Pickling technique and pickling technology of the future

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The importance of surface pre-treatment, ie the cleaning of iron and steel surfaces before galvanisation, has been known since the middle of the 19th century. The pre-treatment technique and technology have hardly undergone any improvements over the last 150 years.

Thus the method of pre-treatment has remained more or less the same without any major innovations to the present day (eg degreasing baths were not introduced until fairly recently).

The increasingly difficult market conditions and the demands made by galvanising customers for better quality combined with lower prices and a faster service, have obliged the operators of galvanising businesses to reflect on process optimisation and cost-cutting in production. This development was used by Körner as the occasion for working out new ideas for galvanising businesses, with the aim of optimising processes and costs:

- Increasing productivity
- Improving quality
- Reducing personnel costs (through automation)
- Optimising materials use
- Increasing the service life of baths
- Reducing waste-disposal costs
- Reducing maintenance costs

In order to be able to implement these ideas, the old approaches must be comprehensively rethought, with the results depending very much on the components used. All system elements must be adapted to each other and as a total system contribute to achieving the objectives mentioned above. What follows is a presentation of the Körner System of enclosed pre-treatment, a pioneering system for pickling techniques and technology. All the components are adapted to each other and everything comes from a single source – from planning, in-company production, delivery and assembly to commissioning by Körner KVK.

The Körner System

The following presents all the components used as an operational unit in modern enclosed pre-treatment systems which, working together, form the Körner System. The sturdy working tanks are specially designed for the tough conditions in pretreatment and are in use for many years. The tank walls are made of KVK chemical construction panels, manufactured in one piece according to the geometry of the tank. The tanks are completely free of welding seams, so as to exclude entirely the possibility of internal stress (caused by welding seams) The KVK construction panels (30mm thick for walls, 70mm for floors) are made in a multilayer sandwich design, with all the materials used being acid resistant.

A filler layer of mineral powder and special resin gives our tanks optimum resistance against mechanical stresses. In the event of damage, it is not necessary to interrupt the production process, since the design of the KVK construction panels (acid restistant throughout) means that no chemicals can escape. The damage can easily be repaired on a later occasion without removing the tank – and without loss of quality. The fact that repairs can be made without removal of the tank is of increasing importance in enclosed systems, since lifting the tank out involves considerable effort (partial dismantling of the casing).

The materials used for the tanks (duroplastics) allow the pre-treatment chemicals to be heated to a relatively high temperature without impairing chemical or mechanical resistance.

Advantages

- sturdy design
- high mechanical characteristics
- easy to repair
- chemically resistant throughout
- heatable to high temperatures
- protected steel construction
- no welding seams

Coating of the installation pit

The chemicals used in the working tanks of pre-treatment systems represent a risk to the environment if they enter the ground water. For this reason, environmental authorities demand that areas in which ground-water hazardous materials are used must be provided with additional safety measures.

The tanks used today are all free-standing and are installed in so-called installation pits (concrete troughs) which collect the chemicals in the event of a tank leak (caused by mechanical damage from falling parts) and prevent them escaping into the ground water. The installation pits are coated with the KVK coating system, an unsaturated polyester resin - activator mixture that is hardened by means of peroxides. Optimum mechanical characteristics are achieved by the insertion of glass or plastic matting. This coating is then sealed with a special resin filler coat.

The coating meets all the requirements of the German Water Resources Act (WHG), which lays down the design of catchment containers for water-hazardous liquids. The system has also been issued a general type approval by the Institute for Constructional Technology in Berlin (DIBt). This coating is not only used for installation pits, but also for acid storage tank areas or for tank-filling areas, and is also available for vehicle-accessed surfaces (stackers, lorries, etc.) or in an anti-slip version (TUV-certified).

Advantages

- excellent adhesion
- also usable on vertical walls
- low susceptibility to cracks
- short assembly time
- easy and quick to repair
- high mechanical characteristics
- resistant to chemicals
- diffusion-tight

KVK heating coils

For many years now, KVK heating coils specially designed for the tough conditions in pickling operations have been in use. The baths are heated using hot water, or steam. The KVK heating coils are made entirely of synthetic materials, the plastic hose bundle being protected against mechanical stresses by a 30mm thick KVK chemical construction panel.

The KVK heating panels are inserted directly into the working tanks (lengthways or widthways) and can be dismantled quickly and easily for maintenance and cleaning. With this type of heating system it is not necessary to install an additional chemical circulation pump since natural convection currents entirely suffice to achieve a uniform bath temperature. This eliminates the need for components (such as chemical rotary pumps) that require intensive maintenance and repair.

Advantages

- robust design
- low operating costs
- minimum maintenance
- made entirely of synthetic materials
- no need for additional circulation pumps
- simple to install and remove
- uniform temperatures in the baths
- simple to repair

Enclosed pre-treatment

With open pre-treatment systems, it is inevitable that there is a higher content of aggressive chemicals in the air around the pickling baths than in other areas. This applies even if the baths are only minimally heated or not heated at all.

The greatest problem in connection with the production of emissions is the "steaming off" of the acid when the material is taken out of the bath, a problem that is only minimally improved by the use of suction systems at the lateral side .

The content of aggressive chemicals in the air is determined by the concentration in the baths, ambient temperature and above all by the temperature of the pickling baths.

In open systems, environmental (toxic limits) and economic (serious corrosion to buildings and crane equipment) limits apply to the heating of the pickling baths. Hence the obvious step is to attempt to isolate the pre-treatment system from the other production areas, and to benefit to the full from the advantages this creates. Pre-treatment is enclosed using KVK casing panels mounted on a steel or wooden structure and coated on the working side with glass-fibre reinforced plastic to create a diffusion-tight, chemical-resistant shell isolated from the other production areas. This special casing design permits pickling up to 45°C and beyond. Increasing the pickling temperature (eg HCl pickling) dramatically reduces pickling times. This advantage can be used in a variety of ways:

- fewer pickling baths needed for the same material throughput
- fewer chemicals in production
- the HCl concentrations in the pickling process can be reduced
- throughput times can be cut
- greater flexibility

In addition, the panels (unlike wood) are long-term resistant to condensation that can form on the walls as a result of the high pickling temperatures. Heating the baths combined with the excellent insulation effect of the KVK panels creates relatively high temperatures inside the pre-treatment process (30°C and higher), which are independent of seasonal ambient temperature changes and hence almost constant.

The advantage of the high bath temperature in terms of energy saving is even more plausible if one considers that, when working tanks in open systems are heated, almost 50% (at 25°C, approx. 60% at 40°C) of the energy is needed to make good the loss of heat at the surface of the liquid and the tanks. Calculations comparing the bath heating energy requirements for open and enclosed systems show that despite a bath temperature of 40°C, enclosed systems require approx. 10% less energy than open systems of the same size at a bath temperature of 25°C. For greater transparency, this comparison ignores a possible reduction of the number of pickling baths and uses the same number in each case.

Basis for the comparison

- One degreasing bath at 60°C
- Six pickling baths (25°C open system, 40°C enclosed system)
- One flux bath at 60°C
- Material throughput: 6,000kg/hr
- System dimensions: 7.5m long x 1.8m wide

The material is fed through a specially designed air-lock gate

Figure 1. Transport units are not exposed to fumes; only hooks are inside the enclosure

permitting rapid opening and closing times. The gate is also chemical-resistant and a special sealing system prevents aggressive vapours escaping from the pre-treatment area. The conveyor system is entirely outside the casing. Only the hooks and chains or ropes are within the area of the emissions.

The chain or cable lines are designed using a displacement-body/sealing-lip system to prevent any aggressive fumes whatsoever escaping from the pre-treatment process, thus eliminating corrosion to the crane equipment and the building. It is this sealing system that permits the use of modern automatic conveying systems with the very sensitive data transmission systems these require. According to the Körner KVK system, there is no need for any personnel inside the pre-treatment unit.

Figure 2. Enclosed pre-treatment unit; no personnel allowed inside the enclosure

Advantages

- diffusion-tight, chemical-resistant casing panels
- short assembly time
- completely isolated from the other production areas
- no corrosion to crane equipment
- no corrosion to buildings
- permits high pickling temperatures
- reduces throughput times
- excellent insulating properties
- minimises energy consumption
- no personnel in pre-treatment
- permits use of fully automatic conveying systems (no corrosion to data transmission lines and drive units)
- maintenance-free

Every effort is made to place the pre-treatment tanks as closely as possible to each other in order to ensure a small and compact pre-treatment area. In the Körner System, the tanks are placed side-wall to side-wall, making optimum use of the space available. The side-walls are glued together in a special process that absorbs the relative movements of the tanks (when filled to different levels) and the resulting stresses, while at the same time sealing the gap between the tanks. This also ensures that spilt chemicals cannot drip between the tank walls into the installation pit.

The areas alongside the tanks are fitted with walkways made of acid-resistant, non-slip KVK floor panels. These panels are calculated and manufactured specially in accordance with the requirements and the width. The panels are mounted at the height of the upper edge of the tank, and slope inwards to the tank chamber. This ensures that any liquid drips will flow immediately back into the correct tank, thus saving a considerable amount of chemicals.

In order to prevent chemicals dripping into the installation pit, the KVK maintenance panels are bonded diffusion-tight with both the tank edges and the casing. The bonding is made in such a way that the relative movements between the casing/tanks and the floor panels do not give rise to any cracks.

This arrangement of maintenance access panels divides the pre-treatment unit into two completely independent areas. The upper part (emission area, wet area) contains the aggressive fumes resulting from the high solution temperatures. However, these fumes are prevented from escaping from the enclosed pre-treatment unit and from entering the floor area (cellar), since the KVK casing panels and the KVK maintenance access panels form a diffusion-tight shell. Since no chemicals or aggressive fumes enter the cellar part, the latter can be referred to as a dry installation pit.

This division of the pre-treatment unit into a wet emission area and a dry floor area can be exploited in order to locate any sensitive parts requiring protection against corrosion at places where they do not come into contact with the aggressive atmosphere. The dry cellar contains all the automatic valves, pumps, electronic components such as transmitters, measuring sensors, etc.

This arrangement protects the components against the aggressive atmosphere normally prevailing in galvanising operations, thus minimising maintenance work and costs.

Advantages

- chemical-resistant
- diffusion-tight
- non-slip
- divides pre-treatment into an emission area (diffusion-tight shell) and a dry galvanise
- sensitive components located in dry galvanise (minimising maintenance costs)
- slope to save chemicals (drip losses)
- arrangement as required

Exhaust air purification system

The heating of the pickling liquid creates fumes in the emission area. These cannot, however, escape thanks to the enclosed design of the pre-treatment unit. In the Körner System, these fumes are continuously extracted through an extraction channel and fed to a scrubber unit for purification.

A plastic fan extracts the air from the emission area and impels it into the scrubber. Locating the fan before the scrubber obviates the need for a silencer on the gas side, since the washer itself performs this function. Since the unpurified air passes through the fan, the design of the latter is subject to the highest demands (corrosion).

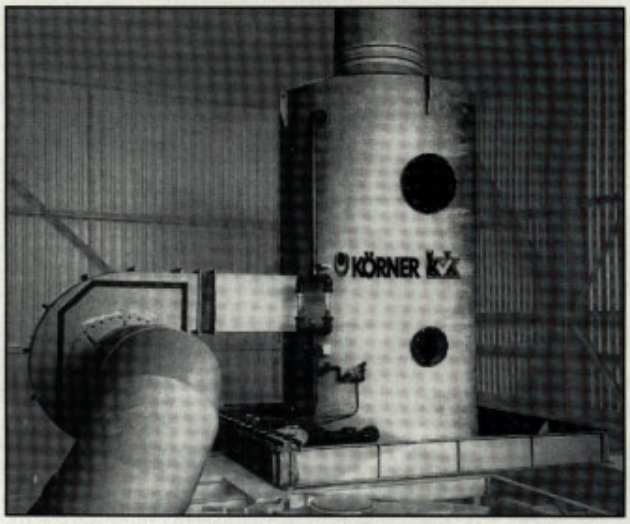

Figure 3. Exhaust air purification system

The purification process is based on the principle of counter-flow washing of the air in water. A circulation pump continuously drives a precisely calculated quantity of air in a circuit, the water is nebulised through spray jets and distributed over the filler material, the air passes through in counter-flow and gaseous impurities are removed. The washing water is returned to the process, thus ensuring a waste-water-free operation.

After the scrubber, the purified air is fed into an exhaust chimney and emitted to the atmosphere above the roof. The inorganic chlorine content after purification is less than one tenth of the official maximum limits.

The exhaust system is calculated specifically for each pre-treatment unit, since the complex interplay of casing volume, air-lock gate opening, arrangement of exhaust air lines, and the size and temperature of the bath surface make a simple design impossible.

Every Körner System unit is dimensioned in such a way that there is always a partial vacuum in the enclosed pre-treatment unit. This prevents any aggressive air escaping from the emission area even when the air-lock gates are opened for entry and removal of the materials to be galvanised. This exhaust system also protects the crane equipment and the building, thus minimising repair and maintenance costs for the operator. An equally important factor for the operator is also the permanent availability of the conveyor system, even after longer stoppages (weekends, factory holidays).

In order to optimise energy costs, the exhaust air system can be fitted with a negative-pressure control that uses a frequency converter to regulate the speed and hence power take-up of the fan motor according to the partial vacuum in the pre-treatment unit. This ensures that no more air is extracted than is necessary to ensure the operation of the system.

The energy consumed by the exhaust air system is roughly the same as is needed to operate a flux bath at 70°C instead of 67°C, ie reducing the flux bath temperature by 3°C (from 70°C to 67°C) saves sufficient energy to operate a modern exhaust air system.

Advantages

- entirely made of synthetic material
- optimised collection and cleaning of aggressive fumes
- partial vacuum in the enclosed unit
- no emissions to the outside (even when air-lock gates are opened)
- protection against corrosion to crane equipment and building
- a precondition for modern automated conveyor systems
- no need for silencer
- negative-pressure control means reduced energy consumption
- exhaust values far below the official maximum
- optimum flow conditions in the pickling unit
- minimum maintenance

Fully automatic level control

Modern operations pay considerable attention to optimising processes and reducing the costs of supplies. If circuits are largely closed, the supply materials that could still be used in the operation are not disposed of, but are instead returned to the working process. This helps to reduce production costs and, as a side effect, minimises waste disposal costs.

In the Körner System enclosed units, all tanks are fitted with KVK level transmitters to achieve fully automated level control of the entire pre-treatment system and are interconnected with a top-up water piping system. If the level in one of the tanks falls below a minimum point (entrainment or evaporation), a switch contact transmits the message "level min." to the central control unit which then fully automatically opens the automatic valve belonging to the tank and raises the level again. All automatic valves are located in the dry installation pit.

Top-up water comes primarily from the washing water from the scrubber, thus returning the valuable materials it contains to the process and at the same time maintaining the high quality of the water in the washer. This system ensures that pickling liquids containing iron are never mixed with chemicals containing zinc. This separated pickling management ensures minimum waste disposal costs combined with optimum service life and bath quality.

Consistent flushing water arrangements optimise the quality of every individual bath, and reduce the top-up water quantities to a minimum. This system of automatic level control and the balanced water consumption achieves an operation that is entirely free of waste water.

Advantages

- constant bath level
- maximum bath quality
- waste-water free operation
- high flushing criteria
- low disposal costs
- long service life of baths
- reduction of production costs

Fully automatic temperature controls

In order to adjust bath temperature as closely as possible to the process technology, all heated baths in the Körner System are fitted with fully automatic temperature controls. Specially developed KVK temperature transmitters continuously record the bath temperatures and transmit them to the temperature controllers in the control cabinet. The operating personnel in the control room can select the bath temperatures as required and compare the target and

actual temperatures. The electronic controllers operate automatic control valves that regulate the flow of water to the heating panels, ensuring that the temperatures set by the operating personnel are maintained.

The automatic valves are located outside the emission area and hence not exposed to corrosion. The automatic bath temperature regulation guarantees operations with constant operating points (depending on the technological requirements).

The temperatures are kept constant at the set value irrespective of outside influences such as seasonal temperature variations, differences in the temperatures of the goods to be galvanised, etc.

Operations by the personnel are reduced to a minimum, thus practically eliminating the human factor as a source of errors.

Advantages

- simple to operate
- freely adjustable bath temperatures
- independent of outside influences
- optimised process with constant operating points
- actual and target temperatures can be compared at any time
- acid-resistant KVK temperature sensors integrated in the tanks
- excellent regulatory characteristics
- minimum maintenance

Fresh and used acid piping

Exposed handling of chemicals is always a problem and can lead to considerable contamination wherever it takes place. In the Körner System, all baths are connected to each other by an acid piping complex that fully eliminates the need for exposed handling. All the tanks can be filled from or drained to a central acid filling station located at an easily accessible position near the tank filling area. It is fitted with several connector nozzles permitting the hoses of the tanker trucks to be connected directly to the connectors in the filling cabinet.

From this filling cabinet, synthetic piping leads to the acid storage tanks and to all pre-treatment tanks. All valves are located compactly on a valve switch panel so that all filling, draining or transfer processes can be controlled from a single point.

This acid piping can be used, for instance, to pump acid from a tanker truck to a fresh acid storage tank or directly into a working tank. The working tanks can be supplied from a storage tank at any time. The tanks are likewise drained via a system of synthetic piping into the used acid tanks or directly into the tanker truck via the filling cabinet.

With the piping system, considerable attention is paid to ensuring that pickling liquid containing iron is not mixed with that containing zinc (separated pickling management).

It is also possible to pump the liquids directly between the tanks. The entire piping system is located in the dry floor area, and complies with all official regulations.

The piping between the pre-treatment baths and the acid storage tanks and the filling cabinet enables absolutely clean handling of chemicals, with obvious advantages in terms of work safety and accident prevention resulting.

The pipes are calculated and designed according to the applicable standards and in the light of the chemicals, their temperature and the distances to be covered (pressure of the pumps).

Advantages

- simple to operate
- clean chemicals handling
- minimises accidents
- increases working safety
- central filling cabinet
- central valve switch panel
- permits temporary storage in acid storage tanks
- optimum disposal possibilities for used acid

KVK bath cleaning systems

In addition to optimised operation (flushing technology, etc.), a range of bath cleaning systems can also cut production costs. Regular and continuous cleaning of the degreasing baths prolongs the intervals between medium replacements, thus helping to cut chemical consumption and hence operating costs. Different cleaning systems can be supplied with the Körner system.

Advantages

- minimum maintenance
- increases service life of baths
- reduces operating costs
- increase bath quality
- increases quality of materials treated

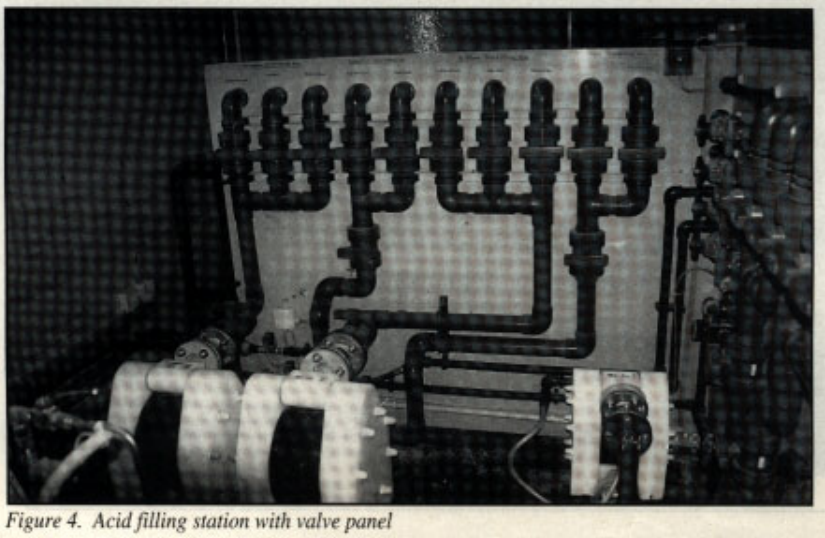

Figure 4. Acid filling station with valve panel

Summary

The ever-increasing pressure of competition must be met by new ideas for system techniques and technologies. In order to reduce production costs, every stage in the production process must be optimised and all system components optimally adjusted to each other. In order to meet these requirements, we have developed the Körner enclosed pre-treatment system, which permits operators to take full advantage of state-of-the-art techniques and technologies.

In conclusion, we set out once again the core advantages of the Körner System.

- By fully isolating pre-treatment from the other production areas, it is possible to operate the baths at high temperatures without corrosion in the rest of the production area.
- Space-saving (reduces building costs)
- Throughput times are cut significantly
- Enclosing the pre-treatment unit and extraction of the emission area (permanent partial vacuum) provide the technical precondition for the use of modern automated conveyor systems, thus increasing the degree of automation
- A high degree of automation reduces labour costs and as far as possible eliminates the human factor as a source of errors
- Enclosure prevents the escape of aggressive fumes from the pre-treatment unit, thus preventing corrosion to the crane equipment and the building.
- The use of KVK floor panels allows a system with dry installation pit in which all the sensitive components can be located away from corrosion
- The consistent flushing technology guarantees operation free of waste water and maximum pre-treatment bath quality combined with long service life of the baths.
- Low energy costs (approx. the same as for open systems)
- Automatic level regulation
- Automatic temperature regulation
- Exhaust air cleaning and return of washing water for reuse ensure environment-friendly operation and a high degree of flushing purity.
- A variety of bath cleaning systems increase bath quality and prolong service life
- The complete acid piping increases work safety and guarantees clean operations
- Separated pickling management guarantees minimum waste disposal costs

The main criteria for deciding in favour of an enclosed Körner System are primarily of an economic nature.

The fact that all environment protection regulations are met, and that the values achieved by the system are in part merely a tenth of the limit values permitted by the laws is a positive side effect of this system design.

Our ideas on optimising pre-treatment systems have been implemented in the Körner enclosed systems with recirculation. Today, ten systems based on this design are already in operation.

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