LIST
LEADER IN HIGH VISCOSITY PROCESSING TECHNOLOGY

Environment

LIST Technology for the Drying of Paint Sludges with Solvent Recovery

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LIST AG is a Swiss engineering company specialised in the construction of proprietary mixing, kneading, thermal processing equipment, as well as on the plant engineering, for the high viscosity sector of processing technologies. The range of developed and implemented processes covers, amongst others, plants for the processing of "difficult"/hazardous industrial residues, with the effective recovery of solvents. The concept of these plants is based on a single step direct (contact) evaporation/drying process in an enclosed operating unit, without recycle or addition of dry materials.

LIST has successfully applied on industrial scale, a process for the evaporation and drying of paint sludges with solvent recovery. The process, which will be highlighted in this document, ensures maximum possible recovery of the solvents in the material to be processed. The final residue is a nontoxic (neutral) and easy to handle solid/granular material. It can be either reused for a variety of applications or utilised as an energy source. The recovered solvents may also be rectified and recycled.

The increase in the amounts of paint and lacquer sludges from industrial processes combined with more stringent legislation, reduction in available land-fills, escalating costs, and the increasing pressure for residues to be processed at the point of origin has created a tremendous incentive for the development of new and economic concepts and techniques for their minimisation.

Paint sludges are often sticky and highly viscous. During processing their rheological state changes between highly viscous, pasty and solid, creating considerable engineering challenge for handling and disposal.

Evaporation and drying, as processing technology, has received increased attention for the treatment of such industrial residues. This technology guarantees a reduction in volume and weight of materials through the removal of solvents, whether aqueous or organic, by vaporisation. Heat is applied to the residues requiring processing in the form of steam or thermal oil. Solvents are heated to their boiling point, vaporised and recovered through condensation. The advantage of this technology is that the recovered solvents can often be reused. Several options exist for recycling the solid residue or it can at least be used as fuel supplement for the generation of energy.

Recognising the advantages of drying of difficult industrial residues over landfilling or incineration the German vehicle manufacturer, VW Kraftwerk GmbH, developed, in collaboration with the German company Gesellschaft für die Aufarbeitung und Verwertung von Reststoffen mbH (GFR = Society for the Treatment and Recycling of Residues Ltd.), a process to refine and recycle paint and lacquer sludges at Volkswagen's Wolfsburg plant, in Germany. This process was implemented applying the LIST-DISCOTHERM B thermal processing technology.

PROCESS AND PLANT DESCRIPTION

The process was developed for the treatment of paint and lacquer sludges from the motor vehicle industry. The target of the process was to split the sludges into three separate secondary product phases:

- Dried solids (dried residual of paints and lacquers)
- Liquid phase with water soluble organic solvents (alcohols and aliphatic compounds)
- An organic aromatic phase (solvents and aromatic compounds).

Once the secondary product phases have been separated there exists different specific recycling possibilities. Overall, the process recycles energy and materials, minimising if not totally eliminating any waste.

Fig. 1 shows the process flow diagram of the installed plant.

The paint and lacquer sludge is delivered in containers (1) and tipped into the sludge hopper (2). The sludge hopper is heated and equipped with a horizontal agitator. The purpose of the agitator is to both homogenise the sludge and press it into the twin screw feeder installed immediately underneath the sludge hopper. Heating the sludge hopper reduces the viscosity of the sludge thereby easing its mixing/homogenisation. The twin screw feeder conveys the sludge into the process chamber of the LIST-DISCOTHERM B CONTI contact dryer (3). The sludge hopper, including the twin screw feeder, is positioned on weighing cells, enabling control of the feed rate of sludge into the dryer (3). The sludge hopper agitator as well as the twin screw feeder are driven by hydraulic motors.

The LIST-DISCOTHERM B CONTI contact dryer (3) consists of the agitator shaft, a vapour dome (4) of large diameter placed on top of the dryer, the LIST-Lateral Discharge System (5), and the electric motor drive. The contact dryer has a double jacket and is heated by thermal oil. The agitator shaft is also heated by thermal oil.

Drying takes place under atmospheric pressure. The heat input required for the vaporisation of the water and the organic solvents is provided by contact of the wet sludge with the large heat exchange surfaces of the dryer (3). The dryer is heated at a maximum temperature of 280 °C. During drying the evaporated components flow through the heated vapour dome (4) and are totally condensed in a water cooled condenser (6). The condensate flows into a decanter (7) to separate the aqueous and organic phases. After this the phases are pumped into various buffer tanks prior to their further processing.

There is only a small amount of non-condensable gases, which are withdrawn from the condenser by a fan (8) and are passed through a catalytic incinerator (9). The purpose of the catalytic incinerator is to remove the solvents contained in the non-condensable gas stream. After this treatment the purified off-gas is discharged into the atmosphere.

The dried sludge has a granular consistency, is free flowing and nontoxic. It is discharged from the dryer (3) through the LIST-Lateral Discharge System (5) at a temperature of approximately 200 °C. Underneath the lateral discharge system there a rotary vane valve (10) is installed which feeds the dried sludge into a water cooled screw conveyor (11). At the discharge

nozzle of the screw conveyor (11) the dried sludge has a temperature of approximately 50 °C. The dried sludge, which is generally quite brittle and can be easily ground or milled, is then conveyed into storage silos.

PERFORMANCE

One ton of raw paint and lacquer sludge contains on average 350 kg dry matter and 650 kg water and organic solvents. Prior to drying this sludge is mechanically treated in order to remove a considerable amount of water (approximately 417 kg). The resultant treated dewatered sludge contains 350 kg dry matter and 233 kg water and organic solvents. Hence the feed material to the drying unit amounts to 583 kg. After drying the dried sludge contains at worst 18 kg of water and organic solvents, which corresponds to 5% final moisture content. Therefore, from each ton of raw sludge 610 kg of water and organic solvents are recovered and 22 kg are contained in the non-condensable gas stream. As already mentioned, these 22 kg are incinerated in the catalytic incinerator.

The VW plant operates at a maximum throughput capacity of 2,000 kg/h dewatered sludge. The total energy demand for the treatment of one ton raw sludge amounts 776 MJ. The plant has operated since 1991. By the end of 1994 the plant had dried 20,000 tons of paint and lacquer sludges. It is important to note that not all the dried sludges came from the VW automobile manufacture. A considerable amount of paint and lacquer sludges delivered for treatment at the VW plant came from other sources such as paint and lacquer producers, thereby proving the versatility of the LIST-DISCOTHERM B CONTI dryer.

Depending on the method of heating and the efficiency of the heating system selected. up to 85% of the energy required to run the plant can be supplied from burning secondary products.

For thermal recycling in VW plant, dried paint and lacquer granules are mixed with coal, ground and incinerated with the organic phase condensate in a thermal power station nearby. According to VW, emission measurements indicate very favourable furnace conditions. Water condensate is returned to the company's waste water treatment plant. Several other options also exist for recycling secondary products. The dried sludge may be used in the production of filling materials, sound-deadening foam, underbody sealant, filling for plastic mouldings, and production of secondary lacquers.

The water phase (containing soluble organics such as alcohols) and the condensates may be separated into various reusable components by distillation or extraction.

OPERATING PRINCIPLE OF LIST-DISCOTHERM B

The LIST-DISCOTHERM B can be designed for either continuous or batch operation. These machines are especially suitable for evaporation/ drying processes involving materials that change consistency during processing from liquid to highly viscous, pasty, or crusting intermediate phases, and eventually to a free-flowing solid. The machine consists of a horizontal, cylindrical housing, and a concentric agitator shaft with disk elements perpendicular to the axis carrying peripheral mixing/kneading bars (see Fig. 2). Stationary hook-shaped bars set in the shell interact with, and clean, the shaft and disk elements as they rotate. The average product fill level lies typically in the 60 to 80 % range of the total free volume.

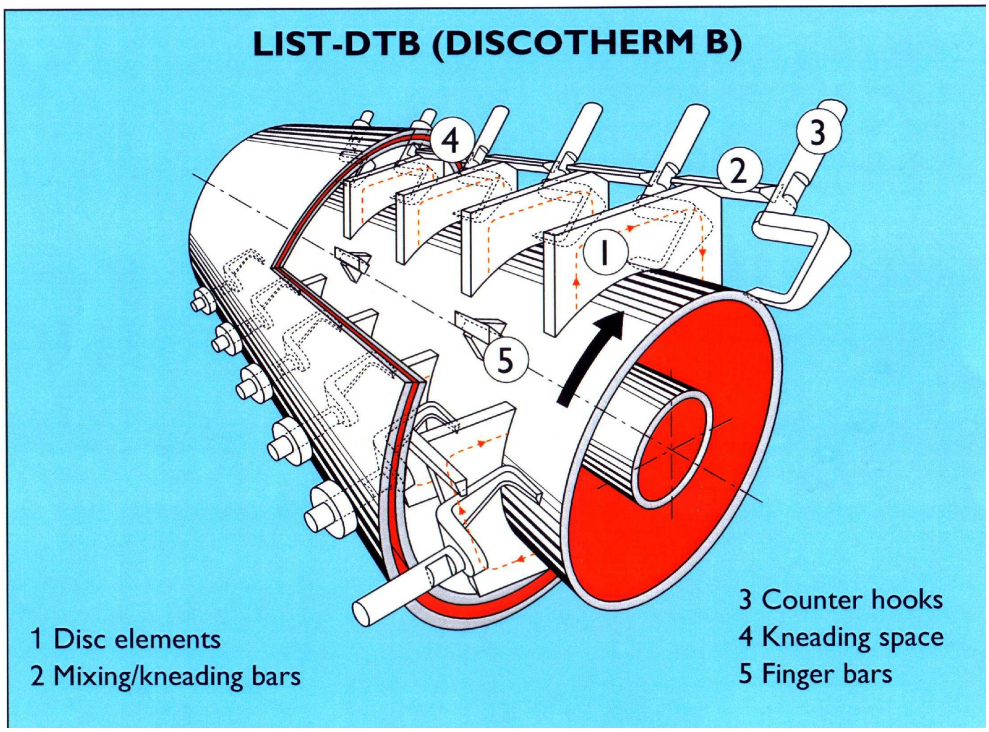

Fig. 2) LIST-DISCOTHERM B Operating Principle

The shell housing, agitator shafts, and disk segments of LIST-DISCOTHERM B can be heated or cooled, giving a very large heat exchange surface in relation to volume. The intensive mixing and kneading action, coupled with self-cleaning of the heating surfaces, combines to break up baked-on crusts, agglomerates and lumps, ensuring a high rate of product surface renewal for both heat and vapour transfer.

The kneading and agitation forces are high. To handle the required power, these units operate with agitator shaft speeds between 10 and 40 rpm, and maximum available torque's as high as $250 \cdot 10^3$ Nm. A spiral arrangement of the kneading elements imparts regular axial conveying, even for highly viscous pasty materials. Either machine is easily adaptable to changing feed rates or composition.

LIST DISCOTHERM B machines operate with fill levels around 60-80 % of total, which leaves adequate free volume for vapour disengagement.

The final product is usually a free flowing material, which is either a granular or powdery solid. The average fill level in the unit is controlled by the height of an adjustable weir plate at the discharge. Unlike screw type processing units, the axial conveying rate is independent of agitator speed, making it possible to select the rotation for optimisation of heat transfer, residence time, and minimisation of attrition.

The disk elements do not affect the forward conveying function, but prevent back-mixing, enabling the processing of any feed stocks directly through to a solid free-flowing material without recycling of dry product.

Table 1 (see page 6) summarises the characteristics and features of LIST-DISCOTHERM B machines.

SCALE OF OPERATION AND OPTIONS

LIST-DISCOTHERM B units for continuous operation are available in a number of sizes up to 16,500 litres, corresponding to a heat exchange area of 128 m^2. For batch operation 11,000 litres corresponding to 64 m^2 is the current maximum size. The housing shell can be jacketed or limpet coiled and heated together with the agitator shaft and disk elements with steam, hot or pressurised water, or thermal oil. If necessary cooling can be effected with water, brine, or thermal oil.

Any type of weldable material can be used for fabrication, and the drives can be either mechanical or hydraulic. Various types of stuffing boxes are available for shaft sealing, and mechanical seals can be used as appropriate.

TABLE 1 Characteristics and Features of LIST-DISCOTHERM B Machines

Intensive mixing and kneading action	Enhanced heat and mass transfer. Ability to handle all product states/phase in a single unit.
Extensive heating and cooling surfaces	Permit high rate of energy input or dissipation and ensure precise temperature control.
Self-cleaning	Improved heat transfer coefficients.
Intensive renewal of phase	Enhancement of mass and heat boundary layers transfer.
Large useful volume	High throughput and effective handling of continuous processes with long residence times (0,5 - 3 h).
Minimal axial intermixing	Virtual plug flow ensuring narrow residence time distributions.
Large cross-sectional area	Permits feeding and disengagement of gases and vapours, as well as flash evaporation of superheated solutions.
Closed, contained construction	Allows vacuum processing and handling of toxic, explosive, or hazardous substances

BENEFITS OF THE LIST TECHNOLOGY

Closed design/product containment

Toxic or hazardous components are controlled. Odours are largely contained. Evaporated products, whether organic or aqueous, are almost totally condensed. Very small quantities of non condensable exhaust gases are produced. Fire and dust explosion hazards are virtually eliminated.

Processing of sticky, crusting, or fouling intermediate phases

The consistency of paint and lacquer sludges changes during the drying process from highly viscous through pasty and crusting intermediate phases, usually resulting in a free flowing granular residue. Low residual moisture content, particularly with high boilers, is achieved by keeping the material being processed sufficiently particulate form during the final drying and allowing adequate residence time.

Flexibility

By using continuous plants for large capacities and batch units for smaller operations the processing requirements of various types of paint and lacquer sludges are catered for. Vacuum processing is also possible if required

One-step process

Drying is carried out in a single step without recycle of material. Also, as no carrier gas is used and almost complete condensation of generated vapours takes place, non condensable exhaust and odours are minimal.

Low operating and maintenance costs

- Sludge hoppers equipped with specially designed twin screw feeder employing gravimetric metering.
- Lateral discharge system for continuous operated dryers.
- Bottom discharge valve for batch operated dryers.

CONCLUDING REMARK

The application of LIST-DISCOTHERM B type of kneader/dryer in the thermal treatment of paint and lacquer sludges contributes to the minimisation if not total elimination of wastes, guarantees a high degree of operability and flexibility, ensures low running costs and last but not least provides an environmentally friendly operation.

Continuous or batch operation under atmospheric pressure or vacuum requires special consideration of feed and discharge systems for trouble-free operation of the recovery plant.

Feed and discharge equipment is available covering a range of rheological properties and process conditions.

Because of its unique characteristics and advantages the LIST mixing/ kneading technology for thermal treatment of paint and lacquer sludges is enjoying increasing acceptance in related industries.

ACKNOWLEDGEMENT

LIST wishes to express their sincere appreciation to VW Kraftwerk GmbH for the provision of technical information which has been used in this article.

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We develop and industrialize advanced and customized solutions for processing of viscous, sticky and crust-forming products for the polymer, chemical, fiber, food and environmental industries.

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