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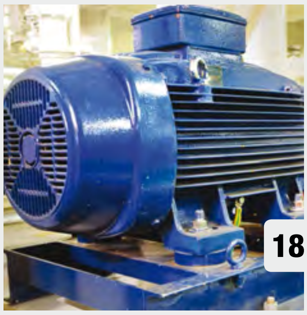

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What happened **to biofuels?**

by Carl Schonborn

In December 2006 a draft Biofuels Industrial Strategy was approved by the South African Cabinet to go for public consultation. This process involved workshops and meetings at both national and provincial level, consultations with organised industry, farmers, communities, and non-governmental organisations.

Comments from stakeholders were duly considered and incorporated into the draft Strategy and in December 2007, Cabinet approved the National Biofuels Industrial Strategy which suggested a 2 % biofuels penetration to the current fuel pool by 2013. The 2 % would slightly contribute to energy security, create 25 000 jobs in rural farming, and achieve a balance of payments saving of R1,7 billion at that time.

At a well-attended and significant Biofuels Conference in Johannesburg in 2007, some 45 papers and presentations were made on ethanol and biodiesel. A sound platform on which to move ahead was formed. Not long after this, it was decided that the development of ethanol from maize (which was one of the main drivers to progress), would endanger food security; the plans for biofuels were shelved.

In the Department of Energy's document "Draft Biofuels Industrial Strategy of the Republic of South Africa" issued in November 2006, it was stated that: "Further support to establish this industry would come from targeting of existing agricultural support programmes". If the oil price were below US$45/bbl, biofuels producers would need some form of additional support, and for prices above US$65/bbl, the biofuels industry would pay in, slightly reducing pump price increases. This would be catered for by the Central Energy Fund (CEF) Act Equalisation Fund Levy as a balanced hedge with consumers, and, at a minimum expected oil price of US$35/bbl, would require fuel price support of less than 1,2 SA cpl.

What the detractors of the conversion of maize to ethanol fail to mention is that, in the last 40 years, through selective breeding and advances in seed genetics, the average maize yield on a hectare of land has risen from some one to two tonnes to about five to six tonnes, per hectare. Agriculture is known to be one of the largest contributors to the creation of jobs in South Africa, however, while food security is, of course, a major concern, so is a lack of progress in the development of the biofuels industry.

In terms of Regulation 6 of the Regulations regarding the Mandatory Blending of Biofuels with Petrol and Diesel, the Minister of Energy declared that October 1, 2015 is the date on which the said regulations will come into operation. At the time of writing, this date has not yet been officially set. Policy decisions made only when all the facts and figures are cast in stone, creates a situation wherein, when the final policy is finally 'signed and sealed', its completion is rendered a virtual non-event.

Now is the time to prepare, so that, when the crude oil price rises again, South Africa will be ready with its biofuels facilities.

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Indigenous biological resources and traditional knowledge –

Regulating their use in the South African economy

If you are in the business of conducting research or beneficiating and exploiting animals, plants, or micro-organisms which are indigenous to South Africa, whether they are traditionally used locally for any purpose whatsoever or not, or if you have been considering doing so, then you had better read this.

In a drive to reap the benefits of South Africa's extensive biodiversity and the traditional knowledge on the subject of its diverse people, the Biodiversity Act was promulgated with its Bioprospecting, Access, and Benefit Sharing (BABS) regulations, the latter updated on 19 May 2015.

The law has now been changed in respect of bioprospecting, ie, searching for plants, animals, and micro-organisms which may have some beneficial purpose, whether medicinal, agricultural, or industrial, and then conducting further research and protecting any invention derived from these products and/or inventions. It is now a criminal offence to search for or identify any indigenous biological resource, such as a micro-organism, plant, or animal, without first notifying the Department of Environmental Affairs and demonstrating that the communities where the Discovery Phase is being conducted have been consulted and have consented to such activity.

If the material obtained through the notification process is to be exported for further research, then a permit for this purpose must be obtained. This is not a trivial procedure. The Discovery Phase notification only permits the search for and indexing of the indigenous biological resource, but no further research or commercialisation. In order to conduct further research or to commercialise any indigenous biological resource or a product thereof, a Commercialisation Phase permit (whether for biotrade, bioprospecting, or an integrated biotrade and bioprospecting permit) must be obtained by each link in the chain of research and development and commercialisation.

The permit or notification in terms of the Act may only be issued to or submitted by a South African juristic person, a natural person, who is a South African citizen or a permanent resident of South Africa, or a foreign juristic person or a foreign natural person if they apply jointly with a South African juristic or natural person. Thus, in short, the benefits of bioprospecting are reserved for South Africans.

To obtain the permits, Material Transfer and Benefit Sharing agreements must be entered into either with the community where the resources were located or whose traditional knowledge is used, or the Director General of Environmental Affairs where such a community cannot be identified.

The BABS regulations even regulate the trade in harvested and virtually unprocessed biological resources, such as leaves, seeds, bark, and the like. In addition, the BABS regulations define 'biotrade' as the buying and selling of milled, powdered, dried, sliced or extract of indigenous genetic and biological resources for further commercial exploitation, and such biotraders require a permit to do so. In fact, the BABS regulations apply to commercial or industrial sectors that utilise any indigenous genetic and biological resources and/or any traditional knowledge for biotrade or for research, application or development of drugs, complementary medicines, nutraceuticals, industry enzymes, food flavours, fragrances, cosmetics, emulsifiers, oleoresins, colours, extracts, and es-

sential oils. They also apply to non-commercial sectors that export from the Republic any indigenous genetic and biological resources for a research entity to generate scientific data.

To complicate matters further, the requirements for the obtaining of these permits are very onerous and, for example, require the identification of the indigenous people who may have been using said indigenous biological resource, providing the GPS co-ordinates thereof, entering into a benefit sharing agreement with them, and the applying to the Department of Environmental Affairs for a permit, all before any research or commercialisation can take place.

In addition to the BABS requirements, the Patents Act also has provisions which refer back to the Biodiversity Act and BABS requirements, so that, where there was no notification or a permit was not obtained prior to conducting any discovery phase or commercialisation phase research, any patent granted on an invention flowing from such research would be void and would be subject to attack by a competitor or any interested party.

Due to the uncertainty which prevailed prior to the BABS amendment in May 2015, there may be may companies or persons who have been illegally exploiting South Africa's biodiversity and tradition knowledge and are therefore subject to prosecution if discovered. In addition, numerous patents which have been filed and granted for inventions flowing from indigenous biological resources and traditional knowledge without the proper permits and so on, may be invalid and subject to revocation at the instance of a competitor, the Department of Environmental Affairs, or another interested party.

As a result of this regulatory environment on bioprospecting, many businesses are simply ignoring this highly complex issue and continuing illegally, thus putting them at risk of prosecution and preventing them from obtaining valid patent protection for their innovation. These businesses are either not aware of the onerous regulatory requirements, or are simply unable to comply due to a lack of skills in dealing with such complexities.

To add to the problem, the Department of Environmental Affairs has recently redoubled its enforcement efforts! For example, rooibos extract-containing products have been removed from supermarket shelves as a result of the failure of the manufacturer to have the proper permits in place.

There is no amnesty provision in either the Biodiversity Act or the BABS regulations and patents obtained unlawfully are unlikely to be saved; however, it may, however, be possible to avoid prosecution if such activities are regularised by entering into the required agreements and obtaining the required permits.

If you need to regularise your bioprospecting activities then contact Janusz Luterek on janusz@hahn.co.za or www.hahn.co.za, so that he can help you navigate the regulatory maze as well as protect your innovations and inventions. ▮

Centre-staging natural gas:

International trends and their relevance for India

by Anomitro Chatterjee, previously a Research Associate at The Energy and Resources Institute (TERI), Delhi, India and Madhura Joshi, Associate Fellow, TERI

What does the advent of shale gas as a 'game-changer' imply for natural gas markets, particularly the pricing of gas? The project team at TERI seeks to answer this question by specifically looking at understanding the movement of natural gas prices vis-à-vis oil prices. Since India's reliance on natural gas imports is set to increase, the project will conduct an assessment of possible natural gas suppliers for India and the impact of changes in pricing regimes internationally.

Over the last decade, especially after the shale gas bonanza in the United States, natural gas has often been referred to as a 'bridge fuel' – a more environment-friendly fossil fuel than coal or oil, that can reduce pollution in the near future and facilitate the gradual transition toward renewable sources of energy. The share of natural gas in world energy production has increased significantly in the recent past and it will undoubtedly play a greater role in world energy production in the future (IEA, 2011).

In the context of this changing global scenario, India needs to make sure that it does not lag behind in taking this opportunity to explore the options offered by natural gas by having a long term strategy in place to ensure optimal utilisation of this energy source. Unfortunately, India's domestic gas production has declined since 2009-10, while demand has increased. Therefore, natural gas imports would play a major role in this transition. This article aims to assess the potential sources of natural gas imports for India and the impact of changes in international demand-supply conditions and pricing regimes.

Natural gas accounted for 23,94 % of world primary energy consumption in 2012 (BP, 2013) and 21,4 % of total primary energy supply in 2010 (IEA, 2012a). The world production of natural gas has increased over the last four decades, as shown in Figure 1 on page 8.

In comparison with this, in 2009-10, natural gas accounted for about 14,13 % of total primary energy production in India, and total domestic gas production in the country has declined since then (TERI, 2013). Although domestic production has been falling, the Government of India plans to increase consumption of natural gas in the country by boosting domestic production and increasing import capacity (MoPNG, 2011). A large number of new Liquefied Natural Gas (LNG) terminals have been planned on the East coast (Kakinada, Ennore, etc), as well as on the West coast (Kochi, Dabhol expansion, Hazira expansion, etc).

As in the case of any other resource, natural gas pricing is a critical factor affecting the development of this fuel across the world. Pricing regimes of internationally traded natural gas can be broadly classified into one of the four regimes – the US spot markets, UK spot markets, European long term contracts and the Asia-Pacific market (largely comprising long term contracts). In both the long term contract regimes, natural gas prices are closely linked to crude oil prices, while the spot markets in the US and UK dissociate gas price from crude oil price. A snapshot of the trends in natural gas prices in some of these regimes is shown in Figure 2 on page 9.

The shale gas 'revolution' in the United States explains why the US Henry Hub prices broke away from the general trend after 2009. This price declined from around USD 9 per million British thermal units (mBtu) in 2008 to around USD 3 per mBtu in 2012. However, the increasing supply of natural gas globally has had no discernible effect on Japa-

nese LNG (an indicator of Asian LNG prices). The Japanese LNG price has consistently increased since 2008, marking a stark deviation from the trend of US Henry Hub prices. This is due to the linkage of Japanese LNG with crude oil prices, specifically the Japanese Customs-cleared Crude Cocktail (JCC) price. The linkage between Japanese crude import price and price of LNG is very strong, with a linear correlation of 92,64 % (Figure 3).

Changing global gas markets

Global natural gas production has followed an almost linear trend, increasing from just over 2 500 billion cubic metres (bcm) in 2002 to 3300 bcm in 2012 (Figure 4). Of this, 1 033 bcm were traded during the year, both in the form of pipelines as well as Liquefied Natural Gas (LNG). At more than 700 bcm in 2012, pipelines accounted for nearly 70 % of the global gas trade (Figure 5).

Most of the pipeline trade of natural gas takes place in Europe and North America, whereas LNG dominates gas trade in the Asia Pacific markets.

Looking at net imports/exports of gas, the major (greater than 50 bcm) exporters in the global gas market include Norway, the Russian Federation, Qatar, Canada and Algeria, while the large importers are Japan, Italy and Germany. The USA is also a major player in the global gas markets – it is both the largest producer as well as consumer of natural gas. With the production of gas from shale, the total gas production in the country increased from a little over 550 bcm in 2001 to more than 680 bcm in 2012, recording an annual growth of nearly 2 % in the eleven year period. This increase in production has also led to a decline in the gap between gas consumption and production from domestic sources (Figure 6).

Figure 7 represents the share of different categories of gas in the total gas production mix of USA. As can be noted, the overall production of gas which started increasing after 2005 corresponds to the production of shale gas.

In fact, this rise in production of natural gas has led to a decline in imports of gas. Among pipelines and LNG, there has been a larger decline in the imports through LNG which declined by 19 % between 2009 and 2011. Pipeline imports (from Mexico and Canada) declined by 5 % in the same period.

Shale gas: The techno-commercial breakthrough

The United States has led the revolution in unconventional gas production in the past decade. It was the commercially feasible combination of two existing technologies, namely hydraulic fracturing and horizontal drilling, which was the major driver of the unprecedented boom in shale gas production after 2005.

Trends in international gas markets

The trends in various international gas markets are becoming

Table 1: US natural gas exports by country in 2012 (in bcm)

US natural gas exports by country in 2012 (in bcm)		
Country	Pipeline exports	LNG exports
Canada	27,5	
Mexico	17,6	
Other Europe and Eurasia*		0,1
Japan		0,4
India		0,1
Brazil		0,2
Total	45,1	0,8

* Excluding Belgium, France, Italy, Spain, Turkey and United Kingdom

Source: BP (2013)

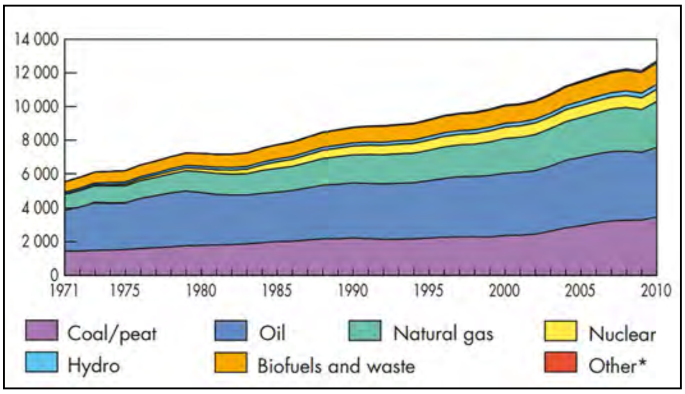

Figure 1: World total primary energy supply by fuel type from 1971 to 2010

Source: (IEA, 2012a)

increasingly relevant to countries like India which are planning to increase natural gas imports. Currently only two countries have substantial commercial production of shale gas: the United States of America and Canada. Already, the shale gas forms 39 % (Figure 8) of the total natural gas production in the US; this percentage is expected to increase further. While countries in Europe and in Asia-Pacific with potential reserves are still debating whether or not to undertake shale gas exploration, given its resource intensity, its contribution to US domestic production and the resultant decrease in its imports has had a definite impact on the international gas markets.

USA rides the shale gas boom

The most direct impact of the shale gas boom was an excess supply of natural gas which brought about a drastic reduction in US natural gas prices from mid-2008 onwards, as indicated by the Henry Hub spot price trend. From a high of USD 12,69 per million British thermal units (mBtu) in June 2008, Henry Hub prices dropped to as low as USD 1,95 per mBtu in April, 2012. Since then, prices have somewhat recovered, touching the USD 4 per mBtu mark in March, 2013.

Such a dramatic increase in US domestic supply and the resultant decrease in prices have had numerous effects. In the domestic gas markets, some analyses conclude that shale gas extraction will not be viable at the current price levels and Henry Hub prices would go up in the near future (Enqdahl, 2013) (Figure 9). In the international gas market, the United States is now being considered as a potential source of natural gas exports. Table 1 shows the country-wise exports of natural gas from the United States in 2012.

Total exports of natural gas from the United States was, therefore, at 45,90 bcm in 2012, as opposed to 23,19 bcm in 2007 (BP, 2008).

Canada develops as a new source of LNG

Canada has been losing its single largest market for natural gas exports: the USA. However, after the developments in shale gas in the US, Canada has started investing in building LNG export terminals. Three such terminals, which were in advanced stages of construction as of 2012, are located in the province of British Columbia on the West Coast. Through these terminals, Canada would seek to sell LNG in the lucrative Asian market.

Investments in LNG exports in Australia

With the LNG export capacity in the Middle East (especially Qatar) reaching its saturation point, growth in global LNG liquefaction capacity has now shifted to Australia. The growth in LNG export capacity has been driven by both conventional gas supplies as well as coal bed methane (CBM) gas.

Australia has definitely emerged as a significant source of LNG for importers, especially those in Asia, who are looking for less expensive import options. The only hindrance to developing the LNG export market in Australia is the relatively high cost of labour, despite which large companies like Chevron have entered into the Australian LNG sector (Reuters, 2013).

Emerging LNG suppliers in East Africa – Mozambique and Tanzania

New gas discoveries and rising reserve estimates in East Africa, especially in Mozambique and Tanzania, have put this region on the radar as potential LNG suppliers in the future (Ledesma, 2013). International oil companies have invested heavily in the upstream sector of both these countries over the past five years. Tanzania has a relatively high level of political stability in the region, although infrastructure is still perceived to be ill-equipped to handle the demands of the extractive industries. The provision of basic services such as electricity is temperamental at best, while facilities at the port of Dar es Salaam are struggling to keep up with growing activities. Mozambique is ideally positioned to take advantage of the growing market for imported natural gas in South Africa as well as the significant demand from Asian LNG importers. However, infrastructure constraints are hindering development of resources as well as export terminals in this country as well (Control Risk, 2012).

Assuming that the existing issues and concerns around development of natural gas resources and export capacity are somewhat mitigated in the near future, East Africa can potentially act as a competitor to the North American LNG exporters, especially in the Asian markets.

UK increases its gas imports

Natural gas is the single biggest source of primary energy consumption in the United Kingdom (UK), contributing 34,63 % in the energy mix in 2012 (BP, 2013). The UK's domestic production of conventional natural gas has been on a long term declining trend. However, the government's

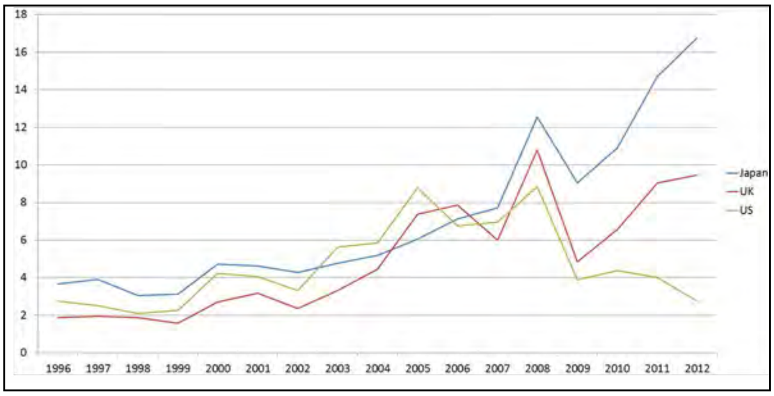

Figure 2: Price trends of natural gas in US, UK, and Asian markets
Source: British Petroleum

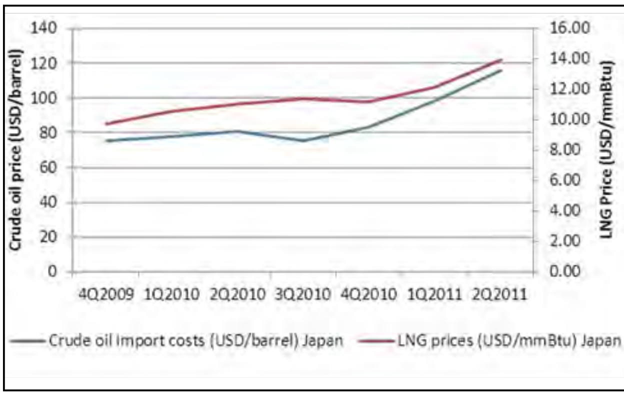

Figure 3: Crude oil import price and LNG import price trend in Japan
Source: (IEA, 2012b). **Note: The horizontal axis denotes quarters of various years (for example '4Q2009' refers to the period October to December, 2009)**

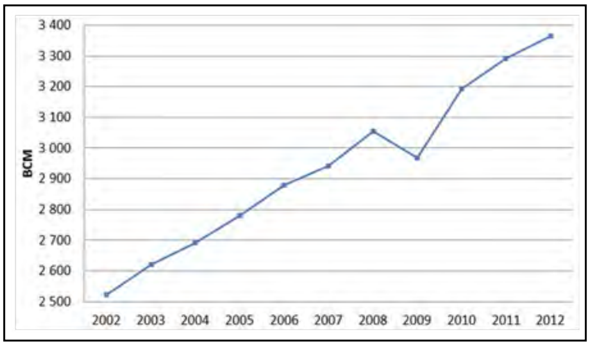

Figure 4: Global production of natural gas
Source: (BP, 2013)

plans on climate change mitigation actions include a shift towards natural gas. Therefore, if the government is to follow through on its plan, it will have to increase the share of natural gas in the country's energy mix, implying an increase in natural gas import dependence, at least in the short term (Bassi, Rydge, Khor, Fankhauser, Hirst, & Ward, 2013). Net import of natural gas in the UK was 37,1 bcm in 2012, increasing from 36,8 bcm in 2011. The lion's share of natural gas imports into the UK is through pipelines from Norway. Qatar is the primary source of LNG imports into the UK (BP, 2013). In importing LNG, the UK faces stiff competition from the big Asian LNG importers, thus making it more vulnerable to shocks in natural gas supplies from Norway (Hung, 2013).

Natural gas in the Indian energy basket

Natural gas contributes nearly 10 % of the country's total commercial energy mix. In the past decade, the share of natural gas has remained nearly constant (Figure10).

Domestic production of gas for 2011-12 stood at 47,55 bcm. Imports of natural gas in India commenced in the year 2003-04 and in the past decade, these have increased from less than 1 bcm to nearly 14 bcm (TERI, 2013; PPAC, 2013). As the domestic production is declining drastically, the share of imported gas is expected to form a major share of total gas availability.

The ability to access imported gas hinges on the availability of adequate infrastructure for importing gas through LNG terminals and liquefaction facilities.

In addition to enhancing the import facilities, domestic gas infrastructure such as pipelines, CNG filling stations and city networks will also need to be expanded.

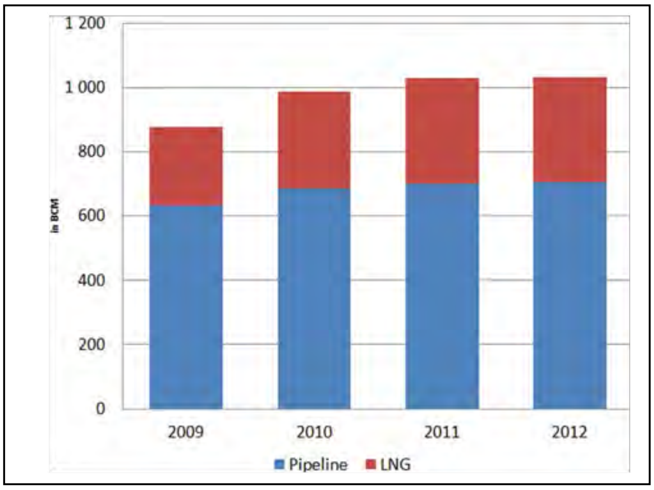

Figure 5: Global gas trade through pipelines and LNG
Source: Various issues of the BP statistical review of world energy

Consumption of natural gas

The power sector (44 %), followed by the fertiliser industry (25 %), are the largest consumers of natural gas in the country. Consumption for energy purposes, which includes power generation, use as industrial fuel, captive usage/ LPG shrinkage, tea plantation and usage as domestic fuel, accounts for nearly 60 % of the total natural gas consumption in the country.

Among the major consuming sectors, the sensitivity to changes in natural gas prices varies depending on the extent to which these sectors can pass through any price rise to their final product prices. In a paper in 2011, Sreenivas (2011) calculated switchover prices for different alternative fuels (see Table 2). Switch-over prices here refer to the level of price of natural gas at which the user shifts to an alternative fuel.

As can be noted, the switchover prices for unsubsidised automotive and industrial fuels are the highest. This is followed by subsidised diesel and LPG, clearly outlining the order of areas that can absorb high natural gas prices.

India's natural gas import strategy in a changing world

Trans-national gas pipelines

Over the years, India has explored the possibility of trans-national pipelines with its neighbours in the east as well

Table 2: Switchover prices of gas

Switchover gas price	USD/mBtu
Base load power	5,82
Peak load power	8.59,
Unsubsidized MS /HSD	17,06
Subsidized HSD	11,55
LPG	15,46
Subsidized LPG	9,42
Industrial fuel	17,06

as west. The key projects which have been under consideration at various points of time have been the Myanmar-Bangladesh-India pipeline, Iran-Pakistan-India Pipeline, Turkmenistan-Afghanistan-Pakistan-India pipeline, and the Oman-India subsea pipeline.

The Myanmar-Bangladesh India (MBI) pipeline

This project was mooted in 1997, and the 900 km pipeline was expected to bring gas from Myanmar's Rakhine basin to Kolkata, India, while passing through the Indian states of Mizoram and Tripura, and Bangladesh (Mehdudia, 2013a). However, certain demands made by Bangladesh, in negotiations with India, and the difficulty and time it took in resolving them, led to substantial delays which cost India the project. In 2008, Myanmar decided to sell the available gas to China.

The Iran-Pakistan-India (IPI) gas pipeline

The idea for this pipeline was first conceived in 1989. The 2 700 km, USD 7-billion pipeline would supply gas from Iran's South Pars field and would pass through Assaluyah in Iran to the Pakistan border and further to reach the Indian border. It would then travel within India to connect to the Indian gas markets. However, despite protracted consultations, India pulled out of the project citing security reasons and issues with the pricing of natural gas. Iran and Pakistan continued with the project and in March 2013, the two Presidents inaugurated the final construction phase (see http://www.gulfoilandgas.com/webpro1/projects/3dreport.)

Turkmenistan-Afghanistan-Pakistan-India pipeline

The plans for this project have been in preparation since the '80s but were suspended due to conflict in the regions it was to pass through. They were taken up once again in 2008, and, despite a troubled past, the project has gained considerable momentum since then. The 1 680 km pipeline would bring natural gas from Turkmenistan's South Yolotan Osman field, through Helmand and Kandahar in Turkmenistan, passing through Quetta and Multan in Pakistan ending in Fazilka in India, and would supply 90 million m^3 per day (mscmd) of gas to the three countries (38 to India and Pakistan, and 14 to Afghanistan) (Joshi, 2011). The Gas Sale Price Agreement between Turkmenistan-Afghanistan, Turkmenistan-Pakistan, and Turkmenistan-India was signed between 2012 and 2013. It is doubtful whether the pipeline will be ready by its planned completion date in 2017/18.

Sub-sea pipeline

Another alternative which is gathering steam is the Oman-India subsea pipeline, considered infeasible in the 1990s. Recently, even Iran has demonstrated an interest in being a part of the project (Aneja, 2013; Bagchi, 2014). South Asia Gas Enterprise (SAGE) conducted a feasibility study to help deliver natural gas from South Pars gas field in Iran to India's west coast.

LNG: The need of the hour

With an increasing gap between demand and domestic supply of natural gas and slow progress on cross-country pipelines, India would need to import more LNG to meet its gas demand and reduce its dependence on coal and petroleum products.

Relaxing infrastructure constraints – LNG terminals and domestic pipeline connectivity

Currently, India has two fully operational LNG terminals (Dahej and Hazira). Apart from import terminals, India also needs to build up its domestic gas pipeline network to ensure connectivity of natural gas supply sources (terminals or gas fields) to end-consumers. End consumers include not only the power and fertiliser sectors (which are price-sensitive) but also the relatively price-inelastic City Gas Distribution (CGD), refineries, petrochemicals, sponge iron and steel plants, captive power plants etc, which can potentially afford more expensive natural gas.

Diversifying LNG import sources

As mentioned before, the global LNG market has changed significantly since the shale gas revolution and India could look not only at the United States, but also at Australia, Mozambique and Tanzania, as well as Canada, for future LNG supplies. The advantage of securing long term import contracts with suppliers is the insulation such contracts provide against short term price volatility, which affects spot LNG markets.

India should also explore potential LNG contracts from East African nations, expand LNG imports from Australia and seek to collaborate with other Asian importers on bringing down LNG import costs in Asia. Moreover, investments along the value chain of LNG (such as ONGC Videsh Limited's on-going investments in the upstream sector in Mozambique), could also help secure further gas supplies.

Review pricing of domestic natural gas

The differential between domestic natural gas prices and imported LNG prices, coupled with the Government's Gas Utilisation Policy continues to be an issue for gas-consuming sectors in India. As per the Gas Utilisation Policy, domestic natural gas (which is priced at around one-third the price of imported LNG) is allocated on a priority basis to the power and fertiliser sectors. Since these sectors are heavily regulated (with large subsidies on electricity and fertilisers), the gas consumers from these sectors oppose any increase in natural gas prices which increases their production costs.

More recently, however, the Government seems to be ready to bite the bullet since the Cabinet Committee on Economic Affairs (CCEA) approved an increase in the price of natural gas to USD 8,4 per mBtu from USD 4,2 to 5,7 per mBtu, which took effect from April 1, 2014. The mechanism of gas pricing is also going to change from the Administered Pricing Mechanism (APM) to a weighted average of international gas prices (as suggested by the recent Rangarajan Committee). However, the Election Commission of India had deferred the implementation from 1 April 2014 due to Lok Sabha elections. A new pricing formula, a modification of the Rangarajan gas

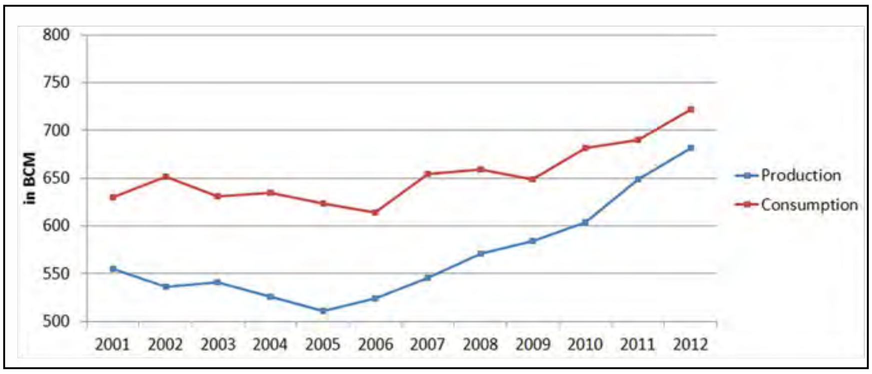

Figure 6: Gas production and consumption in USA

Source: BP (2013)

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formula came into effect from 1 November 2014. The new prices will be determined on a half-yearly basis. While this provides clarity, a multitude of prices still exist.

The logic behind linking gas prices to a weighted average of international hub prices and netback price of India's LNG imports (term contracts only) to arrive at a more competitive price, is questionable, since these calculations are not linked to production costs of gas in India and expose the gas markets to international price volatility. A more typical arm's length transaction between buyers and sellers, where each gas purchase contract is signed between two parties without intervention from the Government, would be the most efficient solution. However, with the existing regulations on power and fertiliser industries, such a free price determination mechanism would be wholeheartedly opposed by these two sectors, which currently account for the lion's share of gas demand in India.

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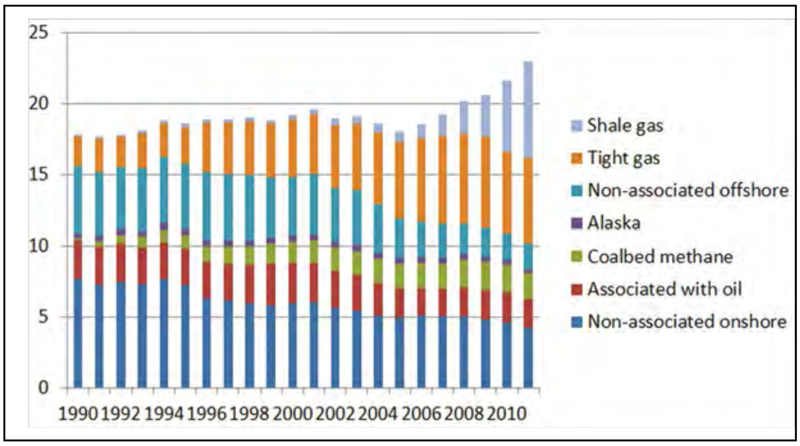

Figure 7: Category-wise natural gas production in USA

Source: US Energy Information Administration (EIA) (2012)

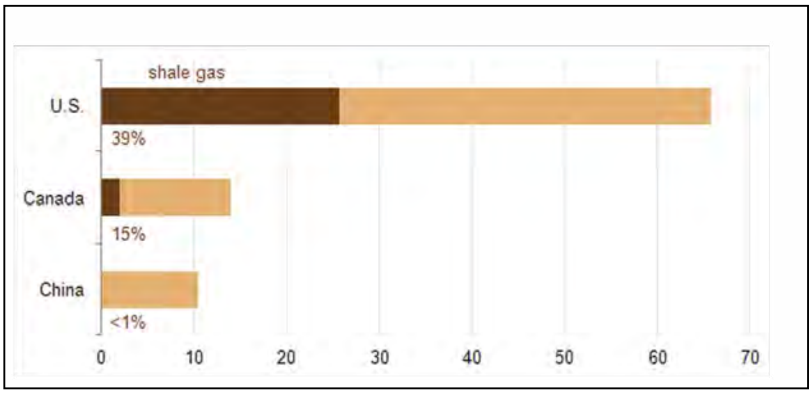

Figure 8 Shale gas as share of total dry natural gas production in 2012 (bcf per day)

Source: EIA (2013b)

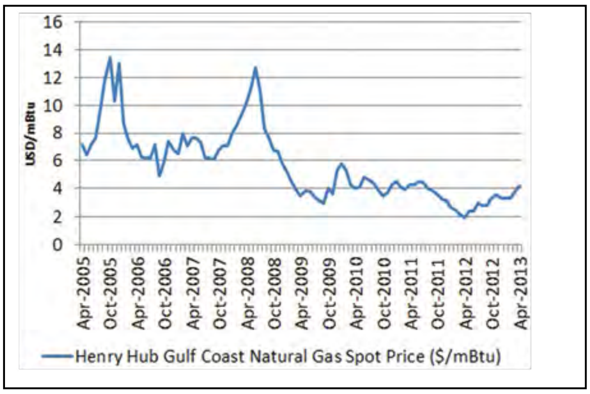

Figure 9: Henry Hub Gulf Coast natural gas spot price (in USD per mBtu) from April, 2005 to March, 2013

Source: US Energy Information Administration (EIA) (2012)

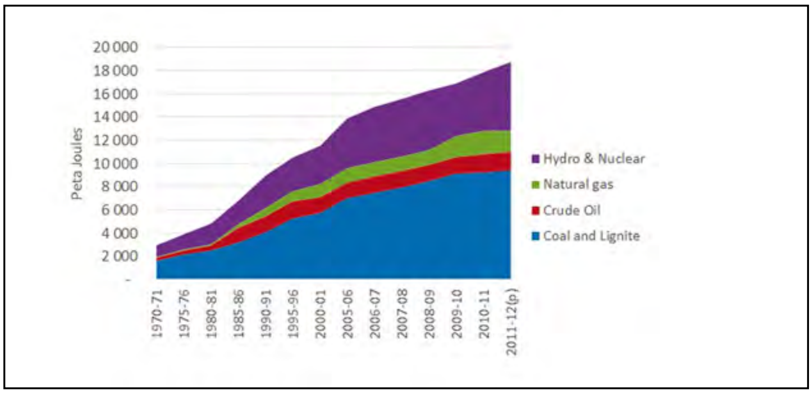

Figure 10: Composition of primary energy basket

Source: (CSO, 2013) "P" refers to provisional data

Certifiably corruption-free

Ethics watchdog TRACE International has re-certified AESSEAL South Africa as complying fully with the association's stringent code of ethical conduct.

The mechanical seals company was first certified two years ago, joining an exclusive club of between 200 and 300 firms worldwide certified by TRACE as corruption-free in all aspects of their business conduct.

Certification has since served AESSEAL well in competitive sales situations, reinforcing the product offering by guaranteeing transparency and ethicality.

TRACE International is an internationally recognised association that works to raise the anti-bribery compliance standards of members.

Founded to set a common standard for due diligence reviews and anti-bribery training, the organisation provides a practical and cost-effective alternative to increasingly expensive and time-consuming corporate compliance.

Compliance certification includes comprehensive background checks undertaken on all key employees driving growth.

Detailed *curricula vitae* on directors, shareholders and sales staff are scrutinised by internet search engine cross-checks seeking evidence of susceptibility to corruption through positional power, multiple directorships or political dynamics created during previous employment or gaps in employment.

Questions arising from the checks are clarified and further checked before certification is awarded.

Re-certification takes place annually.

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

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This certifies that

AESSEAL (PTY) LTD

has completed a comprehensive background review and is TRACE Certified.

June 15, 2015 - June 14, 2016

TRACE*certification* ID: TC5134-3070

Alexandra Wrage, TRACE President

TRACEcertification is not a guarantee against past or potential wrongdoing by the certified entity or a guarantee against potential liability. A summary of any red flags identified during the TRACEcertification review is included in the report, but not all red flags preclude TRACEcertification. Companies doing business with this TRACE Certified entity should always request a full copy of the underlying report. To view a complete list of TRACE Certified entities, please visit the TRACE Intermediary Directory at https://fpms.TRACEinternational.org/IntermediaryDirectory

AESSEAL'S certificate from TRACE International

Senix customizes ToughSonic sensors to monitor sea levels

SENIX specialist distance measurement manufacturers, represented in South Africa by Instrotech, have their ToughSonic sensors playing a critical role detecting sea level changes as part of a sophisticated Tsunami Early Warning System (TeWS) in the Philippines.

Senix engineers collaborated with the Philippines Advanced Science and Technology Institute (ASTI) to customize ToughSonic 50 ultrasonic sensors for this first-of-its-kind system. Each ToughSonic 50 sensor is integrated into a tide gauge platform that also includes ASTI-designed wet and dry sensors, a solar power system and wireless communications equipment. Hundreds of these tide gauge platforms are integrated to create the largest and most sophisticated Tsunami warning system in the world.

The impetus for the TeWS system is the Manila Trench, an earthquake-prone zone west of the Philippine island of Luzon, that reaches depths of 17 700 feet and is prone to earthquakes. The Philippines Institute of Volcanology and Seismology (PHIVOLCS) has forecast that a strong earthquake in the Manila Trench could trigger tsunamis with waves up to 32 feet high that could reach the populous Manila metropolitan area in less than an hour.

How does it work? The Senix sensors detect any significant rise and fall in the sea level. The data is logged on each platform and then sent in real time to a data receiving centre operated by PHIVOLCS where data from all the sensors are consolidated and analysed using data visualisation, interpretation and decision software. The analysis results can be sent to local government agencies in near real-time where officials can sound off sirens to warn people in high risk areas to move to higher ground.

The ASTI chose the Senix ToughSonic 50 ultrasonic sensor because of ToughSonic's specific combination of durability and flexibility and because of the personal service provided by Senix engineers through the research and design process. ToughSonic 316 stainless steel housings, epoxy potting and IP68 immersion rating are ideal for harsh marine environments. Senix worked with ASTI to customize the ToughSonic 50 to meet their unique interface and cabling requirements.

For more information contact Instrotech on tel: +27 010 595 1831, email sales@instrotech.co.za or visit www.instrotech.co.za ▮

WearCheck expand skills base with highly qualified women

Annemie Willers has been appointed as reliability solutions lubrication consultant for WearCheck's LubriGard division.

Lea Bodenstein has been appointed as a diagnostician for condition monitoring specialists WearCheck, based at their Middelburg laboratory.

Loshini Govender has been employed as the manager for WearCheck's speciality laboratory (WSL) in Johannesburg.

Salisha Dhanasar has been promoted to laboratory supervisor for WearCheck's Middelburg laboratory.

Condition monitoring specialists, WearCheck, recently employed several more women.

For more information contact WearCheck on tel: +27 31 700 5460, email support@wearcheck.co.za, or visit www.wearcheck.co.za ▮

Sandvik oil and gas campaign wins recognition from NACE International

Sandvik Materials Technology has received recognition for 'Advertisements of Greatest Interest' from NACE International, acknowledged globally as the premier authority for corrosion control solutions, based on a survey of its own worldwide membership.

The 'AD Q study of Materials Performance' assessed how readers of "Materials Performance" (MP), the official publication of NACE International with a circulation of over 34 000 across more than 130 countries, responded to advertisements with feedback on what captured their attention.

Sandvik's 'fish' advertisement depicts a beastly aquatic creature alongside the slogan 'Ugly challenges, beautiful possibilities'. It was designed to promote the manufacturer's advanced corrosion resistant alloys and other high-performance materials for offshore oil and gas applications including for tube, pipe, wire, welding products and hot isostatic pressed (HIP) products.

The study scored companies based on the opinions of readers 'who buy or specify the advertised product'. Of those surveyed, 37 % recalled seeing the advertisement, just below the 39 % average, while 17 % recalled reading the advertisement against a 21 % average. According to NACE International, 88 % of MP Magazine readers have a role in product decisions.

Another participant, a retired industry professional, commented that, "Corrosion of heat exchanger tubes can result in problems that require plant shutdowns, and the Sandvik ad indicates new materials are available that may mitigate future failures."

For further information on Sandvik Materials Technology visit the website: www.smt.sandvik.com ▮

South African solution for the energy crisis

The world needs energy to support economic growth and to raise living standards. The world's demand for energy could double over the next 50 years. However, we should not double energy production by doubling the burning of fossil fuels. The burning of fossil fuels, especially coal, causes atmospheric pollution and millions of deaths each year as well as global warming, climate change and environmental degradation.

It is an immense challenge to double energy production while reducing the burning of fossil fuels. We believe that all renewable sources of energy should be developed and that nuclear power can help to increase energy production and replace fossil fuels.

The purpose of Steenkampskraal Thorium Limited (STL), a South African-based company, is to make nuclear power clean, safe and sustainable. The company's strategy to make nuclear power clean is to introduce thorium as a fuel with vast resources in the Western Cape at the Steenkampskraal mine. Nuclear power is considered 'dirty' mainly because the waste from the uranium fuel cycle remains radioactive for many thousands of years. By contrast, the waste from the thorium fuel cycle will substantially reduce the problem of nuclear waste.

STL has invested in Thor Energy AS in Norway, a company that has manufactured thorium fuel and is now qualifying this fuel for use in commercial safe reactors. This fuel was inserted into the Halden reactor in Norway in April 2013 and has now been generating power for more than two years. It is performing well and could be licensed for commercial use by 2018 once regulatory approval is given. STL is also designing a refinery to produce reactor-grade thorium for the future manufacture of thorium fuel.

STL's strategy to make nuclear power safe is to introduce fuel and reactor designs that are intrinsically safe and meltdown–proof. In line with this, STL has designed a factory to make pebble fuel that contains TRISO-coated particles. This fuel has been tested and has demonstrated its safety on many occasions. TRISO-coated particles housed in graphite pebbles do not melt, release practically no fission products and is an extremely safe container for the active fuel while it is in the reactor and later for the storage of the spent fuel after it has been removed from the reactor.

STL is also designing a high-temperature, gas-cooled, pebble-bed reactor, the HTMR100. This type of reactor has been designed, licensed, built and operated over many years in Germany and China. High-temperature reactors (HTRs) have demonstrated their intrinsic safety on several occasions, under the observation of the International Atomic Energy Agency. HTRs have demonstrated that they do not melt-down when the coolant stops circulating through the fuel, which was the case with the disastrous Fukushima meltdown.

Safety also relates to the risk of the proliferation of nuclear weapons. The uranium fuel cycle produces plutonium in its waste which can be used to make a bomb. The thorium fuel cycle produces mainly fission products in its waste which cannot be used to make a bomb. The use of thorium does not completely eliminate proliferation risk, as thorium transmutes into U233 in the reactor, but this fissile isotope remains mainly in the reactor as fuel and not in the waste. STL's strategy to make nuclear power sustainable is to use a resource that is plentiful in nature and to use it efficiently so that there is little waste and is safe.

There are large thorium resources in the world. Effective and safe fuel, and reactor designs, can achieve high burn ups that extract most of the energy from this resource. Thorium, used efficiently, could provide clean, safe energy for thousands of years.

For more information contact the writer, Trevor Blench, chairman of Steenkampskraal Thorium Ltd, on tel: +27 12 658 5254, email:trevor.blench@thorium100.com or visit www.thorium100.com ∎

Pump selection
and application guidelines– Part 1

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.

Application limits stated in this article for American Petroleum Institute (API) and The American Society of Mechanical Engineers (ASME B73) pumps were adopted from Process Industry Practice PIPRECP001. Similarly, some paragraphs in API 610, 10^{th} Edition, are referenced in the sections on Oil Lubrication and Couplings and Guards. Power recovery turbines and air operated pumps are excluded from the scope of this guideline.

Selection and application

Centrifugal pumps are widely used in most pumping applications. By selecting appropriate materials of construction, speed, size and using available design configurations, centrifugal pumps can be applied in a variety of services including toxic, carcinogenic, highly corrosive and abrasive fluids.

Rotary pumps are chosen for special services such as viscous fluids at fairly constant flowrate and discharge pressure. The pump internals are lubricated by the pumped fluid. Most rotary pumps are self priming and can handle entrained air or gas. In sub-atmospheric suction conditions, entrained gases in the fluid expand, affecting pump displacement, and thereby reducing its capacity. Rotary pumps with negative suction pressure require that the pump casing be filled with liquid to seal internal clearances and provide lubrication during starting.

Direct acting (steam driven) reciprocating pumps are suitable for pumping relatively small volumes against high differential heads. Where process steam is required at different pressure levels, a direct acting reciprocating pump can be used as a pressure-reducing device to save energy. Reciprocating pumps can be used to pump a wide variety of fluids including those with varying corrosive and erosive qualities.

The centrifugal pump is usually the most preferred configuration in processing industries.

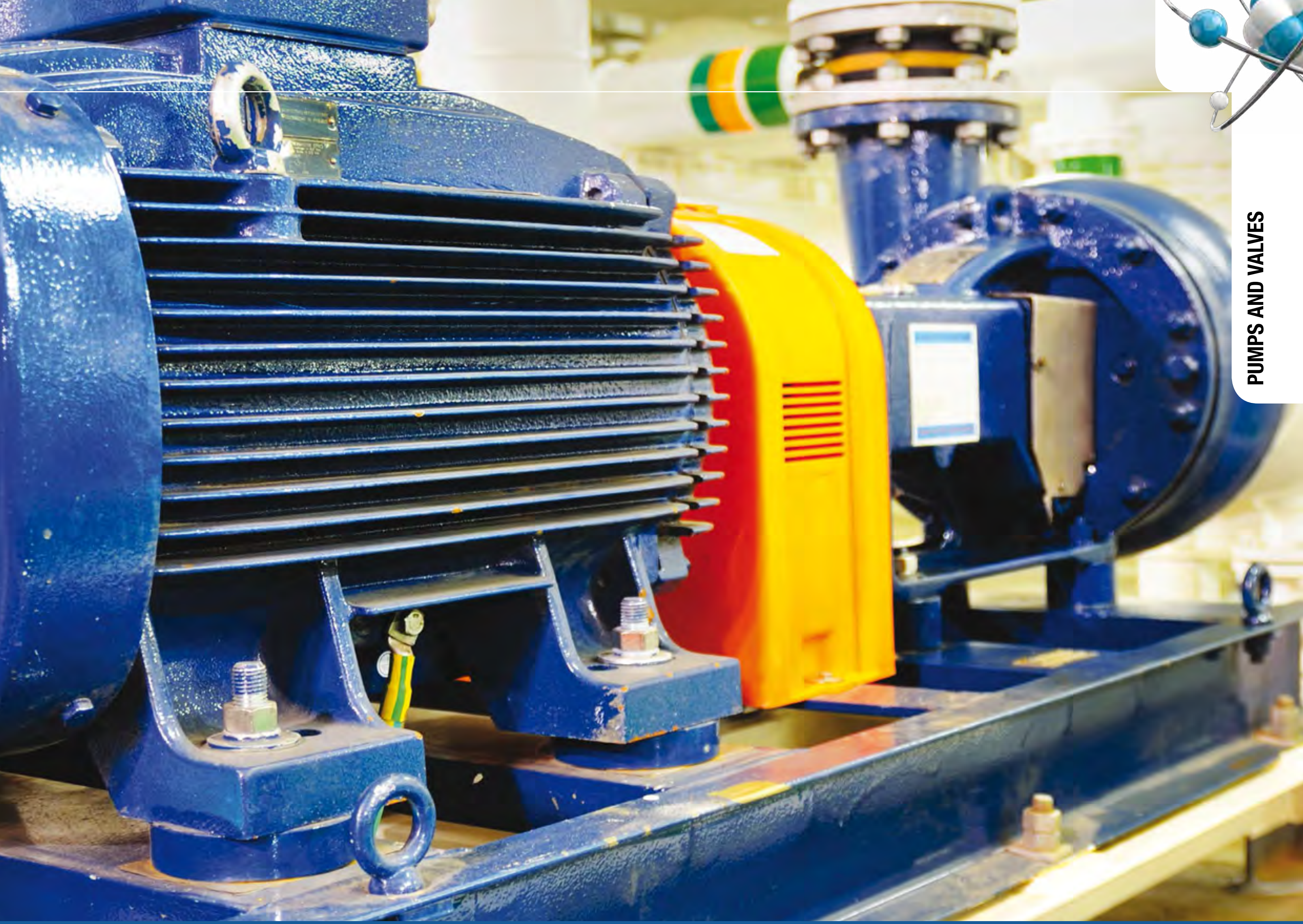
But in certain applications and situations as listed below, centrifugal pumps may not be appropriate.

- A: Low flow and high head pumping needs, such as in chemical injection.
- B: Fluids containing volatile vapours. Presence of vapours undermines performance of centrifugal pumps.
- C: Intermittent services or where a number of liquids of widely different viscosities are handled.
- D: Multiple pumping operations including a range of flow rates and heads.
- E: Constant capacity requirements with varying discharge pressures.
- F: Large capacity and high head or low head or low net positive suction head available (NPSHA) applications.

Performance characteristics of reciprocating pumps make them an ideal candidate for such applications.

Some of the features, characteristics and limitations that engineers should consider when selecting a pump are:

- A: Vertical pumps should be used in those applications where NPSHA or head/capacity make a horizontal pump less practical, or in those services (within the operating



limits stated in this guideline), where a vertical pump will result in significant savings in plot space, piping and foundation. It is worth mentioning here that selection of vertical pump impellers, either open, semi-open or closed, is governed by the pumping temperature, hydraulic balancing, efficiency, and fluid contaminants.

- B: High speed vertical in-line pumps can be used instead of reciprocating pumps for low capacity, high differential pressure services.
- C: Proportioning type injection pumps are suitable in acid, chemical and caustic services. Flow control of pumps can be achieved by adjusting the stroke.
- D: Sealless pumps are ideal for handling hazardous (flammable, corrosive) and highly toxic liquids. Local and prevailing environmental regulations and risk avoidance standards may dictate the use of sealless pumps in such applications. Some pump manufacturers offer centrifugal and rotary pumps, both, in sealless configuration.
- E: Consider rotary pumps when constant flow over a wide viscosity or flow proportional to rotational speed is required. Rotary screw or gear pumps are also preferred in high viscosity (~ 200 000 cSt) services. But slip in rotary pumps increases with reducing viscosity which in turn, affects capacity. Due to small internal running clearances, rotary pumps are not suitable for pumping fluids which contain suspended abrasive particles.
- F: Capacity control of reciprocating pumps can be achieved by regulation of speed, stroke or by both. Some users specify a bypass line for unloaded startup. Other designs incorporate mechanical suction valve unloaders which are functional until the pump reaches 100 % speed. Starting against line pressure (such as in multiple pump applications where they must start against full line pressure), necessitates a driver with higher starting torque capability. Other options are reduced voltage starting or use of soft start devices such as fluid coupling.
- G: Reciprocating pumps are unsuitable when pulsating flow can not be tolerated, especially if flow and pressure control instruments are involved. It should be recognised that pulsations can be damped but the equipment to achieve pulsation control can be expensive. Options to look at are rotary or centrifugal pumps because of their steady discharge pressure and linear flow. Many users stipulate piping pulsation analysis for reciprocating pumps with rated power exceeding 100 KW.
- H: Reciprocating pumps should not be selected when leakage of pumped fluid must be avoided because of hazards, such as fire, toxicity, or loss of expensive fluid. A possible exception is reciprocating diaphragm pumps.
- I: If ambient temperature is below the pour point of the pumped fluid, winterisation of pump casing (applies to spared pumps) and their associated auxiliaries (cooling water, minimum flow bypass, seal flush, and lube oil lines and oil filters, etc.) becomes essential.
- J: Minimum 10 % head rise to shutoff is usually a requirement for pumps in parallel operation. It is also important

Pump Type	Usual Services	Typical Application Limits	
ASME (ANSI) Process Pumps 19 pump sizes in horizontal (up to 250 mm suction x 200 mm discharge nozzle size) 15 pump sizes in vertical (up to 150 mm suction x 100 mm discharge nozzle size)	Corrosive/abrasive liquids, slurries, general purpose process (specific gravity > 0,7) and transfer services	Max. Suction Pressure (kPa):	500
		Max. Disch. Pressure (kPa):	1900
		Max. Temperature (deg C):	150
		Impeller Dia. (mm)	330
		Speed (rpm):	3 600
ASME (ANSI) Horizontal Pumps Sizes AA – A70 and Vertical in-line Pumps. Refer to ASME B73.1standard for horizontal pump sizes	Corrosive/abrasive liquids, slurries, general purpose process (specific gravity > 0,7) and transfer services. (Limit the use of in-line pumps to 150 KW)	For high stream factor (97,5% and higher), for intermediate life (less than 20 years)and long life (greater than 20 years) plants:	
		Flow (m^3/hr):	135
		Total Head (mt):	120
ASME (ANSI) Horizontal Pumps Sizes A80 – A120. Refer to ASME B73.1 standard for sizes Non-metallic (plastic) pumps are covered under ASME(ANSI) specificationB73.5.	Corrosive/abrasive liquids, slurries, general purpose process (specific gravity > 0,7)and transfer services Thermoplastic and Thermo set non-metallic pumps are limited to 100 deg C, 1800 Kpa, 250 m^3/hr and 125 deg C, 1800 Kpa, 800m^3/hr respectively	For intermediate life plants:(less than 20 years)	
		Flow(m^3/hr):	135
		Total Head (mt):	120
		For high stream factor (97,5% and higher) and long life (greater than 20 years) plants:	
		Flow (m^3/hr):	450
		Total Head (mt):	60
API 610 Single Stage Horizontal and Vertical Pumps (Limit the use of vertical in-line pumps to 150 KW. For operating temperatures beyond 150 deg C, use OH3 design with C-face motor)	High Temperature and high pressure services, offsite, heat transfer liquids, hydrocarbon, chemical, refining and natural gas processing services	For intermediate life plants: (less than 20 years)	
		Flow (m^3/hr):	1 140
		Total Head (mt):	300
		For high stream factor (97,5% and higher) and long life (greater than 20 years) plants:	
		Flow (m^3/hr):	680
		Total Head (mt):	215
API 610 Single Stage high speed (3600 to as high as 24000rpm) integrally geared Pumps	High pressure services, offsite, transfer, hydrocarbon, chemical, refining and natural gas processing services	For intermediate life plants: (less than 20years)	
		Flow (m^3/hr):	80
		Total Head (mt):	1 525
		For high stream factor (97,5% and higher) and long life (greater than 20 years)plants:	
		Flow (m^3/hr):	57
		Total Head(mt):	1370
Magnetic Drive Pumps (ANSIMAG	Zero leakage services, toxic liquids, refrigerants, heat transfer, carcinogenic, explosive and hazardous services	Minimum /Maximum Temperature (deg C):	-85/ 120
		Disch. Pressure (kPa):	2 400
		Maximum Solids (% by weight) 125 microns./ 5 %	
		Maximum Viscosity (cst):	200
		Maximum Power (KW):	75

that the capacity of each pump be approximately a constant portion of the capacity from shutoff to the end of its head-capacity curve.

- K: In some cases, the operating conditions at startup, shutdown or off-design may be close to the specified minimum flow (stable or thermal). In these situations or when recommended by the pump manufacturer, a minimum flow bypass line is required. Bypass line is tapped off pump discharge pipe and is routed to the pump suction source. This line includes a modulating control valve and depending upon the fluid temperature, a cooler may also be required. Typically, minimum flow bypass is provided for pumps with high differential heads such as in boiler feed water service.
- L: Warm-up bypass line is considered when pumps are spared and the operating temperature is in excess of 150 °C, and also in those services where the liquid tends to solidify at ambient temperature.
- M: Vertical can type pumps are used for cryogenic services due to low NPSHA and operation in most cases being near the boiling point of the fluids. Cryogenic pump shaft sealing configurations include double back-to-back seals with API flush Plan 53C or labyrinth seals exposed to pump suction pressure. These seals operate in vapour phase. Liquid level and vapour phase monitoring system is a feature that comes with labyrinth seal design.
- N: It is not unusual to carry out the performance test of large pumps (eg, seawater, cooling water) at reduced speed. The test procedure is included in ANSI/HI1.6-2000. As part of the bid review, engineers should investigate with the selected supplier if a performance test in the shop will be carried out at reduced speed. If so, effect on parameters such as efficiency and vibration level should be evaluated and mutually agreed to.
- O: In applications wherein NPSHA is below 2 m, reciprocating steam and power pumps may be limited by the pressure differential necessary for valve action, ie, flow through the valve orifice.
- P: Starting methods and conditions – closed discharge, reduced voltage, closed/open bypass and corresponding starting torques. One or more of these torque situations may exist at starting. Engineers should compare the corresponding load torque curve(s) with speed-torque curve of the driver motor to confirm if there is a minimum of 10 %

Pump Type	Usual Services	Typical Application Limits	
API 610 Single stage double flow between bearings Pumps (Specify pressure pulsation analysis for pumps handling flows greater than 1000 m^3/hr).Specify pressure balancing expansion joints in suction and discharge.	Same as API 610 single stage horizontal pumps For pumping station applications, intake model study should be stipulated when flow per pump is in excess of 9 000m^3/hr.	Flow (m^3/hr):	16 000
		Disch. Pressure (kPa):	2 100
		Total Head (mt):	245
API 610 multi stage horizontally split Pumps	Same as API 610 multistage horizontally split pumps and higher pressure services	Flow (m^3/hr):	16 000
		Disch. Pressure (kPa):	10 300
		Total Head (mt):	1 200
Vertical Turbine Pumps Specify that Pump intake design shall be as per Hydraulic Institute standard ANSI/HI 9.8-1998.Also surge analysis shall be stipulated.	Firewater, Deep well, mine dewatering, cooling and seawater intake, process, condensate, tanker and barge unloading, Irrigation Close-coupled submersible motor configuration is usually applied to deep wells (100+ mt. deep)	Flow (m^3/hr):	30 000
		Disch. Pressure (kPa):	10 000
		Total Head (mt):	1 000
		Higher impeller inlet tip speed reduces allowable operating region (AOR) because of hydraulic constraints. With 25 m/sec tip speed, AOR is usually 85 –115 %	
Sump Pumps	Process, Solids handling, drainage, pollution control, molten salts, corrosive services, sewage lift and cooling tower (typical setting is 5 – 6 mt for cooling tower pumps)	Flow (m^3/hr):	1 550
		Disch. Pressure (kPa):	690
		Total Head (mt):	90
Submersible Pumps	Wastewater, Solids handling and Slurry services	Flow (m^3/hr):	900
		Disch. Pressure (kPa):	690
		Total Head (mt):	90
Horizontal Abrasive Slurry Pumps Specification Parameters: (a) Particle hardness (b) Properties of conveying liquid (c) Solids concentration (d) Particle specific gravity (e) Average particle size and shape	Corrosive/abrasive services, fly ash, mining slurries, coal, slag, sand/gravel services.	Flow (m^3/hr):	5 000
		Disch. Pressure (kPa):	2 500
		Total Head (mt):	250
		Temperature (deg C):with lined Casing	110
		Specific Speed:	600 –1 800
		Spherical Solids (mm):	100
Vertical and Horizontal Axial Flow Pumps (Specify pressure pulsation analysis for these pumps)	High flow, low head process waste, evaporator and crystallizer, sewage sludge, heat recovery, reactor circulation services	Flow (m^3/hr):	50 000
		Disch. Pressure (kPa):	1 035
		Total Head (mt):	10
		Spherical Solids (mm):	220
Cryogenic Pumps (canned type)	Cryogenic fluids such as liquid oxygen, nitrogen, tail gas liquid, liquids near their boiling point	Flow (m^3/hr):	2 000
		Disch. Pressure (kPa):	2 500
		Total Head (mt):	225
		Temperature (deg C):	-180 / 400

margin. Other characteristic motor curves such as time-current heating, current vs load should be also reviewed.

- If vertical pumps are to be started with closed discharge valve, a design that quickly vents pump column assembly and head will be necessary. This is essential to ensure that line shaft bearings receive product lubrication immediately as the pump starts.
- Mixed flow or axial pumps have characteristic curves which are different from those with radial impellers. In these pumps maximum power occurs at shut-off prohibiting pump starting with a closed discharge valve.
- **Q:** When selecting a motor driver, all service conditions, including possible intermittent or cyclic operation and expected number of start/stop cycles per hour, should not be ignored. As a general rule, electric motors are limited to six starts/hour, ie, ten minute cycle to avoid overheating of the winding.
- **R:** Series or parallel operation – Head rise to shut-off for pumps operating in parallel should be 10 %. In series operation, if feasible, consider using one multi-stage pump instead of several single-stage pumps in series arrangement.
- **S:** Review suction conditions – NPSHA and NPSH margin, suction specific speed (Nss), vapour pressure at pumping temperature, viscosity, entrained gas (or gases) etc. Liquids with entrained gas such as in oil well applications are difficult to pump. Entrained gas can affect both head and flow rate. For such services, using an open impeller or using a high specific speed booster pump in series are some of the available options. Pump manufacturers should be consulted for the most appropriate solution.
- **T:** Large flow services such as cooling and sea water require special design of pump intake as well analysis of water hammer. While there are several proven methods of controlling water hammer (surge tanks, slow closing shut-off valves, etc), a detailed engineering analysis should be carried out and the pump manufacturer involved. Driver options for these pumps include soft start, variable frequency and synchronous motors.
- **U:** When a pump is to be selected to handle viscous fluid and the operation involves varying pumping temperatures, the engineer should confirm with the pump and seal manufacturers that the mechanical seal and its auxiliaries (ie, flush system) will be designed for the

Pump Type	Usual Services	Typical Application Limits	
Horizontal Plunger Type Pumps	High pressure, low flow in oil, water, and chemical services	Flow (m^3/hr):	60
		Disch. Pressure (kPa):	2*10^5
		Max. Power (KW):	150
Vertical Plunger Type Pumps	High pressure, low flow in oil, water, and chemical services	Flow (m^3/hr):	125
		Disch. Pressure (kPa):	2*10^5
		Max. Power (KW):	1 100
Horizontal Piston Type Pumps	High pressure, low flow in oil, water, and chemical services	Flow (m^3/hr):	450
		Disch. Pressure (kPa):	7 000
		Max. Power (KW):	1 500
Direct (steam driven) Acting Piston Pumps	Oils, Chemicals The smaller the stroke length, the higher is the pump speed. In single-acting pumps, for stroke lengths of 50 / 100 mm, corresponding standard speeds are 750 / 400 rpm when pumping cold water. In comparison, in double acting design, for strokes of 50 / 100 mm, standard speeds are 140 and 110 rpm respectively.. This analogy applies to all types of reciprocating power pumps, just not direct acting pumps. Speed of reciprocating pumps depends on liquid characteristics (solids, dissolved gases, viscosity, and temperature), NPSHA,NPSHR and mechanical design of pump (type of valves, materials, seals).	Flow (m^3/hr):	225
Direct (steam driven) Acting Plunger Pumps		Disch. Pressure (kPa):	2 400
		Max. Power (KW):	375
		Flow (m^3/hr):	60
		Disch. Pressure (kPa):	14 000
		Max. Power (KW):	375
Metering Pumps (Usual Strokes: 100 – 140per minute)	Metering of chemicals in refinery, HPI industries	Flow (m^3/hr):	4
		Disch. Pressure (kPa):	5*10^4
		Max. Power(KW):	7
Rotary Gear Pumps NPSH is directly proportional to speed unlike pressure in centrifugal pumps. PD pumps can create suction lift (i.e. work with negative suction).	Lube oils, high viscosity fluids(up to 200,000cSt). When handling viscous fluids, the net positive inlet pressure required (NPIPR) and power increase with increasing viscosity whereas the maximum allowable pump speed and slip decrease.	Flow (m^3/hr):	60
		Disch. Pressure (kPa):	1 400
		Max. Power(KW):	40
Firewater and Jockey Pumps	Fire Water Service	Follow NFPA 20guidelines	
Rotary Screw Pumps	Mostly for lube oil service	Flow (m^3/hr):	1 150
		Disch. Pressure (kPa):	35 000
		Max. Power(KW):	750
Progressive Cavity Pumps (If required due to process fluid composition, wetted parts of progressive cavity pumps can be furnished in titanium and hastalloy). Consider twin screw pumps for higher than 170 deg C operating temperature and viscosity up to 200 strokes.	Polymer dispersion, dewatering, paper and pulp, oil and gas upstream, viscous fluids	Flow (m^3/hr):	500
		Diff. Pressure (kPa):	4 800
		Temperature (deg C):	170
		Speed (rpm):	400
		Solids Content (%):	5
		Solid Size (mesh):	<100

entire range of specified and anticipated viscosities and pump shaft, coupling, and driver will be designed to transmit highest torque associated with lowest pumping temperature. Also, when a centrifugal pump is selected to handle a viscous fluid, the engineer should ensure that the vendor's water performance curves are corrected for head, capacity and efficiency.

- **V:** A pump's flange rating is governed by maximum allowable working pressure (MAWP). Engineers should verify that flange rating is based on MAWP corrected for the maximum pumping temperature and that the hydrostatic test pressure is determined from the MAWP which is corrected for temperature and material of construction of the pump.
- **W:** Axial thrust in pumps is yet another area to be aware of. Axial loading is governed by differential pressure across the faces of impeller(s). In the case of vertical pumps, the weight of the rotor adds to down thrust. Pump out vanes on the back of the impeller, balance holes and enclosed impeller design are some of the features that can be furnished by pump manufacturers to reduce axial force in horizontal units.

Multi-stage horizontal pumps, (boiler feed water and charge pumps for example) incorporate balance drum and a balance line. Upthrust in vertical pumps (especially those with shorter columns) during start-up, transient and offset conditions, is handled by thrust bearing in the driver motor. Engineers should check the load capability of motor thrust bearing in both directions when evaluating proposals for vertical pumps. Typically, upthrust during start-up is 30-35 % of the downthrust in steady state operation.

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Standard systems for complex control tasks

At present, control valves are increasingly becoming the focus of a wide variety of applications. In order to provide the customer with a simple selection guide, GEMÜ has now summarised all the relevant components of a control system under the term Process Control System, or PCS.

The PCS type combines the standard GEMÜ control valves with mounting kit, piping system and positioner. In this way, the customer has the option of ordering the appropriate control system and all the necessary components quickly and without error. Each nominal size has two regulating cones (linear and equal-percentage) to choose from as standard.

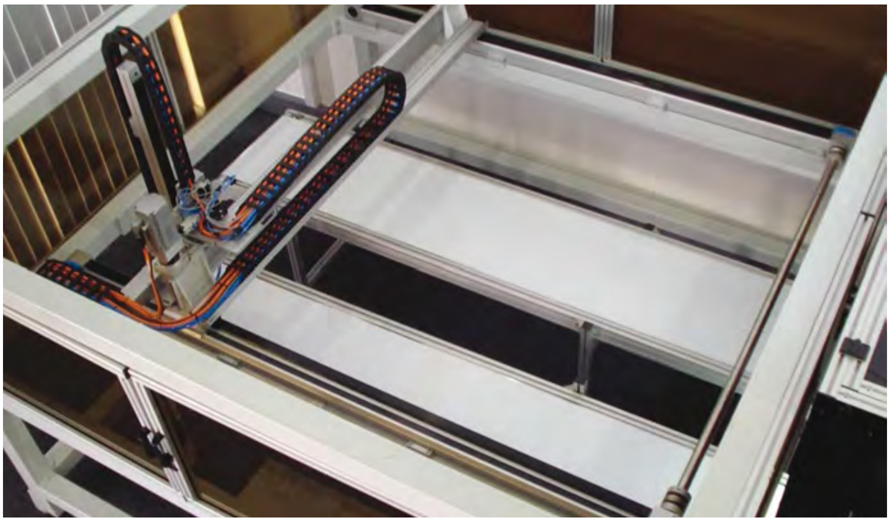
The operators for the GEMÜ 554 (plastic), GEMÜ 514 (aluminium) and GEMÜ 550 (stainless steel) series are available in the form of actuators. GEMÜ 1434, 1435 and 1436 have been integrated into the PCS as controllers. The standard versions of each controller are regarded as basic versions. The GEMÜ 514, 530, 532, 534, 550 and 554 series contain the nominal size range of DN 15 to DN 50. The GEMÜ 536 globe valve covers the nominal size range of DN 65 to DN 150.

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.

Manufacturing is carried out at six manufacturing sites in Germany, Switzerland, China, Brazil, France and the USA. 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.

Further information can be found at www.gemu-group.com

Festo opens innovative applications centre



Festo, a leading automation solutions provider, unveiled its brand new applications centre at its Johannesburg headquarters on 29 July, 2015.

The applications centre is the first of its kind in South Africa, boasting 'state-of-the-art' Electric Drive Handling and Vision Systems. Festo customers will be able to physically test any 4D electric drive applications in a controlled environment to confirm details like maximum speed, accuracy and cycle time.

With remote capabilities such as live video streaming, the applications centre is positioned to meet the needs of customers all across Southern, East and West Africa. Brett Wallace, MD of Festo South Africa, highlighted the value that the applications centre would be able to deliver to African manufacturers in a highly competitive global marketplace.

The applications centre will work hand-in-hand with another recently unveiled Festo innovation, its Handling Guide Online (HGO). This intuitive online tool, another first in the South African market, allows users to quickly and easily design and order a handling system from scratch. The customer is prompted to enter parameters and information critical to the task on hand. The powerful software then makes use of Festo's extensive data base of proven designs to provide possible solutions.

"Integrated solutions like HGO and the applications centre represent the future of business," said Thomas Hohls, Technical Support Engineer. "For customers in need of high speed machines to handle high volume production, they need sophisticated handling solutions, and these tools allow machines to be designed and built with confidence."

The opening of the centre is the latest example of Festo's drive to evolve its ecosystem of automations solutions, which range from training and consulting to implementation. The Application Centre serves another purpose, in addition to providing real life simulations, it also serves as a training facility. Gift Thobejane, Systems Engineer, highlights the multifaceted way the centre marries people and systems to create unique value.

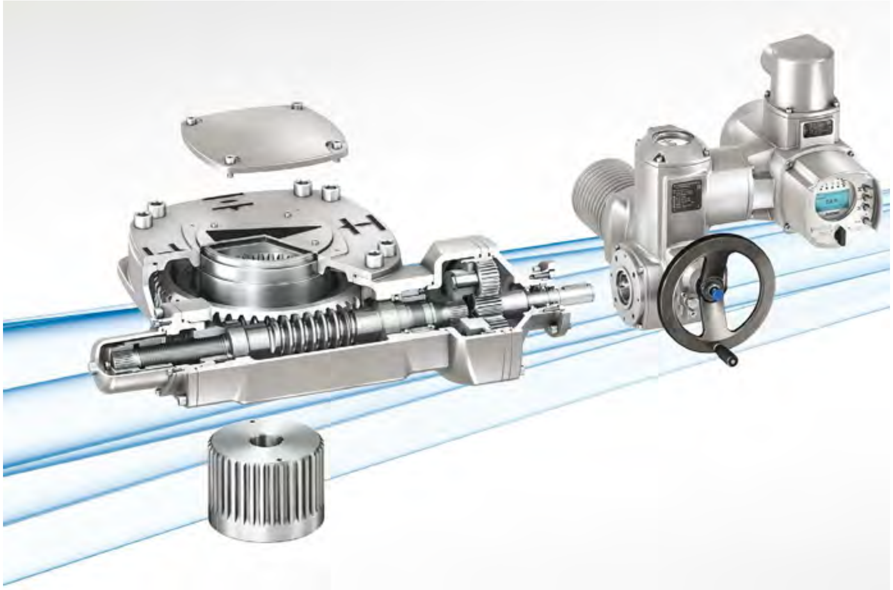
FESTO supports the Sci-Bono Lab

Festo donated R2-million worth of training equipment towards the Sci-Bono Lab Newtown Johannesburg. The FESTO Sci-Bono Mechatronics lab is a Mechatronics Engineering Training System/Lab for secondary schools which will address manufacturing, employability and STEM subjects (Science, Technology, Engineering and Mathematics). The hope is that this facility will improve the human resources needed to drive the industrial manufacturing core of the South African economy by closing the skills gap, improving employability and increasing productivity.

This advanced facility launched on August 4th, during National Science Week, and is suitable for Grade 10 -12 learners.

For more information contact Festo on tel: +27 11 971 5500 or email info_za@festo.com ▮

AUMA part-turn gearbox now has enhanced flexibility for sizing



GS gearboxes are frequently combined with AUMA actuators.

Manufacturing advancements underpin enhanced sizing flexibility for AUMA's part-turn GS gearboxes. Three duty classes, (1, 2 and 3), have been introduced to support all anticipated operations across predicted valve lifetimes. The new classifications, paired with the introduction of additional flange sizes, enable the company's GS gearboxes to be mounted on larger valve flanges.

AUMA GS gearboxes play a key role automating large scale butterfly and ball valves: the company's established range caters for torques between 500 to 675 500 Newton metres. Comprehensive product revisions undertaken by AUMA encompassing corrosion protection, surface treatment of metals, enhancement of connection technologies and selection of optimal lubricants have improved the mechanical properties of the gearboxes and given AUMA a platform to reassess permissible torques.

With no binding standard for valve gearboxes, AUMA continues to adhere to EN 15714-2, which defines high lifetime requirements for actuators. EN 15714-2 specifies a sophisticated load profile for type tests and lifetimes up to 10 000 operation cycles, depending on the device's size. AUMA's rigorous test procedures confirm that its devices exceed these standard requirements.

The lifetime specifications of the standard are the basis of AUMA's newly introduced duty class 1 gearbox. For duty class 2, assuming infrequent operation, 1 000 duty cycles is assumed: this increases the permissible gearbox torque by 25 percent. In these instances, smaller and more cost-efficient gearbox sizes can be selected to suit the customers' applications. Duty class 3 is adopted for manually operated gearboxes enabling higher torque levels due to extremely infrequent operations.

For more information visit www.auma.com

Plant availability increases with expanded Warman® WBH® range

Plant availability is paramount in all commodity sectors and there is an increasing emphasis on optimisation of pumping systems from end users as part of their cost savings drive. "One of the options in terms of reducing operating cost is to replace older technology with new," says Rui Gomes, product manager slurry pumps for Weir Minerals Africa and Middle East.

Gomes points out that Weir Minerals Africa has a depth of experience and expertise in terms of assessing pumping systems. This allows the company to provide solutions aimed at assisting customers in reducing total cost of ownership on pumping systems. "The recent expansion of the Warman® WBH® range of pumps now gives our customers access to the latest technology across a range of pumping applications."

The Warman® WBH® slurry pump is typically used in heavy duty applications such as mill discharge, slurry transfer and process pumping applications and is ideal for both greenfields and brownfields projects. "During its development we extrapolated the best attributes of our existing heavy duty slurry pumps and incorporated these into the new range," Gomes continues.

In 2010 the Warman® WBH® 75 and Warman® WBH® 100 were launched to the African market through a trial programme. The twofold objective was to obtain field and verification data and to gain market acceptance.

The Warman® WBH® pump has proven so popular with customers that the range has been expanded upwards and downwards, and covers from 50 mm discharge diameter up to 300 mm discharge diameter with flow rates of between 5 litres per second and 800 litres per second.

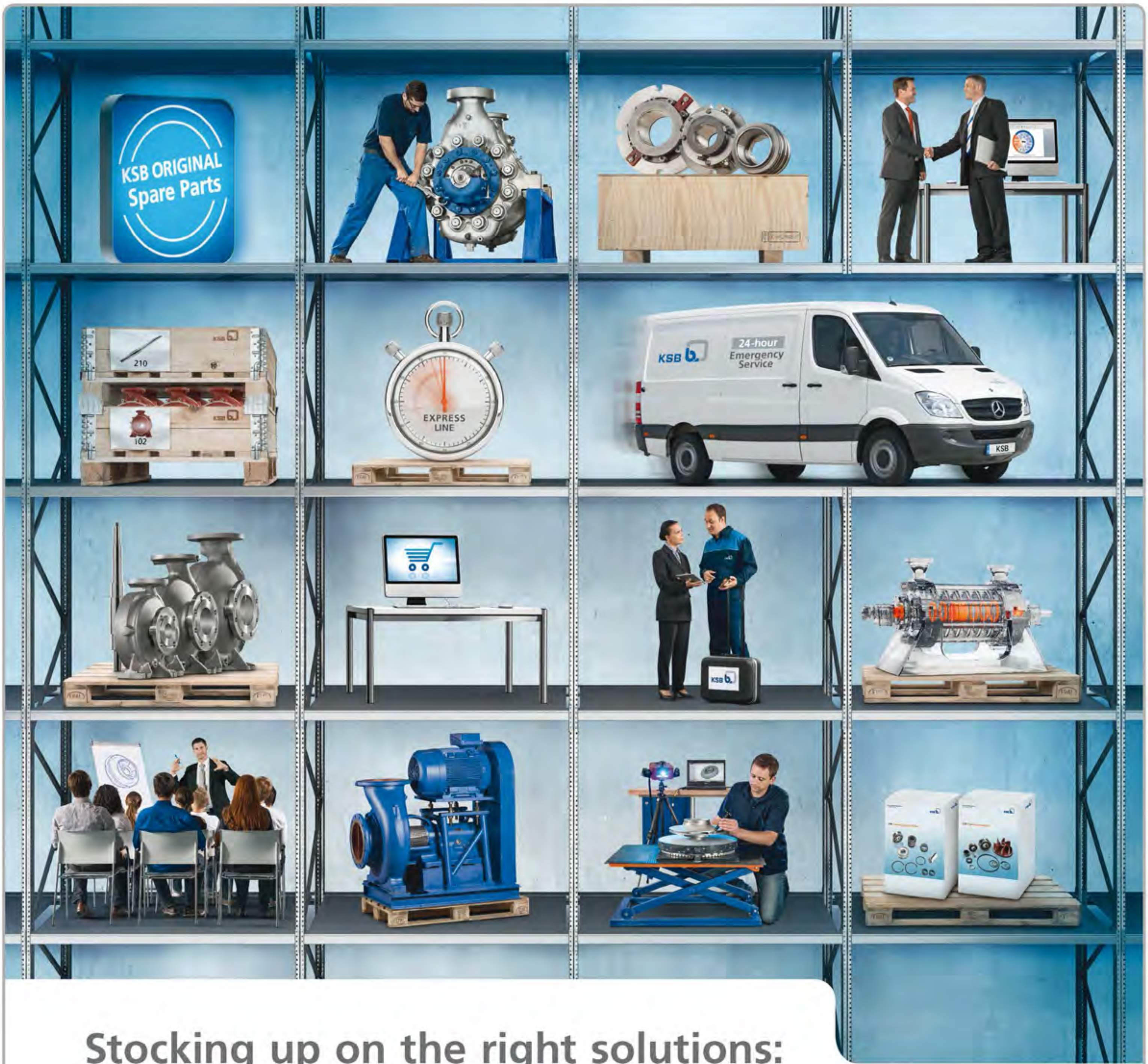
The Warman® WBH® range is available with both metal volute or rubber liners, depending on the application. For instance, rubber would be suited to gold, copper and platinum pumping applications whereas a metal volute is used predominantly in diamond and coal processing plants while in iron ore processing, a mix of metal and rubber is used. Furthermore, the Warman® WBH® pump features a streamlined impeller and volute design, enabling flow paths within the pump that enhance the overall performance and combine high efficiency and long life.


Rui Gomes

The pump is designed with a throatbush or front liner adjustment mechanism, which continuously minimises the impeller gap as recirculation increases. The front liner adjustment mechanism also rotates the throatbush for a more even wear pattern and eliminates premature failure due to localised wear which would occur without this feature.

"The final design was based on a combination of wear component data gained through years of experience and the use of sophisticated software, including Computational Fluid Dynamics (CFD). From a wear life perspective this increase in volute life has translated into a decrease in maintenance costs for pumps users," Gomes concludes.

For more information contact Rene Calitz on tel: +27 011 929 2622, email r.calitz@weirminerals.com or visit www.weirminerals.com


KSB ORIGINAL
Spare Parts
EXPRESS LINE
KSB
24-hour
Emergency
Service

Local SMME pump manufacturer wins awards

The South African Premier Business Awards (SAPBA) Awards is an annual event hosted by the Department of Trade and Industries (the dti) to award business excellence and honours enterprises that promote the spirit of success and innovation as well as job creation, good business practises ethics and quality.

The 2014/15 was the third annual SAPBA awards ceremony and the gala event held at the Sandton Convention Centre was hosted by the dti, in partnership with Proudly South African and Brand South Africa, and sponsored by Absa and the Gordon Institute of Business Science (GIBS) on the 9th of April 2015. The Award categories included: Lifetime Achievement, Manufacturers, Exporters, Enterprise Development Support, Women-Owned Businesses, Young Entrepreneur, Investor of the Year, Proudly South African Enterprise, Play Your Part and SMME.

Niël, Maureen and Thys Wehmeyer with the awards received as winners in two categories of the SAPBA awards

Hazelton Pumps entered into three categories, namely, the Manufacturers, Exporters and SMME categories and was nominated as finalists in all of these. The family-owned and -managed company won the prestigious 'Manufacturer of the Year' award for the design, development and manufacture of a Medium/High Voltage Slurry Submersible Pump in collaboration with customers in order to meet their individual and customised requirements. This pump is the first of its kind in the world.

The company also won in the 'SMME Company of the Year' and was a finalist in the third category.

For more information
visit www.sapremierbusinessawards.co.za ▮

IChemE

SAIChE IChemE

New and old committee members from left to right: Danielle Bearman, Nirvanna Rampersad, Lizelle van Dyk and Dawie Van Vuuren (President of SAIChE IChemE)

SAIChE IChemE Gauteng Branch Annual General Meeting

The annual general meeting of SAIChE IChemE's Gauteng branch took place at the Blue Valley Golf Estate on 28 May 2015. The event was attended by chemical engineers of all ages, industries and institutions.

The evening kicked off with the chairperson's report (Dr Lizelle van Dyk) and the guest speaker was Mr Wayne Duvenage from OUTA (Opposition to Urban Tolling Alliance). Mr Duvenage gave an interesting talk on the history and current state of e-tolls in Gauteng, and the role that OUTA is playing to oppose the implementation of e-tolls. The audience was left with some food for thought and the talk ended with a lively question and answer session.

New committee members were elected and they are Dominique Tharandt, Shaan Oosthuizen and Nirvanna Rampersad. Lizelle van Dyk and Danielle Bearman also chaired a session where members had the opportunity to give suggestions as to how the Branch can improve its value proposition to its members. The response was overwhelming and the ideas were documented on a flipchart for further development and implementation. Some of these ideas included the development of a SAIChE IChemE app to attract younger members, special interest groups, webinars, more social events, internal forums accessible for problem solving, etc.

The Branch would like to thank ISHECON for its continued financial contribution to the Branch through the proceeds of its Process Safety course, Wayne Duvenage for presenting his stance on the e-toll system, and Michelle Low for advertising the event on social media sites.

SAIChE IChemE Gauteng branch would like to invite all of its members to attend forthcoming events such as a talk on the SKA Project and a craft beer evening. For further information and current events, please visit our webpage at http://www.icheme.org/communities/member%20groups/south-africa-member-groups/gauteng ▮

Written by Danielle Bearman and Lizelle van Dyk on behalf of SAIChE IChemE Gauteng Branch

LNG vaporisers selection

based on site ambient conditions – Part 1

by John Mak, Senior Fellow and Technical Director, Nick Amott, Curt Graham and Dhirav Patel, Fluor, USA

This article highlights the results of an LNG vaporisation screening study for regasification facilities located in warm and cold climate regions of the world. The objective is to provide a guideline in the selection of an LNG vaporisation design that is suitable for today's terminals.

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 with environmental impacts. These existing facilities were considered utility companies. LNG cold utilisation, integration with power plants and waste heat recovery were rarely practised.

Another recent development pertains to the rapid growth of shale gas in North America. Many North American import terminals are unused and are being converted into export terminals. Also several new export terminals are being constructed to take advantage of the low cost shale gas. Similar shale gas growth is expected in China, which will eventually slow down LNG import. The future growth of LNG import is expected to be located in smaller developing countries in the equatorial or subequatorial regions. These terminals will serve smaller markets, and the size of the terminals and regasification facilities will tend to be smaller.

Another development is the use of LNG regasification vessels (RV) and FSRUs (Floating Storage and Regasification Unit) with built-in regasification facility. There are a number of projects in the planning and construction stage for LNG RV or FSRU vessels around the world (eg, Indonesia, Lithuania and East Mediterranean). The popularity of these ships is due to their flexibility. They are constructed in ship yards and can be deployed quickly to the site, and can be transported to other sites later.

FSRU can be used to supply fuel gas for power generation of a medium size power plant. Generally when used for power generation, the LNG sendout rate requirement is relatively low. For example, a 100 MMscfd regasification plant can support the fuel consumption of a 400 to 500 MW power generation station.

The countries where these new regasification terminals are located can be broadly divided into two regions. First, there are the equatorial countries where the site ambient temperatures are fairly constant and generally do not fall below 18 °C. Second, there is the sub-equatorial region where the site ambient temperatures can fall below 18 °C during winter months.

The following countries fall under the equatorial region definition:

- Asian Countries (Southern India, Indonesia, Thailand, Malaysia, Singapore, Philippines)
- North American Countries (Mexico)
- South American Countries (Brazil)

whereas the following countries may fall under the sub-equatorial definition:

- Asian Countries (China, Vietnam, Mid-West and Mid-East of India)
- South American Countries (Chile, Argentina)
- European Countries (Spain, UK, France)

Types of vaporisers

Typical types of vaporisers that have been used worldwide for LNG regasification are:

- Open Rack Vaporisers (ORV)
- Submerged Combustion Vaporisers (SCV)
- Ambient Air Vaporisers (AAV)
- Intermediate Fluid Vaporisers (IFV)

Open rack vaporisers (ORV) and submerged combustion vaporisers (SCV) are the most common vaporisation methods in existing regasification terminals, which have generally been located in the subequatorial region. Recent LNG receiving terminal activities have been shifting to the equatorial region where the weather is warmer, and the use of intermediate fluid vaporisers (IFV) is found to be more suitable. Important factors that should be considered in the LNG vaporiser selection process are:

- Site conditions and plant location
- Availability and reliability of the heat source
- Customer demand fluctuation
- Emission permit limits
- Regulatory restrictions with respect to the use of seawater
- Vaporiser capacity and operating parameters
- Safety in design
- Operating flexibility and reliability
- Capital and operating costs.

Seawater (SW) heating

LNG receiving terminals are generally located close to the open sea for ease of access to LNG carriers. Seawater is generally available in large quantities at low cost as compared to other sources of heat, and is the preferred heat source. The oppositions are concerns about the destruction of marine life within the seawater system and the negative impacts from the cold seawater discharge and the spent chemical disposal.

Open rack vaporiser (ORV)

An Open Rack Vaporiser (ORV) is a heat exchanger that uses seawater as the source of heat. ORVs are well proven technology and have been widely used in Japan, Korea and European LNG terminals. The common seawater temperature for ORV operation is at least 5 °C.

ORV units are generally constructed of aluminum alloy for mechanical strength designed to operate at the cryogenic temperature. The aluminum material has high thermal conductivity which is important for heat transfer equipment. The tubes are arranged in panels, connected through the LNG inlet and the regasified product outlet piping manifolds and hung from a rack (Figure 1). The panels are coated externally with zinc alloy, providing corrosion protection against seawater. The panel arrangement feature provides ease of access for maintenance. ORVs require regular maintenance to keep the finned tube surface clean.

The ORV design is very flexible. The panels can be isolated for maintenance and heating duty can be adjusted as needed. The unit can be turned down to accommodate fluctuations in gas demand, gas delivery temperature and variation in seawater temperature.

For large regasification terminals, detailed evaluation of the seawater system including future expansion must be

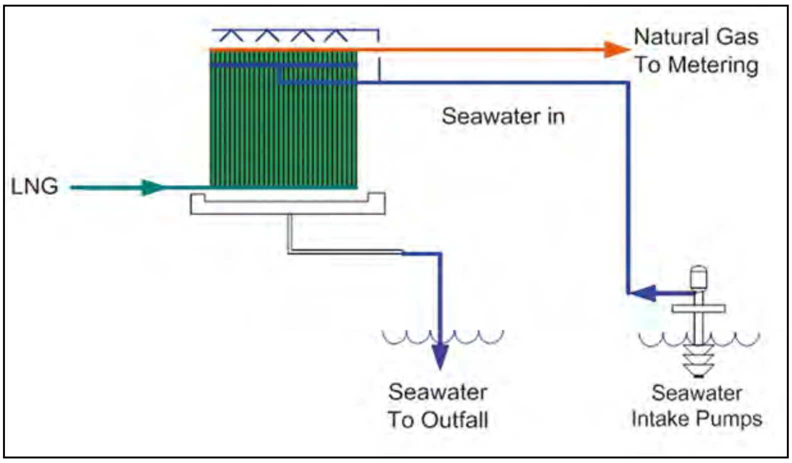


Figure 1: Open Rack Vaporiser flow scheme

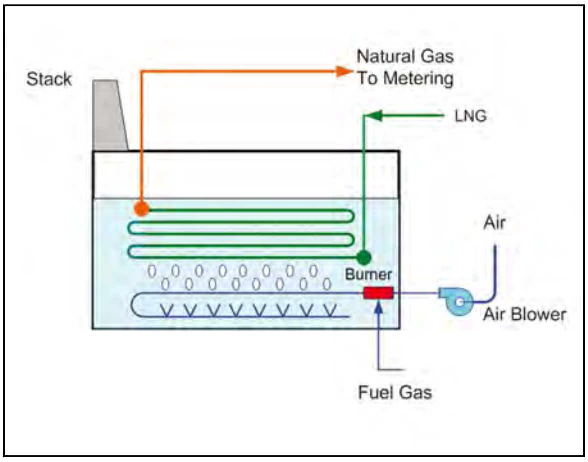


Figure 2: Submerged Combustion Vaporiser

performed. Once the system is installed, changes to the seawater intake and outfall system are difficult and costly to implement. Some of the key issues and design parameters that must be considered include the following:

- Is the seawater quality suitable for operating an ORV system?
- Does the seawater contain significant amounts of heavy metal ions? These ions will attack the zinc aluminum alloy coating and will shorten its life.
- Does the seawater contain a significant amount of sand and suspended solids? Excessive sediment will cause jamming of the water trough and the tube panel. Proper seawater intake filtration systems must be designed to prevent silts, sands and sea life from reaching the seawater pumps and exchangers.
- The design must consider the environmental impacts of the seawater intake and outfall system, and minimise the destruction of marine life during the construction period and normal plant operation.
- Chlorination of the seawater is necessary to slow down marine growth. However, residual chlorine in the seawater effluent can harm the marine life.
- Seawater discharge temperature must comply with local regulations. Temperature drop of seawater is typically limited to 5 °C in most locations.
- Locations of the seawater intake and seawater outfall must be segregated to avoid cold seawater recirculation.
- If the site is located in a cold climate region, supplementary heating is necessary to maintain the shale gas temperature.
- Is a backup vaporisation system provided? Additional equipment is necessary to accommodate maintenance of the seawater pumps or during peaking demand.
- Is the regasification facility located close to a waste heat source, such as a power plant? Heat integration using waste heat can reduce regasification duty which would minimise environmental impacts.
- Is the seawater system designed for future expansion? Modification of seawater systems is very costly and for this reason, extra capacity must be built into the intake and outfall systems to accommodate future expansion.

Fuel Gas (FG) heating

LNG vaporisation using fuel gas for heating typically consumes approximately 1,5 % of the vaporised LNG as fuel, which reduces the plant output and the revenue of the terminal. Because of the high price of LNG, SCVs are only used during winter months to supplement ORV, when the seawater temperature cannot meet the regasification requirement. They can also be used to provide flexibility in meeting peaking demands. The SCV burners can be designed to burn the low heat content boil-off gas.

Submerged Combustion Vaporisers (SCV)

A typical SCV system is shown in Figure 2. LNG flows through a stainless steel tube coil that is submerged in a water bath which is heated by direct contact with hot flue gases from a submerged gas burner. Flue gases are sparged into the water using a distributor located under the heat transfer tubes. The sparging action promotes turbulence resulting in a high heat transfer rate and a high thermal efficiency (over 98 %). The turbulence also reduces deposits or scales that can build up on the heat transfer surface.

Since the water bath is always maintained at a constant temperature and has high thermal capacity, the system copes very well with sudden load changes and can be quickly started up and shutdown.

The bath water is acidic as the combustion gas products (CO_2) are condensed in the water. Caustic chemicals such as sodium carbonate and sodium bicarbonate can be added to the bath water to control the pH value and to protect the tubes against corrosion. The excess combustion water must be neutralized before being discharged to the open water.

To minimize the NOx emissions, low NOx burners can be used to meet the 40 ppm NOx limit. The NOx level can be further reduced by using a Selective Catalytic Reduction (SCR) system to meet the more stringent 5 ppm specification.

SCV units are proven equipment which are very reliable and have good safety records. Leakage of gas can be detected by hydrocarbon detectors which typically would initiate the emergency shutdown system. There is no danger of explosion, due to the fact that the temperature of the water bath always stays below the ignition point of natural gas.

The controls for the submerged combustion vaporisers are more complex when compared to the open rack vaporisers (ORV). The SCV has more pieces of equipment, such as the air blower, sparging piping and the burner management system which must be periodically maintained. Unlike other vaporiser options, SCVs are compact and do not require much plot area.

Ambient air heating

Air is the other source of 'free' heat for LNG heating. Ambient air heating is advantageous in hot climate equatorial regions where ambient temperature is high all year round. In the cooler subequatorial areas, where winter temperature is low, supplementary heating is necessary.

Ambient Air Vaporisers (AAV)

Direct ambient air vaporisers are proven equipment in cryogenic services, such as in air separation plants. They are vertical heat exchangers and are designed for ice buildup on the fins and require periodic defrosting. They are used for peak shaving plants and smaller LNG terminals. When compared to other vaporiser options, they require more heat exchange surface and more real estate.

A typical AAV design is shown in Figure 3 on page 34. AAV consists of direct contact, long, vertical heat exchange tubes that facilitate downward air draft. This is due to the warmer less dense air at the top being lighter than the cold denser air at the bottom. Ambient air vaporisers utilise air in a natural or forced draft vertical arrangement. Water condensation and melting ice can also be collected and used as a source of service/potable water.

To avoid dense ice buildup on the surface of the heat exchanger tubes, deicing or defrosting with a 4-8 hour cycle is typically required. Long operating cycles lead to dense ice on the exchanger tubes, requiring longer defrosting time. Defrosting requires the exchanger to be placed on a standby mode, and can be done by natural draft convection or forced draft air fans. The use of forced draft fans can reduce the defrosting time.

There are other defrosting configurations which can be used to reduce the defrosting time, as shown in Figure 4. In such a scheme, the warm pipeline gas is recycled using a blower to warm up the interior of the vaporiser tubes. When ice is melted next to the tube surface, the ice block will naturally fall by gravity. Less defrosting time reduces the number of standby vaporisers and capital cost, which, however, must be balanced by the cost of additional control and operation complexity.

The main concern of AAV is fogging around the vaporiser areas which can pose a visibility problem and interfere with plant operation. Fog is generated by condensation of the moisture of the outside air by the cold air exiting from the AAV. The intensity of fog depends on many factors, such as separation distances among units, proximity to adjacent structures, wind conditions, solar radiation, relative humidity and ambient temperatures. Fogging is typically denser in the morning and subsides later in the day.

Intermediate fluid heating

LNG vaporisers using an intermediate fluid or a Heat Transfer Fluid (HTF) is becoming more prevalent in recent designs. The use of a closed loop heat transfer fluid provides design and operation flexibility, allowing integration with other technologies and waste heat recovery. There are typically three types of HTF used in LNG vaporisation:

- Glycol-Water
- Hydrocarbon Based HTF (Propane, Butane or Mixed Refrigerant)
- Hot Water.

Glycol-water Intermediate Fluid Vaporiser (IFV)

Ethylene glycol or propylene glycol or other low freezing heat transfer fluids are suitable for LNG vaporiser services. Up to now, the glycol-water intermediate fluid LNG vaporisers only account for a small fraction (around 5 %) of the worldwide LNG regasification units.

The IFV design uses a shell and tube heat exchanger to transfer heat from the glycol-water mixture to LNG. The exchanger (vertical shell and tube design) is very compact due to the high heat transfer rate and the large temperature approaches. The system operation is simple, typically includes a glycol-water circulation pump and an expansion drum for startup and shutdown.

The intermediate fluid system is flexible and can be designed for different heating options as shown in Figure 5 on page 34. The different heating options include:

- Air heater
- Reverse cooling tower
- Seawater heater
- Waste heat recovery system or fired heater.

Using air for heating will generate water condensate, especially in the equatorial regions. The water condensate is of rain water quality which can be collected and used for in-plant usage and/or export as fresh raw water. However, conventional air fin type exchangers which consist of fin tubes are not designed for ice buildup. But with the use of an intermediate fluid, the exchanger tube wall temperature can be controlled at above the water freezing temperature, which would eliminate the ice buildup problems.

The reverse cooling tower design extracts ambient heat by direct contact with the intermediate fluid which in this case is the cooling water. Heat transfer in the reverse cooling tower design is via sensible heat transfer and water condensation, which is sensitive to variations in the ambient conditions.

Similar to conventional ORV, seawater heating in IFV services requires a seawater system and control of biological growth. The seawater system is prone to fouling, and the exchanger (plate and frame type) needs to be cleaned periodically.

If ambient heat heating is sufficient during cold winter months, or during system outage, fuel gas is necessary to supplement heating. If waste heat is available, it would increase the overall thermal efficiency and reduce air emissions.

Intermediate Fluid (Hydrocarbon) in Rankine Cycle

Hydrocarbons such as propane, butane or other hydrocarbon refrigerants can be used as an intermediate fluid in LNG vaporisers. The low freezing property of hydrocarbon avoids the freezing problem's direct contact with seawater. With hydrocarbons used as an intermediate fluid, cold seawater temperature, at as low as 1 °C can be used, an important

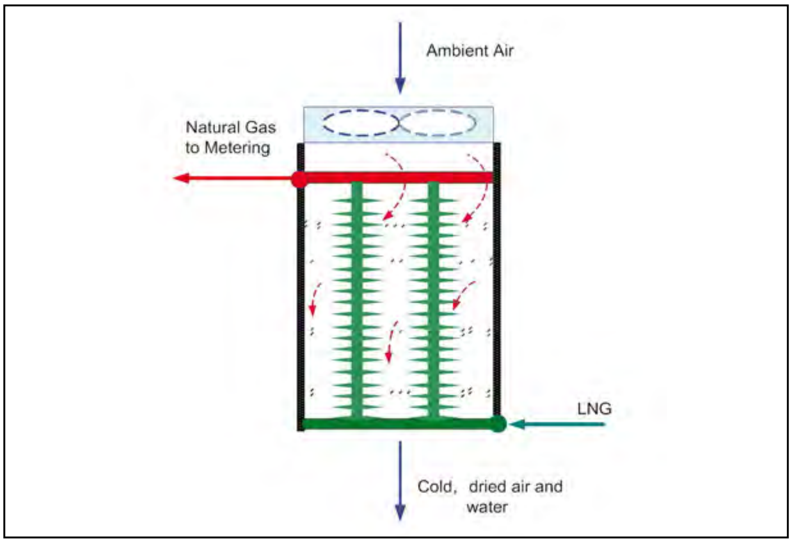


Figure 3: Typical Ambient Air Vaporiser

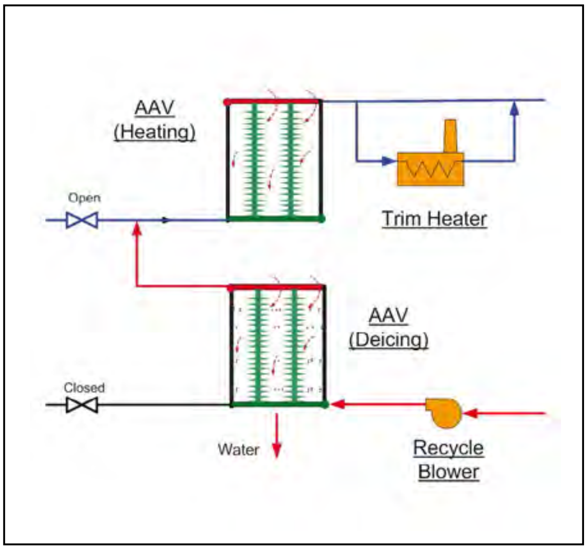


Figure 4: Improved Defrosting on Ambient Air Vaporiser

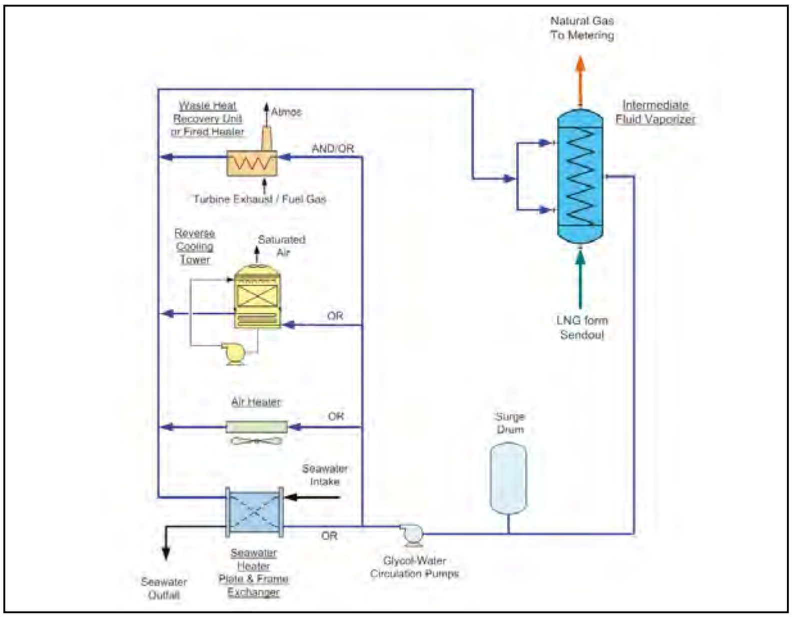


Figure 5: Glycol-water Intermediate Fluid Vaporiser integration with different heat sources

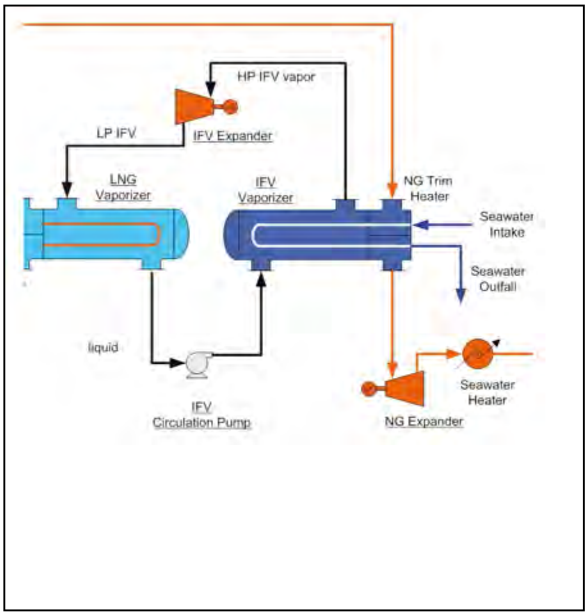


Figure 6: IFV LNG Vaporisers in Rankine Cycle

issue in cold climate operation.

Figure 6 shows one of the configurations using propane as an intermediate fluid in LNG vaporisers. The configuration uses two heat exchangers operating in series. The first exchanger uses the heat of condensation of propane to vaporise the LNG at the cryogenic temperature range, and the second heat exchanger uses the sensible heat of seawater at the higher temperature range. Since direct contact with seawater occurs at higher temperatures, freezing of seawater is avoided. The second exchanger is also used to vaporise the intermediate fluid propane that is recirculated to the first exchanger.

In addition to LNG heating, this configuration can also be used to generate power. In this configuration, high pressure propane or butane expanders can be expanded in a gas expander operating in a closed loop Rankine cycle.

The vaporised LNG can also be used to generate power using a natural gas expander in an open cycle configuration. In most instances, when natural gas is supplied to a power plant, the gas pressure is lower than the LNG sendout pressure. Typically, LNG sendout pressure is at 100 barg or higher, and is required to be letdown to 30 barg at the power plant inlet. The potential work from the letdown operation can be recovered using a natural gas expander for power generation. Sufficient power can be produced to operate the LNG regasification facility. Power generation using LNG as the cold heat sink is attractive since power can be generated without the use of fuel gas or emissions.

References

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Scatec Solar to build first large scale solar plant in West Africa

An historic agreement to Build-Own-and Operate West Africa's first utility-scale solar power plant was signed In Bamako, Mali, on July 10, by Norwegian company Scatec Solar (http://www.scatecsolar.com) and its partners, the Malian Ministry of Energy and Water and Electricité du Mali (EDM), the electricity utility of Mali.

To be located near the ancient city of Segou in South-East Mali, 240 km from Bamako, the 33 MW solar project is being developed in partnership with IFC InfraVentures and the local developer Africa Power 1.

The agreements include a Power Purchase Agreement (PPA) between EDM and Segou Solaire SA, the local project company controlled by Scatec Solar, for the delivery of solar power over the next 25 years. The PPA with the utility is complemented by a Concession Contract with the Government of Mali, granting license to Segou Solaire to operate.

Scatec Solar (SSO) will own 50 % of the power plant and World Bank's project development fund, IFC InfraVentures will hold 32,5 %, while the local project development company, Africa Power 1, headed by Dr Ibrahim Togola, will hold 17,5 %. Scatec Solar will construct the plant, and in addition, provide operation and maintenance services.

Annual production from the 33 MW solar power plant is estimated to be 60 000 Megawatts hour (MWh). The ground-mounted photovoltaic (PV) solar plant will deploy approximately 130 000 PV modules on a fixed tilt system and will connect to an existing transmission line. This will provide clean and affordable energy to a country in dire need for more power generation capacity to support further economic growth. The power generated from the plant represents five percent of Mali's total electricity consumption, equal to the electricity consumption of 60 000 households.

During the construction phase, the project will provide 200 local jobs. As part of Scatec's corporate philosophy, special emphasis will be put on transferring technical expertise to the local community.

In an era of climate change concerns, the 33 MW Segou power plant is an important initiative to reduce carbon emissions by about 46 000 tons once completed. Scatec Solar and EDM will jointly register the project with the United Nations CDM (Clean Development Mechanism) under Scatec Solar's program for solar projects in Africa.

Distributed by APO (African Press Organization) on behalf of Scatec Solar.

For further information, contact West Africa office, Paris: Mr. Paul Francois Gauvin, General Manager, on tel: +33 678821547 or email paul-francois.gauvin@scatecsolar.com or visit www.scatecsolar.com ∎

OPTIMASS 7000 – corrosion-resistant in all applications

Steel corrosion can pose a problem during oil production and in downstream processing using acidic catalysts. This poses no problem for the OPTIMASS 7300, a KROHNE device which makes use of straight tube technology. KROHNE has applied its years of experience and been granted several patents, for perfecting the technology of containing the stress created in a straight tube due to thermal expansion. The company is now in a position to make this innovative technology available for use with highly aggressive and corrosive chemicals.

The measuring tube is made of highly corrosion-resistant tantalum alloy. Even difficult media such as hydrochloric acid, sulfuric acid, nitric acid and other acids for reaction processes, do not attack the measuring tube. (The device is also interesting in terms of the price as a much smaller amount of tantalum is required for the straight measuring tube than for devices featuring twin bent tubes.)

OPTIMASS 7000 features the patented Adaptive Sensor Technology (AST), permanently providing precise and stable measuring results, even under difficult process conditions and non-optimum installation. Regardless of whether you are filling phials or tankers, whether the mixtures are highly viscous or inhomogeneous, whether it is installed between flexible hoses or fixed pipelines, you can rely on the results.

The past decade has seen Coriolis flowmeter technology become the accepted standard in many chemical industries. However, one area where the technology was challenged was the measurement of highly aggressive and corrosive fluids. This was due to the commercial availability of a suitable measuring tube material to handle these chemicals.

Generally, the wall thickness of Coriolis measuring tubes is significantly lower than the associated process piping, which will tolerate a higher rate of corrosion before failing. This is an area where wetted material selection for a Coriolis meter is critical.

Tantalum has been used by some Coriolis manufacturers in the past, but the twin bent tube designs made these expensive. This was due to the flange, flow splitter as well as the measuring tubes all being made from tantalum.

It was not until the advent of the single straight tube design, that the material looked more attractive, as the design now only needed the measuring tube and the raised face of the process flange to be made from tantalum. This brought major cost advantages over the equivalent bent tube designs, but was not easy to achieve as tantalum does not have the same tensile strength as titanium which is traditionally employed.

The tantalum used by KROHNE is an alloy called Tantalum Ta10W, which is made up of 10 % tungsten and 90 % tantalum. KROHNE has found that it is the ideal material for use in its OPTIMASS 7300 mass flowmeter since tungsten provides the additional tensile strength required to handle the stresses associated with straight tube technology.

For more information go to www.za.krohne.com or telephone +27 11 314 1391 ▮

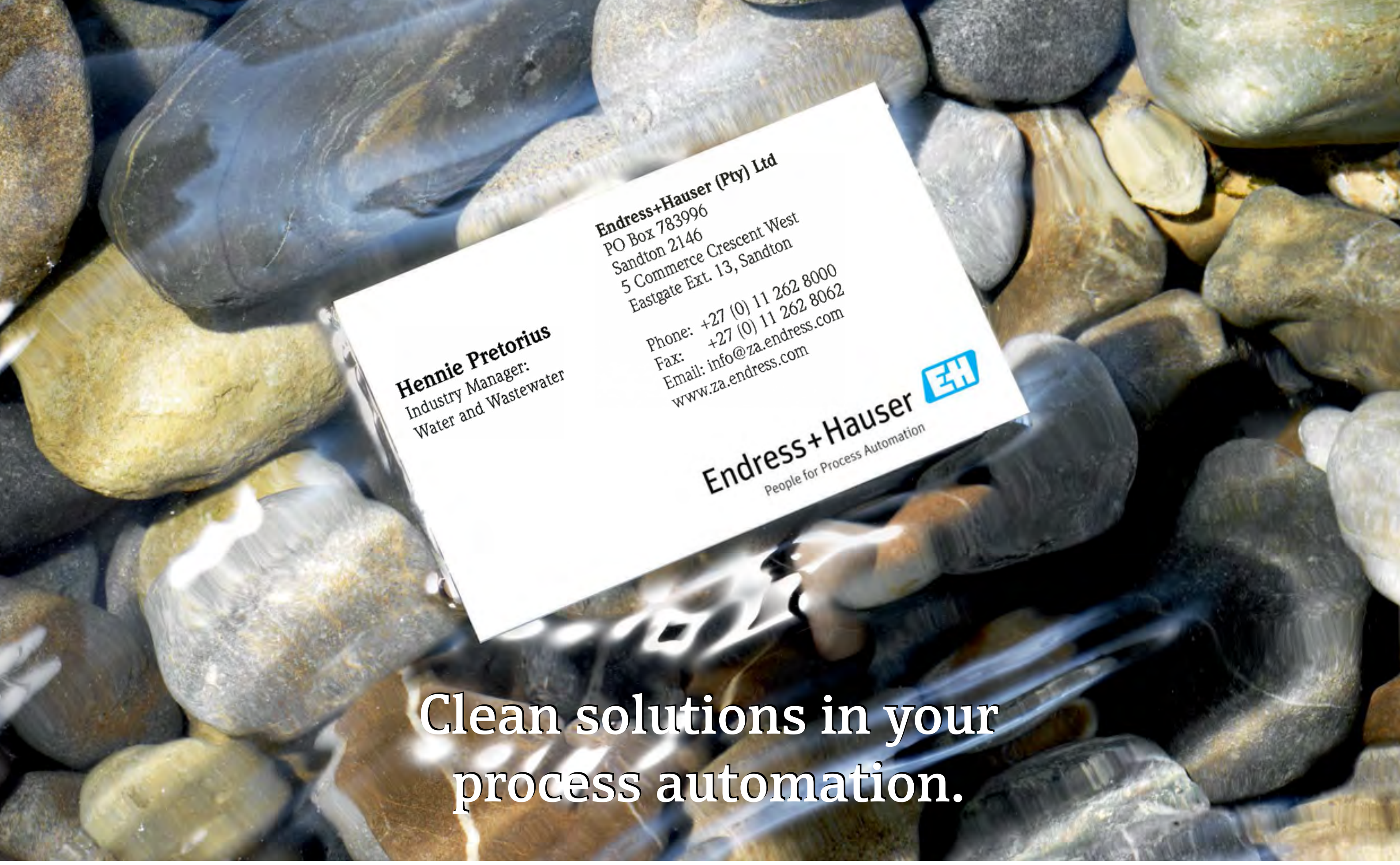
SUDOKU NO. 108

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

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

Solution for SUDOKU 107

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



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