Alchemists Are Us

New Exhibit Shows the Influence of Alchemy on Modern Chemistry

by Neil Gussman and Michal Meyer

Try as we might to distance ourselves from alchemy and its centuries-old bad reputation, the truth is that these early empiricists laid the foundations of modern chemistry. Many experimental methods and lab practices started life with the alchemists and live on, with refinements, to this day. Distillation, purifying metals, isolating elements and compounds, and medical analysis were first practiced by alchemists, and then carried into the modern world as experimentalists began to call themselves chemists.

The Alchemical Quest, on display at Chemical Heritage Foundation in Philadelphia until 7 December, highlights the practical goals of alchemy. The exhibit features rare alchemical books of the 16th, 17th, and 18th centuries drawn from CHF's collections. The exhibit also highlights two fathers of modern science, Robert Boyle and Isaac Newton. Their avid involvement in alchemy during their long and productive lives provided a bridge to modern chemistry.

In *Chemistry World* magazine (UK), December 2004, Vikki Allen writes, "The term alchemy originally referred to an ancient art of spiritual purification and transformation; a way for people to connect with the divine spirits. Although the origins of alchemy vary across the world, in the middle-ages the term became associated with man's desire to harness nature. Alchemists would strive to turn lead into gold and to produce the elusive 'elixir of youth.'

"The alchemist's profession was a mystery and the public viewed it with a mixture of fear and wonder. The alchemical symbols used at the time were unrecognizable to outsiders and the Church discredited the work. But the force of human nature meant the public still wanted what the alchemists were working towards; endless riches and eternal life." The public image of chemistry in the 21st century is hardly better than this image of alchemy. The public wants the clean water, abundant energy, and advanced materials chemistry can and does deliver, but is generally afraid of the word Chemical.

Obviously, some of the bad reputation of alchemy is deserved, but Allen reflects an outdated understanding of what alchemy was about. The best alchemists were not mystical dreamers, but skilled bench chemists. Painters would go to them for pigments, the ill for medicines, and mine owners for better acids to dissolve ores. The chemistry of today finds its origins in the alchemical labs of the Middle Ages and Early Modern periods.

Alchemy is a natural starting point for anyone interested in the history of science. Alchemy's goals were both practical (better medicine) and esoteric (creating the philosopher's stone that would transmute lesser metals into gold). Chemists have kept many of the practical goals, but abandoned the quest for the philosopher's stone in the 18th century.

Alchemy can be a dirty business—just ask Isaac Newton. He began one of his alchemical recipes with "Take of Urin one Barrel." He then instructs the owner of the newly acquired barrel to let the urine ferment for three months in the summer. Imagine being Isaac Newton's neighbor: The glory! The smell!

This story gets a laugh from people who've never encountered the history of science. Laughter is a good place to begin the story of chemistry; humor engages in a way that information and argument do not and provides a starting point for deeper exploration. Such as: Why did Newton want a barrel of urine? His recipe

was for making phosphorous, which had recently been discovered by a 17th-century ex-soldier and alchemist named Hennig Brandt, who had been trying to make the philosopher's stone. The glowing substance distilled from urine (white phosphorous) must at first have filled Brandt with hopes of success. Such stories take us into older understandings of matter, a time before elements as we know them.

Newton's alchemical work was rediscovered in the 19th century and the discoverers were horrified to find their scientific hero had feet of clay. By that time, alchemy was considered a historical dead end, a wrong turn along the highway of progress. At best, it could be considered a distraction from real science; at worst, it was pure charlatanry, certainly not worthy of practice by a scientific hero. Since then, historians have rediscovered the common heritage of alchemy and chemistry, which were inseparable in the 17th century. A new term, "chymistry," is now used to describe the chemical practices of that time.

If you're looking for a moral to this story, here's one: Progress is not a straight line from some moment in the past to now. Otherwise, enjoy the story. As to where Newton or his recipe followers got their barrel of urine, we have no idea. One colleague suggested that Newton would have parked his barrel outside a pub and waited. Modern chemists can breathe a sigh of relief: They can simply order their supplies.

The history of alchemy is the history of chemistry. The beautiful woodcuts and engravings found in the exhibit's books show visitors this strange, intriguing, and beautiful chapter in the history of chemistry. An accompanying digital book display interprets many of these evocative yet difficult to understand images. Dragons, roosters, flocks of birds, kings, queens, and hermaphrodites are translated into modern chemical processes. Alchemists didn't want to let just anybody into their secrets, so they hid them in plain sight, in complex word and picture allegories understandable only to other alchemists.

When alchemy faded into chemistry, the meaning behind these images was lost. But modern-day historical sleuths have begun working out the chemistry behind these images. For example, an old alchemical book in our collection includes 12 images and accompanying text that are the steps or "keys" to making the philosopher's stone. The first three keys have been decoded by Lawrence Principe, a trained chemist and a historian of science at Johns Hopkins University. For example, the third key shows a dragon in the foreground and a rooster being eaten by a fox which is being eaten by another rooster.

It's a lovely image, but where's the chemistry? In this case, the dragon refers to a red crystal known as dragon's blood. Once you realize that sun indicates gold in the alchemical understanding, it doesn't take long to go from rooster to sunrise (crowing rooster) to sun to gold. The fox represents certain acids dissolving the gold and the rooster eating the fox shows a circular process. So gold is being dissolved and redissolved by certain acids (what we know as nitric and hydrochloric). Chlorine (only discovered as a gas in the 18th century) builds up and the gold volatilizes into gold chloride, which is a lovely ruby red color.

The chemistry that goes on in this gold chloride reaction was only worked out in the 19th century. Not bad for the shabby misunderstood alchemists of old. Perhaps one day historian chemists will unlock the rest of the keys. Only one thing is certain, there'll be no philosopher's stone at the end of it all. Though a little bit of recognition for the triumphs of alchemy would be appreciated.

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