iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** IX **Month of publication:** September 2021

DOI: https://doi.org/10.22214/ijraset.2021.38167

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue IX Sep 2021- Available at www.ijraset.com

Evolution of Furnaces

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Abstract: A new generation of industrial melting furnaces has been developed during the last 25 years. Present practices followed in Furnaces are discussed in this paper. Through a literature review account of various practices presently being followed in industries using Furnaces has been carried out with a view to gather principal of working. Apart from this a pilot study has also been carried out in few industries in India. We provide some recommendations for the productivity improvement. Due to lack of proper instruments the effect of the ill practices cannot be precisely judged. If this is properly measured, the percentage of productivity improvement in steel melting Furnace can be calculated. The review is carried out from the literature in the various journals and manuals. The first controlled use of fire in metallurgy dates from the eighth millennium BC, when native copper was deliberately heated to form artifacts. Problems how to distinguish between native copper and smelted copper are addressed, especially what concerns the role of iron in copper. kilns. Metallurgy is an independent development. The decisive factor was the introduction of charcoal that was important to produce reducing conditions during firing. The earliest stages in metallurgy are represented by a non-slagging process. Reduction of ores was carried out in crucibles as exemplified by finds from Anatolia, Iran, Jordan, and the Iberian Peninsula. Special attention is paid to the putative early stages of metallurgy claimed to exist at that age. The is called Neolithic and Chalcolithic copper smelting there is critically prooved in the light of radio carbon data. Wind-powered furnaces played a major role in Early Bronze Age copper metallurgy, as exemplified by sites in the Feinan-area, in Wadi Dara, Egypt, and at numerous sites in the Aegean. Later, artificial air supply by bellows and tuyeres was introduced.

I. INTRODUCTION

Since the early days of civilization, people have invented different ways to keep themselves warm during cold seasons. In ancient Rome, the first underground heating systems were installed to heat buildings via a fire. Early on, these heating systems were fueled by wood. As you could imagine, the maintenance required a lot of work because you would have to constantly place more wood into the furnace multiple times a day in order to keep the heat going. Eventually, coal was used in later systems. While this less maintenance requirements needed to keep the heating system working, the upkeep was still very time-consuming. Aside from reloading the coal throughout the day, a person would have to routinely clear out the ashes from the unit. Finally, during the modern era, gas furnaces were introduced. This awesome invention freed people from the ongoing maintenance required with older models. Also, gas furnaces are more efficient and less harmful on the environment than the burning of coal or wood.

Furnace, structure in which useful heat is produced by combustion or other means. Historically, the furnace grew out of the fireplace and stove, following the availability of coal for heating. A coal furnace is made up of several elements: a chamber containing a grate on which combustion takes place and through which ashes drop for disposal; a chimney to carry away smoke and provide a draft of air; another source of air supply to help burn volatile gases and hydrocarbons; and a metal surface over which the hot gases pass and which transfers heat to circulating water or air. Coal furnaces are still widely used in industry, where they are usually equipped with mechanical stokers.

Chemical energy is transformed into heat by burning fuels such as coal, wood, oil, and hydrocarbon gases. Electrical energy is transformed into heat in an electric furnace or an electric burner (*see* electric furnace). Solar radiation energy is used in the solar furnace (*see* photograph), a device for concentrating large amounts of solar energy into a small area. Nuclear energy is transformed into heat energy in atomic reactors, so that these function as furnaces in nuclear power stations. Furnaces may apply their heat to other devices, as boilers, ovens, and kilns, or they may apply it directly to material in the course of being processed, as in steel production.

II. HISTORICAL EVOLUTION OF FURNACES

The origin of the first smelting of iron is concealed in the unrecorded history of human civilization. The first evidence of iron implements being used in ancient times actually comes from Egypt where an iron tool was found in a joint between two stones in a pyramid. The origin of many prehistoric iron implements was probably meteoric iron. Meteoric iron contains 5 % to 26 % nickel (Ni) while smelted iron contains only traces of Ni and hence iron artifacts made from meteors can be differentiated from objects of smelted iron.

More than 4,000 years ago, people discovered meteoric iron. But it was another 2,000 years before the production of iron from mined iron ore began. The earliest finds of smelted iron in India date back to 1800 BCE (Before Common Era). The smelting of iron is said to have taken place among the Calybes of Armenia, subjects of the Hittite Empire, at about 1500 BCE. When their empire collapsed around 1200 BCE, the various tribes took the knowledge of iron making with them, spreading it across Europe and Asia. The knowledge of ironworking in all of Europe and Western Asia is ultimately traced to this source. The Iron Age began with the discovery of smelting of iron.

Central heating with a furnace is an idea that is centuries old. One of the earliest forms of this idea was invented by the Romans and called a hypocaust. It was a form of under-floor heating using a fire in one corner of a basement with the exhaust vented through flues in the walls to chimneys. This form of heating could only be used in stone or brick homes. It was also very dangerous because of the possibility of fire and suffocation.

Furnaces generate heat by burning fuel, but early furnaces burned wood. In the seventeenth century, coal began to replace wood as a primary fuel. Coal was used until the early 1940s when gas became the primary fuel. In the 1970s, electric furnaces started to replace gas furnaces because of the energy crisis. Today, the gas furnace is still the most popular form of home heating equipment.

Wood and coal burning furnaces required constant feeding to maintain warmth in the home. From early morning to late at night, usually three to five times a day, fuel needed to be put in the furnace. In addition, the waste from the ashes from the burnt wood or coal must be removed and disposed.

Figure 2.1

Until the 1880s, most homes were heated by fireplaces or wood-burning brick furnaces. None other than Benjamin Franklin helped evolve home heating in 1742 when he designed the Franklin Stove, “For the better warming of rooms.” A free-standing cast iron fireplace, Franklin’s stove featured adjustable baffles to control airflow into the firebox. Cast iron construction radiated warmth more efficiently than brick and the unit generated more heat from less wood than an open fireplace. Franklin stoves became perhaps the first widespread furnace improvement in colonial America.

By 1885, coal was a more common heating fuel than wood. Early central heating systems incorporated a coal-burning boiler that produced steam which was piped to radiators. Meanwhile, David Lennox invented the first central warm air heating system. Utilizing a riveted-steel coal furnace installed in the basement, the system relied on convection as warm air naturally rose through ductwork and spread throughout the house.

The industrial furnaces had been used in the beginning of the industrial revolution, it is only on 20th century that great strides have been made in the technology behind the heating and the movement away from driven-fuel systems. Carbolite Gero is a global manufacturer of electrically heated ovens and furnaces and they have been at the front of this technology for the past 80 years.

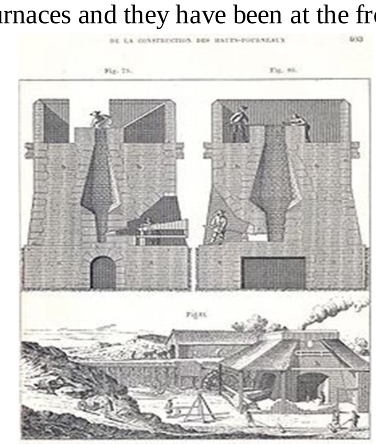

Figure 2.2

Carbolite was first who founded in 1938 in Sheffield, England, taking its name from the silicon carbide heating elements that were just coming into use1. This had been the novel technology of the time, and this approach to innovation can be seen in the way the company conducts its business to this day.

The original furnaces built in Attercliffe were designed for testing coal and coke used in Sheffield's steel industry, but as the company quickly developed a reputation for quality, they were soon building furnaces for the precious metals sector, as well as ash fusibility furnaces for sample testing. It was this diversity and ability to offer custom solutions that set them apart from other manufacturers who have adopted a more "one size fits all" approach.

III. FURNACES IN ANCIENT INDIA

A. Furnace For Copper Smelting

The copper smelting is has been traced at lothal in earliest kiln the klen used for melting copper ingots in earthen bowls was simple circular and brick structure. the mud coated on the inner face of lothal was vetrified due to intense hest there are two types klens used by copper smith for copper ingots.1.circular, 2.Retanglaur. The furnace's long mouth suggest that a bellow was used for pumping air to increase tempartue to a higher degree. The molten metal and thick bowl like crucible found nearby suggest that copper ingots were melted in klen.

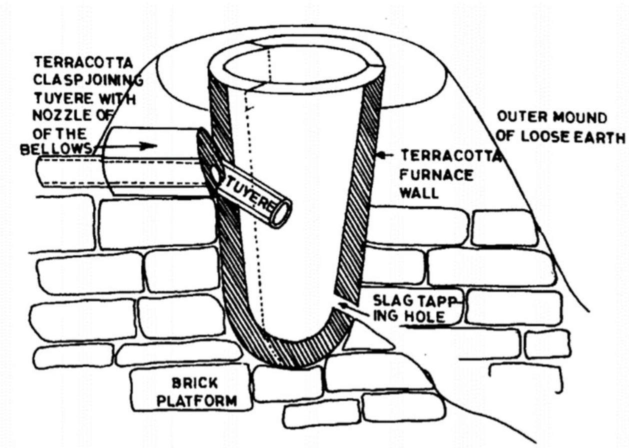

Figure 3.1: Assembled copper smelting furnaces from aravam

B. Furnaces for Gold and Silver Smelting

The archaeological and literacy evidence revels that crucible in Indian subcontinent were in regular use for pyro technological process for different metals right from neolithical period evidence from Mehragarh (Baluchistan).The older furnaces generally made of clay and admixture of organic material which are heat resistant containers used for smelting and melting of metals.

From the excavation at Harappa 16 furnaces has been located, but only one jar furnace associated with stratum II seems to have been used for smelting gold the furnace has round pottery jar with its lower part embedded in earth it contains ash, and on the inside showed frequent contact with marks the fuel that has been used, at least partly, cow dung cakes of which calcined lumps.

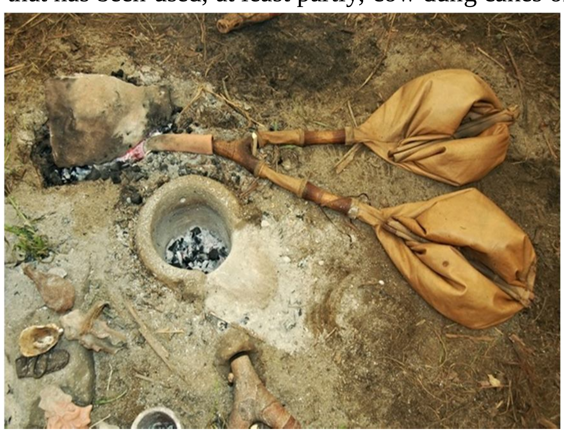

Figure 3.2: Furnaces for Gold and Silver Smelting

C. Furnace for Iron Smelting

It may be apparent from the available details that very little data is available by the way of exact design etc, of iron smelting furnace. Some redesigns has been attempted on the basis of archaeological evidence by hedge, Banerjee, gogte and tripathi. A real breakthrough in understanding technology and more specifically furnace designs comes through an closed observation of ethnological data. The preindustrial working still continues in remote parts of the country even today. Attempt is made to have an idea of earlier furnace designs in some detail.

Remains of furnace structure discovered by Banerjee at Ujjain and gogte and deo at naikund are similar to the iron smelting furnace that was in use until the 40's of the present century by the preindustrial iron working communities in central India.

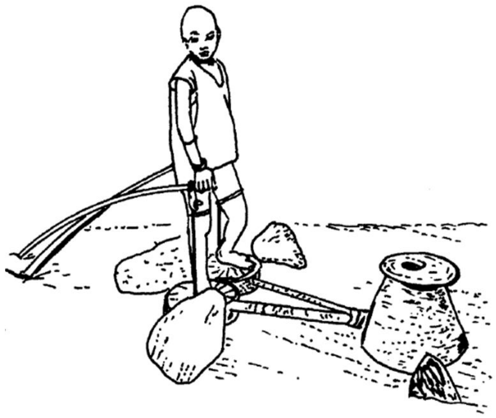

Figure 3.3: Iron smelting furnace

D. Furnace of Zinc Smelting

Zinc was and is still extensively used with copper in the production of brass. Before the advent of modern high pressure reduction technology, zinc had to be produced has vapour. In ordinary metal smelting furnace, the vapour would promptly re oxidize to light white, smoky zinc oxide. The light oxide would be carried up to the furnace and get lost, thus the principle of down ward distillation of zinc vapour was developed.

Figure 3.3: zinc smelting furnace – zwaranla

Excavation at zawar in 1983 brought to light two groups of impressive nearly intact structural remains of furnaces, containing their final charge include both large and small retorts each consisting of an array of (6x6) inverted over a perforated grade or support made of ceramic bricks. The condition of the retorts leave no dought that the fuel was stacked around them and heated directly.

Figure 3.3.1: interior view of zinc smelting furnace

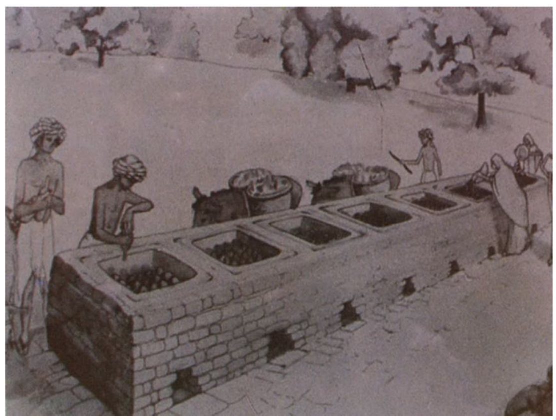

Figure 3.3.2: Artist's working process in zinc smelting furnace

IV. FURNACES THROUGH AGES

A. Blast Furnace

The increased demand for iron for casting cannons, the blast furnace came into widespread use in France in the middle 15th century. The direct ancestor of those used in France and England was in the Namur region, in what is now Wallonia (Belgium). From there, they spread first to the Pays de Bray on the eastern boundary of Normandy and from there to the Weald of Sussex, where the first furnace in Buxted was built in about 1491, followed by one at New bridge in Ashdown Forest in 1496. They remained few in number until about 1530 but many were built in the following decades in the Weald, where the iron industry perhaps reached its peak about 1590. Most of the pig iron from these furnaces was taken to finery forges for the production of bar iron. The first blast furnace in Russia opened in 1637 near Tula and was called the Gorodishche Works. The blast furnace spread from there to central Russia and then finally to the Urals.

Figure 4.1: Blast Furnace

In a blast furnace, fuel (coke), ores, and flux (limestone) are continuously supplied through the top of the furnace, while a hot blast of air (sometimes with oxygen enrichment) is blown into the lower section of the furnace through a series of pipes called tuyeres, so that the chemical reactions take place throughout the furnace as the material falls downward. The end products are usually molten metal and slag phases tapped from the bottom, and waste gases (flue gas) exiting from the top of the furnace. The downward flow of the ore along with the flux in contact with an up flow of hot, carbon monoxide-rich combustion gases is a counter current exchange and chemical reaction process.

B. Gas Furnace

It was 1919, and Alice Parker from Morristown, New Jersey dreamed of an idea for the very first gas furnace. Before that moment, there had been no central heating system created. At that time, homes were heated by individual fireplaces that had to be maintained constantly, day and night. Additionally, in order to stay warm, you had stay very close to the fireplace itself, which was impracticable, especially at night.

Figure 4.2: Gas Furnace

A gas furnace goes into action when the thermostat tells it that the room temperature has dropped below a pre-set comfort level. The thermostat sends a low-voltage electrical signal to a relay in the furnace, which signals a valve to open and deliver natural gas to the burners and for the blower to turn on.

C. Oil Furnace

In the early 1920's, with the invention of electric fans, the idea of a 'forced air' furnace became a reality. Diesel fuel was being utilized in engines by 1900. Its prevalence led to using it as a heat source alongside wood, sawdust, oil, (rarely) coal, and natural gas burner. Oil-fired furnaces and boilers are a popular choice in areas of the country with limited access to natural gas, such as the Northeast. Oil-fired furnaces and boilers present an opportunity to use renewable fuels to heat your home. A number of companies are now offering heating oil blended with biodiesel, allowing their customers to reduce their dependence on foreign oil while drawing on a domestic energy source. The biodiesel blends also produce less pollution than pure heating oil.

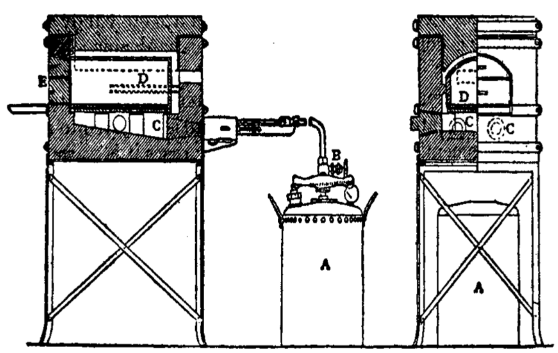

Figure 4.3: Oil furnace

A number of retrofits are possible for oil-fired furnaces and boilers, but before pursuing any retrofits you should consider the potential added benefits you could receive by simply replacing the furnace. The following retrofits are possible

D. Electric Furnace

The German-born British inventor Sir William Siemens first demonstrated the arc furnace in 1879 at the Paris Exposition by melting iron. In this furnace, landscaped placed carbon electrodes produced an electric arc above the container of metal. The first commercial arc furnace in the US was installed in 1906; it had a capacity of four tons and was equipped with two electrodes. Nowadays furnaces range in heat size from a few tons up to 400 tons, and the arcs strike directly into the metal melted from portrait positioned, graphite electrodes. Although the three-electrode, three-phase, alternating-current furnace is in general use, single-electrode, direct-current furnaces have been installed more recently.

Figure 4.4: Electric Furnace

Electric furnace**,** heating chamber with electricity as the heat source for achieving very high temperatures to melt and alloy metals and refractories. The electricity has no electrochemical effect on the metal but simply heats it.

V. MODERN FURNACES

The modern metal furnace was a ground-breaking invention. This represented the end of refilling a furnace multiple times a day with coal. This was also the end of messy cleanups of ashes. Of course, the metal furnaces that we use today are a lot more technical. On one fixture, there are multiple components, including a thermostat, a gas valve, a heat exchanger, and blowers.

A. Importance of Modern Furnaces

Older models of modern metal furnaces are a big step up from the coal-burning fireplaces of the old times. They are not as efficient as the furnaces constructed today, however. The biggest difference is that the older versions only have one exchanger. You want to have a furnace with a secondary exchanger because it makes the furnace more efficient. In fact, the older models with one exchanger can waste over 20 percent of the heat. The recent models have an efficiency of about 90 percent. This saves you money and keeps your building warmer.

B. Hazards of Modern Furnaces

Aside from unnecessary expenses, older furnaces can present dangerous risks. Carbon monoxide poisoning is a notorious silent killer in homes worldwide. The new furnaces have sensors built in to help avoid this, but many older furnaces do not. Also, the old furnaces are more prone to have gas leaks, which cause fires**.**

VI. CONCLUSION

This paper is an attempt to provide comprehensive knowledge of Evolution of Furnace.

The key conclusions derived from this work are as follows:

1) Furnaces has been developed significantly over time as detailed in historical evolution section. The modern advancement's in furnaces. industry significantly rely on computational means to investigate the ancient furnaces, their filling and solidi sequence, and life prediction in the presence of distortion and stresses in the parts of furnaces.
2) A range of melting processes has already developed to produce parts with high degree of implementation, however, efforts are being made to more the melting yield and minimize the defects through continuous process development.
3) Forging practices in upcoming study life and techniques, pattern making and cores, cast alloys, various type of furnaces, pouring, cleaning and finishing operations have to be well understood for streamlined production.
4) Melting defects, their causes and remedies are important to understand by smelting designer and engineers so that these defects can be reduced to minimum.
5) The design considerations such as material properties, mechanical properties of products, pattern and core development, tolerance, economic analysis, machining and cleaning requirements etc. need proper consideration for production of cast parts.

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