User report

Increasing sustainability and reducing the CO2 footprint in filtration during grinding

Sustainable and energy-efficient systems

Working closely with a customer, Lehmann-UMT designed a sustainable cutting oil treatment system for filtering cooling lubricants used in the manufacture of machine tools and precision tools. The goal was to create a system that meets the current requirements of grinding technology while considering energy efficiency, sustainability, and investment costs. The custom-designed and manufactured system is already connected to the machine tool shown below and is operating reliably.

Data collection and optimization potential

The project was based on data collection about the filter technology currently used by the customer. For example, measurement series were taken of the power consumption of the cooling system in use, which allowed conclusions to be drawn about its utilization and consequently identified optimization potential.

In a second step, Lehmann-UMT, together with the grinding machine manufacturer, defined the target parameters for the filter system to be designed. The required filter fineness was set at 5 µm. Further objectives included reducing the energy required and the footprint by 10% each, while maintaining the same investment costs.

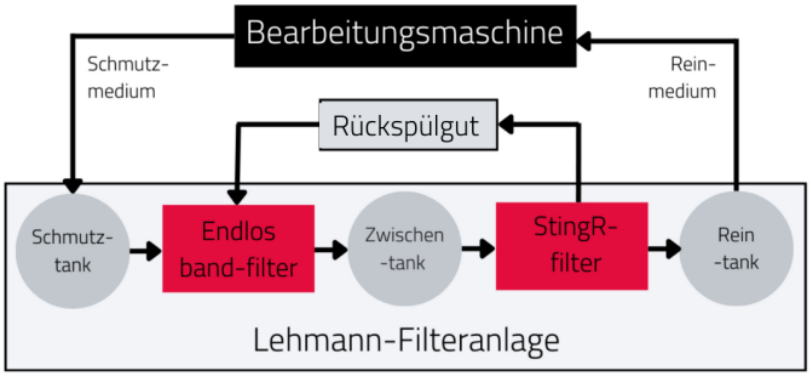
The filtration system was then specifically designed, engineered, and manufactured to meet the customer's needs. The data for the Lehmann-UMT filtration system is derived from practical process tests conducted on-site at a reference customer's location over several months.

System in use at the customer's site

Intelligent adjustment of pumps and coolers

The in-depth process analysis led Lehmann-UMT to install smaller, demand-based machine supply pumps, which significantly reduced energy consumption. By using a hydrostatic filter (with a high water column), a suction pump is unnecessary. The plant's energy requirements were considerably reduced by utilizing naturally occurring energy from the environment.

In addition, the collected data was used to adjust the size of the cooler to the overall system and reduce it by 30%. Furthermore, the process-related needs assessment and the subsequent precise design of the system significantly reduced the energy consumption of the entire process.



Process diagram with processing machine and filter system

Together with the grinding machine manufacturer, Lehmann-UMT conducted various tests on an existing reference system. These tests determined the energy consumption and the number of on/off cycles of the cooling unit. From this, conclusions were drawn regarding the energy required for the filter system to be developed. Furthermore, the control system was adjusted so that the cooling unit is only switched on as needed and, for example, does not operate at 100% power during dressing.

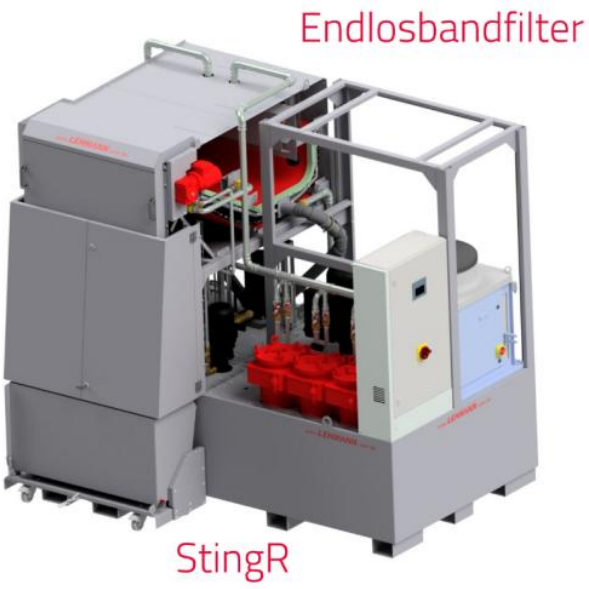
The previous reference system had several feed pumps installed, all operating at full power. The new filter system was equipped with only one feed pump with frequency converter control.

It provides the required power output in stages, as needed. The output of the feed pump is determined by fixed values that have been predefined for each processing step.

Efficiency benefits through multi-stage filtration

To achieve the specified objectives, the principle of multi-stage filtration was applied. For this purpose, approximately 80% of the grinding sludge, as well as corundum and grinding wheel binder, were removed from the process in the first filtration stage using an endless belt filter. The system uses an endless plastic belt and does not require any filter consumables (fleece), which drastically reduces the volume of waste.

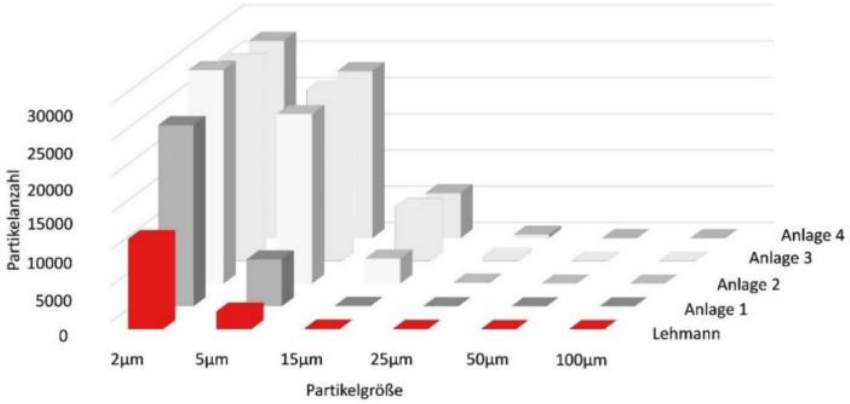
The continuous belt feed is fully automated, sensor- and time-controlled, ensuring the formation of a dry filter cake. The system operates using hydrostatic water pressure (hydrostatic filter system) and requires hardly any additional energy for filtration.



The second filtration stage is the Industry 4.0-compatible automatic filter StingR . The process diagram illustrates the path of the fluid.

The patented backflushing process enables the safe and low-wear fine filtration (down to 2 µm) of abrasive particles from the machining of materials such as HSS, hard metal, SiSiC , ceramics, and glass. A pump draws the contaminated medium into the filter dome from below, where the dirt settles on the filter element. The cleaned medium then enters the interior of the filter, is collected in a tank, and supplied directly to the machining center.

A differential pressure sensor automatically detects a contaminated filter element and triggers a demand-controlled backwash of the filter element. A short pulse of compressed air directed at a liquid reservoir removes the dirt adhering to the filter element from the pores, reactivating the filter surface to almost 100%. The extremely short backwash times of less than 9 seconds enable frequent and effective backwashing , effectively preventing agglomeration. This leads to a noticeable improvement in coolant quality and helps to minimize wear on the machine tools and equipment used.



The diagram compares the Lehmann-UMT filter system with suction belt filter systems from other manufacturers. For this purpose, continuous sampling of the clean medium was carried out using a U-tube. The number of particles was then measured using the Parker PLC 2000 (particle counter).

The improved filtration result of the Lehmann filter is primarily due to the inclusion of StingR filter elements in addition to the first filter stage (endless belt filter). The StingR elements ensure that significantly fewer dirt particles were detected in the purified medium in the 15 to 2 µm range compared to the systems without these fine filters.

Thanks to improved filter quality, tool life has been extended by 50 to 100% for various customers. Furthermore, our customers' practical experience indicates that spindles and rotary unions have seen a tool life extension of 30 to 50%.

Cost savings and environmental protection

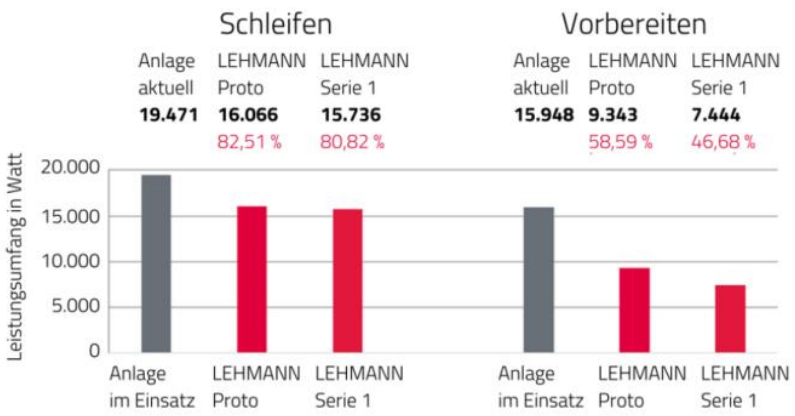
The Lehmann-UMT filtration system offers its users a number of advantages. These primarily include cost savings due to improved filtration efficiency. In particular, the fully automated backwashing process ensures longer service life and consistently high coolant quality. As a result,

The user experiences less wear and tear on the machine tool, filtration system, tools, and workpieces. Consequently, they require less dressing, produce less scrap, and benefit from reduced scrap and follow-up costs resulting from lower energy and spare parts consumption.

The system's intelligent design minimizes wear and tear on the equipment and ensures long service life for oils, tools, and machines. This increases the sustainability of the entire process and actively contributes to environmental and resource protection. Furthermore, upcoming maintenance intervals are reliably predicted.

The differential pressure sensor integrated into the StingR detects a contaminated filter element by the consistently high differential pressure inside the filter after the backwashing process. If the pressure level exceeds a defined limit for a certain period, this is detected early by the fully automated control system. A message is then displayed on the service screen indicating that a maintenance interval is imminent. This allows service times to be scheduled during the machine's downtime, which in turn reduces personnel costs.

Predictions like these can be made possible by appropriately defining limit values for pumps and integrating them into the system's software. Consequently, the filter system is Industry 4.0-ready, leading to a significant performance improvement.



Filter system tested under real production conditions

The system was installed at the end customer's site in cooperation with the grinding machine manufacturer. Once at the reference customer's site, a process verification was conducted under real production conditions for six months. The following results were achieved.

The illustration shows, that the new Lehmann filter system consumed 19% less energy during grinding and 53% less energy during preparation than the originally used filter system.

In this case, preparation time includes all periods when the machine is switched on but not grinding. For example, during programming, loading, or dressing the grinding wheel.

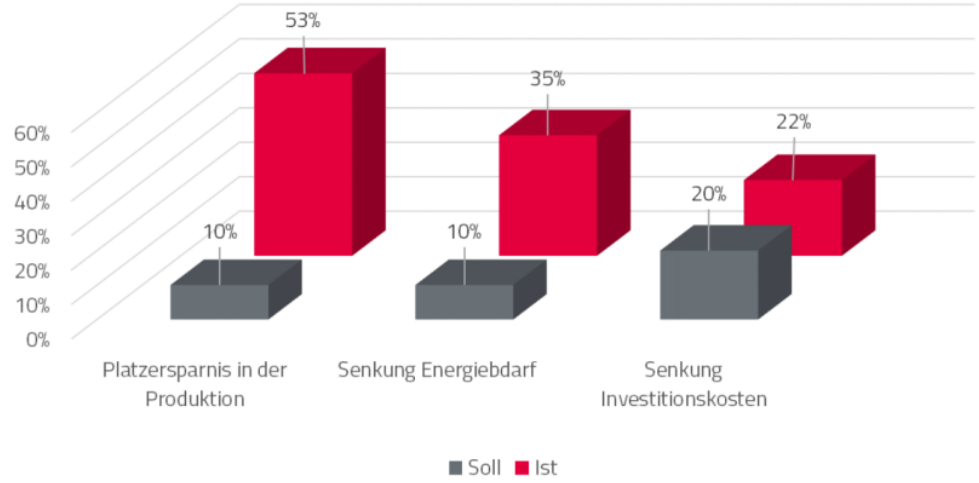
Future vision – injection of grinding sludge

In the Lehmann-UMT laboratory, specific tests were conducted on the supposedly dry grinding sludge. The chips were weighed once before and once after pressing. This revealed an oil content of approximately 30%. Specifically, the procedure showed that 600 g of chips contained approximately 225 g of oil. Particularly for applications involving oil, up to 40% of the oil by mass can be pressed out.

Recovering the grinding oil increases the sustainability of the entire filtration process. Waste volume decreases because the oil no longer needs to be disposed of. At the same time, waste is reduced and the recovered grinding oil is returned to the machining equipment . Furthermore , this results in significant cost savings for the user.

For example, one customer generates 1 m³ of grinding sludge every week. This grinding sludge still contains 20% oil. This means that 200 liters of grinding oil are disposed of per week. Extrapolated to a year, this equates to 10,400 liters of oil. Assuming a price of €5 per liter of grinding oil, this results in annual cost savings of €52,000, as the grinding oil does not need to be refilled as frequently. Additional cost savings can be achieved through reduced personnel costs for chip management and logistics.

Furthermore, the well-pressed shavings are recyclable and can be melted down again. This saves on disposal costs and contributes to resource conservation.



Conclusion

The analysis of customer processes, the precise design of the system, the adaptation of the machine supply pumps and the needs-based design of the coolers resulted in a reduction of energy costs by 35%. Furthermore, the innovative filter concept of the Lehmann-UMT enabled a space saving of 53%.

The analysis of customer processes and the precise design of the systems led to highly efficient filter systems and unlocked a range of optimization potential for the user. In particular, investment costs were reduced by 22%. Through a holistic (process) approach, the objectives were not only achieved but significantly exceeded.