

Alchemy and the Philosopher's Stone

The History of Chemistry

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Where the history of chemistry begins is a difficult question to answer, mainly because it is necessary to define the term, 'Chemistry.'

Whilst many ancient cultures studied the nature of substances and synthesized useful compounds, there was no scientific methodology [1] to their approach and their studies were based upon accident, trial and error, or the quest for riches.

Whilst it could be argued that chemistry as a modern science began in the 17th Century, where the scientific method [2] and empiricism were applied, this modern science still had roots in the past. Modern chemistry was built upon a long history of alchemy, which earns the label of a genuine proto-science. Despite many incorrect observations and inaccuracies, mixed with mysticism and superstition, the ancient alchemists made many useful discoveries and deserve their place in the history of chemistry.

With this clarification, the history of chemistry is one of the most ancient lineages and can easily be traced back to the Babylonians and beyond. Starting here gives a solid base to the history of chemistry before the science moves away from pseudoscience [3] into the realms of modernity. The history of chemistry meandered through the ages of the Egyptians, the Greeks, the Romans, and the Muslims before the great philosopher-scientists of Europe honed the techniques and the overall methodology.

Even the origin of the word 'chemistry' is open to debate, with many scholars believing that it derived from the Egyptian language, whilst others look to the Ancient Greeks. In the Egyptian language, the word for black is *Kemi*, and it is entirely possible that this was used by the Greeks to refer to the art of transmutation, where black base metals were converted to other substances.

Alternatively, the word may derive from the Greek word, *Khymeia*, or fusion, originally referring to the fusion of gold and silver. Whatever the origins of the word, there is little doubt that these two great ancient civilizations were at the forefront of shaping the overall direction of the history of chemistry.

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The History of Chemistry and the Fertile Crescent

The history of chemistry, of course, does not begin with the Greeks and the Egyptians and it can be traced back into the depths of time, at the very dawn of human civilization. The inhabitants of the Fertile Crescent between the Tigris and Euphrates rivers, in modern day Iraq and surrounding nations built sophisticated societies and moved humanity from a hunter-gatherer existence to an agrarian society. The Mesopotamian era saw the building of great cities at Babel, Ur and Kish, and the Sumerians and their descendents developed writing, advanced pottery techniques and the wheel, as well as some refinements in alchemy.

This period saw the rise of metal-working and the smelting, refining, alloying and casting of ores, with the fuel required for the processes coming from the vast deposits of bitumen and asphalts bubbling to the surface in the region. In addition, the Mesopotamian cultures became experts at manufacturing dyes for textiles and paints, advanced tanning processes, glassmaking and blending perfumes. Their knowledge was great and their techniques refined, although there was no methodological process behind the discoveries, just trial and error. However, their importance to the history of alchemy cannot be downplayed.

The History of Chemistry and the Egyptian Gods

The history of chemistry included the Ancient Egyptians, who took many of the techniques learned in Mesopotamia and perfected them. Under the Egyptians, most of the alchemical techniques, still very much perceived as an art, rather than science, were the domain of priests. Whilst meticulously documenting their sources, they also experimented and developed new methods, although it was tied closely to the Egyptian gods, especially Imohep, and divine provenance.

Some of the techniques developed by ancient Egyptian alchemy were remarkable in the level of sophistication.

- **Metallurgy:**

The Ancient Egyptian craftsmen were skilled in working with metals, especially with gold, but the methods used to extract metals from ores and combine them into alloys were more sophisticated still. The Egyptians knew how to make fine quality bronze, from tin and copper, but they were also aware of iron, originally from meteoric sources. However, some iron tools found at the site of the great pyramid suggests that they may have had the secret of steel, in about 2900BC. They were also aware of cobalt and used it for coloring glass and pottery glaze; there is also some limited evidence that they used mercury.

- **Glassmaking:**

The Egyptians were experts at making soda-glass, in intricate shapes and with subtle colors. The remains of furnaces show a large-scale industry for glass beads, artificial pearls and gemstones, and finds have shown that they even knew how to manufacture high quality lead glass.

- **Textiles and Dyeing:**

Like the Mesopotamians, the Egyptians knew how to mix a large palette of colors and used dyes from many sources, which they used to decorate their textiles and paint the elaborate friezes in the temples, palaces and tombs. Obviously, humanity had been using naturally occurring dyes since time immemorial, but ancient Egyptian alchemy used some innovative techniques for making artificial colors. They used fire-based chemistry and, remarkably, laurionite and phosgenite, rare compounds in nature, were found in Ancient Egyptian vials dating from 2000BC. Ancient Egyptian alchemy must have created these through a process of wet chemistry and a number of multi-step reactions.

Certainly, the ancient Egyptian alchemy used some refined chemical techniques and their knowledge was taken and used by the Greeks. In fact, the Egyptians were so skilled that the Greeks made few practical contributions to the history of chemistry, instead concentrating upon rationalism and developing new theories.

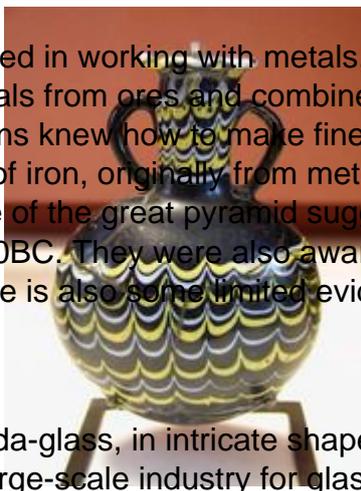
The History of Chemistry and the Greeks

The Greeks made few additions to the practical knowledge of alchemy and, in fact, sent the protoscience the wrong way. Their contributions were largely based upon theorizing and speculating about the properties of matter, whilst attempting to deduce what caused certain substances to be indivisible elements.

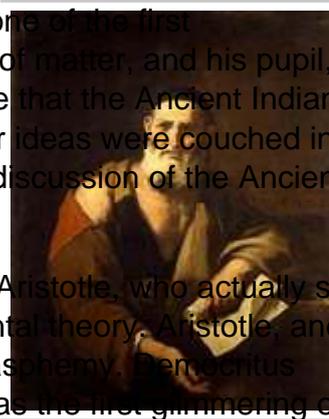
One notable philosopher, Leucippus (Born in around 460BC), was one of the first philosophers to propose the existence of atoms, as indivisible units of matter, and his pupil, Democritus, expanded upon the idea. Whilst there is some evidence that the Ancient Indian philosophers also had this flash of inspiration at the same time, their ideas were couched in the elegant terms of Vedic thought and Eastern spirituality. A fuller discussion of the Ancient Greek atomic theory can be found in The History of Physics.

However, this thought was steamrollered by the Father of Science, Aristotle, who actually set the history of chemistry back many centuries with his flawed elemental theory. Aristotle, and Plato before him, found the views of Democritus to border upon blasphemy. Democritus proposed that these atoms also governed thoughts and reasoning, as the first glimmering of

Leucippus (Public Domain)



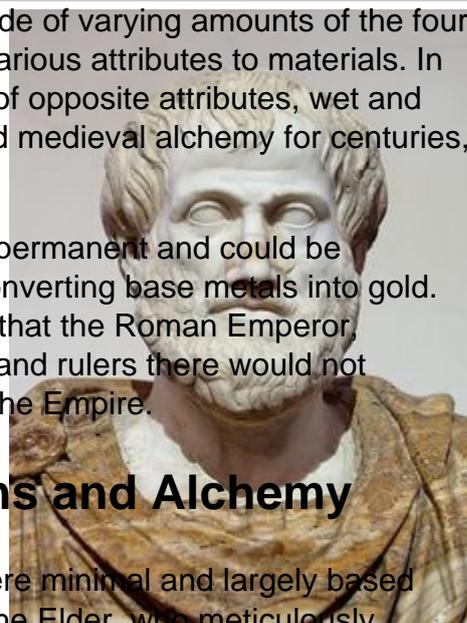
Egyptian Glass Jar (Released from Copyright)



materialist philosophy, and this was anathema to the two greatest philosophers, who believed in a divine will.

Instead, Aristotle firmly believed that all compounds were made of varying amounts of the four elements, earth, fire, air and water, and that they conferred various attributes to materials. In turn, each of these elements was made up of a combination of opposite attributes, wet and dry, and hot and cold. This theory was to pervade Islamic and medieval alchemy for centuries, overriding the correct postulations of the atomists.

In addition, Aristotle's implications that compounds were not permanent and could be changed fuelled the quest for the Philosopher's Stone and converting base metals into gold. This particular belief was so prevalent in the Classical World that the Roman Emperor, Diocletian, allegedly burnt papyri in Egypt so that the priests and rulers there would not uncover the secret and become wealthy enough to threaten the Empire.



The History of Chemistry - The Romans and Alchemy

Whilst the Roman contributions to the history of chemistry were minimal and largely based around construction materials, credit must be given to Pliny the Elder, who meticulously documented what was known at that time. In his work *Naturalis Historia*, he wrote extensively about the physical and natural worlds, including zoology, botany, metallurgy and minerals.

His work on metallurgy was extensive and was centered upon those metals important to the Roman economy and way of life. He discussed the properties of gold, namely its malleability and longevity, and also included a long section about the extraction of this precious metal. Pliny the Elder looked at other metals in the same way, including silver, iron, lead, tin, mercury and antimony, correctly pointing out that mercury was toxic and used extensively to extract gold. In addition, he understood the differences between steel and the softer wrought iron.

His work concerning mineralogy was equally important and, as with the metallurgy section, documented some of the main traits of many minerals. Much of Pliny's work was concerned with preventing fraud and he illustrated some ways of ensuring that gemstones were not fake, advocating that a mineral should be scratched with a harder mineral to verify authenticity. In a precursor to the Moh's scale of hardness, he also knew that diamond was the hardest mineral.

Many passages of Pliny the Elder's work was interwoven with his desire to criticize the rich, so he concentrated upon precious metals and minerals, using them to make sardonic observations about the wealthy. Despite this agenda, the *Naturalis Historia* is a wonderful work and certainly gathered together a large amount of the known knowledge at the time.

The History of Chemistry - India and the Vedas

The history of chemistry must also include the Indians, who certainly made many advances in the art of alchemy. Whilst much of their work involved creating medicines and uniting them with spiritual beliefs and eastern philosophy, they made some refined observations and innovations in other areas. Certainly, the Islamic Golden Age drew heavily upon the knowledge of the Indians and they were respected, even by Imperial Rome, as the leader in the production of chemicals and experts in metallurgy.

Indians possessed a fine history of smelting and refining metals, and evidence shows that they possessed the ability to work iron as early as 1800 BC, and bronze as early as 2300BC. This expertise continues and, by the 1st Millennium BC, Indian metallurgists had mastered the art of forging high quality steel, known as Wootz iron, which was more valuable than gold in many parts of Europe and the Middle East. This type of iron was studied by Europeans in the 17th Century, allowing them to refine their own iron and steel-making processes, showing how the influence of the Indians in the history of chemistry directly influenced the industrial revolution.

In addition to producing the finest steel in the period of Roman rule, the Indian alchemists were renowned as the manufacturers of the finest dyes, glass, cement, tanning solutions, and soap. By the Sixth Century, when Western and Northern Europe were deep within the Dark Ages, the Indians explored such processes as distillation, sublimation, calcinations, and the preparation of salts, compounds and alloys.

The iron pillar in the Qutb complex near Delhi, India. Around 375—413 CE (Public Domain)

The History of Chemistry - Beyond the Romans

Certainly, the foundations of the history of chemistry lay in Egypt, Greece, Rome and India, but most of the techniques were based upon trial and error or were tied closely to theological beliefs. The Islamic Age, which gathered knowledge from both East and West, would see the first systematic approach towards chemistry and would become the doorway by which Europe would enter the history of chemistry.

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