The Characterization of Chemistry

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This short paper is a very brief overview of the process and mechanism by which the Western science of chemistry was incorporated into the Chinese scholarly tradition, through translation. It is based on the excellent book Translating Science by David Brill,[1] with examples taken from a trilingual (Chinese, English, Japanese) glossary.[2] I hope to show how the ingenuity of gifted translators made it possible to meld aspects of Chinese alchemy with certain of the more central philosophical concepts to create a rich vocabulary that facilitated the introduction of Western chemistry into China, while maintaining respect for Chinese philosophy at the same time.

China has a philosophical tradition that extends back for millennia, including the natural philosophy (博物学) that can be compared to Western science. For most of that period, scientific and technical transfer operated mainly in one direction, outward from China. Although foreigners eagerly received knowledge and innovation from China, the scholars of the Middle Kingdom had little use for what they considered the quaint pastimes and parlor tricks of barbarians. Part of the Chinese distaste for Western science came from the fact that many of those foreigners who came to share Western knowledge were missionaries, who also sought the opportunity to substitute Western religion for Chinese philosophy. This isolationist attitude began to change, especially during the European Colonial period of the 19th century, when it became obvious that these foreigners had managed to parlay their quaint pastimes and parlor tricks into economic and military power that could have a significant impact on the stability and perhaps the survival of China. Slowly, Chinese scholars recognized the value of, at a minimum, becoming acquainted with foreign science.

Alchemy (炼金术), such as the metallurgical and mineralogical lore collected in the 天工开物 (宋应星, 1637), had a long established tradition in China, but was not very highly esteemed. The members of the first Jesuit mission to China, led by Mateo Ricci in the late 16th century, were mistaken by the Chinese as alchemists. Welcomed at first, they were viewed later with suspicion when they were unable (or unwilling!) to use their gifts to convert base metals into silver for their hosts.

According to one interpretation, alchemy had developed one thousand years earlier in China, traveled by the Silk Road to the Arabs in Asia Minor, and had then been absorbed into Medieval Europe. It is ironic that, after percolating for several centuries on the European continent, and emerging there as "modern" science while the stultifying influence of the Church was on the wane, this strangely appearing philosophical great-grandchild had come again to knock on the door of its Chinese 曾祖父, hoping to be embraced at a happy homecoming. The reunion was a difficult one.

Once the Imperial philosophers had decided to give Western science a more serious examination, there was the question of how to do so. The scholars were unwilling to travel abroad, and were loathe to acquire a barbaric tongue, so these works must be translated into Chinese. It didn't help that the ablest translators were missionaries, who had the continuing agenda of proselytizing to the Eastern peoples. There were a few exceptions, such as John Fryer (傅兰雅) who came to China from England in the mid-19th century as a schoolteacher hoping to become a missionary. Fate preempted both of these ambitions, and Fryer became instead a translator of scientific books for the Imperial government. The fact that he had distanced himself from religion helped him all the more gain credibility with his new patrons. As more of these "secular missionaries" took up the task, Western science began to gain exposure to the Eastern scholars.

Translation between the languages of related cultures can draw upon a common cultural pool of shared concepts, such as is the case for translating between European languages.

In the case of chemistry, the Chinese cultural pool did contain concepts for some types of chemical process and apparatus developed during the alchemical period. Examples include crystallization and crystallizing dish (结晶, 结晶皿), distillation and still (蒸馏, 蒸馏釜) and filtration and filter (过滤, 滤器). However, the basic concepts of European chemistry, atoms and molecules that make up matter, were completely alien. Chinese natural philosophy is based on a dualistic balance of matter-energy (阳气 / 阴气), and the five elements (五行) of water, fire, wood, metal and earth (水，火，木、金、土). There had been an earlier parallel development of four elements (earth, air, fire and water) in European alchemical thought, but the transmission of Western chemical science took place at a time when the concepts of atoms and atomic elements, and molecules made by bonding these atoms together, had gained ascendancy. The 五行 are not "elements" in the sense that oxygen and hydrogen are elements, so new words were crafted to represent these novel concepts.

Some of these elements were already known in some form to the Chinese, such as iron (铁), gold (金) and carbon (炭). In some cases, an initial traditional form was later modified, such as 炭 ⇒ 碳 for carbon, and 硫黄 ⇒ 硫 for sulfur. For the elements with no traditional antecedent, the Chinese words for these chemical elements evolved over the next century, under the influence of successive translation schools of thought. Early versions often approximated the English syllables with existing characters (homophonic). These proved unwieldy and confusing, and underwent simplification, with a single picto-phonetic character being adopted in the end, where either a new character was created or an existing one was borrowed. A representative case is the element "silicon", which is recorded in different sources[1] as 夕里西恩 (xìlǐxīēn, 1868) ⇒ 玻精 (bōjīng, 1868, since glass was made from silica) ⇒ 玻 (bō, 1870) ⇒ 矽 (xī, 1871) ⇒ 砂精 (shājīng, 1873, possibly because silicon comes from sand, 砂) ⇒ 矽 (xī, 1900) ⇒ 砂 (shā, 1904) ⇒ 矽 (xī, 1908) ⇒ 硅 (guī, modern).

In this adoption of characters to represent the elements, the radical in the corresponding characters for different types of elements harks back to the earlier concepts of 阳气 / 阴气 and 五行. The metallic elements such as 铁 (iron) and (锂, lǐ) lithium have the metal radical (金部首), the solid, nonmetal elements such as carbon (碳) and silicon (硅) have the stone radical (石部首), the liquid element bromine (溴, xiù) has the water radical (水部首), and the gaseous elements, such as hydrogen (氢, qīng) and nitrogen (氮, dàn) have the air radical (气部首).

Finally, with the plethora of hydrocarbon molecules based on chains of carbon atoms in the area of organic chemistry, the early translators found a way to imbue the terminology with a uniquely Chinese flavor. The basic set of hydrocarbon molecules contain from one to ten carbons. The English names are based on nonsystematic historical connections for the first four (from one carbon to four carbons), and on the Greek numbers for five through ten carbon atoms. Chinese utilizes the ten heavenly stems (甲乙丙丁戊己庚辛壬癸), with a second character 烷 (wán) to name these simple hydrocarbons or alkanes. Thus, for example, the one-carbon alkane "methane" is 甲烷 (jiǎwán), the four-carbon alkane "butane" is 丁烷 (dīngwán), and the nine-carbon alkane "nonane" is 壬烷 (rénwán). These alkanes are all highly flammable and can be used as fuels, so it makes sense that their name suffix 烷 bears the fire radical 火部首, which also has the added effect of linking them to the fire element in the underlying Chinese philosophical system.

This systematic use of integrated, native Chinese elements cannot cover the entirety of scientific and chemical terminology. The Chinese renderings of some Western concepts, such as aromaticity (芳香性, fāngxiāngxìng) and spectrometer (分光计, fēnguāngjì), are built piecemeal from native components, translating the morphemes directly while lacking an inherently Chinese flavor. This is analogous to the way that English borrows from Greek and Latin sources in the creation of scientific terminology. In other cases, simple homophony is still used to approximate the technical term, for example where proper names are used as in Grignard reagent (格利雅试剂, gélìyǎ shìjì), and in the Chinese names for complicated molecules such as benzothiophene (苯并噻吩, běnbìngsāifēn). The appropriate syllables can be selected from a set of characters with the mouth radical (口部首) that are reserved to indicate that they are used for their spoken sound.

In summary, the Chinese vocabulary of chemistry reflects a number of integrated, native components, introduced by translators who respected the cultural traditions of the Middle Kingdom. I propose that the recognition of these native components by Chinese scholars eased the acceptance of an otherwise completely alien philosophical system, and made it less unacceptable.

While cultural inertia and socioeconomic upheaval in the country slowed the full exploitation of Western science to improve China's economic and technological well being, this implementation began to progress quite rapidly in the latter decades of the 20th century, and the nation is poised to rejoin (and possibly lead) the group of the most advanced societies in the 21st century.

Resources:

1) Translating Science, *The Transmission of Western Chemistry into Late Imperial China*, *1840-1900*. David Wright, Brill: Leiden (2000).

2) Chinese - English - Japanese Glossary of Chemical Terms. Saburo Tamura and Fumiko Shiratori, Joint Publishing Co.: Hong Kong (1977).