

EQUIPMENT FOR OIL/PAPER DRYING AND STABILIZATION

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Setting the pace in vacuum
equipment engineering.

At a glance:

EQUIPMENT FOR OIL/PAPER DRYING AND STABILIZATION

HEDRICH offers a variety of drying technologies for different applications. Only carefully dried insulation materials ensure a trouble-free function of electric high-performance components and slow down the aging process. The materials used to insulate transformers such as oils and cellulose are hygroscopic. It is therefore important to minimize moisture to guarantee dielectric strength and dimensional stability.

ADVANTAGES OF EQUIPMENT FOR OIL/PAPER DRYING AND STABILIZATION



- Vacuum oil purification equipment with indirect heating and large degasser for effective drying of insulating oils
- Vacuum hot air drying equipment with uniform heat distribution as cost-effective option for windings, distribution transformers and smaller power transformers
- Vacuum nitrogen drying equipment for reduced drying times; also as upgrade of existing vacuum hot air drying equipment
- Vapour phase drying equipment with external evaporator – a must for drying power and high-performance transformers
- Vacuum low-frequency drying equipment for distribution, medium voltage and power transformers for shortest drying and filling times
- Mobile vacuum low-frequency drying equipment for effective drying during the repair of power transformers in the field
- Vacuum drying and filling equipment for high-voltage capacitors – as batch-type or continuous equipment
- Vacuum drying and impregnating equipment for high-voltage cables
- Isostatic pressing devices for length stabilization of windings and shrinkage compensation of active parts already during the drying process





→ VACUUM HOT AIR DRYING EQUIPMENT

The mature technology of these systems provides excellent drying results. So the drying time compared to drying equipment without vacuum is reduced by nearly half. This is achieved by an optimum and uniform heat distribution through fans and air baffles and the complete heating of the autoclave by heat transferring oil.

| P. 6



→ VACUUM NITROGEN DRYING EQUIPMENT

Nitrogen instead of air – this is the principle of the vacuum nitrogen drying equipment of HEDRICH. The new process is characterized by higher drying temperatures, significantly reduced drying times and only minor depolymerisation of the insulation material. This process can be used for new drying equipment but can also be retrofitted on existing vacuum drying equipment because of the modular concept.

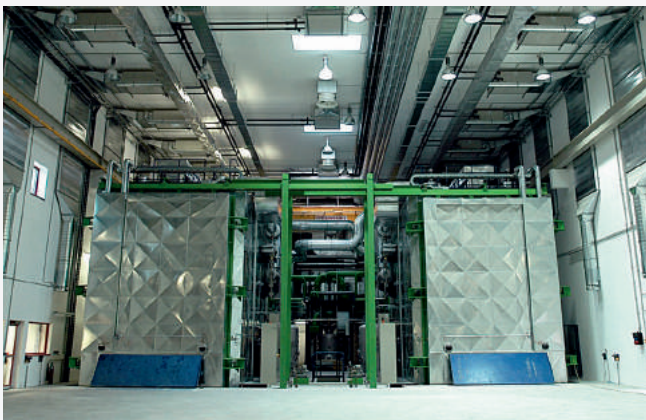
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→ LOW-FREQUENCY DRYING EQUIPMENT

To ensure a fully automatic production of distribution transformers of different sizes in medium and large quantities, HEDRICH has developed its low-frequency drying equipment. The simultaneous heat treatment and vacuum drying ensure short process times. Low vacuum in the complete process guarantees optimum drying qualities and minimum depolymerisation losses of the insulation.

| P. 10



→ VAPOUR PHASE EQUIPMENT

Vapour phase systems are preferably used for the production of power transformers and other high-voltage components. The highly energy-efficient technology, using kerosene, only requires half of the time compared with drying processes using air. This is ensured among others by the external fall film evaporator, the patented system of condensate accumulation as well as innovative regulating and control components.

| P. 12

→ VACUUM DRYING AND IMPREGNATING EQUIPMENT

Drying and impregnating systems are mainly used to process oil/paper-insulated components such as instrument transformers, capacitors, bushings and other electric components. After the components to be processed have been dried, the impregnation is performed by filling with insulation liquid under vacuum.

| P. 14



→ VACUUM OIL PURIFICATION EQUIPMENT

Whether in stationary or mobile design, the vacuum oil purification systems of HEDRICH are characterized by a large vacuum degassing stage and an efficient pumping speed of the pumping unit. To avoid cracking as well as local overheating, the insulation oil is heated up indirectly via a heat exchanger with hot water as heating medium.

| P. 16



→ VACUUM CABLE IMPREGNATION EQUIPMENT

Specialized in the impregnation of signal and HV/DVDC energy cables, HEDRICH ensures absolute process reliability with its equipment. For processing kilometers of HVDC energy cables, the large cable impregnation systems are equipped with a sturdy, reliable vacuum pumping unit with high pumping speed, low ultimate vacuum as well as special condensers and exhaust devices.

| P. 18



→ ISOSTATIC PRESSES

Using isostatic presses during the drying of transformer windings ensures that shrinkage of the insulation is compensated. Different pressing tools – adapted to various winding sizes – are available. A computer control system coordinates and controls the pressing operation according to the entered parameters like pressing force, holding and waiting times and pressure increase.

| P. 20





Vacuum Hot Air Drying Equipment

In a comparison between vacuum hot air drying systems and conventional drying systems that are only operated at atmospheric pressure without vacuum, one characteristic clearly stands out: The drying time is reduced by nearly 50 %. HEDRICH vacuum hot air drying equipment can be used for many applications, achieving excellent drying results based on its mature technology.

ADVANTAGES OF VACUUM HOT AIR DRYING EQUIPMENT



- Control of circulating air to be exchanged by a moisture sensor
- Optimized and uniform heat distribution through fans and air baffles
- All-around heating of autoclave by means of heat transferring oil, including door
- Further reduction of the drying time up to 75 % by additional use of a current heating device to heat the windings.
- Loading by air cushion vehicle or trolley
- Online registration of dew point and water rate during the fine vacuum phase

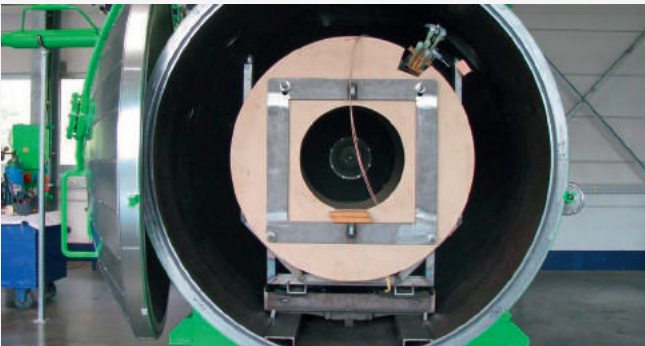
→ CONTROLLED AIR GUIDANCE

In the air circulation system, the heat transferring medium air is circulated by means of fans between the heated autoclave wall and air baffles so that the air is heated up and conducted to the parts to be dried which are uniformly dried. The exchange of air enriched with water vapour is efficiently controlled by a moisture sensor.



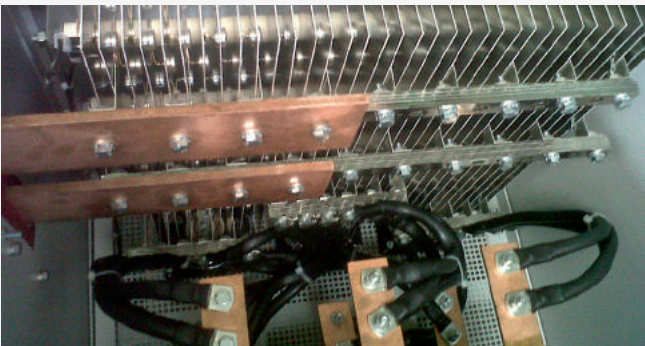
→ CUSTOMIZED DESIGN

HEDRICH constructs its drying equipment according to customer requirements to achieve optimum and energy-efficient drying performances. Depending on the application, round or rectangular autoclaves are used. Also for vacuum pumping units with oil-sealed or dry-compressing backing pumps, HEDRICH meets the specific customer requirements and designs optimum solutions.



→ TIME REDUCTION BY CURRENT HEATING

For reducing the drying time, the vacuum air circulation drying systems can additionally be provided with a direct current heating. This solution is preferably used to dry windings. The combination of resistance heating and air circulation heating ensures a faster and more uniform heating thus increasing the energy efficiency.



→ UNIFORM HEATING

HEDRICH heats the complete autoclave with all surfaces, including top, bottom, rear wall and door. The temperature is controlled via different heating circuits with manual control valves. The typical heating medium is heat transferring oil that is pumped through U-shaped pipes welded on the autoclave. With smaller autoclaves, heating is also possible through electric heating plates installed at the outside.



APPLICATIONS

- | | | |
|--|-------------------------------|-------------------------|
| ■ Distribution transformers | ■ High-voltage bushings | ■ Traction transformers |
| ■ Power transformers | ■ Components for transformers | |
| ■ High-voltage instrument transformers | ■ Transformer windings | |



Vacuum Nitrogen Drying Equipment

The new process of HEDRICH uses nitrogen instead of air for the drying operation. Thus, higher drying temperatures and faster heating times can be reached and the drying times can be significantly reduced. The conventional drying technology using air as heat transferring medium has the disadvantage that the drying temperature needs to be limited because of the existing atmospheric oxygen in order to avoid excessive depolymerisation.

ADVANTAGES OF VACUUM NITROGEN DRYING EQUIPMENT

➤ 30 – 40% shorter drying times compared with the vacuum hot air drying equipment

➤ 15 – 20% higher drying temperatures

➤ Optimization of existing conventional HEDRICH vacuum hot air drying equipment

➤ Auto-adaptation to adjust the drying process to the batch size

➤ Energy-efficient equipment concept

➤ Minor depolymerisation of the insulation paper

➤ Minimization of the nitrogen to be exchanged to save energy

➤ Online registration of dew point and water rate during the fine vacuum phase

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→ REVOLUTION_{N₂}

Through the use of nitrogen instead of air as heat transferring medium, the process happens without exposure to air. This allows higher temperatures, faster heating times and a significant reduction of the depolymerisation rate of the insulation. At the same time considerably shorter drying times are achieved.

→ HIGHER TEMPERATURES

The use of nitrogen allows to increase the drying temperature by 20 °C so that the drying times can be significantly reduced. The effectivity and productivity of the drying systems can be considerably increased.

→ AUTO-ADAPTATION OF PROCESS

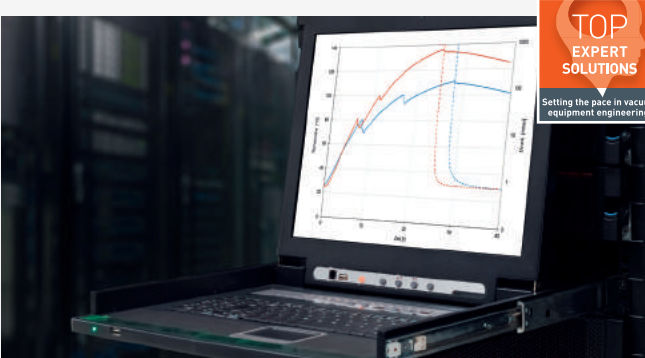
Optimizing the process steps allows a further reduction of the drying time. After the specific transformer data have been entered, the process control unit selects the optimum program and, by means of different sensors, optimizes the duration of the intermediate pressure reductions, the exchange of the nitrogen saturated with water vapour as well as the fine vacuum phase.

→ IDEAL FOR RETROFIT

Not only new drying systems can be equipped with the innovative drying by nitrogen, a retrofit is also possible on existing vacuum hot air drying systems. A modular concept guarantees fast retrofitting including optimization of the control unit with auto-adaptation of the process.

APPLICATIONS

- | | | |
|--|-------------------------------|-------------------------|
| ■ Distribution transformers | ■ High-voltage bushings | ■ Traction transformers |
| ■ Power transformers | ■ Components for transformers | |
| ■ High-voltage instrument transformers | ■ Transformer windings | |





Low-frequency Drying Equipment

HEDRICH systems with direct electric low-frequency heating are designed for fully automatic production of medium and large volume production of different transformer sizes and types. The high flexibility in the batch occupancy is unique just in the production of distribution transformers. Parallel heat treatment and vacuum drying allow to achieve shortest process times. The complete process is performed under low vacuum thus ensuring significantly improved drying quality and reduced depolymerisation of the insulation material compared with conventional drying processes.

ADVANTAGES OF LOW-FREQUENCY DRYING SYSTEMS



- Special low-frequency converter technology for heating under vacuum
- No air flushing necessary to avoid corrosion
- Minimum depolymerisation and aging of the insulation
- Low residual moisture in the insulation
- Very short drying and oil filling times are possible
- Online temperature determination during low-frequency electric heating
- Complete drying and oil impregnating process under vacuum
- Pressure testing and leakage detection equipment for hermetically closed transformers
- Most efficient and fully automated process
- Expandability of equipment to increase production capacities
- Automated database query of process and transformer data
- Stationary and mobile low-frequency systems available

→ SPECIAL CONVERSION

The drying process of the insulation material of distribution transformers under vacuum is significantly accelerated by the use of a low-frequency heating. With specifically developed converters, HEDRICH uses sinusoidal low-frequency heating currents to meet the high requirements for the heating conditions caused by the vacuum.



→ VACUUM FROM THE BEGINNING

From the pre-drying the complete process takes place under vacuum. For transformers with a high portion of insulation material nitrogen is additionally used for heat transfer in most cases. Because of the higher insulation temperatures without atmospheric oxygen aging of paper insulation is minimized.



→ FLEXIBLE EXPANDABILITY

The HEDRICH low-frequency equipment concept is expandable from the addition of individual heating units to the upgrade by another production line. So a basic equipment can be subsequently extended without need to replace the essential components like heating units, control system and vacuum pumping unit.



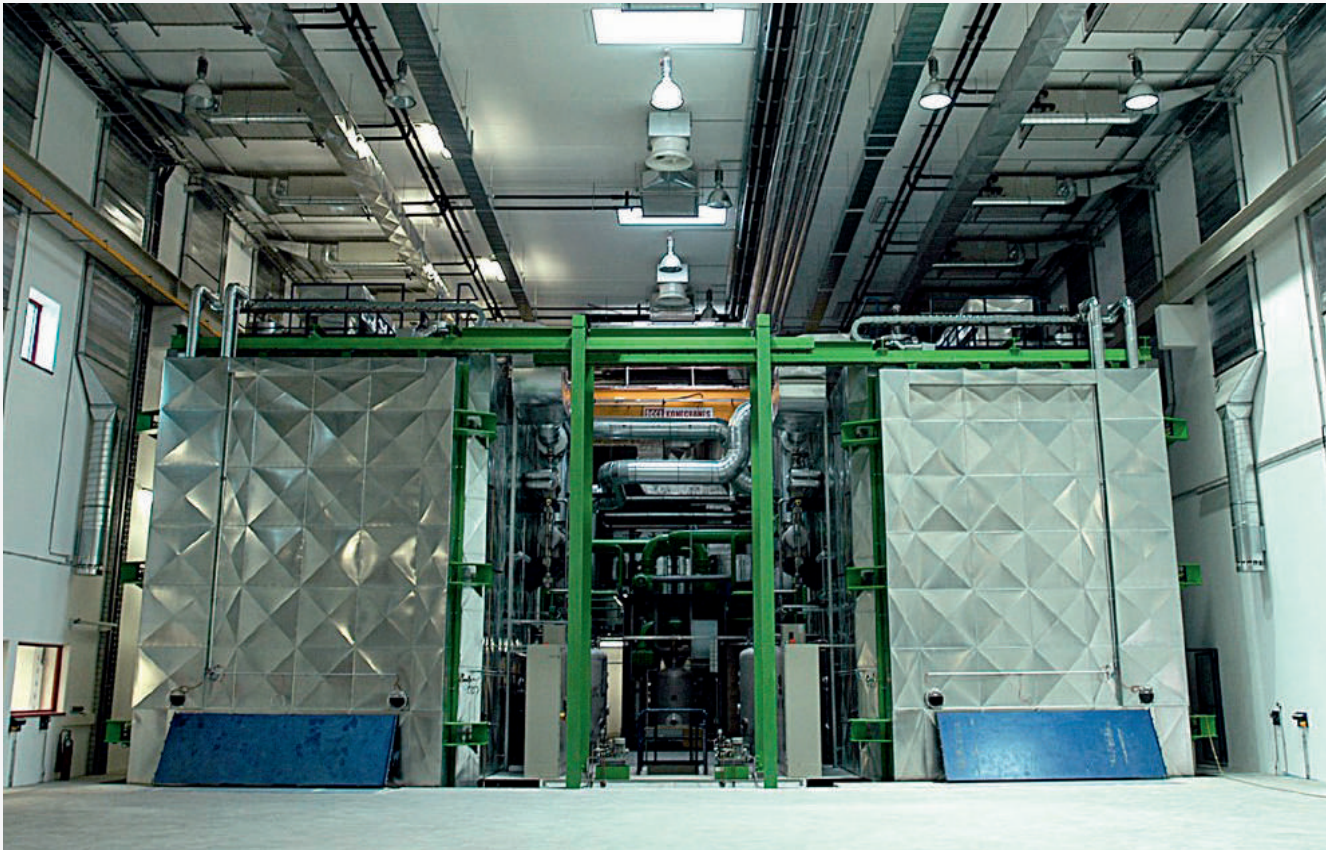
→ CHECKED AND TESTED

Hermetically closed transformers have to meet increased requirements for the sealing of the transformer housing. The HEDRICH pressure testing and leakage detection equipment checks the seals, their seat, the housing and the welding seams by means of cyclically changing and constant overpressure phases. At the same time the varying overpressures enhance the impregnation quality.



APPLICATIONS

- Distribution transformers
- Medium-voltage transformers
- Small and medium power transformers
- Power transformers after repair in the field



Vapour Phase Equipment

The production process of power transformers would be unthinkable without the drying technology by means of kerosene (vapour phase process). But also for other high-voltage components this process is applied. With its outstanding heat transferring coefficients the drying time is nearly halved compared to traditional drying processes using air. This energy-efficient process also minimizes thermal damage to the insulating material.

ADVANTAGES OF VAPOUR PHASE SYSTEMS



- Unique – externally arranged fall film evaporator
- Energy efficient controlled condensation by extracting kerosene/water vapour
- Large collecting vessel for kerosene – optimal for drying repair transformers
- Complete heating of autoclave by heat transferring oil, including door
- Auto-adaptation to adjust the drying process to the batch size
- Integrated safety PLC to increase the process safety
- Vacuum-tight and maintenance-free angle valves
- Parallel distillation during the drying process
- Online registration of dew point and water rate during the fine vacuum phase
- Stationary and mobile vapour phase systems are available

→ FALL FILM EVAPORATOR

The fall film evaporator that is installed outside of the vacuum chamber ensures homogenous heating through droplet-free kerosene vapour. The distillation (separation kerosene from transformer oil washed out of the insulation) can take place in parallel without affecting the drying process. The transformer oils occurring in case of oil-impregnated repair transformers can therefore be immediately pumped off during the distillation process.



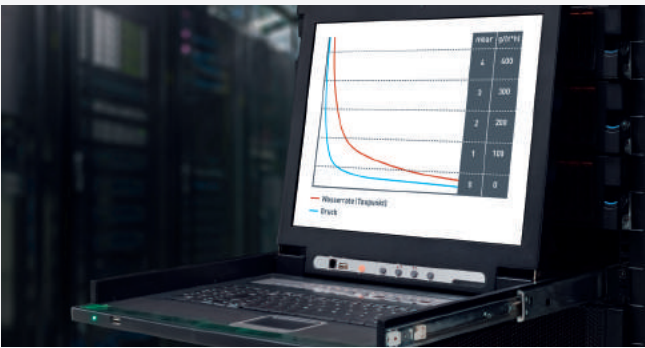
→ OPTIMAL ENERGY SUPPLY

With the patented system of condensate accumulation in the main condenser, the effective condensation surface is adjusted depending on the actually loaded parts (quantity of insulation, iron, copper etc.) so that only the kerosene portion condenses with water that is needed for fast drying. This construction guarantees that only the required energy is needed – a benefit to the total energy balance of the system and drying process.



→ ONLINE DETERMINATION OF RESIDUAL MOISTURE

HEDRICH was the first manufacturer to integrate into its vapour phase systems an electronic measuring instrument to determine the residual moisture of the parts to be dried. The sensors are constructed in such a way that the water diffuses through a gold membrane allowing only water vapour but no kerosene to pass and altering an applied electric field. The dew point is determined in comparison to an integrated calibration curve. A conversion into the water rate is possible.



→ HIGH-PERFORMANCE PUMPING UNIT

For high pumping speeds and a low ultimate vacuum HEDRICH developed the following solution for the vacuum pumping unit: use of liquid ring pumps with kerosene as sealing agent – combined with Roots pumps. This excludes the risk of kerosene condensation in the oil of conventional rotary vane pumps. When required, HEDRICH also delivers pump combinations with rotary vane pumps and dry pumps.



APPLICATIONS

- Power transformers
- High-voltage transformers
- Distribution transformers
- High-voltage bushings



Vacuum Drying and Impregnating Equipment

Modern and effective drying and impregnating systems providing the best dielectric and mechanical properties to the oil/paper insulated electric products are preferably operated using vacuum. This applies to the purification of the insulating oil as well as to the drying of the insulation. HEDRICH supplies vacuum drying and impregnating systems and oil purification units that are individually adapted to the requirements of oil/paper insulated electric products like instrument transformers, capacitors, bushings and other electric components.

ADVANTAGES OF VACUUM DRYING AND IMPREGNATING SYSTEMS



- Available as batch unit and continuous system
- Different possibilities of filling and filling height adjustment
- Complete heating of autoclave by heat transferring oil, including door
- Optimized arrangement of heating/cooling registers for short heating and cooling times
- Optimized arrangement of the capacitors on special loading systems
- Optimized heat distribution through fans and air baffles (continuous)
- Option to dry under nitrogen
- Special filling ports for complete filling of the capacitor
- Loading of autoclave in space saving 2-level version

→ TENFOLD PRODUCTIVITY

The continuous systems of HEDRICH allow to achieve high throughputs of more than 1,000 capacitors per week (90 to 120 capacitors per week in batch systems). A downstream automatic oil filling and pressure test is also possible with continuous systems.



→ INDIVIDUAL FILLING HEIGHTS

HEDRICH offers a multitude of different filling systems. The filling heights can be adjusted via a common open channel in the vacuum tank itself or on the outside according to the principle of communicating pipes. Individual filling vessels offer highest flexibility.



→ SETTING THE PATH FOR SUCCESS

With compact construction and shortest ways, the HEDRICH equipment concepts are the basic elements for maximum productivity. The loading systems are adapted to the respective products so that the resource productivity of the industrial useful area can be increased by an optimum arrangement of the products.



→ UNIFORM TEMPERATURE CONTROL

HEDRICH heats and cools the complete autoclave on all surfaces, including top, bottom, rear wall and door. The temperature is controlled via different heating circuits with manual control valves. The typical heating medium is heat transferring oil that is pumped through welded-on U-shaped tubes. For acceleration, heating/cooling registers can be integrated between the parts to be dried.



APPLICATIONS

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|---|--|---|
| ■ High-voltage capacitors | ■ Capacitive voltage instrument transformers | ■ Oil/paper insulated electric components |
| ■ Voltage/current instrument transformers | ■ Bushings | |



Vacuum Oil Purification Equipment

HEDRICH offers a wide range of standard oil purification systems. These are characterized by an indirect hot water heating to avoid cracking of the insulating oil, a large vacuum degassing stage and an efficient pumping unit. The systems can be built in stationary or mobile version and provided with different measuring sensors.

ADVANTAGES OF THE VACUUM OIL PURIFICATION SYSTEMS

➤ Hot water as heating medium to avoid cracking of the insulating oil

➤ Low residual moisture and residual gas content already after one pass

➤ High pumping speed of the vacuum pumping unit

➤ Extremely large degassing stage

➤ Condensation device for light oil fraction

➤ Safety separator for protection against foaming

➤ Measuring instruments for residual gas, residual moisture and oil throughput

➤ High heating power for optimum heating

➤ Stationary or mobile designs

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→ NO OVERHEATING

To ensure a uniform heating of the insulating oil before the degassing operation, the oil is heated up by means of a heat exchanger. Hot water that is electrically heated in a closed circuit is used as heating medium. Local overheating in case of contact with insulating oils and thus the danger of cracking as caused by electric heating elements are avoided.

→ ONE PASS FOR ALL

The degassing stage is filled with special filling bodies and is provided with a large distribution cone at the inlet ensuring a large surface of the oil to be degassed. The vacuum pumping speed is optimally adapted to the degassing capacity. Whether with or without a Roots stage, different drying and degassing degrees can be achieved in one pass.

→ SECURED

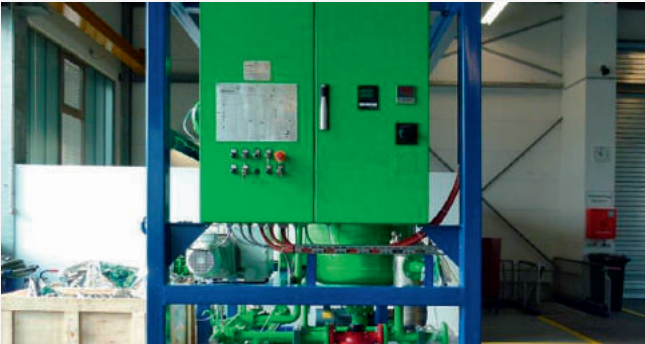
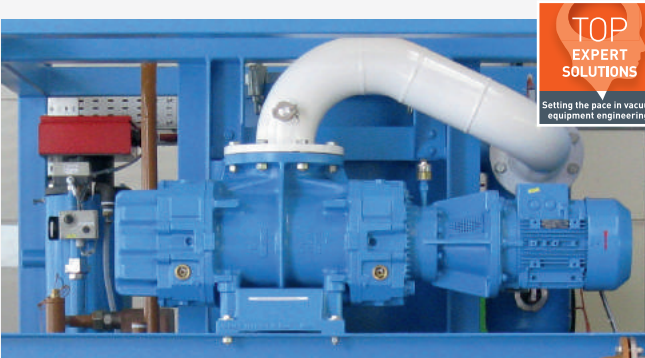
For protection against foaming and ingress into the vacuum pumps, the oil purification systems are provided with a special separator. An additional water cooling allows to collect even low-boiling oil fractions and return them to the insulating oil.

→ EVERYTHING IN VIEW

All oil purification systems can be provided with measuring sensors for residual gas, residual moisture, temperature, vacuum and oil throughput for online recording and documentation of the quality of the purification.

APPLICATIONS

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|---------------------------------|------------------|----------------|
| ■ Mineral oils for transformers | ■ Synthetic oils | ■ Castor oil |
| | ■ Ester oils | ■ Silicone oil |





Vacuum Cable Impregnation Equipment

HEDRICH cable impregnation systems are designed to dry and impregnate signal and HV/HVDC energy cables according to customer requirements. Based on 45 years of experience and more than 35 delivered cable impregnation systems, the comprehensive HEDRICH quality assurance management provides highest standards of quality, efficiency and reliability.

ADVANTAGES OF VACUUM CABLE IMPREGNATION SYSTEMS

➤ Continuous and careful purification

➤ 2-stage special thin-film degasser to degas and dehumidify highly viscous cable compound.

➤ Temperature-controlled storage of the cable compound under vacuum up to 550 m³

➤ Use of proven feeder pumps for careful transport

➤ Use of safety heat exchanger

➤ Design of pipelines to convey cable compound with trace heating

➤ Impregnation systems for rotatable tank sizes up to 700 m³

➤ Controlled and recorded compliance of the heating and cooling phases

➤ Special condensers and exhaust devices for high water vapour quantities

➤ Automatic levelling of the filling level and control of the impregnation pressure

➤ 4-stage vacuum pumping units up to 30,000 m³/h; ultimate vacuum up to 10⁻⁴ mbar

➤ Easy cleaning of compound containing equipment parts

➤ Spray device to clean screw vacuum pumps

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→ GUARANTEED RELIABILITY

With 45 years of operation and more than 35 delivered cable impregnation systems for signal and HV/HVDC energy cables HEDRICH can guarantee the process reliability. During the past 10 years HEDRICH could obtain a process reliability going far beyond the standard requirements and guarantee downtimes of a few hours with process times of more than 40 days.



→ PURIFICATION IN ONE PASS

The special filtering devices, feeder pumps and valves as well as the 2-stage HEDRICH thin-film degasser are exactly designed for the cable compound to be used. Highest purification qualities and optimum dielectric and mechanical properties are thus guaranteed already after one pass.



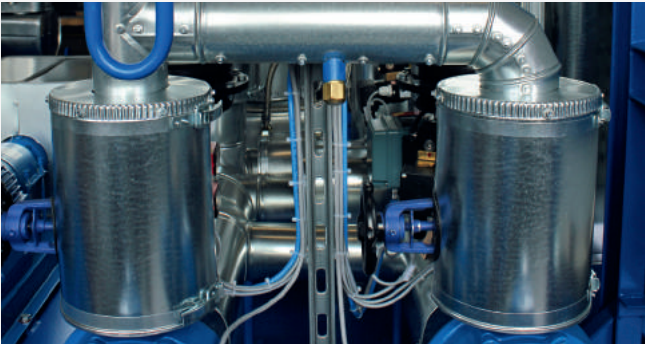
→ EFFECTIVE DRYING

The extremely sturdy and reliable vacuum pumping units with a pumping speed of up to 30,000 m³/h and low ultimate vacua in the range of 10⁻⁴ mbar are provided with special condensers and exhaust devices to effectively pump out the high quantities of water vapour emanating during the vacuum drying.



→ CLEAN IMPREGNATION

In case cable compound emanates, it is collected separately in special condensers and is pumped out without affecting the vacuum pump capacity. The pipes of the nearly maintenance-free, dry running screw vacuum pumps are easily cleaned by means of a spray device.



APPLICATIONS

- HV/HVDC energy cables

■ Oil/paper insulated special cable
- Purification of cable oil and cable compound



Isostatic Presses

Short circuit currents may cause forces in the windings leading to deformation. To ensure that these forces can be absorbed by the windings, these need to be preloaded. The isostatic presses of HEDRICH reduce the plastic deformation component by pressing the winding during the drying process in the oven. They are optimally designed for being used in hot air and in vapour phase ovens.

ADVANTAGES OF THE ISOSTATIC PRESSES



- Design with several small cylinders on the upper pressing plate or with central cylinder
- Pressing tools adapted to the winding sizes
- Isostatic presses of active parts
- Mobile hydraulic unit to load and unload the pressing tools
- Length measurement systems to measure the shrinkage of the windings available as option

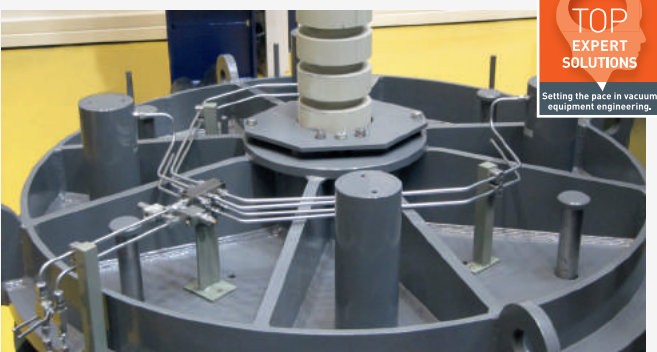
→ ISOSTATIC PRESS WITH CENTRAL CYLINDER

The core of this pressing process is a pulling central cylinder. This cylinder uniformly pulls the mobile upper pressing plate against the winding as well as the lower pressing plate thus stabilizing the winding. The operating pressure of the hydraulic unit is 250 bar. Pressing forces up to 3,200 kN are possible.



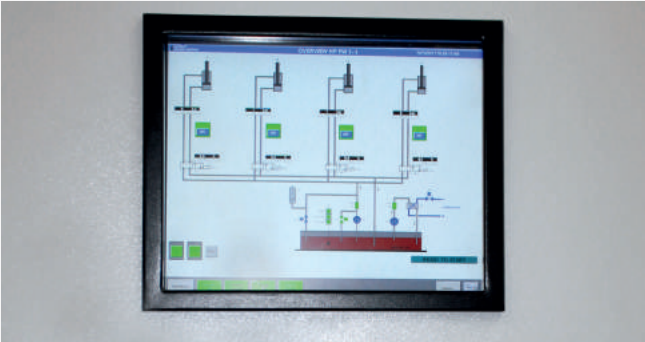
→ SEVERAL CYLINDERS FOR SMALL WINDING DIAMETERS

For windings with a small inside diameter a pressing tool with several small cylinders at the upper pressing plate is recommended. The smaller cylinder cross sections require larger hydraulic pressures to achieve a pressing force of up to 3,200 kN. In this case the hydraulic pressure is 500 bar.



→ AUTOMATIC CONTROL OF THE PRESSING PROCESS

A computer system controls the pressing process. The entered parameters are the ultimate force to be achieved as well as the pressing and holding times for reaching individual pressure increase curves. The pressing process takes place fully automatically. It is represented visually and can also be printed out.



→ LENGTH MEASUREMENT

To check the length variation of the windings during the pressing process, length measurement systems can be fixed to the pressing tools. Inductive way measurement has proved to be optimal. The control of the length variation serves among others as quality proof.



APPLICATIONS

- For hot air and vapour phase systems
- Single windings
- Active parts
- Winding blocks



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PROGRESS

is feasible.