Alchemy in the colours of the Renaissance

An article written for the UCL chemistry department, 2002

If you were a painter during the Renaissance, you were probably something of an alchemist too. That's not to say that you spent your time trying to make gold; but you would have been familiar with the chemical manipulation of matter. You had to be—for there were no art shops, no Winsor and Newton, in those days: you had to make your own paints.

To some of those artists, alchemy was just a chemical technology: a convenient manufacturing process for making colours and other useful substances, such as turpentine and varnishes. Cennino Cennini, a Florentine craftsman, writing around 1390, explains that the brilliant red pigment called vermilion 'is made by alchemy, prepared in a retort'—but he doesn't bother to tell his readers how to do this, for 'it would be too tedious'. Instead, he says, you can buy it from the apothecaries; but don't take it ready-ground, because the swindlers will mix it with brick dust.

To other painters, alchemy was more profound, and they used its symbolism in their art. Jan van Eyck's *Arnolfini Marriage* (1434) may represent the alchemical union of fire and water, and elements of alchemy and other occult arts occur in works by Dürer, Cranach, Grünewald, Giorgione, Campagnola and Parmigianino, to name just a few of the artists of the Northern and Italian Renaissance.

There was no getting away from alchemy for artists of that time, for both painting and alchemy are intimately bound up with colour. To alchemists, colour changes signified the successful progress of the Great Work: the synthesis of the Philosopher's Stone. For artists since the Middle Ages, colours were not chosen simply for their beauty but for their symbolic associations. In both cases, colour chemistry was both an essential practical skill and a process laden with mystical connotations.

In Shakespeare's time a knowledge of alchemy was deemed desirable to any educated person: both he and John Donne were thoroughly versed in it, and so was Ben Jonson, however much he lampooned it in *The Alchemist*. Men of a practical persuasion often shared Jonson's scepticism: both Leonardo da Vinci and Georgius Agricola, the author of the great metallurgical treatise *De re metallica* (1556), said that if you wanted gold you would have to dig in the earth for it, not try to make it from lead. Vannoccio Biringuccio, a Siennese metal smith, asked why, if alchemists could manufacture gold, they were always so poor. But even he had to admit that alchemy was a splendid way to make colours.

It was not surprising that alchemists tended to focus their efforts on brightly coloured substances. They believed that to make the Philosopher's Stone one had to transform the starting materials through a particular sequence of colour changes: black, white, yellow, and finally purple or red. The recipes therefore gravitated towards compounds of lead, arsenic and antimony, which can exhibit these colours.

Since antiquity, painters had known how to turn lead white (by making lead carbonate) and red (lead tetroxide). The monoxide of lead is yellow, and was used as a pigment in the Middle Ages under the name massicot. Arsenic sulphide, meanwhile, can be made in both yellow and orange-red varieties: these were the pigments orpiment and realgar, both deadly poisons.

Cennino explains that all of these can be made by alchemy. Vermilion, however, was one of the most entrancing compounds both for the artist and for the alchemist. It is mercury sulphide, and was made by heating the two raw elements together. A mineral form of the compound, cinnabar, was once considered the most potent of all substances in Chinese alchemy.

The Arabic alchemists in the ninth and tenth centuries proposed that all metals are made of two basic 'principles': Sulphur and Mercury. These 'principles' are not exactly the same as the tangible elements, but are a kind of 'ideal' version, just as Aristotle's elements were not the same as real earth, air, fire and water. All the same, the marriage of mundane sulphur and mercury held a special significance for alchemists.

The synthesis of vermilion was surely an alchemical discovery. In the twelfth century, the monk Theophilus wrote down a recipe in his craftsman's manual that was free of any alchemical jargon and mysticism. But all the same, his process is clearly taken from an alchemical source, because he prescribes far too much sulphur: these 'wrong' quantities make sense in Arabic alchemical theory, even though a practical man like Theophilus must have spotted the error.

The synthesis of vermilion was vital to medieval art, according to art historian Daniel Thompson. He says 'no other scientific invention has had so great and lasting an effect upon painting practice as the invention of this colour.' In Grünewald's *Resurrection* (c.1515), the alchemical significance of vermilion may have been put to use in the picture itself. The union of alchemical Sulphur and Mercury in the perfect proportions produces the Philosopher's Stone, often known as the Red King (for it was reputed to be red). Grünewald shows Christ as a Red King robed in vermilion, surrounded by an extraordinary halo of orange and green light—spiritual perfection encoded in the very material of the painting.

Alchemical ideas pervade the recipes for medieval pigments. One prescription for vermilion specifies an apparently useless ingredient: sal ammoniac. This addition of a salt, however, satisfies the notion, popularized by the sixteenth-century alchemist Paracelsus, that all substances contain three 'principles': Sulphur, Mercury and Salt. Cennino's recipe for a yellow pigment known as mosaic gold also contains these three elements, though they are not all necessary (the pigment is tin sulphide). The same is true for the yellow pigment now known as Naples yellow (lead antimonate), which was often awarded some superfluous salt. Even when they have no interest in gold-making, craftsmen like Cennino and Theophilus retain (probably unwittingly) such traces of alchemical theory in their workshop manuals.

Without the alchemical search for the Philosopher's Stone, artists in the Middle Ages and the Renaissance might never have acquired some of their most valued pigments. Justus von Liebig realized that it was the very futility of the quest that made it such a stimulus to chemical research: 'In order to know that the Philosopher's Stone did not really exist, it was indispensable that every substance accessible… should be observed and examined.' But we should not see early colour chemistry as a mere technological spin-off of alchemy's higher pursuit; rather, the benchtop experimentation and the intellectual and spiritual concepts were intimately entangled in the eyes of artists, 'scientists', craftspeople and philosophers alike.

Further reading:

P. Ball, *Bright Earth: The Invention of Colour* (Penguin, 2001).

S. Bucklow, 'Paradigms and pigment recipes: vermilion, synthetic yellows and the nature of the egg', *Zeitschrift für Kunsttechnologie* **13(1)**, 140 (1999).

Cennino Cennini (c.1390), *Il libro dell'arte* (*The Craftsman's Handbook*), transl. D. V. Thompson (Dover, New York, 1960).

J. Read, 'Alchemy and art', *Transactions of the Royal Institution* **30**, 286 (1952).

D. V. Thompson, *The Materials and Techniques of Medieval Painting* (Dover, New York, 1956).