil filters and nozzles on an oil burner system annually.

Preventative maintenance actions are not limited to the "repair/item change" realm only. A crucial element of the preventative maintenance action is in the visual assessment of the condition of the appliance.

Visual Inspection is vital to identify the need for replacement of certain components BEFORE failure occurs.

To prevent an unexpected appliance failure, the service technician should use their best judgment, ideally based on experience with past failures of similar components; this must be a part of preventative maintenance actions.

Design of Combustion Chamber Refractory

The temperature of combustion can approach 4000° F, which is above the melting point of steel and cast iron, the materials used to construct boilers and furnace heat exchangers. Combustion chambers are capable of also acting as "heat sinks" or "Reservoirs of Heat"; this provides additional energy to the medium being heated, allowing longer periods between burner firings during the heating operation.

The two materials that have traditionally been used to manufacture Combustion Chamber refractory material are Firebrick and Ceramic Fiber.

Firebrick was the first refractory used and was later replaced by Insulating Firebrick, which had more advantageous properties. Initially, firebrick was made with asbestos.

Today, the use of ceramic fiber combustion

*Editor's note: 1020 steel has a melting point around 1500°C, or 2732°F, although this can vary somewhat depending on what type of steel is used.

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(Above) Dismantled dry base boiler. "B" is the "tub-like" refractory in this type of boiler.

(Below) Combustion chamber from an oil-fired furnace.

chamber refractory is used extensively. Some ceramic material can withstand temperatures as high as 4700°F and chambers made of these types of materials are available in shapes that allow any appliance's combustion chamber to be adequately protected.

Chamber design and size must be coordinated with the flame pattern of oil burner equipment, mainly in the selection of nozzle size and pump pressure, if the system is to operate efficiently and safely. Because of this, ceramic fiber refractory "kits" are constructed in varying sizes and shapes to fit any number of furnace and boiler chamber designs.

Causes of Failure

Combustion chamber refractory is damaged by the effects of erosion, continual expansion/contraction and fatigue. Additionally, water contact will affect the integrity of refractory material.

The environment in which this refractory operates is one that fluctuates from ambient to extreme temperatures. A burner stopping and starting will deliver a high-velocity airflow of hot combustion gases over the surface of the refractory thousands of times in a few heating seasons. The chamber refractory must maintain its thickness in order to insulate properly, and maintain its rigidity in order to retain its structure.

Service Life

There are various factors affecting the life of a combustion chamber refractory. These include initial design, burner setting and adjustment (flame impingement quickly erodes refractory) and nozzle size. Some chambers have seen over 20 years of service and others fail in as short as seven years.

Maintenance Damage

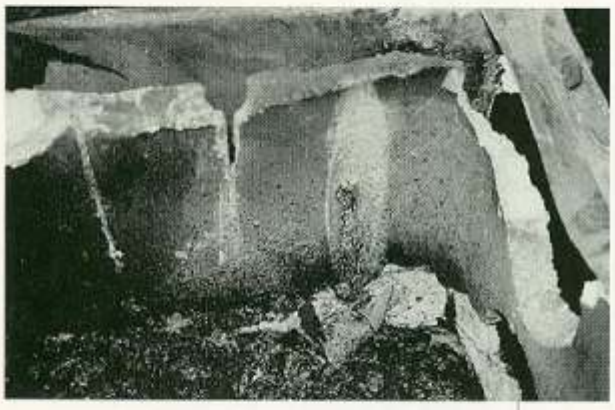
Damage to refractory can also result from cleaning instruments striking the chamber. Care also must be taken to insure that the liner is not damaged during service intervals.

A service technician's duties should include a visual examination of the refractory to determine that it has not been damaged and is still capable of continued service.

Visual Inspection and other indicators of impending failure

The life span of a chamber refractory structure can vary from appliance to appliance. To identify if the refractory is in need of replacement before total failure occurs and to predict the ability of refractory to survive the upcoming heating season, the following characteristics should be accessed at service intervals:

Chamber damaged by cleaning tools



Surface cracks: The first indication of ceramic fiber chamber material deterioration is indicated in the development of surface cracks. These are often concentric in pattern and more numerous on the target wall area.

Thinning: Thinning of refractory is an indication of a limitation of the remainder of its useful life. In the event that the thickness of the refractory is reduced significantly, the refractory should be replaced. Particular attention should be paid to the rear wall (target wall) area of the chamber. If crater-like depressions (spalls) of any depth are seen in the refractory, this is an indication that impingement of the flame to the liner is occurring and that the refractory should be replaced.

Shrinking/Sagging: As refractory fibers break due to continual expansion and contraction, the structural integrity of the refractory shape will begin to fail. Warping and shrinkage of the chamber will result—a precursor to the chamber falling apart entirely.

Gasket leakage in dry base boilers at chamber/heat exchanger interface: Dry base boilers depend on the condition of the combustion chamber refractory since its integrity is the only component containing combustion gases. An early indication of dry base boiler chamber failure is leakage of combustion gases at the Gap/Seal between the combustion chamber and the boiler's heat exchanger.

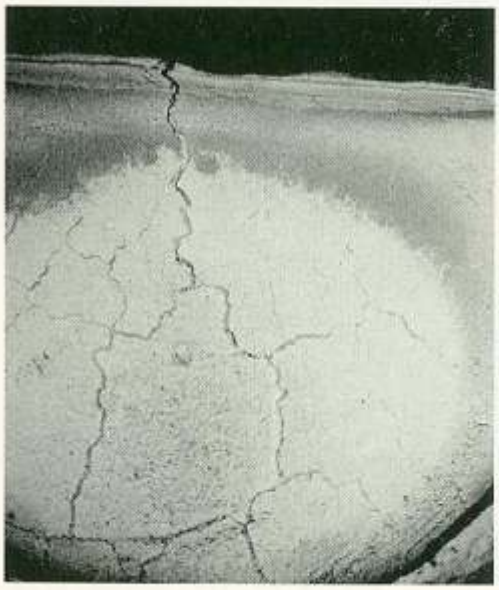
Effects of failed combustion chamber refractory

When the refractory fails, a number of undesirable effects can be realized. These include:

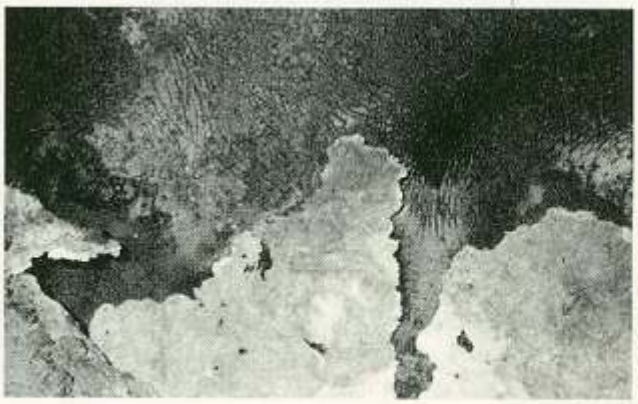
Soot/Fires: Fires—as well as soot discharges into homes—have resulted from failed combustion chamber refractory. This is why the condition of this component is vital to insure that an appliance will operate safely for the upcoming heating season.

Missing and out of position refractory: If refractory falls from its intended wall within the appliance, the space where the burner flame is supposed to be positioned will now be "shared" with the flame and a portion of the refractory. This will cause flame distortion and soot production. A prolonged period of operating the appliance in this condition will result in eventual plugging of a

Surface cracks on ceramic fiber refractory



This combustion chamber refractory is so badly deteriorated, it can easily fall apart.



This target wall's refractory was paper thin; it's no wonder the furnace had a hole in the heat exchanger here.

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The dry base boiler's jacket has been removed to inspect for combustion gas leakage.

furnace or boiler and soot discharge into the structure. This can occur in either oil or gas fired appliances.

Flame impingement induced overheating: Failed refractory will allow the burner flame to contact the steel components of a forced hot air heat exchanger or a boiler's combustion chamber components.

When this happens, the burner flame temperature exceeds the temperature of the melting point of the steel. This in turn causes the heat exchanger to fail in what is called a *Flame Impingement Failure*.

Other damage: In addition to wear and tear, refractories also can be damaged by improperly sized nozzles or by cleaning instruments during servicing.

Repair vs. Appliance Replacement Options

The service technician's responsibility when performing preventative maintenance on a boiler or furnace is to exercise professional judgement in determining if the appliance can operate for the foreseeable future in a safe manner. Assessment of a combustion chamber's refractory is a maintenance action a service technician *should be expected to do.*

Often, the need to replace the appliance rather than replace the chamber is something that must be seriously considered. Refractory kits range from $50 to $100 in cost and labor in most residential appliances and can take from one to five hours, depending on design. When this is weighed against the cost of replacing the appliance, refractory replacement becomes a worthwhile maintenance action—as long as no other problems with the appliance exist.

Responsibility for Safety...

The integrity of the combustion chamber refractory is vital to the safe operation of a boiler or furnace. Since containment of the products of combustion can cause fire, injury or even death, accurate assessment of this component is an important preventative maintenance action item during yearly servicing.

Allowing a boiler or furnace with a combustion chamber that needs replacement to "run until something actually breaks"—also known as *Reactive Maintenance*—can result in premature failure and unnecessary replacement of the entire appliance. Additionally, soot damage can occur to homes as a result of an appliance flame impingement hole or fireside soot plugging due to the burner flame striking a fallen refractory.

Finally, common sense should prevail. When examining the condition of a chamber, consider the visual indicators of wear and tear and the age of the refractory. Always err on the side of safety and "if in doubt... change it out!"

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(Right) The flame impingement hole is visible in the furnace's heat exchanger.