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FEATURES

- Waste management
- Corrosion and coatings
- Plant maintenance, health, safety and quality
- Pumps and valves

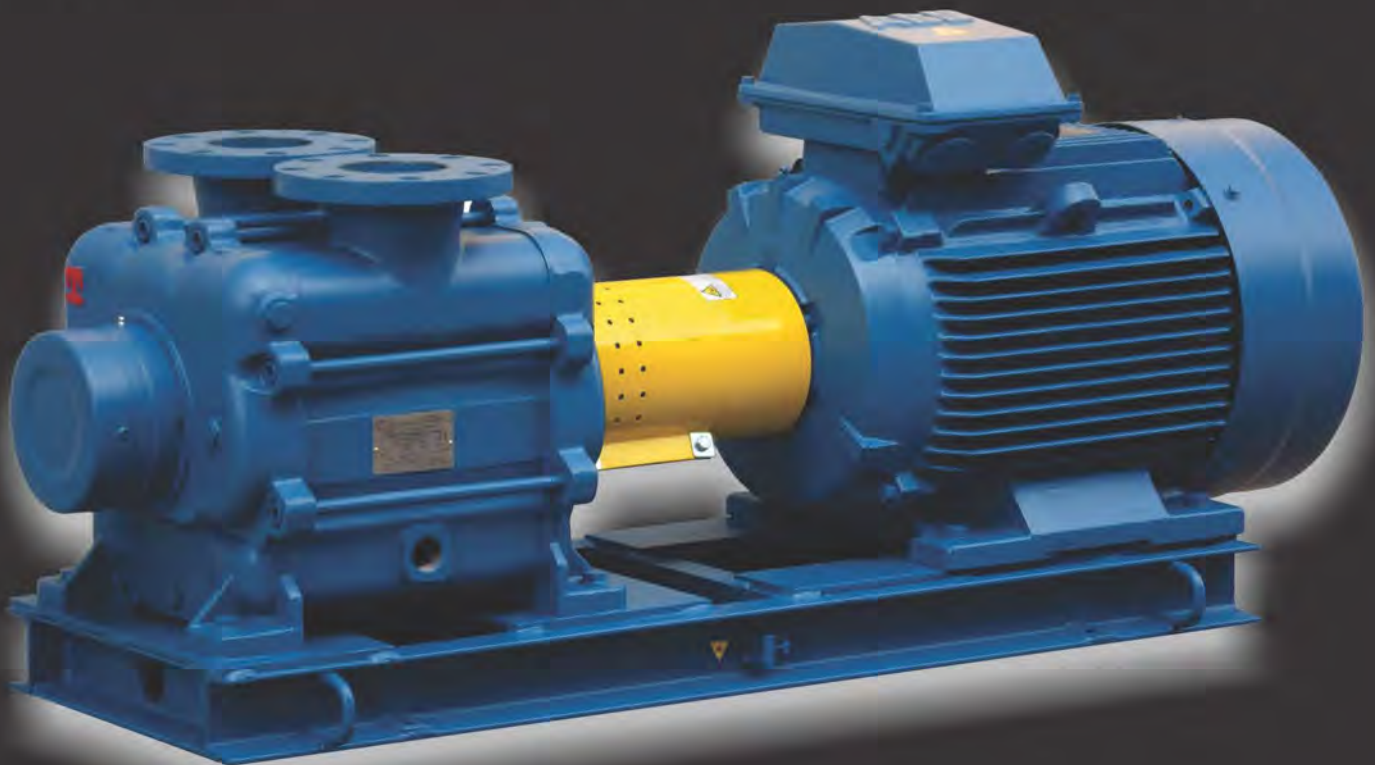
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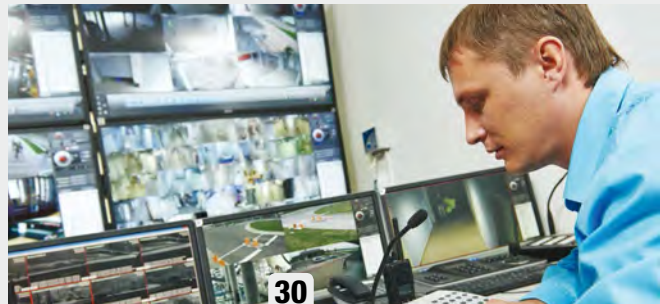
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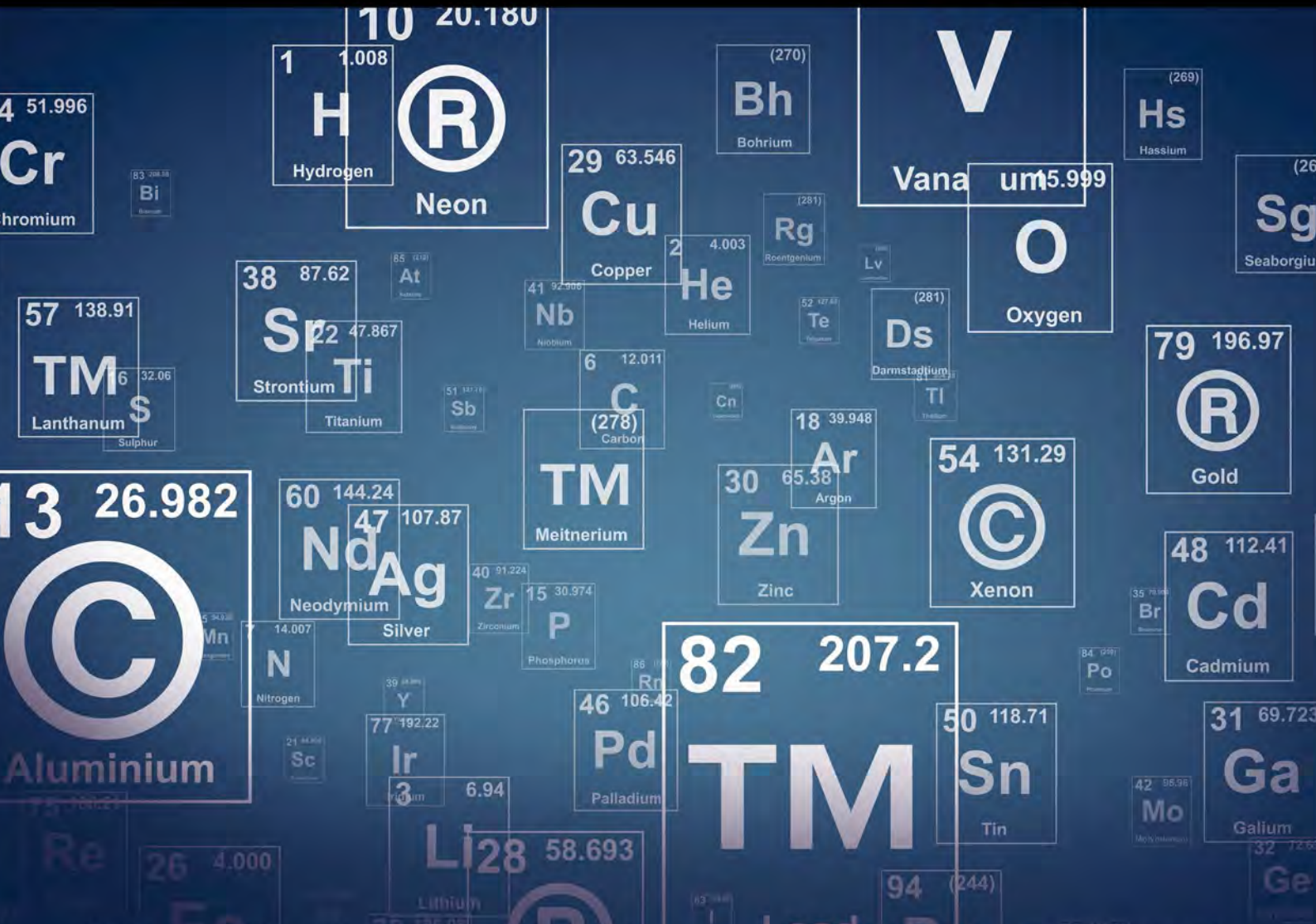


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The state of South Africa's nuclear energy

by Carl Schonborn, PrEng

An informed opinion is based on knowledge of the facts and carefully considered principles. It relies on evidence instead of limited personal experience. (Wordcraft)

If one is an avid reader of newspapers, magazines, journals and other media in South Africa today, one will, undoubtedly, be exposed to a mass of information and/or misinformation. Very important, however, is to attempt to separate the one from the other. If you conclude that the information is reliable, then the next step is to try to establish if it is based on evidence, or on the limited personal experience of the author.

This is not to suggest that every article one reads needs to be researched to establish its authenticity, but rather shifts the onus of responsibility onto the editorial staff who should be well enough qualified to distinguish good from bad information. Only then can informed opinion be possible.

A case in point: In the writer's opinion, reporting of nuclear matters is very often entangled in a web of secrecy and misinformation. This should not be so if one considers the vast amount of accumulated knowledge and number of regulatory bodies available today. For example, the International Atomic Energy Association (IAEA) was created in 1957 in response to the deep fears and expectations resulting from the discovery of nuclear energy.

Then there is the World Nuclear Association (WNA) that is the international organisation promoting nuclear power which supports the many companies that comprise the global nuclear industry. Its members come from all parts of the nuclear fuel cycle, including uranium mining, uranium conversion, uranium enrichment, nuclear fuel fabrication, plant manufacture, transport, and the disposition of used nuclear fuel as well as electricity generation itself.

In South Africa we have the South African Nuclear Energy Corporation SOC Limited (Necsa) which, in terms of Section 13 of the Nuclear Energy Act, No. 46 of 1999, was mandated to:

- Undertake and promote research and development (R & D) in the field of nuclear energy and radiation sciences and technology and, subject to the Safeguards Agreement, to make these generally available.
- Process source material, special nuclear material and restricted material and to reprocess and enrich source material and nuclear material; and
- Co-operate with any person or institution in matters falling within these functions, subject to the approval of the Minister.

South Africa also has the National Nuclear Regulator (NNR), a public entity which was established and governed in terms of Section 3 of the National Nuclear Regulator Act (Act No 47 of 1999), to provide for the protection of persons, property and the environment against nuclear damage, through the establishment of safety standards and regulatory practices.

The debate in South Africa today is whether the country can afford nuclear power and what its cost will be. The problem is not so much what the Capital Cost (or CAPEX) will be, but what construction expertise and cost controls we will have in place to prevent, for example, the cost of construction of a coal-fired power station ballooning from an estimate of R30 billion to an estimate of between R100 billion to R300 billion. Mossgas started at R5,5 billion in 1987 and was completed for about R11 billion.

South Africa cannot afford this type of cost escalation, which leads us to the conclusion: will we ever have a reliable, active nuclear source of energy at our disposal?

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Organic fingerprinting

using Gas Chromatography-Mass Spectrometry

Editor of 'Chemical Technology', Glynnis Koch, recently paid a visit to ERWAT Laboratory Services, a SANAS 17025 accredited laboratory, to talk to Denver Karshagen, GC-MS chemist in charge of the specialist laboratory for organic water and soil analysis.

ERWAT offers the water industry a wide variety of services in the fields of chemical and microbiological analyses, as well as expert advice on water-related problems. It considers its business to be the management of the earth's most sensitive natural resource: water. As a result, the company is committed to the protection of the environment by avoiding pollution of natural streams, groundwater, soil and air. Purified effluent is managed to ensure environmentally safe water is discharged to rivers and streams.

ERWAT Laboratory Services offers advanced chemical and bacteriological laboratory analyses. It aims to serve clients and the environment and support clients in wastewater investigations; to analyse low to high-range concentrations on samples and to handle large volumes, as well as to offer affordable scientific services in a short turnaround time.

Services offered also include: evaluation of effluent processes, dams, lakes and river systems; wastewater and potable water treatment; industrial processes and effluent monitoring programmes; product loss control and effluent quality surveys; pollution risk surveys and wastewater effluent plant operation, troubleshooting and problem solving.

Denver Karshagen began working at the ERWAT Laboratories situated in Hartebeestfontein Office Park in Kempton Park, Gauteng, over seven years ago, when he was employed to start up a specialist laboratory for organic water and soil analyses, mainly in the area of environmental testing. Specifically, the laboratory carries out Gas Chromatography-Mass Spectrometry (GC-MS) applications on a variety of liquid and solid sample matrices which may come from the local council, industry, water treatment works, or even private clients.

GC-MS is very much the tool of choice for tracking organic

pollutants in the environment, according to Denver. Although there are some compounds for which the technique is not suitable, for most organic analysis of environmental samples, including many major classes of pesticides, it is extremely sensitive and effective.

At the ERWAT Laboratory, GC-MS analysis of organic determinants, based on EPA method specifications, cover the following:

- Volatile organic compounds (VOCs) including Benzene Toluene Ethylbenzene Xylenes and Naphthalene (BTEXN) components;
- Semi-volatile organic compounds (SVOCs) including Polycyclic aromatic hydrocarbons (PAHs) and Phenols;
- Polychlorinated Biphenyls (PCBs);
- Organochlorine Pesticides (OCPs);
- Organophosphorous Pesticides (OPPs);
- Total Petroleum Hydrocarbons (TPH-GC) including Gasoline Range Organics (GROs and Diesel Range Organics (DROs); and
- Organic fingerprinting (GC-MS scans).

Denver pointed out that organic fingerprinting is one of the most interesting applications of GC-MS. The scans that result from the analysis may be described as a forensic type of application, in the sense that tracing back problem samples, such as from a pollution incident, (for example, the discharging of effluents from chemical plants into a river or a dam), is made possible.

The object of testing samples is to find out their source by being able to identify the organic compounds within the samples. Reference samples are taken from sites suspected of causing the pollution. Using organic profiling, these





samples are compared with samples from the spill sites. 'Full scan' is useful in determining unknown compounds in a sample. Since the mass spectrum produced by a given chemical compound is essentially the same every time, the mass spectrum is essentially a 'fingerprint' for the molecule. This 'fingerprint' can therefore be used to identify the compound [1].

Denver explained that, in order for a compound to be analysed by GC-MS it must be sufficiently volatile and thermally stable. Samples are usually analysed as organic solutions; as a result, materials of interest need to be solvent-extracted and the extract subjected to various 'wet chemical' techniques before GC-MS analysis is possible. For example, SVOCs such as phenols and PAHs will be subject to liquid-liquid sample extraction.

The sample solution is then injected into the GC inlet where it is vaporised and swept onto a chromatographic column by the carrier gas. The sample flows through the column and the compounds comprising the mixture of interest are separated [2].

The next component (the mass spectrometer/analyser) separates the, by-then positively charged, ions according to various mass-related properties. After the ions are separated they enter a detector which sends information to a computer which, aside from controlling the operation of the MS, also records all of the data produced and converts the electrical impulses into visual and/or hard copy displays [2].

In other words, the MS produces mass spectrum patterns from which chromatograph plots are generated. The analyst looks at each of the chromatograms, overlays the plots (from the various samples that have been analysed),

in order to identify all of the peaks that are in the samples. The peaks are measured in relation to one another. The tallest peak is assigned 100 % of the value, and the other peaks assigned proportionate values. The total mass of the unknown compound is normally indicated by the parent peak. A 'full spectrum' analysis considers all the 'peaks' within a spectrum [1].

After identifying the peaks, the analyst will check to see if there are any matching patterns. Most volatile compounds show up first, Denver explained, and heavier compounds later. This enables very accurate identification of where that sample may have come from. Molecular masses of each compound are visible on the chromatograms. If necessary, the analyst can also do a computer library search, to match spectrum patterns of compounds stored in an electronic database.

Denver said that quantitative methods analysis can be done at a later stage, based on the findings of the initial GC-MS scan analysis. Many test methods are available at the ERWAT Laboratories whereby a wide range of organic compounds can be quantified, depending on what has been identified in the scans. Techniques available now are extremely sensitive, indicating low parts per billion.

For more information telephone +27 11 929 7014/7000; email: laboratory@erwat.co.za/mail@erwat.co.za.

References

1. www.gmu/depts/SRIF/tutorial/gcd/gc-ms2.htm
2. <http://www.bris.ac.uk/nerclsmf/techniques/gcms.html>

Development of novel corrosion techniques for a green environment

by Zaki Ahmad and Faheemuddin Patel, Mechanical Engineering Department, King Fahd University of Petroleum and Minerals (KFUPM), Dhahran, Saudi Arabia

Conventional anti-corrosion techniques have traditionally paid no regard to the greenhouse effect. Work on eco-friendly anti-corrosion techniques is scanty and largely proprietary. The innovative techniques discussed in this article provide direction to corrosion scientists, engineers, and environmentalists concerned about the increasing contamination of the planet and about endeavouring to maintain a green environment.

Traditionally, base load regasification terminals have predominantly used two types of vaporisers: 70 % use the Open Rack Vaporiser (ORV), 25 % use the Submerged Combustion Vaporiser (SCV) and the remaining 5 % uses the Intermediate Fluid Vaporiser (IFV). In addition to these, other types of vaporisers such as Direct Air Vaporisers and Ambient Air Vaporisers (AAV) have been used in smaller regasification plants and peak shaving facilities.

Most of the existing LNG regasification terminals are large in size and were designed to supplement domestic production. They were built at a time when energy price was fairly low and there were fewer concerns about environmental impacts. These existing facilities were considered utility companies. LNG cold utilisation, integration with power plants and waste deterioration of materials and equipment by atmospheric pollution is not a new phenomenon. Corrosion engineers have long been developing appropriate strategies to combat atmospheric corrosion. However, in the last decade, global warming has placed heavy responsibilities on engineers and scientists to transform the conventional production processing techniques into eco-friendly techniques in order to control the greenhouse effect, which is slowly, but surely, inflicting irreversible damage to materials and mankind on this planet.

Whereas air pollution commonly refers to aerosols con-

taining suspended impurities of particles such as sulfates, nitrates, organic compounds, and fly-ash particles, the greenhouse gases contain mainly carbon dioxide (CO₂), methane (CH₄), nitric oxide and nitrogen dioxide (NO_x), sulfur(s), and chlorofluorocarbons (CFCs). Typical aerosols contain 25 % sulfate, 11 % organic, 9 % BC, 6 % nitrates, and 18 % other materials. The Indian Ocean Experiment (INDOEX) conducted during 1996–1999 showed that the aerosols over the oceans show typically 1 % sea salts and 10 % mineral dust (Figure 1 on page).

Brown clouds containing dangerous levels of aerosols observed in Asia have a tendency to increase global warming by as much as 50 % [1]. The atmosphere is reported to be warming at a rate of 0,25 °C per decade since 1950 at altitudes higher than 2-5 km above sea level [2]. These brown clouds appear to have the same effect as greenhouse gases. In the context of corrosion, both greenhouse gases and brown clouds have a deleterious effect on the integrity of buildings, vehicles, cultural monuments, and all engineered products. In the Eurozone, 12 billion Euros are lost annually as a result of deterioration of buildings [3]. The existing corrosion prevention practices are like a double-edged weapon: they stop corrosion, but the chemicals and materials used in corrosion prevention techniques interact with the atmosphere and add to environmental pollution.





Corroded objects act synergistically to elevate pollution. Several metal ions interact with organic compounds such as humic acid and retard photocatalytic oxidation [4].

Corrosion prevention practices applied to power plants, desalination plants, transportation, aerospace, gas, oil, petrochemical and construction industries, need to be modified to keep the environment green. No formal eco-friendly corrosion protection techniques have been reported by professional corrosion organisations. The results obtained by the authors from their previous work and some work reported in the literature have prompted them to present an overview of some eco-friendly corrosion techniques which could be improved further to save the planet from the greenhouse and brown clouds effects.

In spite of media's commentaries and the Bush administration's rejection of global warming caused by carbon levels, Norway has installed third generation carbon sequestration in the North Sea, while the USA has fallen behind in this critical technology.

Eco-friendly techniques and their applications

Desalination plants

Saudi Arabia is now the largest producer of desalinated water in the world. It houses 30 desalination plants with a

production capacity of million gallons of water per day. It produces 28×10^6 MW/hour of electricity. These plants contribute to air pollution with the release of 282 955 thousand metric tons of CO_2 [5]. The shift from traditional designs to eco-friendly design is shown by the Carlsbad (California, USA) desalination plant. It has been designed to produce 13,5 kW/5 000 gallons of drinking water [6]. This plant is designed to reduce greenhouse carbon footprints by energy-efficient design, clean corrosion protection techniques, use of CO_2 for water production, CO_2 sequestration, and using warm water sources.

By using warm cooling water, additional electrical energy savings of 12 208 MWH/yr and carbon dioxide footprint of 30 565 tons/year are predicted to be achieved. Clean water and superhydrophobic surfaces in heat exchanger tubes would have the capabilities to keep the tube surface ultraclean. Waste CO_2 releasing from chemical or other industries may be used in the desalination plants to make the design more eco-friendly. The above measures would reduce pollution in an area inflicted with one of the harshest environments containing dangerous levels of aerosols.

Water filtration

Water quality directly affects the magnitude of corrosion. Replacement of old techniques by new technologies such

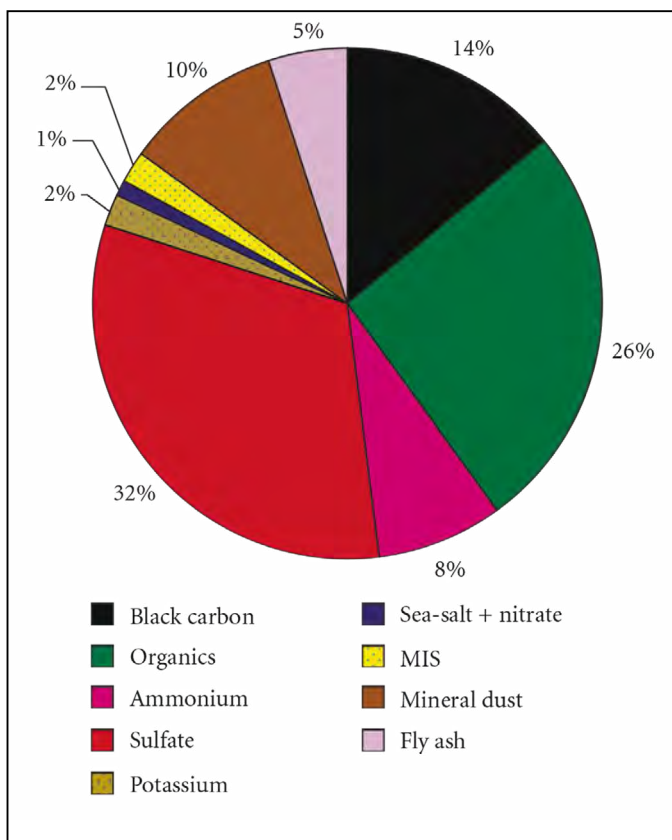


Figure 1: Fractional contribution of chemical components to the INDOEX aerosol, as measured over the Indian Ocean by aircraft in February and March 1999 [1].

as vibratory shear enhanced technology (VSEP) has made it possible to produce clean water from reverse osmosis rejects by removing TOC (total organic compounds), TSS (total suspended solids), and TDS (total dissolved solids) content which induces corrosion and biofouling by formation of colloidal suspension [7]. A fluid dynamics comparison between crossflow filtration and vibratory shear enhanced process (VSEP) is shown in Figure 2, and a schematic of VSEP is shown in Figure 3. The VSEP technology is mature, proven, and cost-effective [8].

New eco-friendly surface modification techniques

In corrosion prevention methods, coating is most widely practised but it has caused serious concerns because of its effect on environmental pollution. New environmental regulations focus on reducing the volatile organic compounds (VOCs) in paints which have the highest ozone-forming potential. The breakdown of coating under ultraviolet radiation and harsh environments necessitated the development of nanocoatings. Lotus flower, which remains clean in polluted water, provided a stimulus for the development of nanocoatings, which are corrosion-resistant with dust- and water-repulsion properties.

In a recent work by authors [9], nanoparticles of TiO_2 were introduced in alkyd resin binder in a ratio of 21:37 and blended in a high-speed dispersion mill. These paints were subjected to UV radiation, salt spray, and dust- and water-repulsion tests as specified by ASTM. After exposure to the above tests, it was observed that the nanotitanium dioxide

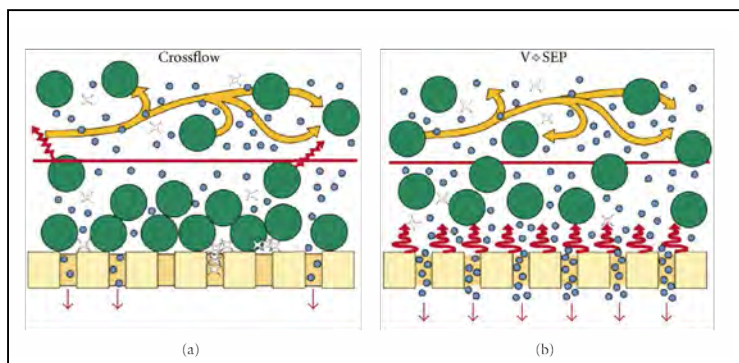


Figure 2: A Comparison of conventional treatment methods and VSEP: a vibrating membrane filtration system, VSEP treatment of RO reject from brackish well water [8].

Table 1: Comparison of conventional and nano coatings

Properties	Conventional	Nanostructured	Improvement
Toughness	Poor	Excellent	Dramatic
Hardness	1,000	1,000	—
Wear	7.5×10^3	40×10^3	~5X
Corrosion	Good	Exceptional	Significant
Grindability	Poor	Excellent	Dramatic
Fatigue life	<1 million cycles	>10 million	>10X
Flex tolerance	Result in coating spallation	Can be bent over 180 degrees with	Dramatic
Bond strength (psi)	1,900	~8000	~4X

coatings (Figure 4) showed a higher corrosion resistance with excellent water- and dust-repulsion properties and an outstanding resistance to ultraviolet radiation. These coatings showed a 90 % reduction in coliform bacterial population due to their photocatalytic activity.

Most of the work on nanocoatings is proprietary and still in developing stages. The nanocoatings have opened a new gateway to contribute to a clean environment. Corrosion studies on nanostructured plasma-sprayed titanium dioxide and nanoalumina/titania coatings showed that these coatings offer an excellent barrier to erosion-corrosion in harsh environments such as encountered in pulp and paper industry [10]. A recent work has shown a high resistance to erosion-corrosion in 3.5 wt% NaCl containing polystyrene particles and a good photocatalytic activity [11]. The behaviour of these coatings is dictated by the geometry of splat lamellae, volume percentage of unmelted particles, degree of residual porosity, and interlamellar spacing. A narrow interlamellar spacing prevents water penetration, and hence, erosion corrosion. A schematic of erosion-corrosion phenomenon in a nanostructured coating is shown in Figure 5.

The nanostructured TiO_2 plasma-sprayed coatings are eco-friendly and showed a higher corrosion resistance than their conventional counterparts [12]. Table 1 shows the advantages of nanocoatings over conventional coatings.

Development of innovative surfaces

Environmental consideration is a prerequisite to an eco-friendly design. Galvanising was a global choice because of the longer life of steel; however, with the advances in

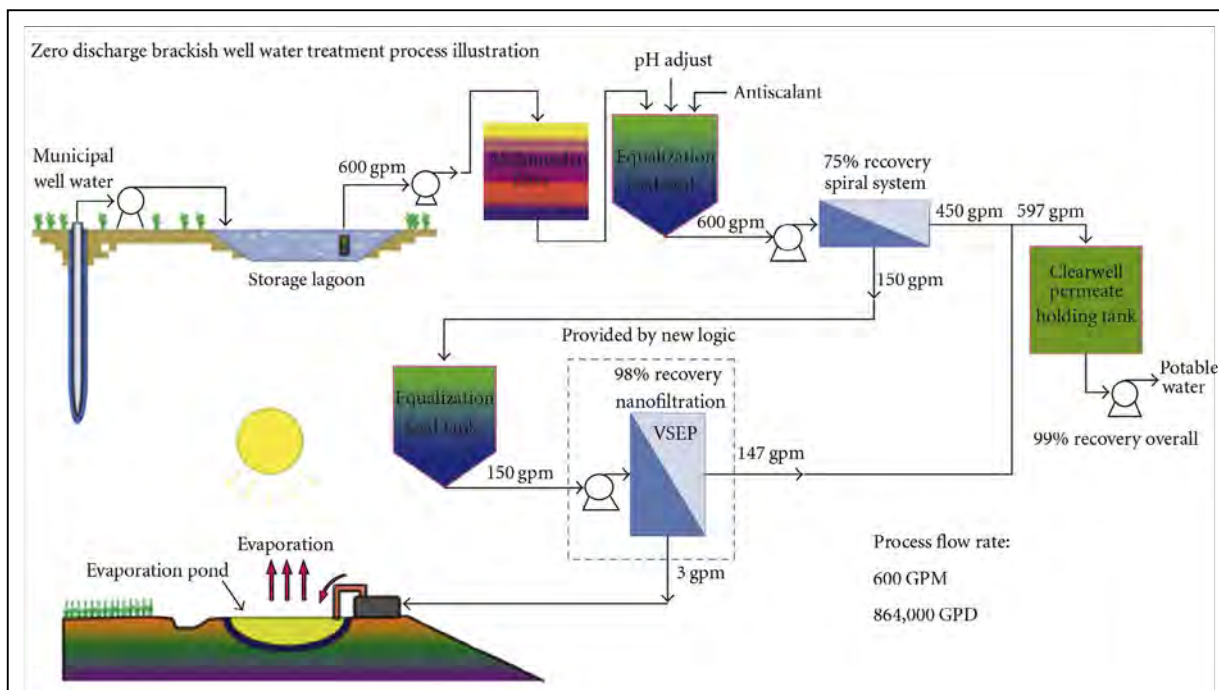


Figure 3: VSEP process schematic for pilot-tested RO reject application [8].

nanocoatings with photoreactivity, the choices have been broadened. A marked progress has been observed in recent years in fabrication of engineered surfaces, for example, hydrophobic surfaces. The authors have recently published a comprehensive review on fabrication of superhydrophobic surfaces [13]. The super-hydrophobic surfaces possess excellent photocatalytic, water- and dust-repulsion, and corrosion resistance characteristics, and they represent the 'state-of-the-art' eco-friendly corrosion protection techniques.

Two methods have been utilised to fabricate hydrophobic surfaces, modifying a rough surface with low energy compounds and roughening low surface energy materials. The water and dust repellency properties of such surfaces make them highly promising for a wide spectrum of applications in paints, coatings, photovoltaic cells, lubricants, electronic devices, biomaterials, prosthesis implants and a host of micro/nano-electromechanical devices. The secret of superhydrophobicity lies in its unique two-level hierarchical surface comprising nanobumps and microhills (valleys and troughs) embedded with epicuticular nanowax crystals as shown in Figure 6 overleaf. Figure 7 shows a waterdrop rolling on lotus leaves without sticking and taking the dirt away due to superhydrophobicity.

Water contact angles are formed between the water droplets and substrate as shown in Figure 8 on page. For a superhydrophobic surface the water contact angles must be drops roll through the troughs and carry away the dust particles from the surface as shown in Figure 9 on page.

Low-surface materials such as tetrafluoroethylene (Teflon), polydimethylsiloxane (PDMS), polyamides, polycarbonates, ZnO, and TiO₂, have been used to fabricate superhydrophobic surfaces. Techniques such as laser etching [14], sol-gel [15, 16], and chemical etching [17] have been used to modify rough surface. These superhydrophobic surfaces keep corrosion at bay by not allowing a large volume of water to interact with the active surface. These

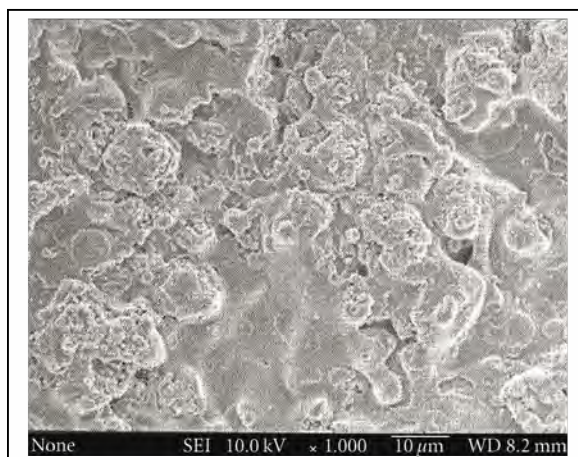


Figure 4: Surface of the sprayed nanotitanium dioxide coating [9].

surfaces can also be made to switch from a hydrophobic to a hydrophilic state. A hydrophilic surface can be used to separate oil from water. A stainless steel mesh coated with nanofibres of polyvinyl acetates has been successfully utilised to separate oil from water [18].

Self-healing materials and surfaces

Recent attempts to create self-healing surfaces are directed at increasing the life of engineered structures, which do not require periodic repairs or replacements over a long period of designed service life. An electroplated coating can be made more durable by encapsulating healing agents like chromium and zinc. In principle, capsules containing a healing agent (Figure 10 on page) are embedded in a polymer. When the material is damaged, the capsules rupture and release the repairing agent (Figure 11 on page).

One serious problem, which contributes to environmental pollution, is concrete corrosion. To tackle this problem, hollow and porous fibres filled with adhesive liquids are embedded in concrete. As soon as a crack appears, the

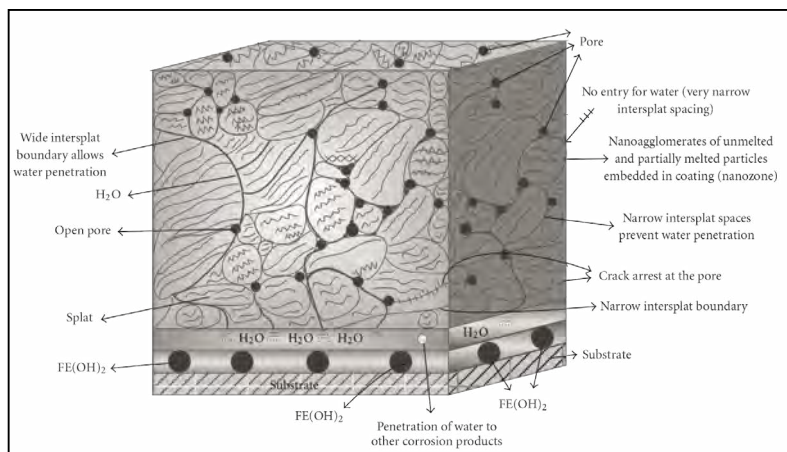


Figure 5: Erosion-corrosion phenomenon in nanostructured coating.

Figure 7: (a) Water rolls across a leaf without sticking at all and carries away dirt; (b) microscopic bumps (a few microns in size) all across the leaf's surface hold the key to its water-repelling properties.

liquid is released to heal the crack. Delivering a healing agent from a remote reservoir to the damaged region via a vascular network housed in a honeycombed structure offers the potential of robust and sustainable system. Aeronautical and automobile companies are developing an autonomous system that triggers the repair mechanism upon the onset of damage to retain the structural integrity and the service life without hurting the environment. A schematic of controlled release is shown in Figure 12.

Corrosion inhibition and cathodic systems

Severe damage to the environment has been caused over the years by the use of organic and inorganic inhibitors in oil and gas and water treatment plants. Inorganic inhibitors such as chromates, nitrates, phosphates, and silicates, organic inhibitors like monoamines and diamines, synthetic inhibitors like chromophosphates, and scavengers like sodium sulfate have been indiscriminately used without regard to environmental pollution. Recent eco-friendly methods used in this regard include photo-induced inhibition of 304SS in sodium chloride by UV radiations. It has been shown that UV radiation has a significant effect in corrosion prevention [19]. Ultraviolet radiation has also been utilised to provide cathodic protection of steel structures in the presence of semiconductor films like TiO_2 . Recently, the authors of [20] have designed a cathodic protection system by overlay of a thin TiO_2 film on steel substrate and exposing the system to UV radiation. The system is attached to a solar panel to store the electrons during bright and sunny days and regenerate the electrons at night and on cloudy days. Because of a wide band gap of 3.2 eV, TiO_2 serves as an anode without sacrificing itself, unlike the zinc and magnesium. While protecting the steel, the film of titanium dioxide surface generates hydroxyl radicals (OH^-), superoxide anions (O_2^-), and hydrogen peroxide (H_2O_2) which clean the organic contamination by their photocatalytic activity, as shown in Figure 13.

This nonsacrificial galvanic cathodic protection system with added environmental and antibacterial properties offers an alternative to the conventional galvanic cathodic protec-

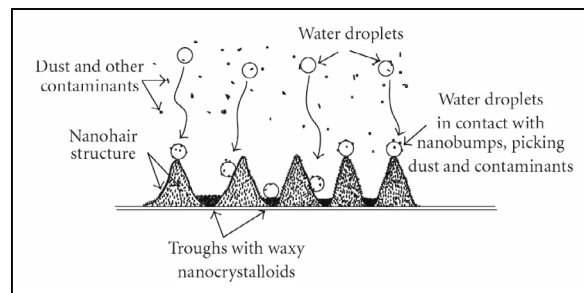
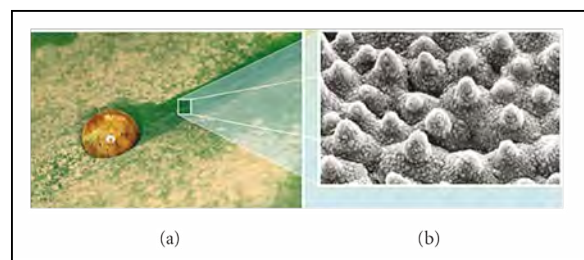


Figure 6: Schematic of superhydrophobic surface showing nanobumps and waxy troughs.



tion system where anodes are consumed and need periodic replacement. The eco-friendly techniques described above need further development; however, they offer a promise of clean corrosion prevention practices without damaging the environment.

Conclusion

With the revolutionary progress in industrialisation and urbanisation witnessed in recent years, the intensity of air pollution and greenhouse gases has increased in alarming proportions. Both materials and mankind are thus exposed to enhanced risk. New strategies to preserve materials and other resources need to be developed to enhance the life of materials whilst keeping the environment green.

Existing corrosion solutions need to be transformed to green solutions by developing eco-friendly techniques. It has been shown how corrosion protection methods such as inhibitor treatment, metallic-nonmetallic coatings, paints, and cathodic protection can be made greener by utilising emerging techniques such as nano- and micro-technologies. Examples in this article have shown how some of the traditional corrosion protection techniques can be transformed to eco-friendly techniques. It is just the beginning for a hopeful tomorrow.

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References

References for this article are available from the editor at chemtech@crowm.co.za.

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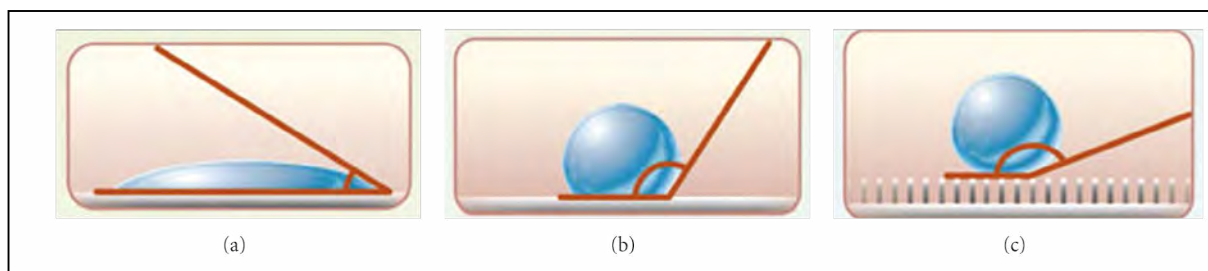


Figure 8: (a) Hydrophilic surface: angle less than 30 degrees; (b) Hydrophobic surface: angle greater than 90 degrees; (c) Superhydrophobic surface: angle greater than 150 degrees.

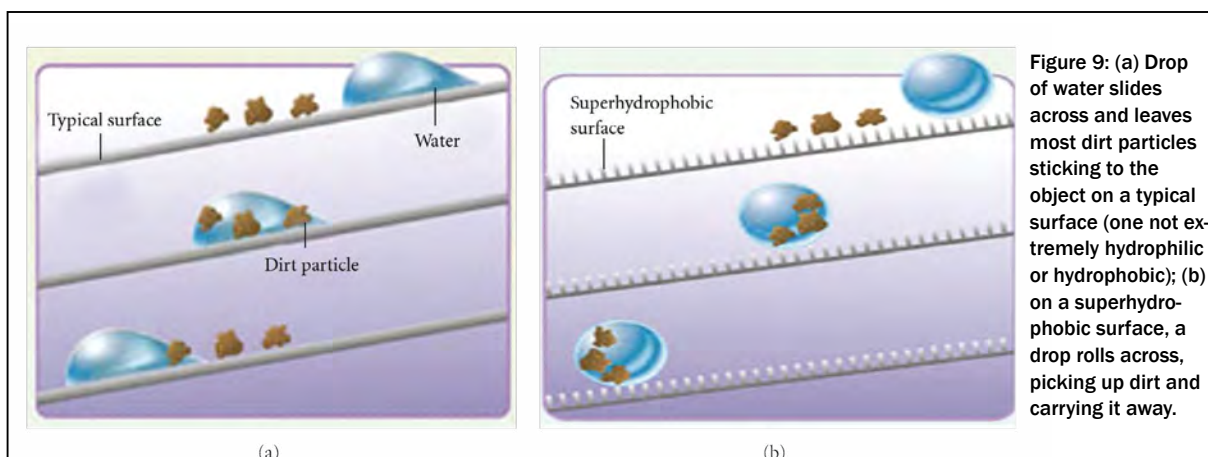


Figure 9: (a) Drop of water slides across and leaves most dirt particles sticking to the object on a typical surface (one not extremely hydrophilic or hydrophobic); (b) on a superhydrophobic surface, a drop rolls across, picking up dirt and carrying it away.

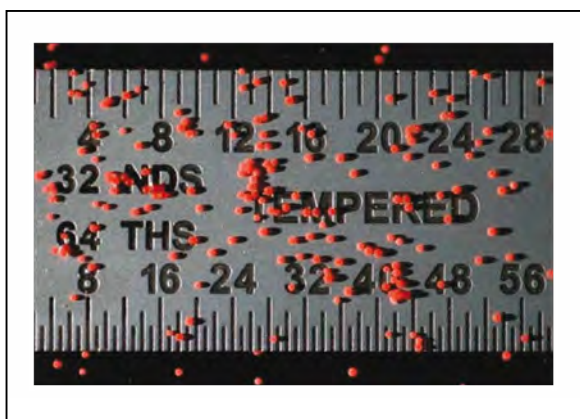


Figure 10: Healing-agent-containing microcapsules used in self-healing polymers. A steel ruler is pictured in the background for reference (Magnus Andersson, University of Illinois).



Figure 11: Close-up image of one-half of a self-healing epoxy specimen after it has been fractured into two pieces (Magnus Andersson, University of Illinois).

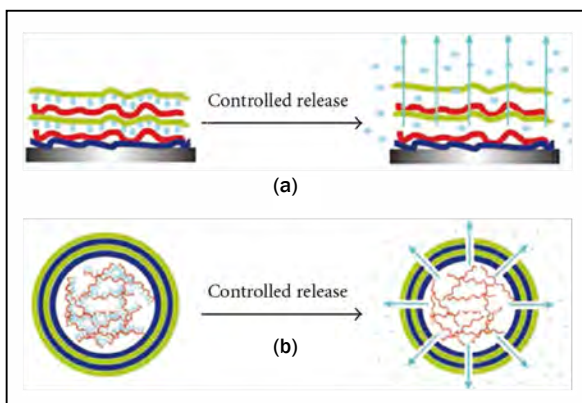


Figure 12: Schematic illustration of the entrapment/release of active materials: (a) Active material is embedded in the 'passive' matrix of the coating; (b) active material is encapsulated into nanocontainers with a shell possessing controlled permeability properties.

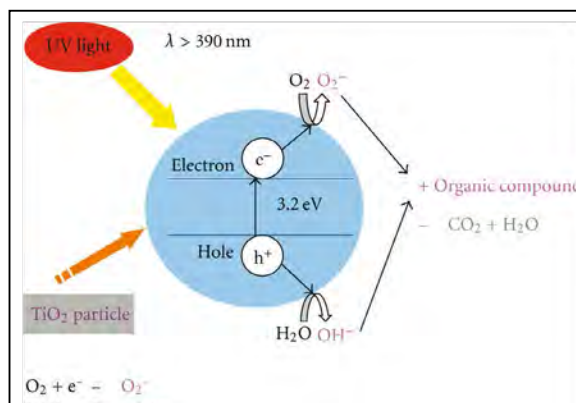


Figure 13: Cathodic protection system using UV radiation.

A conference like no other

The upcoming European Coatings Conference dedicated to Anticorrosive coatings on 3 and 4 November 2015 in Düsseldorf, Germany, will feature a newly designed hands-on practice session that will reveal insights into coatings raw material development.

Learn about the latest developments of anti-corrosive alloys during the conference and find out which treatment fulfils your needs best; whether anti-corrosion pigments or special fillers are the right choice; if the right polymer backbone is the better alternative; or if nanotechnology can prevent future damages.

Included in the conference is a 2-hour short course presented by Dr Ulrich Christ, of IPA, Germany, that will convey the principles of anticorrosive coatings, such as: Basic know-how on corrosion; Wrap up on corrosion protection systems; Status quo on coatings technologies; and Trend and outlook on what's changing in this coatings system. Profit from the gathered expertise and ask the audience about market trends, technology developments and experience with specific additives. Your questions will be answered instantly by the audience of the conference via a polling system. Use

crowd intelligence to expand your knowledge.

Other presentations include:

- High performance water-based anticorrosion coatings without active pigments - A paradigm shift? by Guido Möllenbeck, Alberdingk Boley, Germany
- Optimizing formulation with Zinc-free anticorrosive pigments by Fabiana Requeijo, Nubiola, Spain
- Insights in practical milestones of gaining Cr-free primer on EG and HDG steel with corrosion inhibitors by Dr Jürgen Ott, Heubach, Germany.

Tutorials with practical applications and individual problem-solving will cover chemical resistant boosters; How to choose the right mica for corrosion prevention; Reducing a layer, gaining a better epoxy anticorrosive coating; Optimising flow characteristics of high build anticorrosive primers; Economical protection with waterborne epoxy-amine; and, A non-biocidal coating approach to the prevention of fouling and microbial induced corrosion.



All this and more will be available at the conference.

For more information go to <http://www.european-coatings.com/Events/European-Coatings-CONFERENCE-Anticorrosive-coatings-Conference-schedule> or contact Matthias Janz on tel: +49 511 9910-273 or email matthias.janz@vincentz.net.

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Thermaspray optimises PTA process parameters

Thermaspray, a leader in south African surface engineering and thermal spray coating technology, has optimised the parameters of its Plasma Transferred Arc process (PTA) to ensure high quality, crack-free stellite hardfacing deposits on a wide range of substrates.

Weld deposits of hardfacing alloys are commonly employed to increase the service life of components that are subject to abrasive wear and corrosion. Properties in the deposits vary and generally greater life is achieved with deposits of higher hardness which is obtained by the presence of hard carbides in the matrix. Because this cracking does not significantly reduce the service life of the component it is sometimes seen as advantageous in reducing residual stresses in the material.

However, Shaik Hoosain, Metallurgical Engineer at Thermaspray, points out that in many instances, cracking, whether to obtain a sealing surface or to prevent fatigue failure, is undesirable. He explains: "Cracking in stellite hardfacing alloys are essentially related to the very high strength and low tensile ductility of the weld deposit and its sensitivity to dilution. To avoid cracking in these hardfacings, it is essential to control or adjust parameters. Subsequently we have developed welding parameters in our PTA process which are strictly controlled to ensure high hardness stellite deposits that

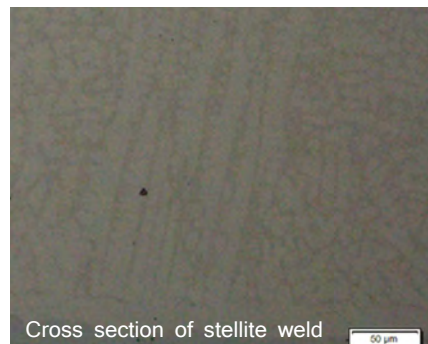
are free from cracks and flaws."

Outlining the PTA process, Hoosain explains that this hardfacing procedure heats metals and merges them by means of arc outlines constriction. "It is a versatile method of depositing high quality, metallurgically fused deposits on relatively low cost substrates."

PTA is mainly used on components that are subjected to severe corrosion or abrasion, thermal shock, slurry erosion or extreme impact forces to give the necessary protection to the substrate by providing a coating that can withstand these conditions. Hoosain adds that PTA can be applied in practically every case where hardfacing is needed.

Cracking in the subsequent deposits results from unequal cooling rates within the deposit and the expansion mismatch between the substrate and the weld. Thermaspray has addressed this through the dilution of the stellite by a steel substrate which involves the reduction of compositional mismatch, making a more ductile weld deposit by decreasing the carbide content. Furthermore, increased sensitivity to cracking as more deposits are made as a result of lower dilution and higher deposit hardness, can be reduced by the application of a correct preheat and current level.

The cracking risk is also influenced by preheat levels and ensuing cooling rates.



"Here it is most critical to carefully control the heat input which makes it possible to control weld dilution to less than 5%, which is crucial for many high-performance alloys," states Hoosain.

Thermaspray, ISO 9001 accredited and an Eskom level 1 approved supplier of coatings and PTA welding, has conducted several welding qualification procedures on various material substrates. Thermaspray, in a joint venture with Surcotec, offers an extensive portfolio of engineering and thermal spray coating solutions that extend component life cycles to assist OEM and end-user clients across southern Africa in reducing costs and increasing production.

For more information contact Dr Jan Lourens on tel: +27 11 316 6520/8/9, email jlourens@thermaspray.co.za or go to www.thermaspray.co.za.

Flame retardant breakthrough is naturally derived and nontoxic

Inspired by a naturally occurring material found in marine mussels, researchers at the University of Texas at Austin have created a new flame retardant to replace commercial additives that are often toxic and can accumulate over time in the environment and living animals, including humans.

Flame retardants are added to foams found in mattresses, sofas, car upholstery and many other consumer products. Once incorporated into foam, these chemicals can migrate out of the products over time, releasing toxic substances into the air and environment. Throughout the United States, there is pressure on state legislatures to ban flame retardants, especially those containing brominated compounds (BRFs), a mix of human-made chemicals thought to pose a risk to public health.

A team led by Cockrell School of Engineering associate professor Christopher Ellison, found that a synthetic coating of polydopamine – derived from the natural compound dopamine – can be used as a highly effective, water-applied flame retardant for polyurethane foam. Dopamine is a

chemical compound found in humans and animals that helps in the transmission of signals in the brain and other vital areas. The researchers believe their dopamine-based nanocoating could be used in lieu of conventional flame retardants.

The researchers' findings were published in the journal 'Chemistry of Materials' on September 9, 2015.

"Since polydopamine is natural and already present in animals, this question of toxicity immediately goes away," Ellison said. "We believe polydopamine could cheaply and easily replace the flame retardants found in many of the products that we use every day, making these products safer for both children and adults."

Using far less polydopamine by weight than typical of conventional flame retardant additives, the UT Austin team found that the polydopamine coating on foams leads to a 67% reduction in peak heat release rate, a measure of fire intensity and imminent danger to building occupants or firefighters. The polydopamine flame retardant's ability to reduce the fire's intensity is about 20%

better than existing flame retardants commonly used today.

Ellison said he and his team were drawn to polydopamine because of its ability to adhere to surfaces as demonstrated by marine mussels who use the compound to stick to virtually any surface, including Teflon, the material used in nonstick cookware. Polydopamine also contains a dihydroxy-ring structure linked with an amine group that can be used to scavenge or remove free radicals. Free radicals are produced during the fire cycle as a polymer degrades, and their removal is critical to stopping the fire from continuing to spread. Polydopamine also produces a protective coating called char, which blocks fire's access to its fuel source—the polymer. The synergistic combination of both these processes makes polydopamine an attractive and powerful flame retardant.

Source: <http://www.chem.info/news/2015/10/flame-retardant-breakthrough-naturally-derived-and-nontoxic>

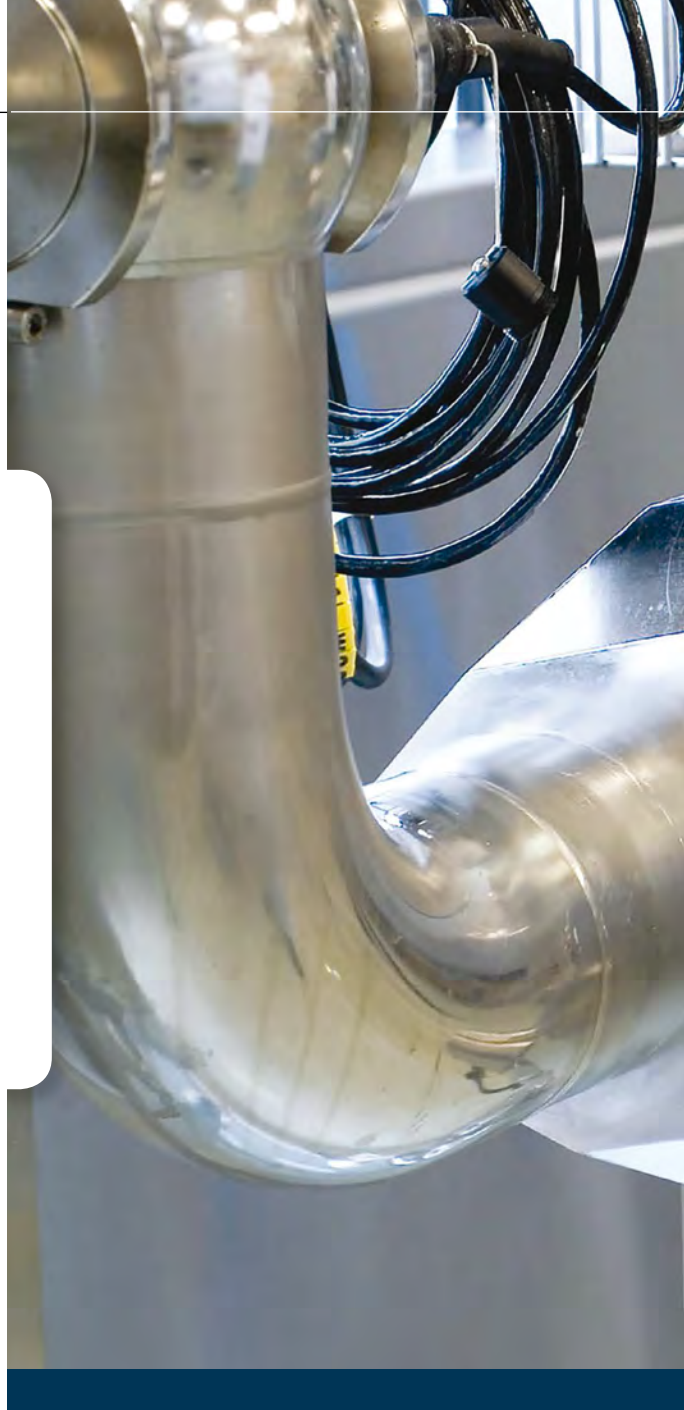
Adapting valve designs to meet industry's exacting requirements

by Bryan Orchard

Hygienic diaphragm valves are needed for a wide variety of applications in the pharmaceutical and biotech sector. Having paved the way for reliable aseptic production with its unique design years ago, the SISTO-C series is continually adapted to meet industry's increasingly stringent requirements.

In sterile process engineering, such as in the production of insulin, vitamin enzymes or APIs (Active Pharmaceutical Ingredients highly potent agents), users place special demands on the hygienic valves that they use. This is particularly apparent in the exacting requirements regarding the production process and the materials. There is a noticeable trend here: "Operators are continually demanding higher quality materials. In the pharmaceutical sector, stainless steel grades such as 1.4435 are usually used. However, users are increasingly requesting 1.4359 and Hastelloy qualities," reported Alfred Knöbl, product manager of the SISTO-C series at SISTO Armaturen SA Echternach, Luxembourg. "This is because these materials are far more corrosion-resistant. The valves are not necessarily affected by the cleaning liquids used in the CIP/SIP processes, but rather by fluids that are needed for product processing, for example after fermentation."

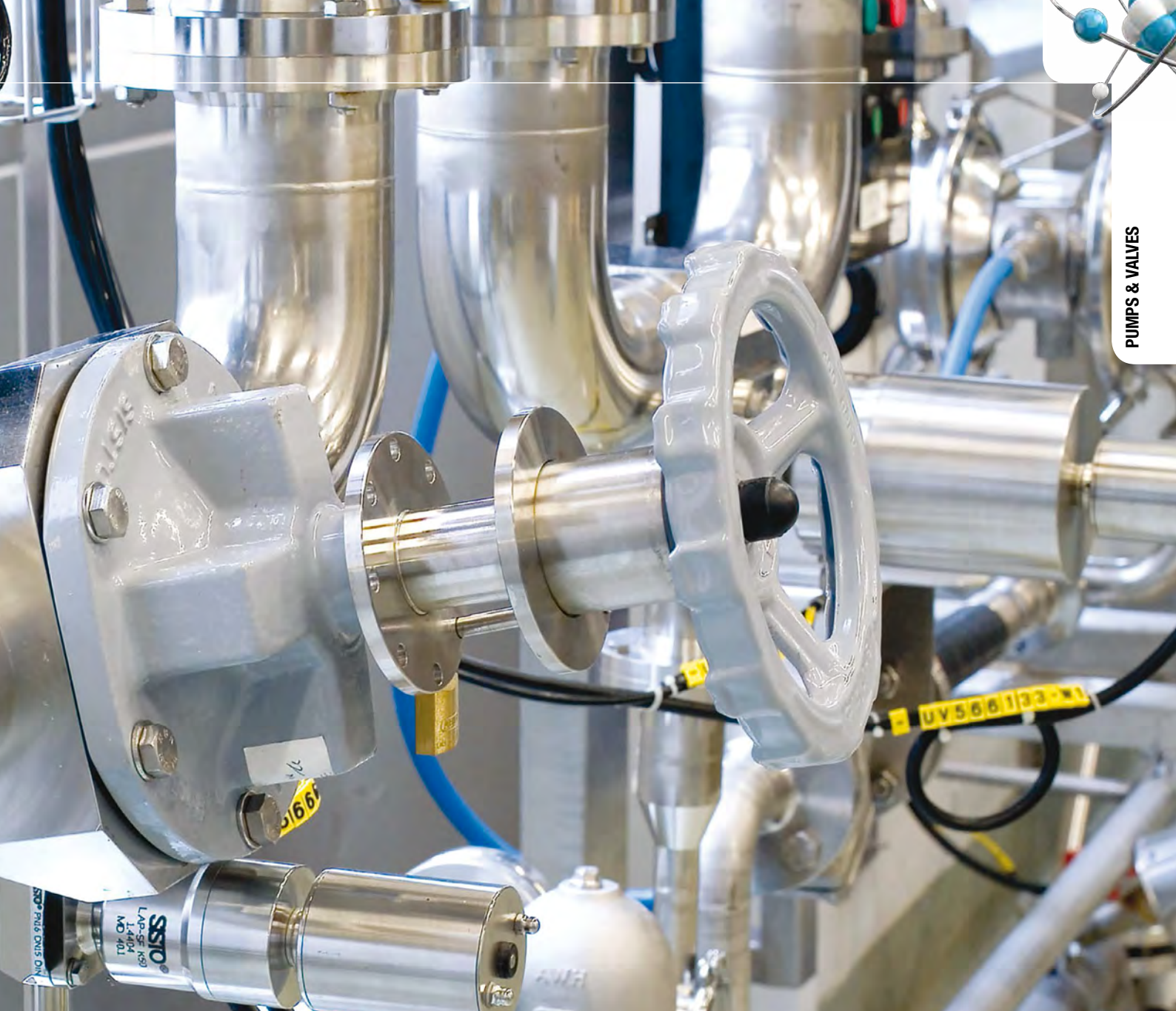
In old systems a lack of space was a common problem and it is also an issue in new biotech systems. This has given rise to the present trend of building production facilities in an increasingly compact way, often grouping together multiple valves as valve manifolds. As a result, many valve manifolds



are frequently installed under the tanks. From a hygiene point of view, this new design offers nothing but advantages, as Knöbl explained: "The compact design reduces the necessary distances between the valves and eliminates dead legs in the piping."

Another trend that has an impact on the production process is the increasing use of very small nominal diameters. Typical nominal diameters used in the pharmaceutical sector range from DN 8 to DN 50; most are between DN 15 and DN 20. However, valves with a nominal diameter of DN 2 are also needed sometimes. "These are not laboratory applications," clarified Knöbl. "Producing such nominal diameters is a big challenge in terms of the production process." For this reason, in addition to establishing new production processes at SISTO, the necessary measuring methods and quality monitoring systems were also set up.

Very low flow rates are also needed in processing methods such as chromatography, for example. Another particularity: these applications require a very high compressive strength in some cases and operating pressures of 20 bar are quite usual. "In normal pharmaceutical production we have operating



Diaphragm valve in a plant for producing agents

pressures of 2 to 3 bar. In WFI supply, the pressures can reach up to 10 bar,” commented Knöbl, comparing applications.

Key starting point – the material

A valve for sterile applications has to do far more than steer fluids for CIP/SIP cleaning into the right direction. For over 20 years the Luxembourg-based valve manufacturer has been optimising its SISTO-C series and supplied prestigious projects with this diaphragm valve. “Around hundred thousand of these SISTO-C valves have been installed to date,” said Knöbl. The valves fulfilled the following requirements:

- GMP Guidelines (Good Manufacturing Practice)
- Food and Drug Administration (FDA) of the USA
- United States Pharmacopeia (USP)

The selected materials were very carefully tested and their production was precisely documented. To avoid cracks in the high-alloy stainless steels during orbital welding and to enable optimum machining processes, the sulphur content has to be kept within very tight tolerances. Furthermore, an optimum delta ferrite content is a key requirement in the pharmaceutical sector. Pharmaceutical valves are often

made from forged materials to ensure high steel homogeneity and to avoid the risk of cavities in the material. Of course, this requires the valve to be produced in large batch sizes. Economically viable production of forging dies can only be achieved by producing large quantities.

Completely enclosed diaphragm

During the design stage of the SISTO-C series innovative new paths were explored. A wide range of variants comprising simple straight-way valves, welded designs and complex multi-port valve manifolds means that SISTO can offer customised solutions for every type of application. “If we combined all of the possible components together, we would have at least 1 000 different variants,” Knöbl estimated.

The valve series set new benchmarks with its completely enclosed diaphragm. This is crucial for the high pressure limit offered by the series. The diaphragm is inserted in a recess and seated on a small defined surface. The biggest advantage is that it is very robust in operation and has an increased service life compared with conventional diaphragms. “This property often influences our customers’ purchase decisions



SISO-C diaphragm valve



3A and 3B: complex Multiport valve



Elastomer diaphragm with TFM-film



Diaphragm valve with pneumatic actuator and limit switches



Preparation of EPDM diaphragms for vulcanisation

because it is the valve's long service life that ultimately ensures reliable processes." Another design element that contributes to the extended service life is the diaphragm's spiral support. This absorbs the pressure forces transferred from the fluid to the diaphragm and thus reduces the load on the elastomer.

The valve's centrepiece – the diaphragm

In order to be able to offer the ideal diaphragm material for every fluid, three different qualities are available. It is possible to change the diaphragm using one of the same size without having to replace other components. Premium EPDM grades are used for the elastomers. The raw mixtures that are processed to produce the diaphragms are prepared by materials specialists in accordance with the required specifications for the particular moulded part. EPDM diaphragms are particularly suited for use in 'cold applications' such as WFI systems, and thanks to their high ozone resistance, they have proven extremely successful in CIP applications with all types of standard cleaning fluids.

Elastomer diaphragms with a bonded TFM film are another variant, offering improved mechanical properties and lower permeability compared with conventional PTFE. The TFM's chemical and thermal properties make this diaphragm type ideal for applications with chemically aggressive fluids and high temperatures.

This material is also used for fluids that have to be protected against rubber abrasion and fluids containing oils and greases. Diaphragms with a higher TFM thickness are also available. To make optimum use of the force exerted via

valve actuation and to ensure a long service life of the plastic, the TFM diaphragm is backed by a second diaphragm made from EPDM. This dual element design is ideally suited to high chemical and thermal stresses.

Dependable actuator and reliable feedback

The vast majority of the valves have pneumatic actuators, some of which are equipped with limit switches for open/closed position feedback or with positioners for position control. With regard to sampling, some companies prefer to have everything run automatically while others favour a manual actuation method. What is important for the user is that the valve manufacturer itself installs the pneumatic actuators and fits the actual-position feedback devices.

This is the only way to ensure that the actuator and the valve are perfectly matched to each other in terms of stroke and actuating force, resulting in a positive effect on the service life and reliability. For Knöbl the key to success lies in the high degree of in-house production: "We produce all components ourselves in Luxembourg – from machining to electrolytic surface treatment to diaphragm production."

Today, diaphragm valves form an integral part of a wide range of systems used in the pharmaceutical and biotech sector. Thanks to their special design, they provide the basis for reliable aseptic production. Even in the face of increasingly stringent requirements, they will continue to play a crucial role in the production process.



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Pump selection and application guidelines – Part 2

by Neetin Ghaisas, ME, PEng, Director of Design Engineering and Rotating Equipment Group Leader at Fluor Canada, Calgary, Alberta, Canada

A standard set of considerations and best industry practices that Rotating Equipment Engineers apply in the selection of various types of pumps and their auxiliaries, is described. Typical services and limiting operating conditions of centrifugal and positive displacement pumps are included to aid in the selection process. Part 1 appeared in the August 2015 issue.

Lubrication of pump bearings

Standard methods of lubrication are:

- A Grease
- B Wet sump with oil ring or oil flinger
- C Purge (wet) or Pure (dry sump) oil mist
- D Forced oil
- E Bearings lubricated by pumped fluid as in the case of magnetic drive pumps and vertical line shaft pumps.

1. The first three types of lubrication methods are used for anti-friction bearings.
2. Forced or pressure oil lubrication is applied to hydrodynamic bearings.
3. Oil lubrication is the preferred method over grease lubrication.

Minimum specification requirements and limiting conditions grease lubrication

- A Greased bearings should be used when oiled bearings cannot be used; such as in cryogenic services where the fluid temperature may be close to pour point of the mineral oils or where access is limited or where leakage of oil can be hazardous or surrounding atmosphere is laden with soot, dust, or ash particles.

- Most calcium, barium and lithium based greases have an operating temperature range of -30 to +120 °C. Organic thickener grease such as alkoxyfluoroether oil based grease have a higher range; -40 to +250 °C. Greases with solid lubricants are normally used for mixed/boundary friction. During operation, thickeners in grease together with wear particles gradually form abrasive paste which in turn, may induce further wearing of bearing elements.
- When sealed bearings are required, engineers should specify “Sealed for bearing life” greased bearings. Use of sealed greased bearings is usually limited to operating temperatures not exceeding 100 °C.

Oil lubrication

- Wet sump with oil flinger is the preferred method of lubrication for horizontal pumps.
- Pump bearing housings should have non-contacting, labyrinth type seals as a standard to preclude atmospheric contaminants from entering the housings. For pumps installed outdoors in dirty environments (loose fly ash, soot, dust, sand etc.), magnetic type bearing isolator seals should be considered to achieve positive isolation of bearing housings from the environment, especially when the pump is not in operation.





- Oil lubricated anti-friction bearings with non-metallic cages can continuously operate at elevated temperature up to 120 °C. Polyamide, pressed steel and machined brass bearing cages are suitable for different operating temperatures (steel cages can operate up to 300 °C, machined brass cages are suitable up to 250 °C while glass fibre reinforced polyamide cages have an operating temperature range of -40 to 120 °C). Bearing manufacturers should be consulted to make the most appropriate choice of bearing type, clearance and materials. Thrust bearing cages should be specified in non-sparking metallic construction.
- Consideration should be given to using a pure oil mist method when bearing operating temperature is in excess of 120 °C. It is known from experience that pure oil mist helps bearings to run cooler.
- Hydrodynamic bearings are required when the conditions as specified in "Table 9 – Bearing Selection" of API 610, 10th Edition, exist. The pressure oil system for hydrodynamic bearings should be in accordance with Chapter-3 of API 614, 4th Edition - General purpose oil system. Some users favour special purpose oil systems as specified in Chapter-2 of API 614, 4th Edition, for unsparred pumps requiring hydrodynamic lubrication.

- Specify finned bearing housings and fan cooling if the operating temperature of the pumped fluid is below 200 °C. Beyond 200 °C, finned tube oil cooler mounted inside the bearing housing should be stipulated.

Pump baseplate grouting considerations

- For baseplate mounted pumps and drivers rated up to 150 KW, cementitious grout can be used. The cost of cementitious grout is typically one third that of epoxy grout but it lacks the bond strength and nonporous surface finish of epoxy grout. Epoxy grout should be used beyond 150 KW driver rating.
- For centrifugal pumps handling acids, oils and aggressive/reactive chemicals, epoxy grout should be specified regardless of the driver rating.
- Epoxy grout should be a standard for reciprocating pump baseplates.
- Baseplate surfaces which will come in contact with grout must be cleaned as outlined in SSPC-SP6 (Society for Protective Coatings).
- Most epoxy primers (except inorganic zinc silicate primer) applied in preparation of epoxy grout is typically effective only for 90 days. If grout work on site is expected to take



A.	Minimum service factor: (Standard SF=1.5 for Disk/Diaphragm Couplings)	1.0 for constant torque applications 1.25 for pumps driven by motor + gearbox 1.5 for PD Rotary pumps 2.0 for Reciprocating Pumps 125 mm (5" standard)
B.	Minimum spacer length:	125 mm (5" standard)
C.	Standard shaft end:	* Cylindrical with rectangular key, or * Taper shaft end as dictated by API 610, 10th Edition, Para 6.2.8) * Fits and tolerances on fits to be as per AGMA 9002-A86. * Taper shaft end with hydraulic fit should be specified for centrifugal pumps when power rating exceeds 1500 KW.
D.	Material	Corrosion resistant steel
E.	Minimum Balance Grade	AGMA 9
F.	Coupling Guard	In accordance with API 610, 10th Edition, Para 6.2.14 except that non-metallic guards as stated in 6.2.14 c) are not acceptable. Specify non-sparking metallic guard

place after 90 days of primer application, the baseplate will need to be recoated with primer.

- F For modularised pumps, consideration should be given to pregrouted baseplates.

Couplings and guards

Elastomeric and disk type spacer couplings are used for connecting pump and driver shaft ends. Progressive cavity pumps are driven by lubricated universal joint. While disk spacer couplings are preferred for all applications, the manufacturer's standard coupling design for vertical in-line pumps can be accepted. API 671, 4th Edition, based special purpose couplings should be specified when continuous operating speed is over 3 600 rpm.

The standard requirements for disk type spacer couplings are:

Monitoring instrumentation guidelines

- API 670, 4th Edition based monitoring instrumentation should be specified for pumps fitted with hydrodynamic bearings and rated 1 118 KW (1 500 HP) and above. This requirement also applies to pump drivers (steam turbines, electric induction motors and gear units, if furnished).

Radial bearings

- X-Y pair of non-contact proximity probes for each radial bearing Two-(2) Resistance Temperature Detectors

(RTDs) per bearing

- Thrust bearing
- Two-(2) axial position non-contact proximity probes
- Two-(2) Resistance Temperature Detectors (RTDs) per side (active and inactive); total four-(4) RTD's per bearing

Phase reference probe

- On motor and steam turbine shaft ends.

Winding temperature RTD's

- Two-(2) per phase; total six-(6) RTDs

Casing accelerometers

- One accelerometer each on pinion and gear sides
- Casing accelerometer should be furnished for direct acting reciprocating pumps above 150 KW.

Pumps fitted with hydrodynamic bearings and with rated power between 746 KW and 1 118 KW should have provision for installing non-contact type radial vibration and axial displacement probes. RTDs should be furnished for pump and driver radial and thrust bearings.

Vibration, thrust position and bearing temperature-related shutdowns are generally dictated by plant operating and safeguarding philosophy and should be agreed to by all parties involved in equipment selection, including the equipment manufacturer.

This article first appeared in 'Pump Engineer News' published by KCI Publishing. www.pumpengineer.net

New component seal range is configurable-by-design

AESSEAL has launched a completely re-engineered modular component seal range that aims to raise the industry standard and allow configurable component seals to be built to order.

With 10 000 product lines available from stock and over 44 000 product permutations configurable, it offers customers the greatest possible product availability, quality assurance and service.

The new range, in development for almost four years, incorporates unique patented features which help to improve pump reliability. These features include improved seal face cooling through directed fluid barrier flow systems, hydraulically balanced seal face technology, and plug-in designs to improve performance and reliability.

Incorporating a build-to-order philosophy, the new range offers a larger selection of product variants and standard product lines that can easily be adapted to suit the customer's requirements.



AESSEAL's new modular component seal range

By manufacturing the majority of the parts, and having full control of the supply chain, AESSEAL can now offer a much wider portfolio of seals.

The new product range is further supported by the AESSEAL seal-selection app, enabling an equivalent AESSEAL component

seal to easily be selected knowing just the pump type, competitor seal reference, or dimensional information.

For more information contact Rob Waites (managing director) on tel +27 11 466 6500 or email rwaites@aes seal.co.za

New generation of liquid ring vacuum pumps

The new series of TRVX Pompetravaini single stage, variported, liquid ring vacuum pumps introduced a new design in performance and reliability concepts. This is the result both of Pompetravaini's 80 years of experience and of the views and suggestions of its end users; in other words, a milestone in the way Liquid Ring Vacuum Pumps (LRVPs) are designed and manufactured to provide the end users with tangible benefits.

This new hydraulic profile allows for a performance increase of over 10 % over traditional LRV designs. These increases apply to efficiency and to operational cost savings achieved over the entire pump life.

There are numerous advantages to LRVs, of which the following are just some:

- The pump weight is on average 30 % less than traditional designs.
- Compact dimensions and volume of 40 % less than traditional designs.
- Single and direct service liquid connections.
- Up to 50 % service liquid usage reduction.
- Central body impeller housing with integrated suction and discharge manifolds, a feature which reduces pump components and increases robustness.
- Suction, discharge port plates and impeller in stainless steel allowing greater reliability.
- Standard ISO 3069/DIN 24960 mechanical seals fitted, easily obtainable, reducing component stocking.
- Mechanical seals can be replaced without disassembly of the pump reducing downtime.
- External precision regulation of the impeller shaft. Easy maintenance and performance optimisation assembly time and cost.
- The length between bearing supports is 25 % less than traditional pump designs with consequent reduction of eventual vibration and shaft deflection.
- Connections are universally flanged to meet both DIN-EN and ANSI standards.

The TRVX is "a true leader in its own class" with capacities from 690 m³/h up to 2 000 m³/h with a maximum vacuum of 33 mbar abs. With this range it covers many of the industrial applications out in the market.

For more information or a quotation, contact Air & Vacuum Technologies which is the official and sole agent for the full Pompetravaini LRV range in southern Africa. Tel: 0861 VACTEC (822 832), burnm@vactech.co.za

SIL assessment of GEMÜ products

Together with the independent testing organization EXIDA, GEMÜ has assessed a selection of different products in accordance with SIL.

This assessment according to SIL covers the functional safety of the products and is used to evaluate the systems in relation to the reliability of fail safe functions. The result is safety-relevant design principles which must be complied with in order to minimize the risk of a malfunction.

SIL itself is a measure of the probability that a system will correctly fulfil the required fail safe functions for a specific time period.

In addition to pilot valves, the GEMÜ products assessed include globe and diaphragm valves and electrical position indicators.

By assessing the product selection referred to here, GEMÜ is complying with its customers' requirements primarily from the process and manufacturing industries. With the data made available, these can now carry out assessments of entire plants.

GEMÜ is one of the world's leading manufacturers of valves, measurement and control systems. Over the course of more than 50 years, this globally focused, independent family owned enterprise has established itself in important industrial sectors thanks to its innovative products and customised solutions for process media control.

A broad based modular system and adapted automation components mean that individualised standard products and customised solutions can be combined to make over 400 000 product versions.

For more information contact Ivona Jovic on tel: +49 (0) 7940 123 708, email: ivona.jovic@gemu.de or go to www.gemu-group.com.

Acquisition could bring new pumps to market

Customers in mining, industry and petrochemicals are likely to benefit from increased competition in the South African pump market resulting from the acquisition in June 2015 by WPIL of Italian pump company Gruppo Aturia. WPIL is the holding company of local manufacturers APE Pumps and Mather+Platt, both well known in the South African and southern African pump markets.

Gruppo Aturia has as its core product a range of horizontal split-case pumps already covered by Mather+Platt at low duties, and by APE Pumps at the high-volume end of the market.

However, there are other product ranges not covered by the South African companies, including submersible vertical turbine pumps and sealless magnetic drive pumps.

Gruppo Aturia also manufactures specific models of horizontal and vertical multistage pumps that have the potential to plug gaps in the local ranges.

The WPIL acquisition includes subsidiary companies of Gruppo Aturia. Rutschi Fluid (Switzerland) and Pompes Rutschi (France) focus on nuclear and petrochemical applications, potentially providing new



API 685

API 685 products for local petrochemical applications.

“We are excited about the potential for new products offered by this acquisition, and will certainly make as many of these pumps as possible available to local customers,” said a spokesman for the WPIL.

“We are also investigating the introduction of an asset management

product that will allow customers to offload responsibility for pump reliability and up-time onto us.

An announcement on the availability of new products, including asset management, would be made soon, the spokesman said.

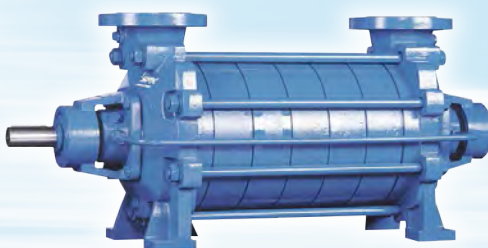
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AZ-Armaturen South Africa: Celebrating 30 years in South Africa

AZ-Armaturen South Africa, a subsidiary of the German AZ-Armaturen Group is excited to have reached its 30-year anniversary as a leading manufacturer of high quality plug valves and special valve solutions. The company is proud to celebrate three decades of progress, success, development and its commitment to manufacture sleeved, self-lubricating plug valves in Sub-Saharan Africa.

The AZ-Armaturen Group manufactures industrial valves, particularly plug valves for many production facilities in the chemical, petrochemical, mining, power, pharma, paper and food industries. The family-owned business was founded 1963 in the Black Forest in Germany, where the first plug valves were manufactured. In 1985, AZ-Armaturen South Africa was founded as the first manufacturing subsidiary. Since the day of founding, AZ South Africa has been committed to manufacturing the majority of AZ's product range locally and to purchase castings and raw materials from South African suppliers. In 1995 and 2009 respectively, manufacturing plants were established in Brazil and China.

Global growth, market-driven product innovation and the utilisation of new materials and innovative production processes can only be achieved with a team of motivated employees. AZ-Armaturen South Africa would like to offer its heartfelt thanks to customers, employees, suppliers and partners for their continuous support.

Improved valve design sets quality benchmark to a new top level

The AZ-Armaturen Group has further developed its high quality plug valve range with the introduction of a safe, reliable and modular sealing and mounting arrangement.



Team AZ-Armaturen South Africa 2015

According to a spokesman for the company, the specialised valve design sets the quality benchmark high for valves used in hazardous, dangerous and difficult applications where highest reliability is needed. The new modular valve design provides maximum flexibility so that the basic valve design can easily be modified according to customer requirements. The new "ISO-Standard" design provides advantages such as: valve free of cavities and maintenance; improved shaft and cover sealing; safety sealings to prevent fugitive emission of aggressive and toxic media; actuator mounting flange according to ISO 5211; modular system for maximized flexibility; and a patented cardanic dihedron coupling.

The new valve design will be supplied to the sub-Saharan market from early 2016 and will further benefit customers' needs by providing higher reliability, advanced safety features and more flexibility.

For more information tel +27 11 397 3665, email sales@az-armaturen.co.za, or go to www.az-armaturen.co.za.



Monitran's new compact hand-held vibration meter

Instrotech, distributor and manufacturer of a range of process control instrumentation and specialised systems, has announced the launch of UK-based Monitran's MTN/VM220, a compact, handheld meter for measuring vibration levels. It is a rechargeable, portable instrument designed to operate with a constant current accelerometer to provide accurate vibration measurements. Conforming to ISO10816-3, the MTN/VM220 is engineered to detecting the early signs of component wear or failure in pumps, motors, gearboxes and other mechanical assemblies.

Measuring only 122 x 78 x 28 mm, the MTN/VM220 has an easy-grip, rubberised case and a long-life rechargeable battery.

The unit is shipped in a foam-lined, durable carry case and includes the MTN/2200, a general purpose sensor probe with a default sensitivity of 100 mV/g, as well as a magnetic base and spike (for use with the probe), a coiled cable with a 4-pin Lumberg connector at each end, and a universal battery charger.

The meter features a colour LCD display and has the ability to store up to 100 readings against a real-time clock. Monitran is a world leader in the design, development and manufacture of sensors and systems for vibration and displacement measurement.

For more information on Monitran's new MTN/VM220 vibration meter, contact the



Instrotech team on +27 010 595 1831 or email sales@instrotech.co.za.

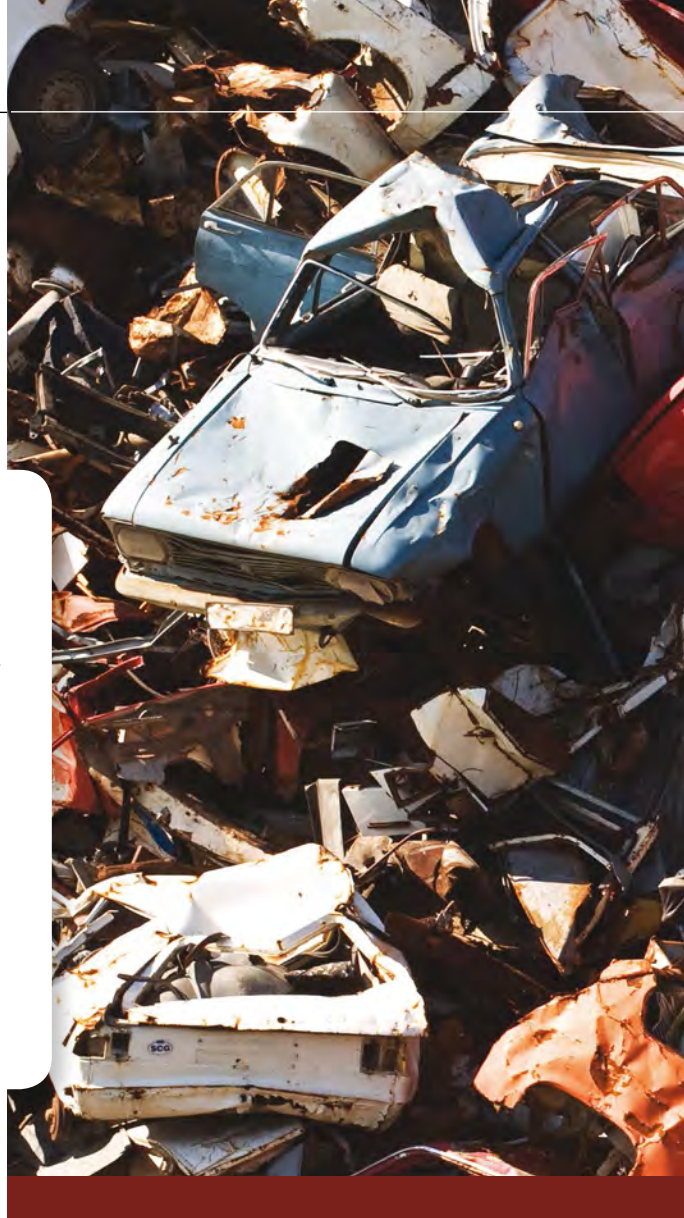
Precious metals in automotive technology: **an unsolvable depletion problem?**

by Ugo Bardi, Dipartimento di Scienze della Terra, Università di Firenze, Italy and Stefano Caporali, Dipartimento di Chimica, Università di Firenze, Italy and Consorzio Interuniversitario Nazionale per la Scienza e Tecnologia dei Materiali, Firenze, Italy

Precious metal scarcity is a critical factor that may determine the future development of road transportation in the world. The authors state that we must explore new technologies for road transportation, concluding that the clean engine of the future will most likely be electric and powered by batteries.

Road transportation today is mostly based on vehicles powered by internal combustion engines. These engines need fuels which can be easily gasified and which can provide a large amount of energy per unit weight and volume. In practice, all the engines commonly available on the market use hydrocarbons as fuels. In particular, liquid hydrocarbons such as gasoline and diesel fuel are the most commonly used even though, in recent times, gas phase fuels such as methane and liquefied petroleum gas (LPG) have become popular due to their lower cost.

The combustion of hydrocarbons in these engines creates a number of polluting substances, including unburnt hydrocarbons, particulate matter, and harmful chemicals such as carbon monoxide (CO) and nitrogen oxides (NO_x). In engines operating with the Otto cycle and using gasoline as fuel, these chemicals are removed using catalytic converters at the exhaust. These devices can substantially reduce the amount of toxic substances emitted, but they are also expensive because of the need to use platinum group metals (PGM) as active catalytic substrates. On average, an automotive catalytic converter contains $1-3 \times 10^{-3}$ kg of platinum and smaller amounts of rhodium and palladium. As a consequence, nowadays, automotive converters use more than half of the world's mineral production of platinum [1]. This raises the question of whether there exist sufficient PGM mineral resources extractable at reasonable prices in order to satisfy the future demand.



In this article, we update previously published results and discuss the issue in view of what appears to be a 'production peak' for PGMs observed in recent years. We discuss how the depletion of PGM may affect the world's road transportation system and we arrive at the conclusion that high costs of platinum group metals is a problem destined to get worse with time. That creates a critical problem for a large sector of the world's road transportation system which cannot run without PGM-based catalysts, unless we were to return to unacceptable levels of pollution. This situation is a strong incentive for developing radically different alternatives, in particular battery powered vehicles, which are inherently cleaner and appear to suffer from less important depletion problems.

Pollution removal from combustion engines by means of catalytic converters

Practically all internal combustion engines available on the market today use hydrocarbons as fuels. The combustion of hydrocarbons in internal combustion engines generates mainly water (H₂O) and carbon dioxide (CO₂). Neither is considered a harmful substance even though CO₂ is toxic for human beings at very high concentrations [6]. Both water and carbon dioxide are greenhouse gases, but only carbon dioxide creates global warming because, unlike water, it remains in the atmosphere for times of the order



of tens of thousands of years [7]. Then, the untreated emissions of an internal combustion engine normally contain substances which are toxic for human beings even at low concentrations. The most important ones are: (1) unburnt hydrocarbons, especially if aromatic, (2) carbon monoxide (CO), (3) nitrogen oxides (NO_x) and (4) particulate matter, typically in the form of carbon micro- and nano-particles.

For gasoline engines, the problem of particulate matter is less important and the exhaust filter must address the problem of eliminating three different harmful gases: CO, NO_x and unburnt hydrocarbons. This is accomplished by means of 'three way' catalysts based on noble metals (Pt, Pd and Rh, collectively referred to as 'PGM' or platinum group metals. Of these three metals, rhodium catalyses reduction while palladium catalyses oxidation; platinum is active for both. The task of the catalyst is complex because it must perform several tasks at the same time: oxidize CO and unburnt hydrocarbons, while reducing NO_x. In order to optimize the yield of these reactions, the exhaust gas must contain a specific fraction of oxygen. The correct gas composition is obtained by controlling the air/fuel mix by means of oxygen sensors at the exhaust. In general, when in good conditions and operated properly, the converter can remove up to about 90 % of the three gases; as described, for instance, by Kummer [10].

Considerable efforts have been dedicated to developing non-PGM materials that can catalyse these three reactions,

but the task has turned out to be very difficult and a practical solution has not been found [11, 12]. The electronic structure of the platinum group metals is unique and it generates chemical properties that are not matched by any other element of the periodic table nor by compounds which can remain stable for a long time in the conditions of high temperature of automotive catalytic converters. Therefore, although it is not possible to exclude an unexpected breakthrough, the present situation raises a serious problem of future availability of PGMs in sufficient amounts, as will be discussed in the next section.

Platinum Group Metals' abundance and production

PGMs may occur in native form associated with gold, iron, copper and chromium and, due to their high weight and chemical inertness, can also be found in placer deposits. The production of PGMs is concentrated in a few mines: the main ones are the Bushveld igneous complex (South Africa), the sulphide deposits of Norilsk in Russia, placer deposits in the Ural mountains (Russia), the Sudbury mine (Ontario, Canada), the Hartley mine (Zimbabwe), the Stillwater complex (Montana, USA), Northern Territory (Australia) and the Zechstein copper deposit in Poland. South Africa produces about 85 % of the total world PGM production, having 82 % of the world's resources [17].

In Figure 1 on page, we can observe how the production

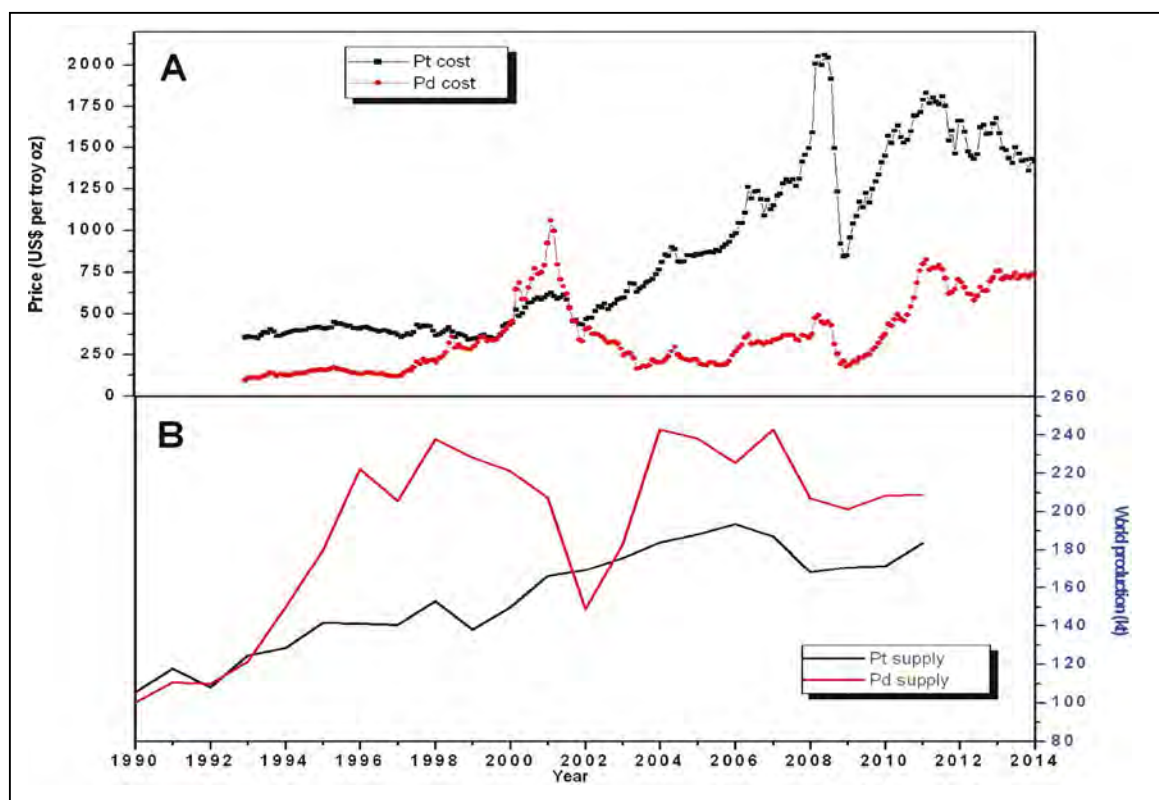


Figure 1. (A) Pd (red) and Pt (black) monthly average price in US dollars per troy oz and (B) world production in thousands of tons. Data sources [25, 26].

of both platinum and palladium appear to have peaked in 2006, maintaining a plateau at lower levels afterwards. We cannot exclude that a weak economy would depress demand and make the 2006 peak as the ultimate production peak for these metals. (Editor's note: As indeed it has, the current, 2015, price for Pt is about \$1 000 per ounce and the production about 120 kTonnes per annum.) In any case, the plateauing of the past few years clearly indicates the strain placed on the industry by a combination of high costs of extraction and high costs of energy.

At these levels, the cost of the active metals in a three way catalytic converter can be US \$200-300.

What can be done to ease the high cost problems that derive from increasing PGM scarcity? As discussed in the previous section, developing non-noble metal catalysts appears to be a very difficult option, hence – if we want to maintain the present technology of pollution abatement in combustion engines – we can at least mitigate the problem by (1) reducing the amount of catalyst in the converters and (2) recycling platinum group elements more efficiently.

Reducing the amount of PGMs in catalytic converters – and in particular of the expensive platinum – is possible, but there are limits to this approach. Often, it is possible to attain such a reduction by increasing the surface/volume ratio of the catalytic particles that is making them smaller. However, below some dimensions, the particles become unstable, may move and coalesce with other particles with an overall loss of catalytic activity, or simply, they can be removed from the substrates and be carried away by the exhaust. It is also possible to vary the ratio of the different metals in the catalyst, for instance, partly replacing platinum with palladium, which has a market price about one third lower. This is a route presently explored by catalyst manufacturers but, of course, it does not solve the problem at its root.

Regarding recycling, established procedures exist to recover platinum and the other noble metals from automotive converters efficiently [28]. The concentration of platinum in converters may be as high as 2 g/t in the ceramic catalyst brick, of the same order of magnitude as the gold content in primary ores (on average < 10 g/t). However, the end of life recycling rates of platinum from catalytic converters reach a global average of only 50-60 % [29].

This relatively low amount recycled is the result of two factors: one is the loss of noble metals during the life cycle of the catalyst, the other is that not all catalytic converters are actually recycled because cars may end their life in remote areas where there are no recycling facilities, or be lost in conditions where the catalyst cannot be conveniently recovered. While the recovery rate of old converters can surely be improved, we face a fundamental problem when considering the PGM loss at the exhaust. In an early study [30] the loss (or 'attrition') of noble metals during operation has been estimated as 6 % over 80 000 km of operation of the car. These metals are potentially dangerous pollutants and have generated serious concerns regarding their effects on the environment [31] and on human health [32, 33]. Apart from this, these metals are dispersed in the environment at very low concentrations and are lost forever for all practical purposes. For this reason, recycling alone cannot solve the PGM depletion problem.

Consequences of PGM scarcity: moving to electric transportation

Given the inherent limitations of the previously discussed solutions for the limited availability of PGMs, it appears clear that the scarcity of platinum group metals is a critical factor in the future of road transportation. What alternatives can be conceived to solve the problem? A much discussed possibility in this field is to use fuel cells operated using

hydrogen as fuel. Fuel cells are efficient converters of the chemical energy stored in hydrogen, able to transform it directly into electrical energy. Because of this factor, fuel cell-powered road vehicles can attain an acceptable range by avoiding the need for an inefficient thermal engine. Unfortunately, this approach raises an even worse platinum depletion problem than that encountered with exhaust catalysts. Low temperature fuel cells, usually using proton exchange membranes as electrolyte, need about 1.3×10^{-3} kg of platinum per kW of engine power as catalyst at the electrodes. Replacing the present world fleet of road vehicles with this kind of technology would simply not be possible with the limited platinum reserves available [34]. The industry is making a considerable effort in order to reduce the amount of platinum used in fuel cells, but it does not appear possible to eliminate it completely.

So, a better idea to provide power for road vehicles may be based on the new generation of lightweight batteries for automotive use. In the past, several new electrochemical systems were proposed and tested, such as nickel-cadmium, or nickel-metal hydride. However, at present the main effort in this field is directed toward batteries based on lithium compounds, which provide the best available values of energy density. The range of a road vehicle powered by lithium batteries is still lower than that obtained by traditional thermal engines, but it is often perceived as acceptable by customers. The problem with lithium is that it may also suffer from depletion problems and this fact has generated a lively debate on the subject [35–39].

On this point, we remark that there are three main types of lithium sources: brines, minerals (eg, pegmatites), and seawater. Brines formed by evaporation are commonly found in salt flats, such as those located in South America, China, and Tibet. Among these salt flats, the Salar de Atacama in Chile is at present the world's largest currently exploited lithium deposit, producing almost 40 % of world lithium. At the current production rate (37 000 t per year), the known lithium reserves (13 million tonnes) [18] would last for more than 300 years. If we could exploit all the land-based estimated resources then we would have about a millennium's supply, even without considering the other possible land sources. Extracted from seawater, lithium is one of the few minerals whose concentration is sufficiently high that extraction from the sea is an economically conceivable task [40], even though it is not industrially performed today.

However, just as it was discussed for PGMs, simply listing theoretically available resources is not a good way to understand how depletion will affect extraction costs and, hence, market prices. A detailed comparison of the relative depletion trends for PGMs and lithium is outside the scope of the present article. However, we wish to remark that: (1) Unlike platinum and other PGMs, lithium production, so far, has shown no production peaks. (2) Lithium prices have increased during the past few years, following the general trend of mineral commodities, however – unlike the case of PGMs – the pure cost of lithium is still a negligible fraction of the total cost of an electric car. (3) Lithium recycling does not suffer from the dispersion problem that strongly limits the fraction of the PGMs which can be recycled from a

catalytic converter. At present, lithium prices are still so low that recycling is not normally performed, but in the future that will be certainly possible. (4) Most of the negative views of lithium's future availability, eg, those expressed by Tahil [34], are the result of the assumption of a continued growth in the number of road vehicles for the foreseeable future. This assumption looks unrealistic in the present situation of economic constraints. The world sales of cars are still weakly increasing [41] but have stalled and are going down in many countries. This situation appears to be leading to a static volume and perhaps a contraction in the number of road vehicles that society will be able to afford in the future and that will surely ease the depletion problem with lithium, especially considering that, unlike the case of PGM, a very high recycling rate is possible with lithium batteries.

As a final note, we need to consider also that a radical shift to electric vehicles would also generate the problem of obtaining sufficient electric energy. This subject is beyond the scope of the present article, but it is a very general problem that involves the transition from a fossil fuel-based economy to a renewable (or nuclear) based one. In general terms, the transition is ongoing [42, 43] and is involving a shift from chemical energy obtained from fossil carbon to electric power directly obtained from non-carbon fueled sources. This transition is obviously favouring applications which can directly use this electric power, such as electric vehicles. So, at least for those applications which do not demand long range transportation, the substitution of internal combustion engines with battery powered electric motors would greatly reduce pollution and also lengthen the life span of the presently available mineral resources of platinum group metals. These could therefore be saved for other purposes in catalysis as well as in other fields of the chemical industry.

Conclusions

The peaking observed in the production curve for platinum group metals indicates that the mining industry is already under heavy strain in maintaining a sufficient supply of PGMs at costs compatible with those of road transportation vehicles. This is a critical problem for the whole world's transportation system and it is not too early to start developing new technologies for road transportation which do not involve the use of extremely rare and precious materials where, even in the short term, supply disruption and price spikes could threaten the whole system. In the long run, we argue that the only definitive solution for the PGM depletion problem will be to replace vehicles powered by fossil hydrocarbons by battery-powered electric vehicles.

Acknowledgments

The authors would like to thank the Club of Rome for providing a grant that made this study possible within the production of the 33rd report to the Club of Rome titled 'Extracted' [44].

Note: This article was originally published in 'Minerals' 2014, 4, 388-398; doi:10.3390/min4020388 ISSN 2075-163X, www.mdpi.com/journal/minerals, and has been shortened by the editor of 'Chemical Technology' because of space constraints.

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Municipal solid waste suitable material for design products

According to VTT Technical Research Centre of Finland, municipal solid waste can be used as material for design products. In the ReLight project, soiled, used grave candles were turned into high-standard plastic material, which was utilised for making a trial batch of Origo keyrings designed by Eero Aarnio.

Even though plastic collected with mixed waste can be used for energy production, recycling it as material would be a more desirable alternative in terms of the environment and material economy. Generally, municipal solid waste is regarded as secondary material. The ReLight project showed, however, that it can be used as material for high-quality design products. In the future, even design products can increase their brand value by using recycled materials.

In this trial, VTT chose to use grave candles, soiled with soot, paraffin and stearin, as raw material. Scouts collected them from graveyards in Tampere, and a school class currently collecting money for a school trip, was invited to VTT to sort the load. VTT recovered certain fractions of the material, cleaned them and ground them to be used for melt processing of a material mixture. The design used for the demo piece was a keyring made in the shape of Origo bright light lamp designed by Eero Aarnio. Injec-



In the ReLight project, used grave candles were used for manufacturing high-standard plastic material, which was utilised for making a trial batch of Origo keyrings designed by Eero Aarnio. (Photo: Innolux)

tion moulding was performed by Merocap in collaboration with All-Plast, and the idea generation and assembly of the design keyring was conducted by Innolux.

The result was a keyring, where 85 % of the plastic parts contain recycled plastic materials from graveyards, with some added fillers and colourants.

"In this project implemented with an open mind, we succeeded in combining several ethically sound matters. The challenge is how to make the lighting characteristics of the material suitable for lighting fixtures requiring large amounts of material. Use of recycled materials in lighting fixture applications requires further development," states Jukka Jokiniemi, CEO and founder of Innolux.

The plastic fraction collected from graveyards mostly consists of polyethylene terephthalate (PET) or polypropylene (PP). It can also contain small amounts of PVC or plastics filled with fire retardants. The materials can be effectively sorted for industrial use. The plastic fraction can be cleaned, for example, simply by heat treatment, where stearin or paraffin residues are drained from the ground plastic material. Soot particles can be left in the final product to give a certain look for the product, or the material can be lightly coloured to hide the particles.

For more information contact Härkki Outi, Research Team Leader, on tel: +358401647647 or email Outi.Harkki@vtt.fi

ThyssenKrupp Industrial Solutions and Sasol Mining join forces in successful refurbishing project

ThyssenKrupp Industrial Solutions teamed up with Sasol technical staff to refurbish drum reclaimer no 6 which has been operating reliably at Sasol Coal Supply East Plant since it was first commissioned in 1976.

The TAS 40 bi-directional drum reclaimer is used for the bulk handling of coal which is fed into the Synfuels plant from bulk stock yards. With a 40 m rail centre, a cutting circle of 6 m and 64 buckets, the machine is capable of handling 2 200 tonnes of coal per hour.

The refurbishment project comprised the manufacture and supply of two new riding rings as well as parts and components for the refurbishment of the drive rack unit. ThyssenKrupp Industrial Solutions meticulously planned the project to ensure the least possible downtime for the customer. All the required tasks were completed on time over a period of 21 days and the machine was handed back to Sasol with no losses experienced. ThyssenKrupp also provided on-site operator training during the shutdown.

Cobus van Wyk, Technical Services Manager at ThyssenKrupp Industrial Solutions, agrees that the project's success is thanks

to a great team effort. The ThyssenKrupp Industrial Solutions Service Centre based in Chloorkop, Johannesburg, was instrumental in fabricating spare parts at short notice with Production Manager, Craig Harvey, spearheading the effort. Van Wyk conveys his appreciation to Sasol for their outstanding support and assistance, without which he says this project would not have been possible.

ThyssenKrupp Industrial Solutions' scope of supply to Sasol Mining and Sasol Synfuels over the years includes six stackers, four drum reclaimers, one portal reclaimer, one bridge type reclaimer, two curved overland conveyors for coal, two crawler mounted stacker/spreaders and two shiftable conveyor systems for coarse ash, four plough feeders, four tripper cars as well as one load-out station for export coal. Services provided over this period entail ash dump conveyor upgrades, spreader relocations, stacker upgrades as well as



refurbishment projects on all machines and equipment supplied.

ThyssenKrupp remains committed to building and maintaining customer relationships and is rightfully proud of the longstanding relationship with Sasol. "It bears testament to the fact that we supply long-term solutions that encompass equipment, training and after-sales service to maximise plant availability for our customers", concludes Van Wyk.

For more information contact Jeanine Arundale on tel +27 11 236-1128 or email jeanine.arundale@thyssenkrupp.com.

Simplifying **remote asset management with IP**

by David Bell, Consulting Solutions Architect, Cisco, California, USA

From oil well heads drilled into Arctic tundra to pumping stations far beyond the walls of water treatment plants, Internet Protocol (IP) technology is driving down the cost and complexity of monitoring remote operations while increasing critical data flows and improving cyber security.

IP creates a single, streamlined platform upon which to deliver all the services necessary to operate satellite assets. That's a significant leap forward from the conventional approach of multiple segmented systems.

Consider this: Automation controls, physical security and surveillance systems; each of these remote services have in the past required multiple, often proprietary, networks and configurations to deliver their data to central control centres. Such diversity drives up operating expenses, including the high costs of maintaining disparate services and cross-training staff on the intricacies of mismatched technologies.

Contrast to the use of IP: A single unified, wired and wireless networking platform, with integrated cyber security that easily interconnects different types of devices and streamlines data delivery and control. This just scratches the surface of the benefits that can be gained.

IP's 'always on', connections provide the ability to collect far greater quantities of data. More data provides the opportunity to perform more analytics – and more analytics means faster, more intelligent decisions to manage, monitor and maintain remote assets. This really is the 'Internet of Everything' in action.

However, with this surge of data comes the need for careful planning and engineering to ensure that each remote service receives the appropriate level of network access and priority. If the network cannot differentiate the types of traffic coming from the asset and manage them based

on priority, then all the data will potentially be fighting over the network uplinks.

The best systems also are tailored to the security needs of the remote asset, from both physical and cyber security aspects.

Streamlined wastewater management

Good planning equals good network design. Early engagement of network and automation vendors will help ensure companies with remote assets have the right services with the correct capabilities.

A case in point: Early engagement was key in the recent deployment of converged platforms for water/wastewater treatment centres in the UK and the Netherlands. Each treatment centre required a number of different remote outstations, depending on the size of its geographical reach.

Each outstation had remote telemetry units collecting various data about the localised treatment process, such as the pH, turbidity and water flow rates.

Information from these outstations is critical to helping water utility operators manage their hydrological models. The more data they have, the more information they can feed into these models to improve the efficiency of the algorithms that help balance the supply of treated water and ensure the capacity to treat wastewater. Getting this right drives down operating costs and reduces the risk of expensive fines from releasing untreated water into rivers, streams and seas.





For example, if heavy rain falls in one region, process operators know the system will receive an influx into the treatment systems there. The operators can then adjust their processes to ensure capacity is available or to divert untreated water into storage reservoirs.

In the past, limited data from this telemetry would have been delivered to the central control centre via an automation network, with separate networks for video surveillance, swipe-card entry systems and other onsite security.

Today, outstations are connected using a single IP network infrastructure that carries all data from the automation equipment, closed-circuit television and physical security devices as well as normal office traffic, such as e-mail and IP telephony.

This is possible because of various technologies, such as quality of service (QoS), Application Visibility and Control (AVC) and bandwidth management. These technologies are built into the IP network devices and accomplish the critical task of delivering network data according to the needs of the specific applications. If issues arise that cause network congestion, QoS and AVC ensure the most critical automation control traffic is delivered first and then prioritises delivery of other business and security traffic depending on criticality.

For example, non-essential closed-circuit video from the outstation could be classed as low priority traffic,

closed-circuit video for process monitoring would have a higher level of priority and automation control traffic would be the highest priority.

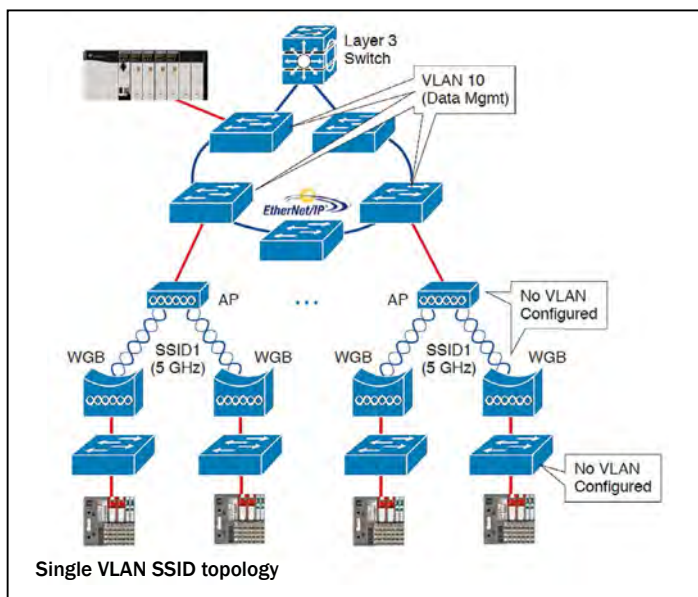
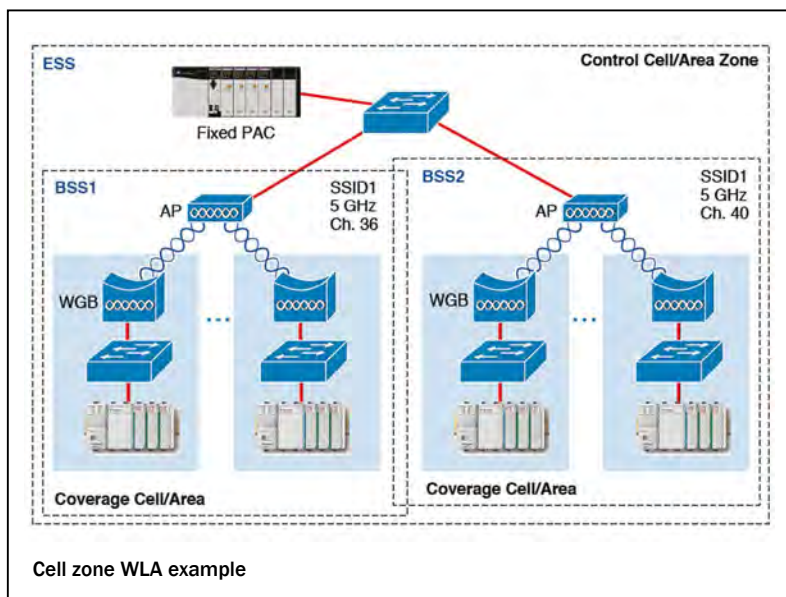
In-depth network security

Oil well heads and drilling pads tend to be located in remote locations, including some of the hottest and the coldest places on the planet. These assets may be far from the nearest human outpost, however, they are still targeted by people who want to gain unauthorised access to the IP network supporting them.

The first lines of defense are simple: physically securing remote assets with fences and putting the automation and network devices into locked enclosures and cabinets. It may also be appropriate to provide closed-circuit surveillance and associated video analytics to detect intrusions. However, how should the network be secured from a 'cyber' standpoint? If somebody successfully bypasses these physical barriers, they can plug into the network. How do you protect against that threat?

Some of the simplest safeguards come down to the capabilities built into the network access switch and then more advanced technologies can be layered on top of this to provide the 'Defense-In-Depth' approach that presents multiple barriers to cyber attackers.

Managed switches have basic built-in security capabilities to limit the number and types of devices that can



be connected, some with the ability to prevent the connection of unauthorized devices.

Firewalls can restrict traffic flows between certain devices but have no understanding of 'who' may be using those devices. The addition of modern security technologies such as Identity Services, enables connected devices, the user of the device and their associated traffic to be profiled. This in turn allows the creation of company-wide policies that determine who should have what level of network access, regardless of where they physically connect to the network. This could be wirelessly connected in the company headquarters or physically plugged in with a cable while out maintaining a remote asset. In another example, if a company employee logs onto a company laptop and accesses the network, he/she could be given unrestricted access. However, if a contractor is logged onto the very same laptop, he/she could be restricted to accessing just the automation devices and servers they support.

Other technologies like Intrusion Prevention and Detection can continuously scan and monitor the traffic crossing a network. These can delve deep into network packets, providing a view into how the network and automation protocols are behaving. If something abnormal occurs within the automation protocol, whether intentional or malicious, alerts can be generated allowing operators early visibility of potential issues. If the alerts relate to remote assets, operators can bring up closed-circuit video cameras, see what



is happening on that site and then provide the appropriate response limiting the spread of any problems.

Remote assets don't seem so remote anymore

More and more process and automation managers are looking for the infrastructure and technologies that will help them better monitor and operate their satellite assets. Many of these managers have already begun the migration toward IP tools, devices and services that can help them create a single, streamlined communications platform. This move is driving down the cost and complexity of monitoring remote assets, while increasing critical data flows and improving cyber security. As a result, remote assets are becoming nearly as easy to manage as local assets.

This article was originally published on the website to be found at <http://www.industrial-ip.org/knowledge-center/solutions/remote-assets-and-services/simplifying-remote-asset-management-with-ip>, and is reprinted with kind permission

ThyssenKrupp Industrial Solutions opts for Siemens software

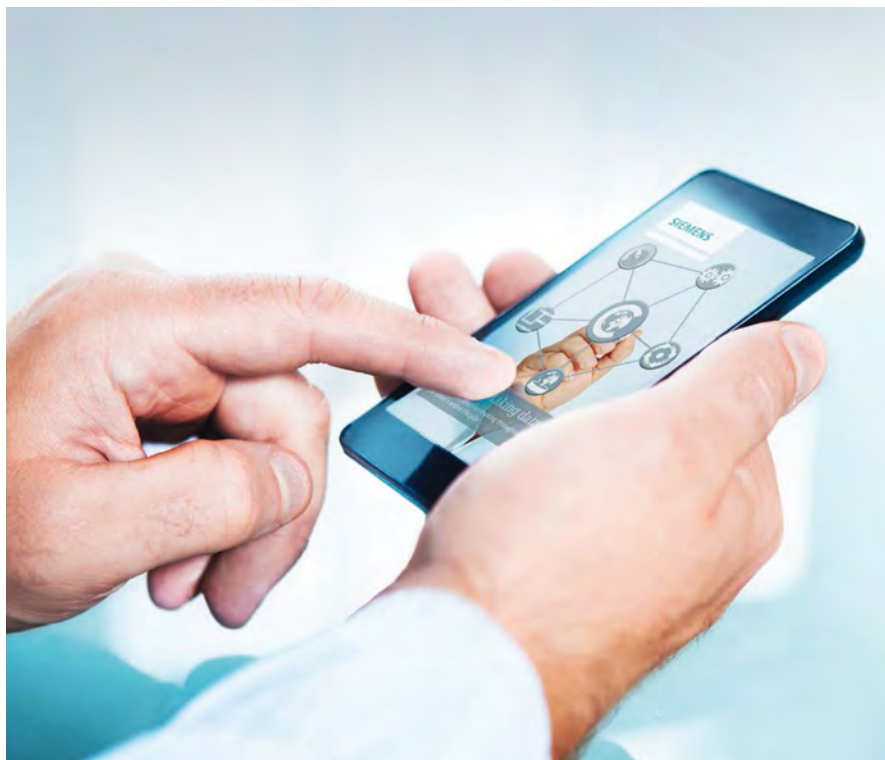
ThyssenKrupp Industrial Solutions, the plant construction specialist within the ThyssenKrupp group, has opted to use Siemens' Comos plant engineering and plant management software solution with immediate effect throughout the company as part of the further integration of its global plant construction business.

The Process Technologies unit (formerly Uhde) has already been using Comos since 1997. Using standard software enables ThyssenKrupp Industrial Solutions to handle global engineering processes and plant management much faster and more efficiently.

Jens-Michael Wegmann, Chief Operating Officer and Director of the Industrial Solutions Business Area, comments: "For us, Comos is a future-proof software solution for holistic plant management over the entire lifecycle of an industrial plant. Consolidating and harmonising the IT infrastructure provides us with the basis to make optimum use of global opportunities for growth in plant construction."

Andreas Geiss, Vice President, Comos Industry Solutions: "We are delighted at the decision by ThyssenKrupp Industrial Solutions to extend our long-established collaboration to cover the whole of the enterprise. We will bring our expertise and long years of experience to bear in the form of intelligent and individual solution concepts. Our Comos portfolio helps users to meet engineering challenges that arise throughout a plant's entire lifecycle."

Comos plant engineering and plant management software encompasses the process engineering of components and plants all the way through to complete automation including operations relevant to



electrical engineering, measurement and control. The function planning complies with standards, and is therefore implemented efficiently and accurately right through to the automation, by way of the process design, basic and detail engineering phases and operations. Comos is a consistent system landscape from engineering through to operation. It enables the user to achieve higher plant efficiency through all phases of the lifecycle.

The uniform data platform of the Comos software solution gives plant designers, operators, and installers a seamless flow of project-relevant data across all company levels and project phases.

Integrated engineering reduces sources of error as there are fewer interfaces between the various technical subsystems. It also raises quality in all steps of the engineering workflow and cuts times-to-market by means of measures such as parallelisation. Jobs such as process engineering or design of the electrical engineering can be carried out in parallel with automation engineering.

For more information please go to tp://www.siemens.com/press/PR2015090317PDEN or telephone Evelyne Kadel on tel: +49 211 6916 1003; email: evelyne.kadel@siemens.com

Dangerous Goods seminar sets tone for Transport Month

At the recent Responsible Care® Transportation of Dangerous Goods seminar, organised by the Chemical & Allied Industries' Association (CAIA), CAIA encouraged its members, allied industries, students and academics in the transportation and logistics areas, to be aware of significant changes in revised legislation, SANS codes and the challenges experienced when transporting dangerous goods within Africa. The seminar's aim was to illuminate all the above and also to provide insight into dangerous goods compatibility and special provisions, such as loads.

Featured speakers included dangerous goods and legal specialists, Keith McMurray of Keith McMurray & Associates, Janette

Botha of Latamus Legal Consultants and James Buys of Sasol.

Responsible Care® supports the safe transportation of dangerous goods, no matter what mode of transport or what route is taken. Continuous efforts to improve safety during transportation and the associated handling of chemicals are part of the overall objective of both the chemical and transport industry, in accordance with the guiding principles of Responsible Care®.

CAIA launched the Responsible Care® programme in South Africa in 1994. This is the global chemical industry's unique initiative to improve health, safety and environmental performance and to communicate with stakeholders about products and

processes. CAIA is a member of the International Council of Chemical Associations (ICCA), the worldwide voice of the chemical industry, representing chemical manufacturers and producers all over the world and is recognised by the United Nations Environment Programme (UNEP). These international alliances allow the Association to source best practice in training, information, advocacy and legislative compliance.

For more information contact Deidré Penfold on tel +27 11 482-1671, email rcare2@caia.co.za or go to www.caia.co.za.

Rosatom starts construction of most powerful research nuclear reactor in the world

In mid-September this year, in Dimitrovgrad, in the Ulyanovsk region of Russia, construction of the world's most powerful fast-neutron nuclear reactor started in Russia. The research multipurpose reactor called MBIR will be used for nuclear power development projects.

The first concrete of the reactor was filled on Friday, September 11, on the site of the Russian State scientific centre, Research Institute of Nuclear Reactors (NIIAR, a part of Rosatom's branch 'Science and Innovations'). It is planned to commission the reactor in 2020.

MBIR is a sodium-cooled fast breeder reactor, the capacity of which will amount to 150 MW. It is being constructed within the framework of the Federal target-oriented program, "New generation of nuclear power technologies for the period of 2010-2015 and in the prospective up to the year 2020".

As nuclear expert, Aleksandr Uvarov, (editor in chief of the website AtomInfo.ru),



said: "MBIR is vital for development of the new types of nuclear fuel and construction materials". He noted that at present "the BOR-60 reactor is used for these purposes, but its expected life will come to an end in the foreseeable future. That is why Russia needs one more reactor that will replace BOR-60."

MBIR will become the most powerful research reactor among those being oper-

ated, constructed and even designed in the world. Its unique technical characteristics will allow for the resolution of many research problems, as well as for the creation of new energy installations, including fast-neutron reactors for nuclear fuel cycle closing.

For more information contact Tshene Wedi, Consultant at Instinctif, on tel +21 11 447 3030 or cell +27826598318.

The rise of perovskite solar cells 2015-2025

Perovskite photovoltaics efficiency gains are double those of organic PV, exciting researchers from KIMM in Korea to Dyesol in Australia. However, it is, like the little girl, "When she was good she was very, very good and when she was bad she was awful". Perovskite photovoltaics promises over 20% efficiency, low cost materials and even flexible, transparent and stretchable versions dearly needed for new applications. Record power to weight ratio is needed for the electric vehicle end game, the land vehicles, boats and aircraft described in the IDTechEx report, "Energy Independent Vehicles 2016-2026".

Ultrathin, flexible, stretchable and light-weight versions have been produced by Johannes Kepler University in Austria powering a miniature aircraft and airship. With 100% yield, exhibiting 12% efficiency, they are only 3 μm thick and weigh 5.2 g m^{-3} . Organolead halide perovskites are promising because they absorb light more efficiently: thinner layers are needed. Researchers sug-

gest it could power EIVs as robotic insects and drones, and its flexibility and stretchability could be useful in bio-electronics.

"But when she was bad she was awful". Pbl, one of the breakdown products of the perovskite, is both toxic and carcinogenic. A glass panel can be made hermetically sealed, but plastics can be easily pierced. We need a barrier layer to make flexible versions last for 5-10 years, and yet still not be that much heavier and even then it will not be chewable by children as required for packaging and toys. OPV will be better for that.

The new IDTechEx report, "The Rise of Perovskite Solar Cells 2015-2025" finds that the stability of perovskite cells under ambient conditions is a persistent problem. The perovskite decomposes in the presence of water and the decay products attack metal electrodes. Heavy encapsulation to protect perovskite can add to the cell cost and weight. Water vapour penetrating the perovskite can produce reactive iodides that rapidly corrode the metal electrodes.

Progress is being made. New perovskite solar cells with 16% efficiency have been developed by researchers from Switzerland and China. Stable and moisture-resistant, they overcome some of the problems of perovskites. An interlayer protects the metal, allowing the cells to preserve their efficiency for two days. The resulting solar cell has greatly enhanced stability because of stabilising crosslinks in the material.

On the other hand, IDTechEx advises that lead-free perovskites in photovoltaics have very low efficiency but the many other benefits may find them a market slot and they will be improved in efficiency in due course. All this will be covered by IMEC of Belgium, IDTechEx and others in presentations and masterclasses at the IDTechEx Show, November 18-19, 2015 in Santa Clara, California.

For more information email research@IDTechEx.com

Story by Dr Peter Harrop, Chairman, IDTechEx

South African chemical engineering journal goes international

Open-access journal, the 'South African Journal of Chemical Engineering' (SAJCE), has found a new publishing home at Elsevier. Originally published by the South African Institution of Chemical Engineers (SAChE), the move to a leading scientific publisher brings published papers to the attention of a wider international audience

for the first time. The Institution of Chemical Engineers (IChemE) and SAChE signed a partnership agreement in 2014. This allows both organizations to explore and offer enhanced member benefits. The partnership has enabled 'SAJCE' to join IChemE's journal portfolio, which is published by Elsevier.

The journal's aims and scope have been

revised to attract papers under a new topic heading: Unique issues facing chemical engineering in developing nations. New and emerging economies face specific technical and societal challenges. Detailed knowledge of local conditions is needed in order to tackle these challenges more effectively. This aspect of chemical engineering is not

Book launch and lecture by Prof Thokozani Majoji

On the evening of Monday, 21 September 2015 in the Richard Ward Building at the University of the Witwatersrand (Wits), Johannesburg, South Africa, Professor Thokozani Majoji of the Wits School of Chemical and Metallurgical Engineering, where he holds an NRF/DST chair in sustainable process engineering as well as being a full professor, gave a short lecture on the subject of his newly published book, 'Synthesis, Design, and Resource Optimization in Batch Chemical Plants'.

This much praised book was co-edited by Dr Esmael Reshid Seid, who has written several publications on design, synthesis, scheduling, and resource conservation, with particular emphasis on water and energy for multipurpose batch plants, and Dr Jui-Yuan Lee, an assistant professor in the Department of Chemical Engineering and Biotechnology at the National Taipei University of Technology, Taiwan, who focuses his research on process integration for energy savings and waste reduction using mathematical programming.

Professor Pramod Bajpai, Department of Chemical Engineering, Thapar University, Patiala, India describes the publication as 'an excellent collection of very relevant chapters, written by experts from different parts of the globe, covering the various aspects of scheduling, design and synthesis, and resource conservation for batch chemical plants. The environmental aspects have been addressed in the form of energy and water conservation. The emphasis has been placed on the rigour and essence of scheduling framework in batch chemical plants. It has also included the most recent and 'state-of-the-art' techniques for scheduling of multipurpose batch plants including pipeless batch plants, which are the most complex type in this category.'

At the launch at Wits last month, Professor Herman Potgieter, Head of School: School of Chemical and Metallurgical Engineering, welcomed attendees and spoke of the importance of working together as a team. Professor Zeblon Vilakazi, Deputy Vice-Chancellor (Research and Post Gradu-



Dr Esmael Seid, Professor Thokozani Majoji and Glynnis Koch, editor of 'Chemical Technology', at the launch of the book, 'Synthesis, Design, and Resource Optimization in Batch Chemical Plants' at Wits.

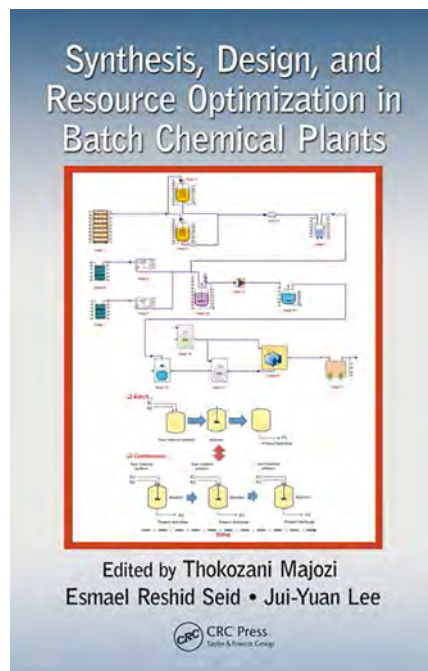
ate Affairs) and a Professor in the School of Physics at the Wits, introduced Prof Majoji, stressing the fact that the new book's contents are at the forefront of the technology of process systems in batch chemical plants.

About the book

The manner in which time is captured forms the foundation for synthesis, design, and optimization in batch chemical plants. However, there are still serious challenges with handling time in batch plants. Most techniques tend to assume either a fixed time dimension or adopt time average models to tame the time dimension, thereby simplifying the resultant mathematical models. A direct consequence of this simplification is a suboptimal process. 'Synthesis, Design, and Resource Optimization in Batch Chemical Plants' aims to close this scientific gap.

Presenting state-of-the-art models for the scheduling, synthesis, design, and resource optimization of batch chemical processes, this scholarly work describes different ways to represent and capture time in the optimal allocation of tasks to various units with the objective of maximising throughput or minimising makespan (the total length of the schedule, ie, when all the jobs have finished processing).

The contents cover synthesis and design where the objective is mainly to yield a chemical facility, which satisfies all the



targets with minimum capital cost investment and deals with resource conservation aspects in batch plants, where water and energy take the centre stage".

The lecture closed with a response to the author's address by Professor Mahmoud El-Halwagi of the Texas A&M University, USA, and a vote of thanks from Professor Ian Jandrell, Dean of the Faculty of Engineering and the Built Environment.

widely addressed by other journals, hence Elsevier's enthusiasm to publish new work in the area.

Launched in the 1980s, the 'SAJCE' is accredited by the South African Department of Higher Education and Training, and allows local researchers to claim state support for their work.

The journal will be hosted on Elsevier's

digital platform ScienceDirect, providing international exposure for authors.

The journal's core topics include: environmental process engineering, reaction engineering, separation technologies, process and materials synthesis, metallurgical process engineering, coal technology and chemical engineering education.

The journal is now open for submissions.

Authors wishing to submit a paper or get further information about the South African Journal of Chemical Engineering should visit: <http://www.journals.elsevier.com/south-african-journal-of-chemical-engineering>.



SAIChE IChemE AGM

The SAIChE IChemE AGM was held on July 22, 2015 in Rosebank, Gauteng. The president, Dawie van Vuuren, opened the meeting and welcomed everyone. Minutes from the last AGM, and the financial statements were circulated. Introductions of the council members and attendees took place. In attendance was Rodney Jones (current president of SAIMM—South African Institute of Mining and Metallurgy) and Louis Mielke (who launched and guided the Small Tonnage Interest Group of the South African Institution of Chemical Engineers).

Dawie van Vuuren gave his president's report highlighting the transition from SAIChE to SAIChE IChemE and the harmonisation of the membership grades with that of IChemE. The Western Cape (WC) member group is now active, and the 2017 SAIChE IChemE conference will be held in the WC. SAIChE IChemE will focus on Pr (Eng) development, as well as building relationships with the other institutions in South Africa, such as SAIMM.

Council voted unanimously to accept the invitation from the WCCE (World Congress of Chemical Engineering) to host an interim international WCCE conference in 2019 in South Africa. The AGM concluded with the treasurer (Lizelle van Dyk) presenting the financial statements for 2013 and 2014. In line with IChemE, SAIChE IChemE's financial year has been changed to run from January to December each year.

A question and answer session took place following the reports. Member D Hill commented that he looks forward to the collaboration between SAIChE and IChemE. A question was raised if it is compulsory to join



Dawie van Vuuren (SAIChE IChemE President) and Rodney Jones (SAIMM President)



ECSA (Engineering Council of South Africa). Currently members are encouraged to join ECSA as it is mandated to protect society and the environment, and we as members need to fall in line with it.

The evening ended off with snacks and networking between members. SAIChE

IChemE would like to thank its members for attending, and hope to see them at the next AGM in 2016. In the meantime, please do participate in your local branch activities.

Written by Michelle Low and Dawie van Vuuren on behalf of SAIChE IChemE Council

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SUDOKU NO. 110

Complete the grid so that every row across, every column down and every 3x3 box is filled with the numbers 1 to 9. That's all there is to it! No mathematics are involved. The grid has numbers, but nothing has to add up to anything else. You solve the puzzle with reasoning and logic. For an introduction to Sudoku see <http://en.wikipedia.org/wiki/Sudoku>

	3	7		9				
9		6	3					
2				6			1	
4			5					7
						1		
	8				4		9	
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6	8	7	4	5	3	9	2	1
3	5	9	1	8	2	6	7	4
8	9	5	2	7	1	3	4	6
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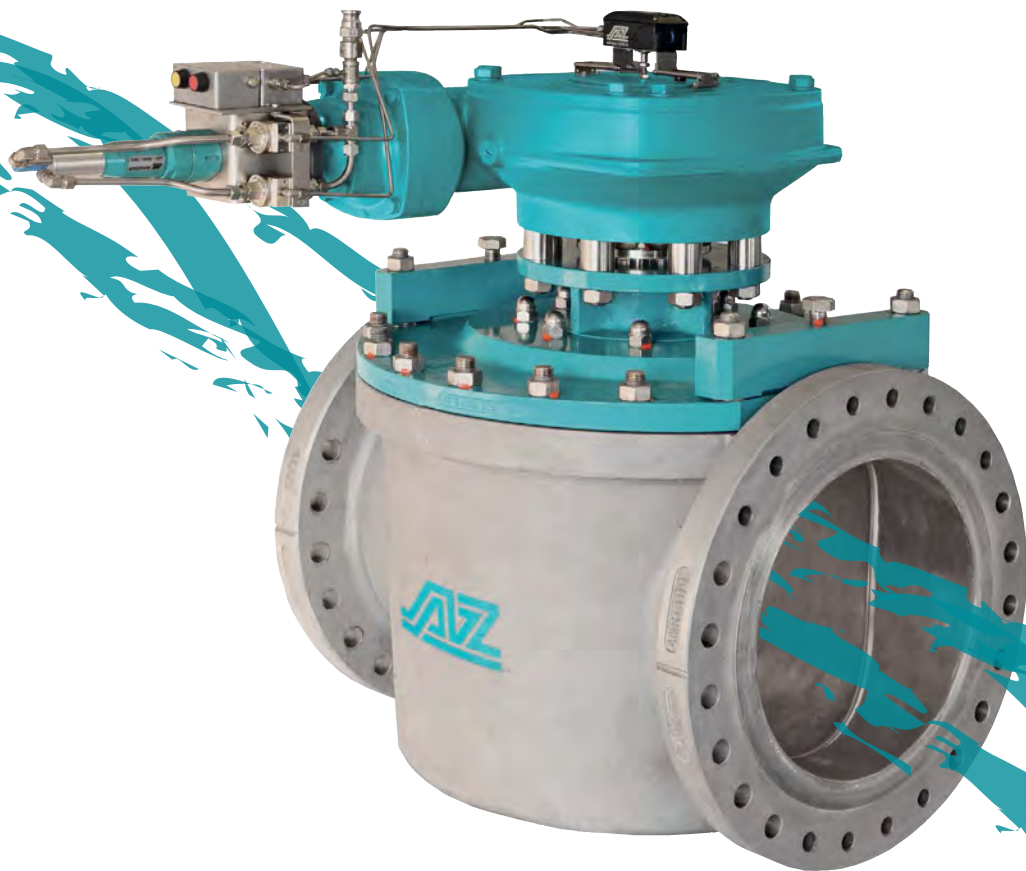
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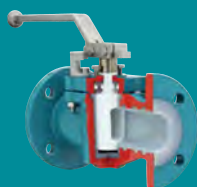
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