Cobalt, the technology-enabling material

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Cobalt has been used to colour pottery and glass for at least 2600 years, as evidenced by cobalt-based glazes that have been found in Ancient Egyptian tombs. Chinese pottery from the Tang (600–900 AD) and Ming dynasties (1350–1650 AD) also contained blue colours made from minerals containing cobalt.

The metal itself seems to have only been isolated in 1735 by Georg Brandt, a Swedish scientist, and its metallic uses stem from Elwood Haynes's studies and patents in the early 1900s. Cobalt-chrome (Co-Cr) alloys, and superalloys in general – which caused the great leap in cobalt use – are, of course, still in use, as are the Alnico series of magnets invented in the 1930s. At around that time, Karl Schröter developed cobalt-tungsten (Co-W) 'hard metals', which now play a vital role in industrial activities like cutting, drilling and grinding.

Primary applications today

Cobalt has increasingly been used in specialist applications where it is difficult to substitute it with alternative materials. In some applications, such as in medical diagnostics, pharmaceuticals and fermentation processes (e.g. biomass), cobalt is essential. Demand for cobalt has now moved away from traditional metal applications (superalloys, medical prosthetic alloys, hard metals, diamond tools and magnets) and towards chemical applications, mainly as a result of the large increase in demand for rechargeable batteries.

Another important application for cobalt is in catalytic reactions, where it provides essential characteristics for some vital applications, such as producing clean fuel (removal of sulphur oxide and nitrogen oxide), and the manufacture of purified terephthalic acid (PTA) for textiles, unsaturated polyester resin (UPR) for plastic moulding, and Fischer-Tropsch processes for gas to liquid technology (GTL). As a catalyst, it

plays an important role in coatings as a paint and varnish dryer, as well as an essential safety function in tyres, helping the rubber to bind strongly to the steel bracing. Cobalt is also an oligo element, essential for health and vitality in humans and in animals, as it is the central component of the coenzyme vitamin B12.

In small quantities, cobalt is used to support a multitude of other industrial sectors: electronics, for enhanced digital storage and digital processing; surface treatment, for improved article finishing; animal feed, as cobalt deficiency causes significant health issues in animals; and the production of synthetic diamonds. The list of uses for cobalt is indeed extensive. Such is the importance of cobalt to industrial and technological development, that in 2011 it was recognised as 'critical' under EU law and 'strategically important', according to the United States Geological Survey (USGS).

Production

Cobalt is considered a minor metal and almost exclusively arises as a by-product of copper and nickel mining. The only primary source of cobalt is the Bou Azzer Mine in Morocco. The Cobalt Institute (CI) calculates cobalt arisings as follows:

- nickel industry: ~36 per cent
- copper industry and other: ~58 per cent
- primary cobalt operations: ~6 per cent.

Cobalt reserves are largely found in Central Africa, and are dispersed as shown here (USGS 2016):

- Africa: ~54 per cent
- Americas: ~12 per cent
- Australasia: ~18 per cent
- Russia: ~5 per cent
- rest of the world: ~11 per cent.

Global refined production, as measured by the CI, was about 94,000 tonnes in 2016, with China accounting for almost 50 per cent of this total; however, the largest mine production was emanating from the Democratic Republic of Congo (DRC) (www.cobaltinstitute.org).

As mentioned earlier, cobalt has a broad spectrum of uses, which are summarised below (CI 2016):

- rechargeable batteries: 44 per cent
- superalloys: 17 per cent
- hard metal: 9 per cent
- catalysts: 8 per cent
- magnets: 5 per cent
- pigments: 5 per cent
- organics: 3 per cent
- high-speed steel: 3 per cent
- hard-facing alloys: 3 per cent
- other: 3 per cent.

Responsible sourcing

Most cobalt is produced as a by-product of copper and nickel mining from large-scale operations, which are committed to responsible and sustainable practices. The CI members sign up to a code of conduct that exemplifies the very best standards in protecting human health and the environment, and in upholding human rights. These are usually already incorporated into the individual company's code of conduct and as such, the CI sets the standard for the entire industry to follow. Downstream companies purchasing cobalt products from a CI member company have the assurance that these products are produced according to the highest ethical standards. Company policies and codes of conduct stress a zero-tolerance policy for child, forced or compulsory labour.

The CI is developing a Cobalt Industry Risk Assessment Framework (CIRAF), which will integrate with various downstream raw materials initiatives so that these end-users can have confidence that cobalt emanating from these sources is responsibly sourced.

Cobalt provides the ability to improve the desired characteristics of an alloy or article, and help to improve industrial processes, making them more efficient and effective. We consider cobalt to be the technology-enabling, bio-essential metal of the moment.

For further information on this special metal, visit the Cobalt Institute's website: www.cobaltinstitute.org.

Small quantities of cobalt are used in animal feed