Editor
Sue Matthews

Editorial Board
Himla Soodyall (EO: ASSAf) (Chair)
Lesley Swartz (SAJS)
Martin Bucher (UKZN)
Don Cowan (UP)
Amanda Esterhuysen (Wits)
Marina Joubert (SU)
Robin (Ted) Kroon (UFS)
Walter Matli (UFS)
Caradee Wright (MRC)

Editorial enquiries
The Editor | e-mail: Quest-Editor@assaf.org.za

Advertising enquiries
Barbara Spence | Avenue Advertising
PO Box 71308, Bryanston 2021
Tel: (011) 463 7940 | Cell: 082 881 3454
e-mail: barbara@avenue.co.za

Subscription enquiries and back ssues
Tsepo Majake | Tel: (012) 349 6645
e-mail: tsepo@assaf.org.za

Published by the
Academy of Science of South Africa (ASSAf)
PO Box 72135, Lynnwood Ridge 0040

Subscription rates
(4 issues and postage)
(for other countries, see subscription form)
Individuals/Institutions - R145.00
Students/schoolgoers - R72.00

Design and layout
Garnett Design Studio

Printing
Seriti Printing Digital

Website and social media
https://questonline.org.za
Twitter:@questSA1
Facebook: Quest: Science for South Africa

Cover image
Shutterstock

Magnetism: the forces around us

Magnetism is part of our everyday lives, but the variety of ways in which it is used is commonly overlooked. While fridge magnets holding mementos and reminders in place are obvious examples, less apparent are the magnets or electromagnets in earphones, loudspeakers, doorbells, security systems and induction cookers. Our household appliances contain electric motors that rely on electromagnetism, which is also used by electric generators to produce electricity. Magnetism is even used to store data on hard disks in our computers and on the magnetic stripe on our bank cards.

Cranes fitted with powerful electromagnets are used to lift heavy metal objects, and magnetic separation is widely used in the recycling and mining industries. For example, sand-mining operations on South Africa's east and west coasts extract beach sands that are rich in heavy minerals. Magnetic separation is used to recover the magnetic ilmenite ($FETiO_3$), which is then smelted to produce titanium dioxide slag (TiO_2) and pig iron, from non-magnetic concentrate that undergoes further processing to produce rutile (TiO_2) and zircon ($ZrSiO_4$). The TiO_2 is a white pigment that is used in paints, paper and plastics, and South Africa is one of the main producers worldwide, since its production of ilmenite is second only to China, and its production of rutile is only exceeded by Australia. Zircon is mainly used in ceramics, such as tiles, sanitaryware and crockery.

Magnetic separation is now being taken to an extreme scale. The Pacific Northwest National Laboratory in the United States' Department of Energy has developed magnetic nanoparticles to recover valuable materials in effluent brines from, for example, mineral mining, geothermal plants and seawater desalination. The nanoparticles have an absorbent shell that selectively binds the compounds of interest, while the core consists of a form of iron oxide better known as magnetite. This means that exposure to a magnet attracts the nanoparticles, allowing them to be easily filtered from the brine. Two pilot projects have been initiated to test the technology's effectiveness in removing lithium from brines associated with oil and gas extraction and with lithium mining. Lithium is a rare earth element in high demand for use in batteries as well as in the manufacture of semiconductors and wind turbines.

Magnetic nanoparticles also have a range of applications in biology and medicine. For example, they are being used in the preparation of 'lab on a chip' sensors, and their potential as drug-delivery vehicles to cancer tumours is being tested.

At the other end of the scale, the world's largest magnet system is currently being constructed for ITER – a multinational collaborative project to build a magnetic fusion device designed to prove the feasibility of fusion as an energy source here on Earth. Fusion is the process that takes place in the intense heat of the core of the Sun and stars, when hydrogen atoms collide and their nuclei fuse to form helium atoms, with the release of vast amounts of energy.

The core of the ITER fusion reactor will be a thousand-tonne central solenoid made up of six modules, each consisting of a coil pack wound from niobium-tin superconducting cable. These modules are being built by General Atomics in California, and the first of the six was delivered to the project site in France on 9 September 2021. Fully assembled, the central solenoid's magnetic force could lift an aircraft carrier out of the water!

In this issue of *Quest*, we explore some uses of magnetism in science and technology, as well as its effects in the natural world.

Sue Matthews
Quest Editor

Lesisiqephu se *Quest* sikhuluma ngesayensi yomazibuthe, esetshenziswa ngezindlela eziningi empilweni futhi ibalulekile kwi sayensi nobuchwepheshe.

Translated by Zamantimande Kunene

2021

Quest Volume 17 Number 3 2021

Academy of Science of South Africa (ASSAf)

Academy of Science of South Africa (ASSAf)