

ZOROASTER AND THE THEORY OF FOUR ELEMENTS

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Introduction

The concept of four elements: air, water, earth, and fire, thought to have its origin with the Greek philosopher Empedocles about 440 B.C., held sway for many centuries. Aristotle (384-322 B.C.) added to this concept that the properties of substances are the result of the simultaneous presence of certain fundamental properties. The Aristotelian doctrine was therefore concerned not with what modern chemists call elements but with an abstract conception of certain contrary properties or "qualities," especially coldness, hotness, dryness, and moistness, which may be united in four combinations: dryness and heat (fire), heat and moisture (air), moisture and cold (water), and cold and dryness (earth) (Fig. 1).

Aristotle and his followers believed that all substances are composed of these four elemental states of matter and this is usually cited in history of chemistry books (1,2). Indeed there is no history of chemistry book comparable in depth and breath to that of Partington (1), who devoted 370 pages to the early history, fully documented by thousands of references. He wrote about the Greek philosophers, about medicine, gnosticism, magic,

astrology, and many other topics. However, he devoted only two pages to the earlier Persian philosopher Zoroaster and his religion. Not surprisingly, perhaps, the idea of four "sacred" elements is absent.

A typical argument is presented as follows (3). According to Aristotle, the basis of the material world was a prime matter, which had only a potential existence until impressed by "form." By form he did not mean shape only, but all that conferred upon a body its specific properties. In its simplest manifestation, form gave rise to the "four elements," air, water, earth, and fire which are distinguished from one another by their "qualities." In each element, one quality predominates over the

other: in earth, dryness; in water, cold; in air, fluidity, and in fire, heat. None of the four elements is unchangeable. They may pass into one another through the medium of that quality which they possess in common. Thus fire can become air through the medium of heat; air can become water through the medium of fluidity, and so on. Another example often cited to show that matter is composed of these four elements is the following. If water in a container is sub-

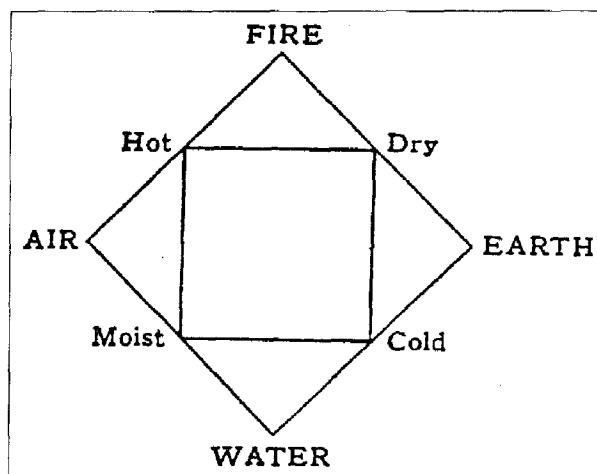


Figure 1. The four elements as represented in almost all chemistry and history of chemistry books.

jected to fire, it becomes air (vapor) and earth (the dissolved residue remaining).

This legacy of Greek science held sway during the Medieval Renaissance and Early Modern eras in western Europe; but beginning in the seventeenth century, a number of natural philosophers began to challenge the Aristotelian view of matter. Johann Baptista van Helmont (1580-1644) argued that all substances, except air, were ultimately derived from water. To demonstrate this he made his quantitative experiment with a small willow tree, an experiment that took five years, and he concluded that the tree had grown entirely from the water that he had supplied to it during this long period. His theory had one great patron, Isaac Newton (1642-1727) who accepted it and referred to it in the *Principia* (London, 1687). Helmont's most significant work was, however, his recognition of the material nature of what he called *gas*, a generic name that he used for those products of chemical reactions that had been previously regarded as merely spirituous and immaterial. He explained to chemists that the many familiar and destructive explosions that shattered their glass apparatus when they experimented on reactions in sealed or closed vessels were due to the release of "a wild spirit" or "gas." In a simple way he observed differences between gas from various sources but, as he did not isolate any gas, his distinctions were not precise; and he sometimes confused one gas with another. He had, however, advanced the chemistry of his time by demonstrating that these substances were material.

In 1661 Robert Boyle (1627-1691) published *The Sceptical Chymist*, a book in which he discussed the criteria by which one can decide whether a substance is or is not a chemical element. He concluded that the four Aristotelian elements and three principles commonly accepted in his time cannot be real chemical elements since they can neither compose nor be extracted from substances. The theory, however, was so influential that even Joseph Black (1728-1799) was still teaching his classes that water was transmutable into earth.

The works of Aristotle and the other Greek philosophers are numerous, and the books commenting on these works are extensive. Few of these commentary works, however, trace the influence of the oriental thought in general and the Persian in particular, on the philosophy of the Greeks. It also seems that the Theory of Four Elements is only a minor contribution by the Greeks as compared to their other philosophical concepts (4). Afnan (5, 6) for example, devotes only a few lines to fire. He mentions that Heraclitus considered

fire to be the primary physical substance, from which other substances sprung, and into which they merged (5):

All things are an exchange for Fire, and Fire for all things, even as waves for gold and gold for waves. The very existence of Fire depends on this strife and tension.

Further, he mentions that Heraclitus regarded justice as the balance or equilibrium that prevailed between contending forces. It characterized the "ever living Fire, with measures of its kindling, and measures going out." Justice, therefore, was maintained by identity in difference and unity in diversity, and in that respect was symbolised by Fire. Thus Fire became the crucible, or rather the principle of constant change, in which opposites meet and from which they emerge.

Origin

The origin of the Four Element theory, however, seems to be Persian and not Greek. It was the Persian prophet Zarathustra (600-583 B.C.) whose name was corrupted by Greek writers to Zoroaster about two centuries before Aristotle. This Zoroastrian concept of four elements has a different perspective which makes more sense than the Aristotelian. According to this prophet, air, water, earth, and fire are "sacred" elements (7-11). Humans and animals need air to breathe, water to drink, fire to cook food, and earth to grow plants for their survival. Earth, air, and water are to be kept free from defilement. To till the field and raise cattle are parts of one's religious requirements. Rain water when it falls in abundance to irrigate the fields is a blessing from God. When it is scarce, famine may result. In a country like Iran (Persia) where earthquakes are frequent, their damage not only causes panic and loss of lives but it can be interpreted as a warning message from an angry God.

Fire, on the other hand, had a more complex significance. It is the symbol of divinity. It is not worshipped as thought by many writers who describe a Zoroastrian temple (Fig. 2). It is fed daily by the attendant priests with pieces of sandalwood. The worshipers come individually at any time they wish. Inside the entrance each follower washes the uncovered parts of his body, recites a prayer, and then, removing his shoes, proceeds barefooted through the inner hall to the threshold of the fire chamber, where he gives the priest his offering of sandalwood and money and receives in return a handful of ashes from the sacred urn, which he rubs on his forehead and eyelids. Bowing toward the fire, he offers

prayers and then retreats slowly backward to his shoes and returns home. These four elements, therefore, have nothing to do with the chemical elements.

According to Vuibert (12), Magism was the religion of the various Scythic tribes which inhabited the mountain range of Armenia, Azerbaijan, Kurdistan, and Luristan. Its chief objects of worship were air, water, earth, and fire. It was to these elements, to the actual material things themselves, that adoration was paid. Fire, as the most subtle and ethereal principle, was held in the highest reverence. On fire altars, erected in temples on top of lofty mountains, the sacred flame was ever kept burning. To a large degree, Magism supplanted the original creed of Zoroastrianism. The Magi religion was characterized by a belief in a divinely authorized priesthood. Its priests seem to have held their office by hereditary succession. They claimed not only a sacred and mediatorial character, but also supernatural prophetic powers. They explained omens, expounded dreams, and predicted future events. Their dress was imposing, their ceremonial magnificent, and their influence over people and kings unbound. They were not only the keepers of sacred things, the learned of the people, the philosophers and servants of God, but also astrologers. No transaction of importance took place without or against their advice. An unspecified number of these wise men came to Bethlehem to worship the newborn Jesus when they saw his star in the east. They offered him gold, frankincense, and myrrh, the most treasured commodities at that time. The Magi were also mentioned by Herodotus. Incidentally, the word "magic" is derived from the Magi and is related to superstition. The region where the Magi lived was an ancient metallurgical center, famous for using fire to melt rocks to produce copper, bronze, iron, and gold.

Pliny the Elder (23-79 A.D.) wrote the following statement about fire (13):

We cannot but marvel at the fact that fire is necessary for almost every operation. It takes the sands of the earth and melts them, now into glass, now into silver, or minium or one or other lead, or some substance useful to the painter or physician. By fire minerals are disintegrated and copper produced: in fire is iron born and by fire is it subdued: by fire gold is purified: by fire stones are burned for the binding together of the walls of houses ... Fire is the immeasurable, uncontrollable element, concerning which it is hard to say whether it consumes more or produces more.

Zoastrianism

According to Zoroaster there is one god Ahura Mazda or the "Wise Spirit" and one evil (Ahriman). Fire had the "Wise Spirit." The result of this dualistic conception of the universe is a continuous warfare going on between the two hostile camps. All creatures, even veg-

etables, belong to one or another of these camps. All dangerous, noxious, poisonous animals and plants are evil by their very nature. This warfare will go on to the end of time when the Good triumphs and the Evil is annihilated. According to Zoroaster's teachings, a general resurrection will take place at the end of the present world. The good and evil will then be subjected to an ordeal of fire and molten metal. By this fiery test the evil will be made known by

their terrible burning, but the righteous will find the fire kindly and the molten metal harmless. The world's history is therefore nothing but the story of the contest between good and evil which shall endure for 12,000 years, divided into four equal periods of 3,000 years. The final aim of Zoroaster's system is to assure world perfection by the individual's adoption of the right path.

A curious practice, however, arose in the disposal of the dead. No bodies could be burned, buried, or thrown into the water, as thereby defilement to the air, soil, and water would result. They were consigned to

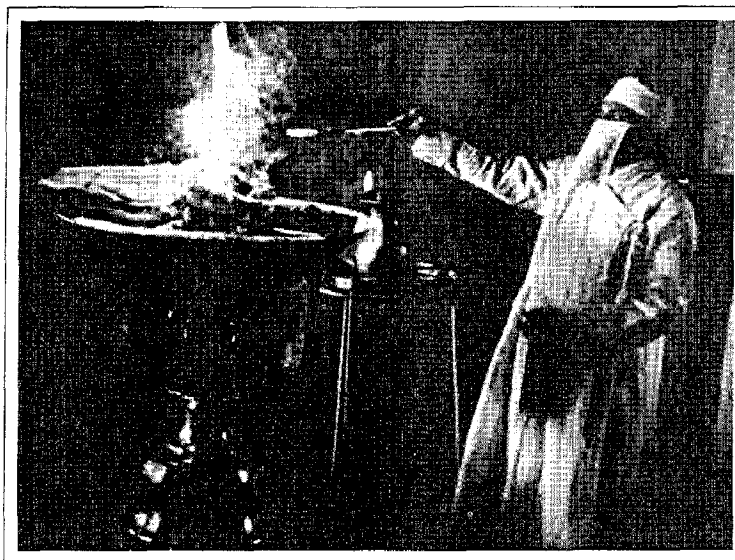


Figure 2. A Zoroastrian priest attending to fire in a temple (11)

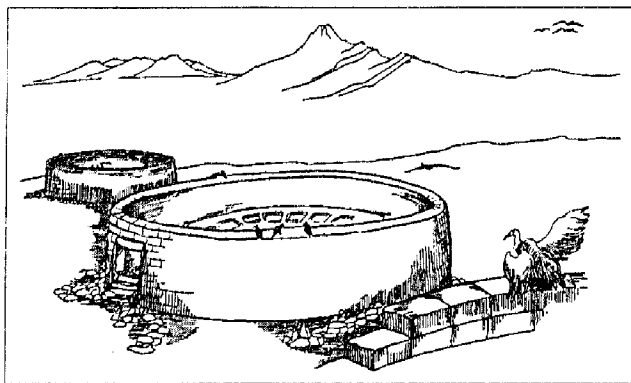


Figure 3. Tower of Silence

high places called a "Tower of Silence" or "Dakhma." These are shallow pits in which the corpses are laid in the central enclosure, where they are devoured by vultures (Fig. 3). This results in the stripping of the corruptible flesh from the bones of the dead without contamination of the soil.

Zoroaster was highly venerated in antiquity. Darius the Great (549-485 B.C.), who reigned from 521 to 485 B.C., and his successors were loyal followers of the prophet. The Greeks and Romans were much impressed by what they heard of him and his religion. This is evidenced by the numerous references to him in the extant literature and by the fact that Plato was reportedly prevented, shortly after the death of Socrates, from going to Persia to study Zoroastrianism first hand by the outbreak of the War of Sparta with Persia in 396 B.C. Zoroaster was also mentioned by the Egyptian alchemist Zosimos (250-300 A.D.). While Zoroastrianism was the national religion of Persia, it spread to Armenia, Cappodocia, and the entire Near East. Cambyses first, then Darius, and later Xerxes, turned to world conquest. They marched into Egypt and then toward Europe. Xerxes invaded Greece, and perhaps only the disaster of Salamis prevented Zoroaster's faith from becoming a major religion of the Western World.

In 538 B.C. the Persian King Cyrus captured Babylonia. The Jews exiled in that land by Nebuchadnezzar came directly under the suzerainty of the Zoroastrians until the Persian empire fell under Alexander the Great in 330 B.C. The loss of the sacred books is attributed by the followers of Zoroaster to the invasion in 330 B.C. of Alexander, who burned the palace library at Persepolis. With the Sassanides the national religion was restored, and the priesthood became strongly organized with unlimited power. The head of the hierarchy was next in power to the king. When the

Arabs conquered Persia in 636 A.D., they overthrew the religion of Zoroaster. Today only a few followers of the prophet are found in Iran, mainly in the ancient city of Yazed. Many followers escaped to Bombay, where they are known as the Parsees.

The first scholar to make the language and the contents of the sacred books of the Parsees known to Europe was a young Frenchman, Anquetil du Perron, who went to India in 1754 for this purpose. On his return in 1771 he was able to give to the world the first translation of the Avesta, the sacred book of the Zoroastrians. There are many striking resemblances between Zoroastrianism and Judaism and Christianity. Ahura Mazda, the Supreme Ruler with the attributes of omnipresence, eternity, and creative power which he employs through his "Holy Spirit" with the best of angels and archangels on his side, suggests the Old Testament Yahveh and his magnified manifestation in the Gospels. So Ahriman reminds one of Satan. There are also close parallel ideas as to the Messiah, the resurrection of the dead, and everlasting life. Zoroaster received his law on the "Mountain of the Two Holy Communing Ones," as did Moses on Sinai. There are six periods of creation in the Avesta like the six days in Genesis and a single human pair, Moshya and Moshyana, like Adam and Eve. The deluge of the Bible has its counterpart in the devastating winter. Shem, Ham, and Japhet are recalled by the three sons in the Avesta. Similarities in ritual details are many and have been studied at length. The larger number of



Figure 4. The concept of four elements as illustrated by the Flemish artist Crispij van de Passe (12)

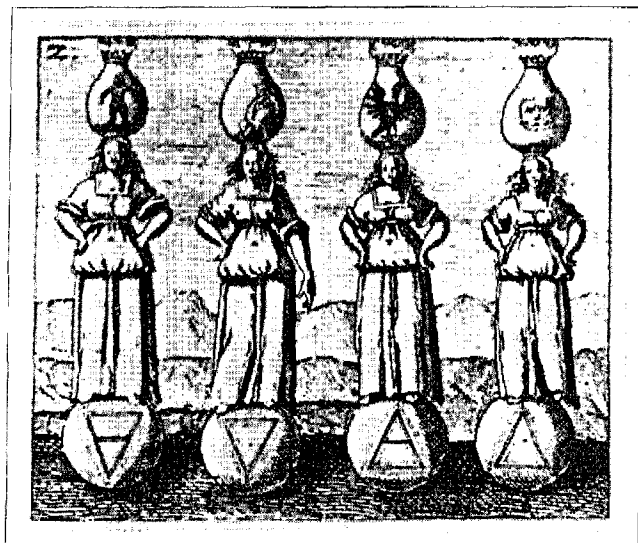


Figure 5. The four elements as illustrated in Mylius, *Philosophia Reformata*, Frankfurt 1622 (14)

critics trace these analogies to the influence exerted on Judaism by Zoroastrianism during the period of exile, if not earlier. On the other hand, the contrary view is also advocated. Perhaps also fire in the form of a burning candle and water blessed by the Christian priest are two rituals in the church that may be traced back to the time of Zoroaster.

The Four Elements in Art and Alchemy

The concept of four elements survived for at least two thousand years. Seventeenth-century engravings attest to the influence of this theory. For example, the Flemish artist Crispijn van de Passe (1564-1637) depicts allegorical figures in decorative scenes symbolizing the four elements (Fig. 4). Fire (ignis) holds brands and a burning coal. Water (agua) wields a flowing pitcher while behind her a fisherman plies his trade; Earth (terra) carries a cornucopia of the Earth's fruits while a hunter pursues its beasts. Air (aer) strides across the clouds, birds flying around him, the four winds blowing. Figure 5 shows the four elements as illustrated in a 1622 engraving (14). Each element was given a symbol based on a triangle; the alchemists used these symbols until the reform of Lavoisier and Berzelius. Figures 6 and 7 are representations of the elements from Michelspecher's book dated 1654, while Figure 8 shows Roger Bacon pointing to a pair of scales in perfect equilibrium on which are being weighed water and fire, from a book published in 1617 (15). This may be an indirect reference to the Zoroastrian faith; the balance between the good and the evil.

Epilogue

The alchemists believed that water, on being heated, was converted at least in part into earth. This was the result of the observation that on boiling water some residue was always formed (from impurities in solution). This problem faced Lavoisier when he was asked to improve the supply of drinking water to Paris. At that time no chemical method for ascertaining the purity of water was available, and the only way was to determine the density of water by hydrometer. After studying all that had been published on the conversion of water into the earth Lavoisier concluded that it was not satisfactory and decided that further experiment was necessary. From October 24, 1768 to February 1, 1769 he heated a known mass of water, as pure as could be obtained by repeated distillation, in a weighed sealed glass vessel, the alchemist's pelican, in which a liquid could be continuously distilled in itself. At the end of this 100-day experiment, the total weight of the unopened vessel and its contents was the same as it was at the beginning. He

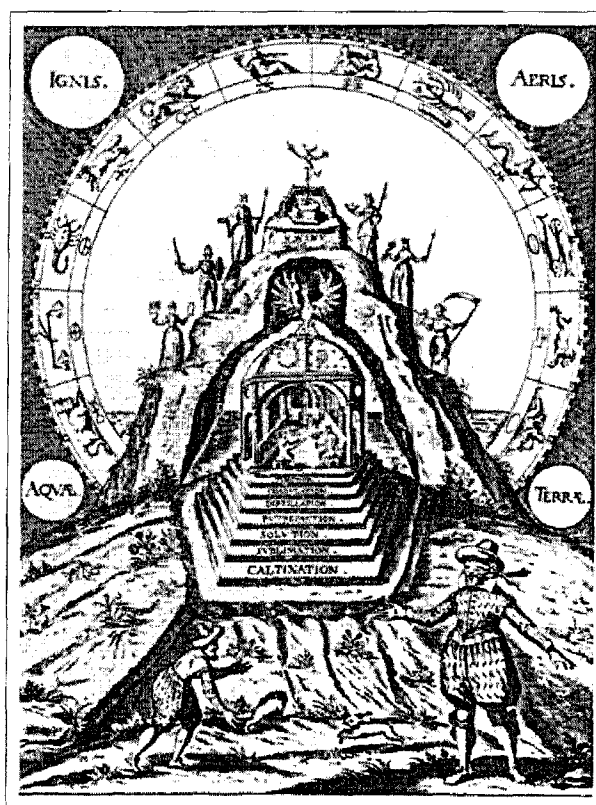


Figure 6. Engraving dated 1654 from Cabala, *Speculum artis et matura in alchymica* by S. Michelspecher showing the seven steps leading to the Philosopher's Stone, some alchemical symbols, and the four elements ignis, aeris, aqua, and terra (15)

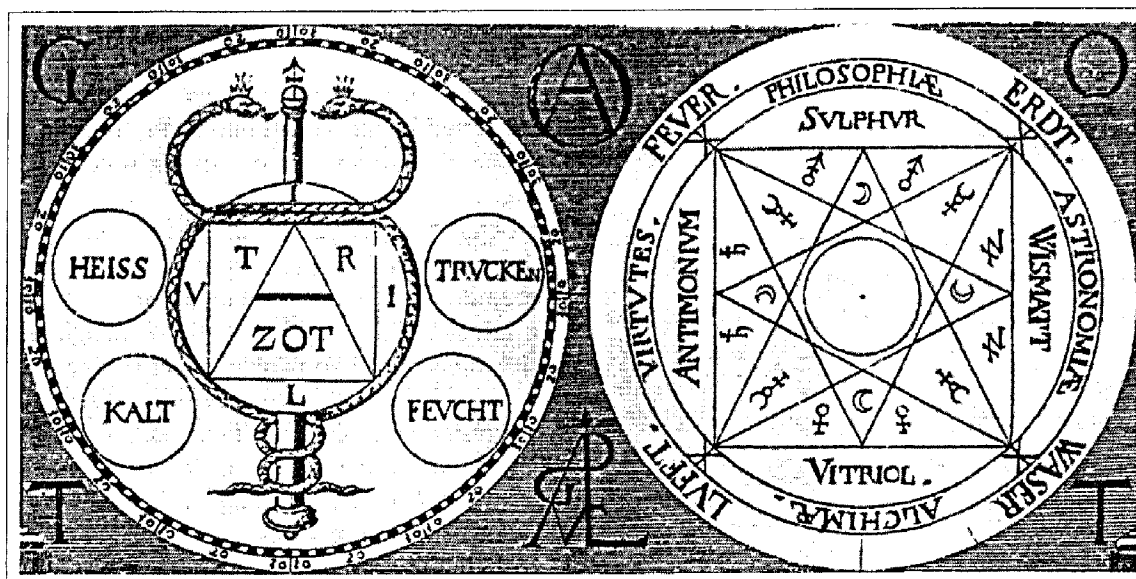


Figure 7. Another engraving from the same book in Figure 6 showing the four elements Feuer, Luft, Wasser, and Erdt (in Old German) and the four properties = hot (heiss), dry (trucken), cold (kalt), and wet (feucht) (15)

then weighed the pelican after opening it and pouring the contents into another vessel. Some earth had been formed. However, he found that the weight of the pelican had decreased by an amount nearly equal to the weight of the earth obtained. He therefore concluded that the earth had been produced by the erosive action of the water on the glass, not by the conversion of water into earth. This refuted the theory held for centuries and was accepted by many of his contemporaries.

The studies by van Helmont, John Mayow (c. 1641-1679), and Robert Hooke (1635-1703) suggested the existence of different kinds of air. Boyle's studies that resulted in his famous law also undoubtedly convinced skeptics regarding the uniformity of air, since gases in general followed the inverse pressure volume relationship. The difficulty of collecting gases in a reasonably pure state discouraged studies of air. It was the English biologist Stephen Hales (1677-1761) who observed that plants absorb air through their leaves. He invented the pneumatic trough, a simple

device for collecting gases over water, that allowed him to collect gases formed from different processes such as fermentation, calcination of limestone, heating of wood, etc. He was, however, interested in the quantity of air fixed in solid substances, not in possible differences in the air itself.

Fire remained a mystery for about two thousand years. The theory of phlogiston was introduced in the seventeenth century to explain its formation: a substance burns because it contains the combustible principle "phlogiston" which is liberated in the form of a flame. The theory was abandoned, however, a hundred years later when oxygen was discovered and the phenomenon of combustion was explained by Lavoisier in 1777 as an oxidation process, and with this began modern chemistry. However, an "earth" was still considered as an element that cannot be decomposed to simple components until Humphry Davy (1778-1829) in 1807 announced the discovery of the alkalis by electricity although



Figure 8. Roger Bacon (1214-1294) pointing to a pair of scales in perfect equilibrium on which are being weighed water and fire. From *Symbole auneae mensae* by M. Maier, 1617 (15)

he failed to decompose alumina, the earth obtained from clay. Charles Martin Hall (1863-1914) and Paul Héroult (1863-1914) finally decomposed this earth in 1886 by passing an electric current in a molten solution of alumina in cryolite.

The concept of four elements (air, water, earth, and fire) consistently mentioned in history of chemistry books as due to Greek philosophers, is shown to have a much older origin and a different meaning. About two centuries before Aristotle, the Persian philosopher Zoroaster described these four elements as "sacred," i.e., essential for the survival of all living beings and therefore should be venerated and kept free from any contamination. As useful as the concept of the four elements was to the Ancients, these material entities have nothing to do with the modern concept of "chemical elements". While lost in the mists of time, this theoretical construct remained central to our understanding of the material world and chemical change to the seventeenth century. It is recommended that authors of chemistry textbooks or history of chemistry books, when mentioning the Theory of Four Elements, should stress its Persian origin and should mention it as the "Theory of the Four Sacred Elements," as it has nothing to do with *chemical* elements. This will eliminate confusion to the reader and also provide a philosophical concept that is related to our modern views regarding the environment.

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