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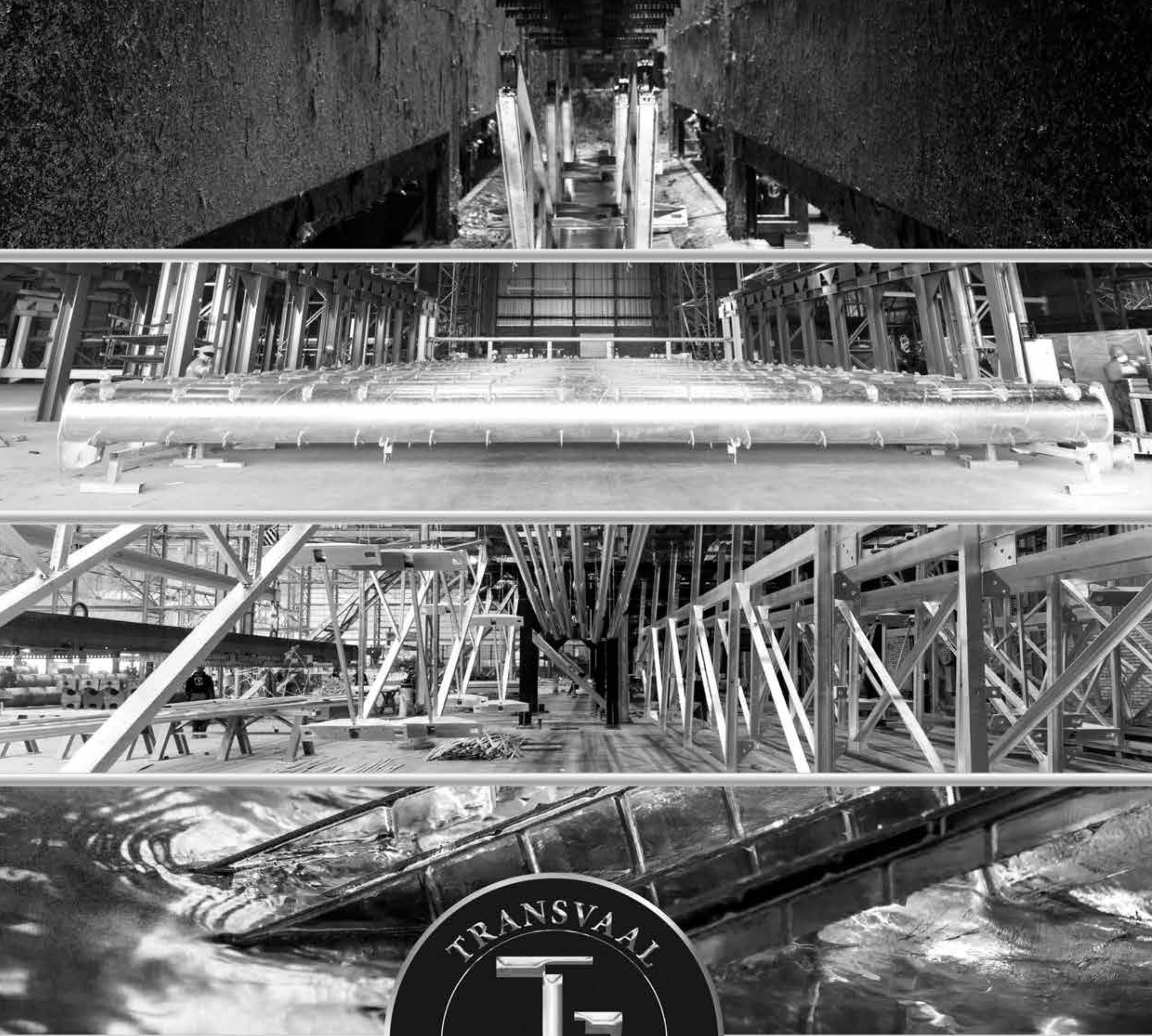
HOT DIP GALVANIZING TODAY 78

The Official Publication of the Hot Dip Galvanizers Association Southern Africa

CORROSION CONTROL OF STEEL



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Hot Dip Galvanizers Association Southern Africa
Bedfordview Office Park, Building 1, Ground Floor, 3 Riley Road, Germiston
P.O. Box 2212 Edenvale 1610 Tel: 011 456 7960 Email: hdgasa@icon.co.za Website: www.hdgasa.org.za

Executive Director: Robin Clarke Cell: 082 902 5119 Email: robin@hdgasa.org.za

Publication Liaison: Anthony Botha Cell: 082 326 6080 Email: anthony@hdgasa.org.za

Design and Layout: Sandra Addinall Tel: 011 868 3408 Email: cbtdesign@adcot.co.za

Reproduction and Printing: Camera Press Tel: 011 334 3815 Email: cpquotes@camerapress.co.za

EXECUTIVE DIRECTOR'S
Comment

The simple and robust technology that is hot dip galvanizing, provides corrosion control to iron and steel items through the provision of a barrier to the atmosphere and equally importantly the fact that the zinc in the coating provides cathodic protection to the substrate.

It is imperative that project managers and detail specifiers such as engineers, architects and fabricators are sensitized to all aspects of corrosion control systems. The ability to evaluate the outcome in terms of service life and life cycle costing of each system against initial expenditure - cost and time to produce - is vital.

For the reasons above the Hot Dip Galvanizing Association has, and continues, to invest a significant percentage of its efforts into education and training. This has taken many forms. Liaison with engineers at project initiation phase allows for discussions related to estimated service life, recommendations for material selection and design detailing for optimum coating outcomes. Discussions related to specifications of standards are shared. The application of standards is vital in assuring the correct outcomes as well as defining accountabilities for all participants in the project value chain.

Formal training activities include a number of courses convened as classroom sessions. Both one- and three-day courses cover a wide range of topics such as the basics of steel production, the hot dip galvanizing process, coating development on immersion into zinc, how zinc protects as well as the SANS/ISO standards for a variety of galvanized products.

This year the Association has experienced a most encouraging uptake in formal training across the country. Typically design, production and quality engineers have availed themselves of training.

Further developments in the training arena have been the sharing of the three- day course with the International Zinc Association for development of hot dip galvanizing awareness in South America. The Hot dip galvanizing Association is also developing on-line courses specifically aimed at servicing the need out of the sub- Saharan Africa region. Technical queries and requests for assistance in setting up project specifications are increasing from this region. The Association also tailors' technical sessions to meet the needs of project specifiers and can deliver such presentation at customer premises.

Knowledge facilitates good decision making.

EDITORIAL COMMENT
in this issue

It seems that living through 2021 has all the characteristics of being in the "On again, Off again" relationship that has been a challenge to people over the eons. Covid 19 on again, Covid 19 off again. Eskom load-shedding "on again, off again". The only way to deal with that type of relationship is to focus on the most productive outcomes you can achieve in spite of the flux we find ourselves in.

- The acid test, to be or not to be – on site regeneration.
- Training – the way to win, knowledge and skills developed in times of challenge pay dividends both now and in the future.
- Furnaces, cleaning solutions, passivation – the galvanizing process and plant challenges and opportunities abound.
- Protecting our heritage under the shield of sacrificial zinc – The Mandela Capture Site.

NUGEN LAUNCH ON-SITE pickle liquor regeneration system

1: Arthur Pretorius (MD).

2: Ian Tunnicliffe.

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In this era of challenges environmental management, preserving and protecting the environment, is not only a national but also an international focus point. As such it is highly legislated and continuously under scrutiny from organs of government. South African law exempts no one, be it corporate and/or government organs, from practicing responsible environmental practices.

Pickling of metals

The process of pickling is a metal surface treatment used to remove impurities, such as stains, inorganic contaminants, rust or scale from ferrous metals, copper, and aluminum alloys. A solution called *pickle liquor,* which contains strong acids, is used to remove the surface impurities. It is commonly used to de-scale or clean steel in various steelmaking and steel processing processes.

Acid reacts with the oxides and base metal to produce dissolved metal salts, thereby neutralizing the acid.

Sustaining the earth and resources

The global growth of public concern for the natural environment has been one of the most important developments in recent decades. The proliferation of more effective environmental laws and legal systems throughout the world has become critical to directing economic development and growth onto the path of environmental sustainability.

As a business, a non-profit or governmental body, the burden of proof insofar as demonstrating a full and comprehensive understanding of the implications of transparency and accountability to environmental sustainability is the responsibility of directors and management.

While in the past a commitment to ethical behavior in business strategy, operations and culture have at times been on the periphery of corporate governance. In today's globalized and interconnected world, investors, creditors and other stakeholders accept and at times require that environmental, social, and governance responsibilities of a company be integrated into an organization's performance and long-term sustainability.

It has been proven that environmental programs have many benefits; and can provide financial returns by reducing operating costs and opening up leads to new markets and technologies together with improving employee health and morale. The reputation for good management of environmental, social and governance responsibilities strengthens reputation and brand value.

Legislative framework – South Africa

Section 1 of the National Environmental Waste Management Act ("NEMA") contains a number of principles which serve as a general framework and guide for the interpretation, implementation and administration of all environmental laws and all laws concerned with the protection and management of the environment. The environment is defined in NEMA as: *"the surroundings within which humans exists and that are made up of (i) the land, water and atmosphere of the earth; (ii) micro-organisms, plant and animal life; (iii) any part or combination of (i) and (ii) and the interrelationships among and between them; and (iv) the physical chemical, aesthetic and cultural properties and conditions of the fore going that influence human health and well-being".*

Pollution is defined as *"any change in the environment caused by –*

(i) substances,

(ii) radioactive wastes, or

(iii) noise, odours, dust or heat, emitted from any activity, including the storage or treatment of waste or substances construction and the provision of services, whether engaged in..."

In particular, the "Polluter Pays" principle, requires that the *"costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimizing further pollution, environmental damage or adverse health effects must be paid for by those responsible for harming the environment".*

The "Polluter Pays" principle is encapsulated in the duty of care provisions contained in section 28 of NEMA. Section 28(1) of NEMA requires *"every person who causes, has caused or may cause pollution to take reasonable measures to prevent significant pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorized by law or cannot reasonably be avoided or stopped, to minimize and rectify such pollution or degradation of the environment".*

A duty of care falls upon:

- The owner of the premises;
- A person in control of the land or premises; and
- A person who has the right to use the land or premises on which or in which an actively is or was undertaken or any other situation exists which is likely to cause pollution and/or degradation to the environment'.

Spent Pickle Liquor Processing

The industry in South Africa is currently serviced by Spent Pickle Liquor processors who service their clients at facilities located centrally to the areas in which such regeneration is needed. The processor removes the SPL from a customer's site to their facility to provide acid regeneration services that recover "free acid" content (Hydrochloric Acid) for use again as a serviceable pickling acid. This then gets resupplied to the client.

The NuVest Group and its core business

The NuVest Group started in 2012 with NuVest Chemicals. NuVest Chemicals imports and supplies chemical raw materials into the South African market and offers services and products to the entire Southern African region.

NuVest Recovery Solutions has been in operation since 2017; with product and service offerings that include technology aimed at eliminating, reducing, re-using and recycling resources, with a focus on savings achieved throughout the supply chain. "NuVest Recovery Solutions base our model on a scientific-focus seeking to create technologies and chemistries that are economically viable, ecologically sound, and socially responsible" says CEO Arthur Pretorius.

The NUgen Process for regeneration of spent liquor

The NUgen process for the regeneration of Spent Pickle Liquor (SPL) is focused on a method of regenerating SPL without the need for energy using fossil fuels (Gas) or dumping waste to a landfill.

While there are many steel producers and steel processors in South Africa and globally operating pickling lines (Acid based deoxidizers), only the largest have, until now, been able to operate their own spent pickling liquor regeneration systems in-house.

The NUgen Spent Pickle Liquor regeneration process negates this limitation by providing on-site facility solutions. Both time and cost can be reduced with the SPL regeneration equipment being in situ at the client's site. These on-site facility benefits aim to ensure product quality consistency, reduced down time and ultimately lowered service costs and savings.
The NUgen model installs equipment on site, under an own manage and operate agreement for a pre-determined contract period. The equipment can be containerized utilizing technology that operates using a patented double decomposition technique together with additional technology providing the user with regenerated Hydrochloric acid without having to leave site.

SAVINGS FROM LOWER ENERGY USAGE
for pretreatment-cleaning trialed

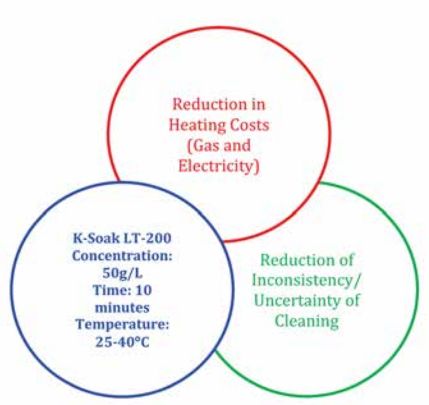
BY COURTNEY ORLIK – KROME METAL CHEMICALS, BSC CHEMISTRY AT THE UNIVERSITY OF PRETORIA

Krome Metal Chemicals technology have conducted trials which show that at the first stage of cleaning in the hot dip galvanizing process, lower than previous temperatures of the cleaning solution is able to provide an opportunity for cost reductions through reduced energy usage.

Misconceptions of caustic-based degreasers

Contrary to belief, caustic cleaners cannot chemically attack oil particles without the use of emulsifiers/surfactant systems. Oils used in the steel industry have contact angles greater than 90°, resulting in unfavorable wetting of the surface.

Emulsifiers/surfactants are systems added to degreasers that specifically aim at reducing surface tension and changing wettability of oil particles, breaking the outer layer and allowing alkaline solution to then attack oil particle. However, the use of the incorrect and outdated surfactant will result in the oil staying soluble within the solution, contaminating further the parts to be processed.



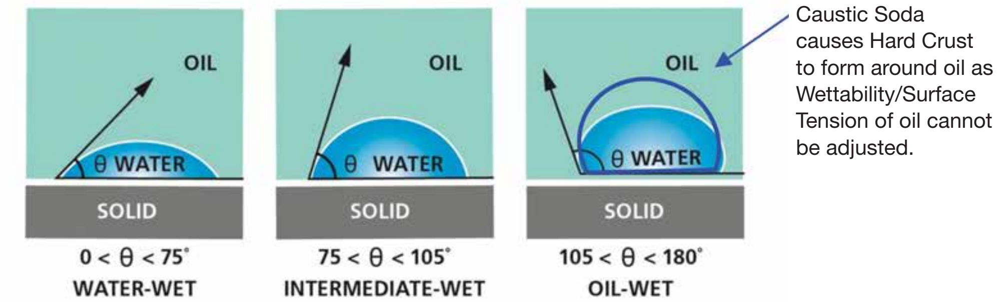
In a majority of cases the degreasing products used by South African galvanizers have to run at the high temperature range of between 60 and 80°C for the activity of the emulsifier/surfactant to become effective. With electricity and gas prices on a constant rise the need to provide a solution having lower energy requirements provides the galvanizer with cost reduction options.

"Cold" cleaning

With galvanizers facing exorbitant heating bills and with the electricity increases still to come in 2022, energy and heating costs are becoming a primary process step for reducing energy costs.

Krome trials of a new cleaning solution agent to be marketed as K-Soak LT-200 and liquid version, K-Soak 2730 with operating parameters that will allow for realizable heating cost reductions.

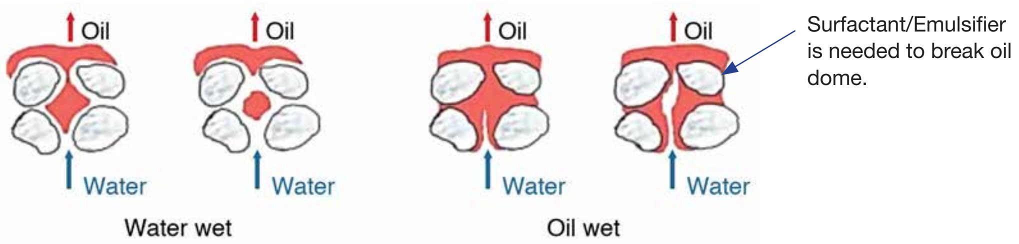
Heating costs are always overlooked but figures are beginning to show otherwise; *Table 1* shows Estimated Savings (both Electricity and Gas Heating) based off



High Temperature Degreaser	K- Soak Degreaser	Temperature Reduction (°C)	Monthly (22 Days) Savings (Rands)	Yearly Savings (12 Months) (Rands)
Tanks Heated Using Electricity				
70°C	30°C	40°C	R50 913,28	R610 959,36
60°C	30°C	30°C	R38 184,96	R458 219,52
Tanks Heated Using Gas (LPG)				
70°C	30°C	40°C	R31 252,94	R375 035,29
60°C	30°C	30°C	R23 439,71	R281 276,47

(Electricity: R2,26/kWh – Gas: R21,00/kg of LPG)

Table 1: Monthly and yearly savings on electricity of a 30 - 40°C heating reduction of a 10 000lt tank.



Average Industrial Ekurhuleni R/kWh rates for 2020.

Not only will heating costs be reduced, but by reducing maximum demand of Rand/kWh this will aid in further reduction of the galvanizers overall electricity pricing. With the highest price increases in South African history having being approved, it may be the most opportune time for companies to start looking for energy reduction opportunities. A miniscule change to reduce heating costs would surely be the first place to look.

Progress is impossible without change and sometimes the smallest change results in the greatest differences.

AVAILABLE FROM THE ASSOCIATION

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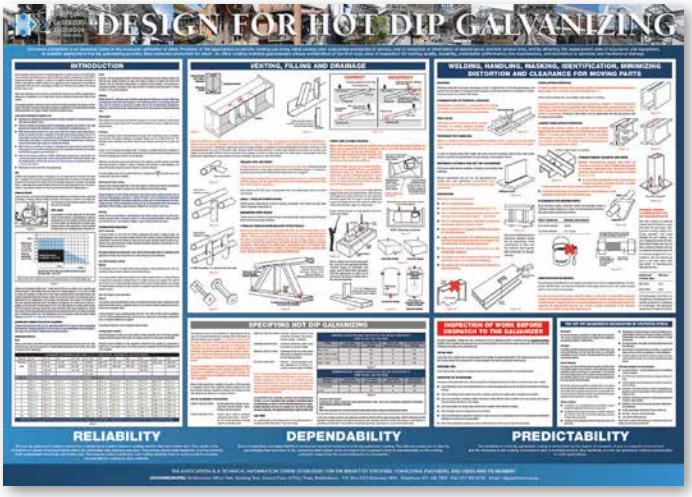
DESIGN FOR HOT DIP GALVANIZING WALL CHART

The **wallchart** is an invaluable reference chart for fabricators and specifiers. Key information is readily available to allow for best engineering practice for galvanizing.



TECHNICAL GUIDES

The HDGASA **Steel Protection Guide** and **Facts about Hot Dip Galvanizing** are available in high-gloss printed material for reference and guidance.

HOT DIP GALVANIZERS ASSOCIATION SOUTHERN AFRICA

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OPTIMISING THE COMPROMISE
in galvanizing furnaces

BY ROB WHITE

Abstract

The first stage technology evolution of indirect heating systems for galvanizing was driven by the availability and cost of fuels. This paper tracks this development with an explanation of how and why systems have changed and the drive for more environmentally acceptable heating methods. After an outline of the realities of operating heating systems, the divergence between theory and practise will be illustrated. With the galvanizing industry largely copying developments in heating systems within steel operations, the background to the need for pulse fired systems becomes clear. Such systems (double and triple fire) provide for the precise control required to maximise permissible heat efficiency. This technology has allowed the second stage of evolution, performance interrogation via digital interfaces. These opened the opportunity for comprehensive algorithm development. Past the use of Human Interface controls, mobile internet usage now allows for real-time monitoring and control from remote locations, the development of large databases by suppliers to further refine designs and controls and, economic (efficiency) benefits for the galvanizer. Challenges still exist and possible future developments will be explored.

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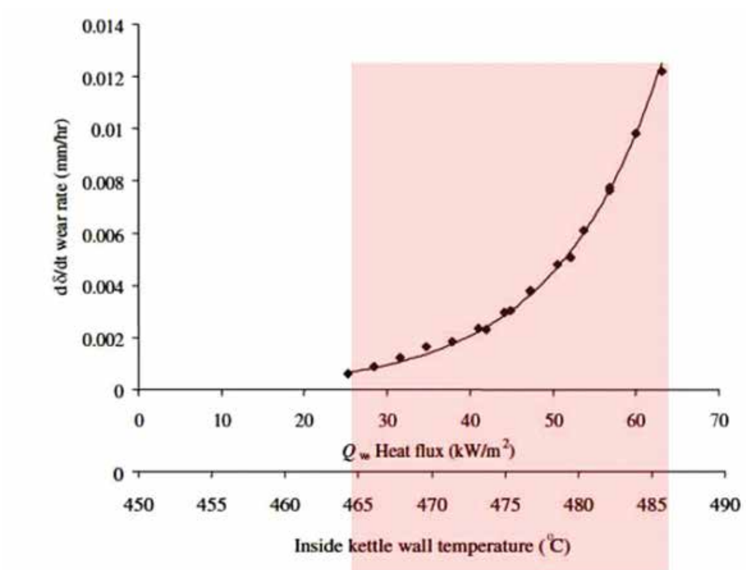

Figure 1: Kettle wear rates for various heat flux and internal kettle wall temperatures.

Introduction

By its nature, a galvanizing plant spends much of its economically active time in an unsteady state. In a batch process, the application of steady state assumptions and laws whilst providing guidance can lead to unmet expectations for the galvanizer.

Theoretically, the objective of galvanizing is clear – have a mass of molten zinc heated with minimum fuss such that an article can be dipped into the zinc and gain a protective coating. Looking at things simply, there would appear to be three things to balance in designing the heating system for a kettle:

1. The size and shape of the kettle and furnace should be optimized to keep the heat requirement to the absolute minimum required. Most of the undesirable heat losses are from the surface of the kettle so this should be kept to the minimum required and the kettle should be used to capacity
2. As much of the calorific value of the fuel should be used to heat the zinc in the kettle. It should be noted that, overall the higher the calorific value of the fuel the easier it is to control.
3. The heat has to be applied in such a manner to minimize kettle heat

stress in terms of the kettle wall and maintain a minimum variation in zinc temperature during the dipping process to avoid issues relating to local temperatures resulting in excessive dross, ash and scale production on the kettle walls (internally and externally).

A simple assessment of the above factors immediately shows that there are a series of compromises to be made when operating a galvanizing kettle.

Heat input requirements

Referring to various references the following numbers may be used to calculate the heating requirements when using a kettle[1, 2].

- Heating steel to 450°C requires around 55kW per ton
- Melting the zinc to 450°C requires around 82kW per ton

So, theoretically 66kW is required to heat the steel and melt out the replacement zinc but,

- Evaporating water takes 1.1kW per ton (assuming 20g water per m^2 of steel surface).
- Heat losses by radiation and convection can be up to 17kW/h per m^2 of kettle surface and 1kW/h per m^2 of unheated kettle surface. This latter number indicates why a proper fitted, insulated cover should be used during idle times.
- There is also heat lost through ash removal.

In total some 70kW is required per tonne of steel galvanized, although this figure will vary according to the kg/m^2 of steel, actual zinc pick-up, etc. However, what is clear is that high tonnages will increase thermal needs and so thermal stresses across the board.

The greatest heat loss is through the surface when articles are dipped. This is why some furnace designers feel that a double furnace chamber system should be used. Indeed even 75 years ago it was suggested that 2/3 of the heat should be applied to the top half of the kettle, 1/3 to the next quarter and little if any applied to the bottom quarter[1].

The maximum heat flux should not exceed 24 – 29 kW/m^2. This should prevent the inner kettle wall reaching a temperature greater than 490°C where accelerated attack of the kettle walls by the zinc is well underway *(Figure 1)*. Galvanizers want enough surface area and depth to permit the galvanizing of the maximum amount of product for a minimum mass of molten metal. So in general furnaces are long, narrow and deep. Good furnace design should minimise vertical thermal gradients which would limit heat transfer and so capacity.

Energy availability

Energy inputs for galvanizing have broadly followed industrial progress. Solid

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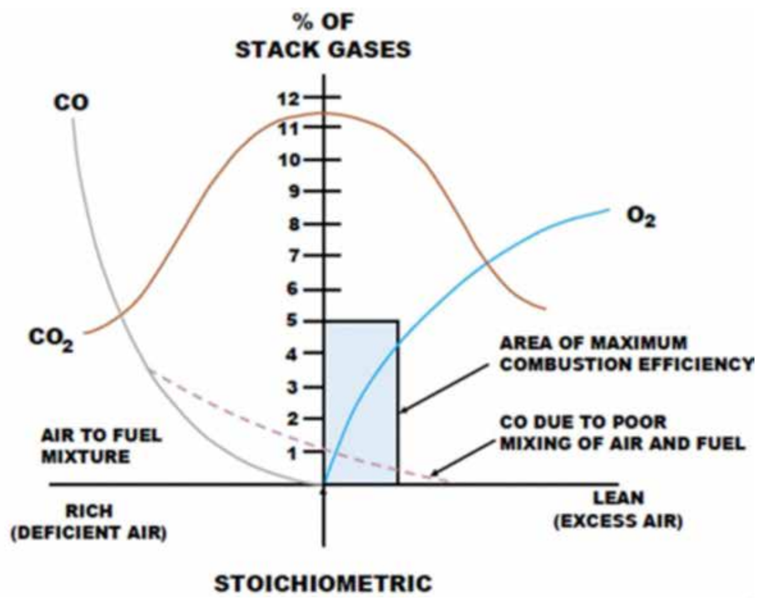

Figure 2: Ideal stoichiometric combustion point for gas fuels.

products such as coal and coke have been used and gas has been produced from both. Oil has and, in some areas, is still used. Electricity is widely used but many plants now use gas in its various forms. This paper focuses upon gas fired furnaces and as such, electrical heating is not considered. However, it is always important to ensure that, when comparing heating fuel costs, the actual calorific value of the various fuels are compared to get realistic fuel running costs and ensure that burner and other requirements are tailored accordingly.

What is often not understood is that the evolution of furnaces has walked largely hand in hand with gas supply development – both quantity and quality. So there has been coal gas which was really the old town gas. It was rich in Sulphur and ammonia and had variable calorific value. As the main market was for illumination the presence of hydrocarbons to produce soot and visible flames was important but this reduced the calorific value. Other gas types have been water gas (CO and H_2), producer gas (similar to water gas but contains N_2 and hydrocarbons and was used in China in some areas until quite recently), wood gas, oil gas and now natural gas. It's worth noting that many of these gases had a much higher calorific value than many natural gasses but they were polluting and had inconsistent properties from batch to batch. It's the cleanliness and consistency combined with overall availability that has allowed natural gas to become preeminent and so permit adoption of gas furnace heating on a wide scale.

Relying upon the combustion of carbon means that:

1. The calorific value of the various fuels available is determined by the ease and nature of the energy release in burning carbon with oxygen.
2. The greater the surface area in contact with the oxidizing agent (generally air) the more efficient heat generation will be. That is why burner manufacturers have the mantra of temperature (high enough to maintain ignition), turbulence (to ensure intimate mixing of fuel and oxygen) and time (sufficient for complete combustion).
3. Liquids such as oil are easier to control and are more efficient than (say) coal and the use of gas should be even easier to control and more efficient still as atomization is not required as with liquids. One should also be aware of the polluting nature of some fuel oils.

The oxidizing agent is generally air which, of course, has to be heated and contains 80% nitrogen which does nothing other than absorb heat and produce NOx. Heating the air through the burner is another source of heat requirement and generally, a small excess of air is required to ensure complete combustion and avoid smoke or soot. Until around 50 years ago typical burner efficiencies were around 30%. With the oil price shock, the furnace industry started to use heat recovery (recuperative – outside, or regenerative – inside the furnace) to pre-heat the combustion air and increase burner efficiencies up to 60%.

In an ideal world maximum furnace efficiency with gas is achieved when the temperature of the gas exiting the flue system is just above 450°C. This is irrespective of high or low turn-down rates and has some assumptions concerning excess air used in combustion at low fire rates.

Once hydrocarbon gases are used water vapour is generated as a product of the combustion process and this adds another level of complexity in terms of the need to avoid condensation within the after furnace flue chimney system.

Using a generalised combustion equation, the point where all oxygen is consumed and all fuel burned is defined as the stoichiometric point (SP) *(Figure 2)*[3]. This can be seen from the equation below –

$$C_mH_n + (m+n/4)O_2 \rightarrow mCO_2 + (n/2)H_2O$$

and specifically for methane -

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + heat$$

The SP is the air to fuel ratio which gives complete combination of the gas and the oxygen in the air to form carbon dioxide (CO_2) and water (H_2O). Ideal operation occurs at the SP. Operation to the left of the SP results in incomplete gas combustion and production of carbon monoxide (CO), with a greatly lowered efficiency, and presence of unburned gas in the flue gas. Operation to the right of the SP results in excess air which is heated by the flame. Heat is carried out in the flue gas, resulting in efficiency loss. The excess oxygen also results in an increase in NOx production. The highest efficiency occurs in the zone directly to the right of the SP.

The development of indirect heating gas furnaces

Indirect heated gas furnace design has largely been led by developments in the steel industry. Furnaces are used for many heat treatment processes in steel production and galvanizing heating systems have been fast followers of this technology development.

The simple use of the hot gases results in the best form of heating but a key issue is

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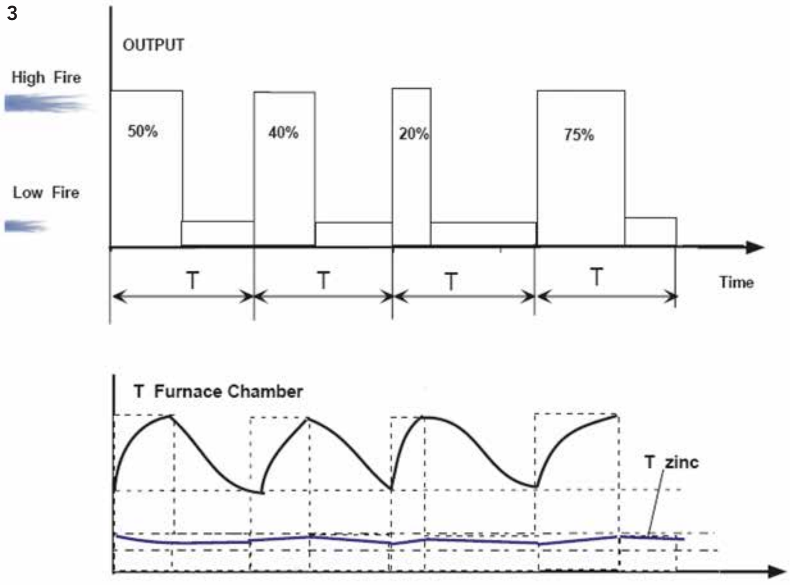

Figure 3: Typical High Fire, Low Fire and resultant furnace temperature.

how best to circulate the gases? Initially gases were forced around the furnace area using a fan and whilst uniform temperature over the kettle heated surface with no over-heating are possible, inefficiencies remain and the fan systems require regular maintenance and take up space.

The three key issues to be overcome with indirect heating by gas are:

1. Poor temperature uniformity within the furnace which would impact upon kettle life and heat use efficiency.
2. Inadequate turn-down. Initially heating burners were switched on and off to control heat inputs. This resulted in excessive maintenance and reliability issues with burner systems. By having a high fire and low fire mode, issues of poor combustion and some complexity and maintenance issues are addressed but only if low fire is low enough to avoid overheating.
3. Excessive fuel consumption was an issue with early furnace systems. Increasing energy prices and just the need to get better control of things has resulted in the modern furnace systems we see today.

A high velocity pulsed flame system whereby heated air is driven around the furnace chamber with sufficient mixing to ensure temperature uniformity within the chamber may be considered to be the most efficient option for heating. The key advantages of such as system can be listed as:

- Enough thermal capacity to meet the maximum demanded production rate. The kettle can be sized to the production rate in tons/hour, not compromised to suit work dimensions. The burner operating output can be optimized to the demand.
- Flexibility to control the system to a constant zinc temperature. A highly variable heat input can be provided through the use of control systems. So, temperature can be controlled to within a few degrees without overshoots and fuel/gas control is relatively simple.
- Low maintenance is achieved through the minimal numbers of burners required - unlike flat flame. Simple control and minimal moving parts, such as recirculation fans, means that kettle lives can be extended to over 10 years.
- Maximum Fuel Efficiency can be achieved through using appropriate flue temperatures when compared with flame temperatures, the high velocity system ensures uniform convection of heat and direct heating of the entire kettle maximizes heat transfer.
- The simplicity of the system means that there is a low cost civil engineering outlay, there are a few burners and they are located at ends of furnace, no access is required along the furnace length, unlike flat flame systems, so furnace chambers can be narrow. Overall there is a lower hardware cost on combustion equipment, both flow gear and electrical equipment and this lends itself to pre-packaged designs requiring a few days for installation before melt out can commence.
- Better environmental performance due to accurately pre-set fuel/air ratios which ensure complete combustion. NOx emissions are minimized as the high velocity flame entrains more furnace gases through complete mixing

and lower peak temperatures than alternative systems.

Burner controls

Initially, burner (and so flame) control was simply managed through adjusting the flow of gasses as part of a feedback system reacting to kettle temperature. This type of analogue control often resulted in temperatures over and under shooting the ideal beyond a reasonable excursion. This form of modulation control is not ideal.

Probably the final area of pure engineering development in high velocity flame systems was the introduction of preset systems. With modulation control the fuel is controlled to provide for a variable heat flame. It is important to bear in mind that it is the flow of hot gasses along the furnace gallery that ensure that an even flue gallery temperature is achieved within a short distance from the flame. There is no direct flame onto a kettle surface. With a pulse firing regime, the flame is either on maximum (high-fire) or a low value (low-fire) generally dictated by the burner. High turn-down rates (the ratio of high to low fire) are targeted to ensure that the resulting furnace gallery exit temperature remains above 450°C. Pulse firing is not simple high fire/low fire as high/low fire systems would have high firing for as long as it takes to return the zinc temperature back to its set value. This generally results in temperature overshoot. Pulse firing on the other hand is a set on a high/low timing sequence which is preset for the furnace capacity. The variable time on high fire provides for full kettle heating within the overall design of the system. This results in more even and consistent heating along the walls of the kettle. Only two settings of air and fuel are required which greatly improves the efficiency and ease of operation.

By controlling the high fire pulse times sufficient heat can be sent to the furnace gallery – shown in the lower graph of *Figure 3*. Although there would appear to be some hysteresis in gas temperature, the kettle wall has sufficient thermal capacity to dampen the variations in furnace gallery temperature. So the protective zinc alloy layers on the inside of the kettle wall are not stressed by the gas temperature variations at all. At high fire, the velocity of the flame can reach 170m/s. This adds sufficient velocity to the gas in the gallery to ensure active scrubbing of the whole kettle surface which improves even heating along the kettle surface.

Further environmental pressures are beginning to bear down on the furnace industry. Simple aspirator burner nozzles are being replaced with nozzle mix burners and electronically controlled mass-based variable mixers which allow real time control over the air-fuel ratio, based on measurement of the flue gas composition and other parameters.

Flue Gas Recirculation (FGR) can lead to cooling of the flame to reduce NOx to <9ppm. MFT involves pre-mixing fuel and air and stabilizing the flame on a metal-fibre material. Surface stabilized combustion stretches the flame, eliminates hot-flame zones and reduces thermal NOx formation within the flame and this can get to <9ppm without using FGR. However, metal-fibre burners typically require excess air levels of 50 – 60%.

Finally, it should be mentioned that the steel furnace industry is starting to experiment with Fuzzy Logic controllers for high velocity pulse burner control based upon Mamdani's models[4]. This certainly flattens the outside of kettle variations in temperature and will be the way forward very soon.

Furnace control and management systems

With all the above developments in play, it is clear that software enhancements should ensure fine tuning to gain not only greater efficiencies but also easier management control.

Control and management systems now allow for:

- The maintenance of the optimum (sometimes pre-set) air/fuel ratios for the desired heat output. This is set by process controllers to achieve full combustion and uniform heat transfer from combustion products via the kettle to the work-pieces. Studies have shown that where large kettles are used and rarely reach full production capacity a lower High Fire Pulse can save at least 2% of gas costs. This additional (third) set-point is easy to introduce and control with current software.
- The control of deviations in air and fuel temperatures and pressures and furnace chamber pressures to fully trim the air/fuel ratio and ensure full burner turn-down.
- Remote servicing and control which is now possible via internet connections and mobile devices. Open source and in-house network architectures provide for secure, remote supervision and diagnosis.

Conclusions

It is clear that the use of pulse fired, high velocity burner systems should provide the optimum furnace installation for hot dip galvanizers. The current state of understanding of systems has developed such that rigorous control is possible to really optimize energy utilization in the dipping process. The development of software algorithms enables the galvanizer to be guided in such a way as to make the best use of the furnace in terms of ensuring long kettle life and operating with sound practice. Further automation is now possible along the whole galvanizing process and the use of "big data" is providing enhancements more rapidly than can be absorbed. However, galvanizing remains as stated in the introduction, a process in unsteady state. As a result, there remains no substitute for having galvanizers who are well versed in the theory and art of galvanizing.

References

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PASSIVATION OF hot dip galvanized articles

While galvanized steel is tolerant of diverse atmospheric and environmental conditions, passivation-quenching is routinely undertaken as part of the hot dip galvanizing process.

The chromate film established on the coating surface avoids the formation of excessive zinc-oxides and zinc-hydroxides during the first several weeks. The thin chromate film delays their formation. Once the chromate film is depleted, the galvanized steel begins to weather and develop its zinc carbonate film which is evident as the zinc patina.

Typical Morphology of HDG Passivation
**1 nm = 1 nanometre = 1/1000µm*

Passivation should be avoided if the article is going to be duplex coated (painting or powder coating over the galvanized steel) as the chromate layer on the hot dip galvanized coat will affect the barrier coat system.

Chromate passivation is however recommended for galvanized reinforcing bar to control reactions between zinc and cement while the concrete cures. Tests of the bond strength on chromate-passivated galvanized rebar show equal or slightly better bond performance when compared to uncoated rebar due to the formation of tenaciously adhering zincates at the rebar-concrete interface.

Traditional chromate coatings most often of a yellow tinge. The colour of the surface has no effect on the performance of the passivate.

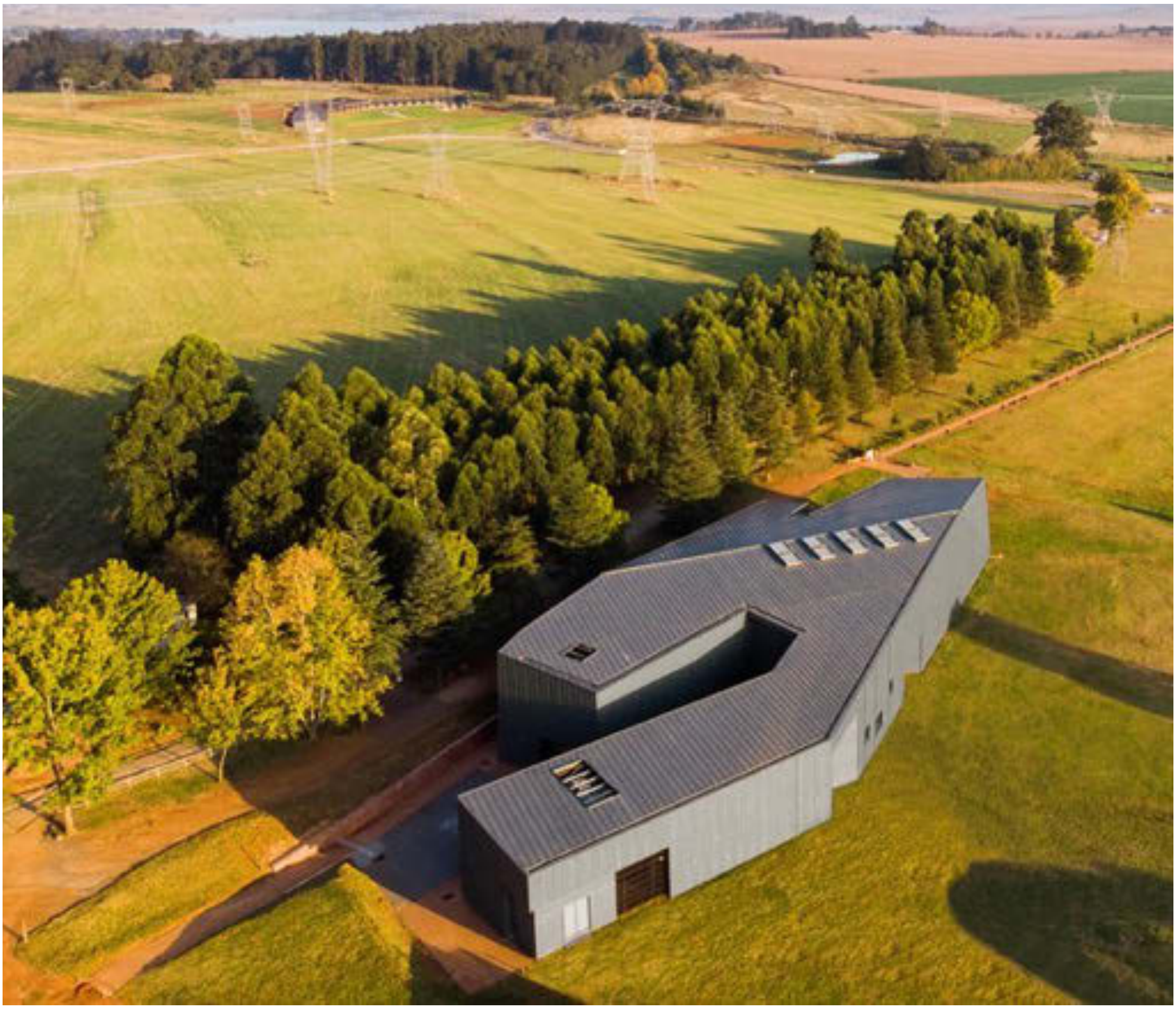
The surface condition most often enquired about is the Passivation Staining

Passivation of the hot dip galvanized article requires a small amount of Sodium Dichromate added to the quench water bath as the last stage of the process. Although the recommended quantity of Sodium Dichromate lies between 0.15 to 0.3%, occasionally when topping up, more is added. This often results in a dark yellow to brown colour on the galvanized surface. The darker colour will provide enhanced initial corrosion protection as a chromate film.

This can be accepted since there is no adverse effect on corrosion control as there is no reason for rejection. The staining will gradually disappear over a relatively short period.

NELSON MANDELA CAPTURE SITE VISITORS CENTRE AND MUSEUM covered in RHEINZINK

NELSON MANDELA WAS ARRESTED ON 5TH OF AUGUST 1962 OUTSIDE HOWICK, NATAL, SOUTH AFRICA AND THE NELSON MANDELA CAPTURE SITE COMMEMORATES THIS MOMENT IN HISTORY WITH A VISITOR CENTRE AND A MUSEUM.



The site is complemented by a 'Long Walk to Freedom' through the landscaped garden. The building's equally imposing exterior, is part of the project initiated by architects Mashabane Rose and Associates, and sets the tone for visitors to experience the life of Nelson Mandela and the profound consequences of his capture. The design brief called for a statement of the history and poignancy of this site, needing to make use of unconventional materials to create a structure that captured the attention, blended with the environment and to withstand the test of time.

RHEINZINK was the material of choice to envelop and clad the building's exterior and safely house its contents, anchoring the strength and courage that this site represents. The result is a destination, which has become the catalyst for local and international tourism.

RHEINZINK is 99.995% pure zinc, with small traces of titanium and copper, and is specifically developed for the building industry because of its long-lasting, durable, low-maintenance and aesthetically pleasing properties.

To complement the availability of the RHEINZINK roofing, facade cladding and water drainage systems, the company's South African partner "Wilkinson Architectural Metals" offers a comprehensive support service, including technical assistance on application technique and specifications for planners and installers.

RHEINZINK contact data for Sub-Saharan Africa:
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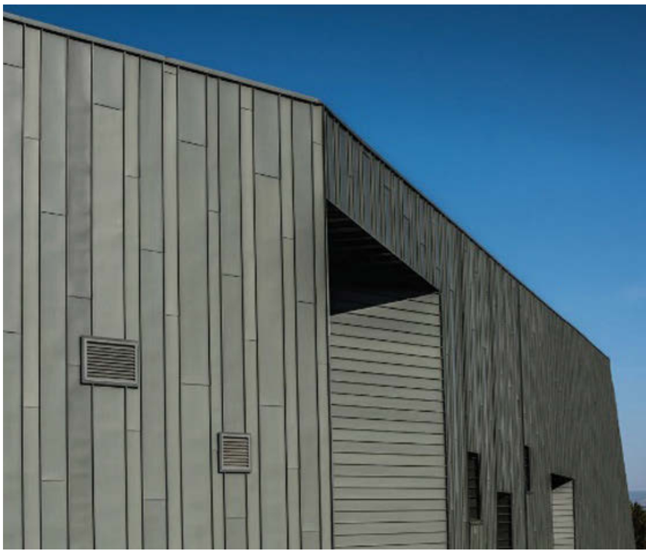
RHEINZINK WAS THE MATERIAL OF CHOICE TO ENVELOP AND CLAD THE BUILDING'S EXTERIOR AND SAFELY HOUSE ITS CONTENTS, ANCHORING THE STRENGTH AND COURAGE THAT THIS SITE REPRESENTS.



TRAINING, STRENGTHENING THE FOUNDATIONAL KNOWLEDGE
through industry participation

The ongoing requirement for foundational knowledge has been understood by key industry players. The level of quality and effectiveness of the Galvanizer lays in the proficiency of the operators, supervisors and inspectors. Furthermore outside of the galvanizer's organization fabricators and site crews dealing with hot dip galvanized articles must be on point with the technology, the standards and the outcomes that can be expected from materials delivered to the galvanizer.

To this end the HDGASA has trained more than 80 delegates, throughout South Africa, since January 2021 – on a face to face basis. The support of Transvaal Galvanizing, Protech Galvanizing and ARMCO Galvanizing in Gauteng has been a major factor in the ongoing drive to ensure:

- Knowledge of the facts regarding hot dip galvanizing and corrosion control.
- All relevant personnel are clearly acquainted with the hot dip galvanizing process and the applicable standards. This includes the galvanizer and parties using, designing and engaged in construction / erection as well as end users of hot dip galvanized articles.
- The relevant people are able to conduct a necessary activity or activities for the best possible outcome, when specifying and using hot dip galvanizing technology.

Training in the Western Cape has been strongly attended, albeit under strict Covid 19 rules and has been supported by Advanced Galvanizing in Cape Town.

"Knowledge is the only instrument of production that is not subject to diminishing returns" John Maurice Clark

COURSES OFFERED

Level I: Introduction to Hot Dip Galvanizing

The HDGASA one day INTRODUCTION TO HOT DIP GALVANIZING course is designed to provide an initial understanding of the concepts relating to hot dip galvanized coatings applied for corrosion control of steel components. The course comprises six modules. In order for the course to be viable we require six or more candidates to attend. Arrangements can also be made for this course to be held at a venue of your choosing for more than six candidates. In addition to the course, a special visit to a hot dip galvanizing plant may be arranged on a separate date, should six or more candidates be interested and able to attend.

Level II: Certified Galvanizing Inspectors

The HDGASA advanced Level II course provides the necessary skills to assess the quality and conformance of Hot Dip Galvanized coatings and Duplex Systems to the applicable specification. Delegates are introduced to other metallic type coating specifications and their application for corrosion control design.

The course provides an in-depth interpretation of the specifications and accepted best practice procedures for determining coating thickness, visual inspection of surface finishes as well as the evaluation of these coatings for corrosion control of steel components. The course includes a visit to a hot dip galvanizing plant where delegates will have an opportunity to assess finished product against the relevant quality standards on a real time first hand basis.

Three Continuous Professional Development (CPD) points are awarded to delegates attending the entire course. Bookings are limited to a maximum of 10 people, with applications treated on a first-come-first-serve basis. In order for the course to be viable we require 6 or more candidates to attend. Arrangements can also be made for the course to be held at a venue of your choice for more than 6 candidates.

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INCLUDES ELECTRONIC 'HDGASA INSPECTOR TOOLKIT'

HOT DIP GALVANIZERS ASSOCIATION SOUTHERN AFRICA

In all instances where training has been provided the delegates have strongly advocated that more of their peers and associates consider attending training to maintain the level of proficiency and professionalism the engineering fraternity in South Africa strives to maintain across all disciplines where hot dip galvanizing is employed.

Training webinars were undertaken, with support from renowned experts such as Dr. Rodney Rankin, to over 250 members of the South African Institute of Civil Engineers (SAICE).

Specialized training was undertaken for Associate Members of the HDGASA. Key aspects that support the efforts of best engineering practice and understanding of the factors impacting on their products were covered in a customised one day event at their head office.

Hot dip galvanizing training throughout Africa is eminent with tailored offerings to online students being initiated through seasoned training providers. Thus allowing remote learning where ever access to the internet is available, in the near future.

Full details of existing courses are available on the Hot Dip Galvanizers Association's website. The association is also available to discuss your particular training needs as they may arise by appointment. Courses on all aspects of hot dip galvanizing and the applicable level of knowledge are available at reasonable rates from the Hot Dip Galvanizers Association. From a basic lecture outlining hot dip galvanizing's role in corrosion control to a high level comprehensive three day course as a specialist and inspector.

The Hot Dip Galvanizers Association Southern Africa (HDGASA) is a not-for-profit trade organization, founded in 1965, dedicated to serving the needs of end-users, specifiers, architects, engineers, contractors, fabricators and hot dip galvanizers throughout Southern Africa.

To further this aim, the Association provides advisory involvement, training and information by way of courses, workshops, specialized presentations on corrosion control, technical research papers and case studies of hot dip galvanizing's effectiveness at corrosion control.

The Association liaises with regulatory and standards authorities governing the corrosion control and associated industries.

The HDGASA provides services for independent inspection against relevant standards and reviewing compliance against the relevant standards by the stakeholders in the industry, and provides applicable analysis through metallurgical and SANAS approved analytical laboratories.

The Galvanizing Members of the HDGASA represent the majority of the hot dip galvanizing fraternity both by mass and value in sub-Saharan Africa. Through close liaison with the EGGA, AGA, Australian Galvanizers and associated organizations the HDGASA maintains a global presence and participates in arenas of common interest including the ISO standards.

The HDGASA publishes supporting literature such as our Steel Protection Guide, Design Wall Chart and Facts about Hot Dip Galvanizing. These are used effectively to bring third parties with little or no knowledge of hot dip galvanizing up to speed with the technology.

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HOT DIP GALVANIZERS ASSOCIATION SOUTHERN AFRICA

Bedfordview Office Park
3 Riley Road, Bedfordview
T: +27 11 456 7960
E: hdgasa@icon.co.za
W: www.hdgasa.org.za

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