Ironing bed sheets in economy mode

Energy-saving, thermal oil-heated chest ironer with optimised temperature control system

Laundries consume a total of around 2 kWh of energy per kg of linen; 90 % of this energy is used for generating heat. A flatwork ironer manufacturer from eastern Westphalia has therefore adapted its heat generation system by using a gas burner. In addition, an improved control system manages the temperature of the thermal oil-heated heating band technology that substantially determines the ironer performance. In order to recycle heat, an air-water heat exchanger is used that utilises the warm exhaust air for heating the fresh water.

Enormous amounts of dirty linen are produced in hotels, restaurants, care homes and hospitals. These not only have to be washed but also ironed. Flatwork ironers are used for this purpose both in industrial laundries as well as in small- and medium-sized companies. The linen is fed through the machine using a large, padded roll, whereby it is drawn under high pressure past a metallic chest that is heated to a high temperature. Depending on the type of flatwork ironer, either the roll or the chest is raised and lowered during this process. Large-sized flat linen such as sheets, bed linen and tablecloths – called flatwork – is particularly suitable for mangling. The heating requirement is enormous: in the laundry industry, 90 % of the energy consumed is used for generating heat. The specific thermal energy consumption in laundries is approximately 1.8 kWh/kg of linen. Therefore, enormous potential for saving energy is given. For example, energy-optimised processes can reduce the thermal energy consumption to 0.8 kWh/kg of linen.

This research project is funded by the:
Federal Ministry of Economics and Technology (BMWi)
Various factors influence the thermal energy requirements: in terms of the chest ironer, the heat transferred from the heated chest plays a role, as does the exhaust air and waste heat given off by the ironer. In addition, the loading of the ironer and the moisture that has to be removed from the linen is also decisive. Specific energy-saving measures were developed in the project “Development of energy-saving flatwork ironers based on direct gas heating as well as corresponding ironing processes for small and medium-sized laundries”. The flatwork ironer manufacturer Kannegiesser from Vlotho in eastern Westphalia, Germany, together with the wkf – Cleaning Technology Institute and three other companies have optimised the heating band and heat generation and developed a comprehensive temperature control system and an air-water heat exchanger.

**Non-stop ironing**

High-performance flatwork ironers with working widths of up to 4.2 metres and ironing speeds of up to 60 metres per minute are used for drying and ironing flatwork. During the ironing process, the washed, still-moist linen is fed under pressure through a gap between the heated, rotating roll and the chest. The flexible heating band which is heated with thermal oil comes into contact with the moist linen in the ironing bed and thus transfers its heat to it. “Once they have been washed, textiles have an approximately 50 % moisture content,” explains Wilhelm Bringewatt, project member and Head of the Development Department at Kannegiesser, which manufactures laundry technology. “Under a contact pressure of around 100 mbar, the linen is fed through two chests.” All so-called mangel chests have one heated chest designated one rotating roll (Fig. 1). During the ironing process, the temperature of the oil drops and the moisture in the linen reduces to 2 %. Once the linen has been ironed, it is removed from the roll with a stripper and is then ready for further processing, for example in a folding machine. For chest ironers, it is important that the heat is transferred evenly from the heating band to the linen. Such heating bands consist of two stainless steel sheets of different thicknesses that are laser-welded together with a pattern of welding points between them. Widened by hydrostatic pressure, narrow, pillow-shaped cavities are formed through which the heating oil flows that indirectly heats and dries the linen. Because the heating band is very flexible (sheet thicknesses of 1 to 5 mm), this improves the heat transfer with equal pressure across the length of the roll. In order to minimise pipe losses, a gas-fired boiler fixed directly to the ironer heats the heating oil (see info box). The linen only comes into partial contact with the surface of the heating band (ironing path 180°). Decisive for the heat transfer is the surface area that comes into contact with the linen. The greater the temperature difference between the linen and the heating band, the more quickly the washing dries. The pressure with which the linen is pressed to the heating band also influences the drying process. “To ensure that the ironer uniformly dries and irons the washing, and prevents damage caused by heat, the ironer must also be adjusted to the respective type of linen,” explains the project member.

**Well-temperated management**

The temperature control of the heating band directly influences the output of the gas burner and measures the temperature of the oil’s in- and outflow with an electrical resistance thermometer. A control unit regulates the burner and the inlet temperature of the oil in the ironer. The gas burner is regulated in accordance with the target value. For energy-related reasons, it needs to be ensured that the gas burner does not switch off if the gas burner output cannot be lowered far or quickly enough if the heating band has too high a temperature. The minimum output of the gas burner was therefore reduced as a further energy saving measure. If the ironer only has a small output requirement, for example because it is not fully loaded, the output of the burner is reduced. Since the previous control mechanism was not able to sufficiently react to fluctuating load requirements, a continually active controller has been deployed. This responds, for example, in accordance with the speed at which the temperature of the oil changes. Reducing the gas burner’s output has therefore also enabled the previously frequent switching on and off of the gas burner to be minimised. Because the linen is ironed at temperatures of around 210 °C, a small amount of residual moisture is ensured with a uniform contact pressure. In contrast to steam heating, with oil-heated ironing the temperature control is only used for the inlet temperature. “At the beginning the thermal oil has a temperature of 210 °C. At the end the temperature reduces by itself – in other words it’s inherent to the system – while still having a temperature of around 190 °C in the second chest,” adds Wilhelm Bringewatt. The temperature of the ironing bed determines the evaporation and drying output of the
Gas heating in laundries

Laundries are often equipped with outdated heat generation technology. Systematic disadvantages include reduced efficiency, increased pollutant emissions and relatively large combustion chambers as a result of non-adapted heat generation systems. Gas burners have the advantage that they can be flexibly used. They also work without pressure, which means that TÜV inspections can be dispensed with and only the exhaust gases need to be tested by a chimney sweeper.

When correspondingly well loaded, the project ironer with its two 1.2-metre-diameter rolls has a primary energy consumption of 400 to 500 kW. A burner with an output of 200 kW therefore had to be further developed in order to achieve the required output of 500 kW for the chest ironer and to keep the operating losses as low as possible. In addition to indirect ironer heating, this required a correspondingly sized combustion chamber (boiler geometry).

Optimising the flame geometry as well as the flow and mixing process enabled the natural gas to be fully saturated with oxygen, which is required for complete combustion. These types of boiler-burner combinations achieve efficiencies of between 82% and 86%. The gas burner was able to lower the gas consumption from 135.6 m³/h to 109 m³/h.

Recycling waste heat

When the moisture in the linen evaporates during ironing, the evaporation energy is transferred to the exhaust air in form of heat and steam. By using a heat recovery system, this energy can be used to heat the fresh water. The ironer exhaust air, which has a temperature of between 100 and 120 °C, has a relative humidity of around 20%. The exhaust air flowing out of the ironer is fed into the heat exchanger via insulated air ducts. The air-water heat exchanger extracts the thermal energy from the ironer exhaust air and steam and transfers it to the inflowing fresh water. In order to ensure that the water remains free of bacteria, the two media are always kept separate from each other. The heated up fresh water is used directly as process water.

**Fig. 3 Energy flow diagram showing the heat recovery for the thermal oil-heated ironing system with decentralised gas heating. Source: BINE Information Service**

**Fig. 4 The gas burner and boiler are installed on the rear side beneath the discharge table for the ironer. Source: BINE Information Service**

"The heat generation system can be used with all ironers heated with thermal oil," says Bringewatt, summing up the project. He explains that, depending on the ironer construction, the system can even be retrofitted, whereby the vast majority of the ironers installed so far can be retrofitted with the energy saving system.

The energy consumption of all optimised components was reduced by a total of 50%, whereby up to 30% is due to the heat recovery system. The ironer itself saves between 80 and 100 kW/h, which amounts to an energy saving of around 20%.
Washing, ironing and folding

The increasing costs for waste water, energy, water and detergents mean that textile service companies need to further reduce their consumption of resources – but without compromising quality. To achieve this, not only are existing processes being optimised, completely new processes are also being developed, including ones that work completely without chemicals. For example, not only are considerable amounts of waste water produced when washing, the heating is also very energy-intensive. A sensible possibility for reducing the amount of energy used in laundries is to utilise the thermal energy from the waste water by means of heat recovery.

In the “SMILES“ EU research project, 16 new sustainable technologies for reducing greenhouse gas emissions and for saving water and energy have been developed and implemented with a focus on industrial laundries. The abbreviation SMILES stands for “Sustainable Measures for Industrial Laundry Expansion Strategies: Smart Laundry-2015.” Based on comprehensive market penetration in all EU Member States by 2015, it is planned to lower the annual water and energy consumption by between 30 and 45 %, whereas the CO₂ emissions shall be reduced by 47 %. In the project, various technologies were investigated for treating process water with low organic contamination in order to reduce the consumption of water in laundries. The focus of the investigation was on degrading organic substances through electrochemical treatment. Further investigations to reduce the detergent consumption focused on the use of special enzymes that are intended to partly replace conventional crude oil-based detergent ingredients. During washing, enzymes such as proteases and lipases already act as catalysts at low temperatures (20 °C).

Another possibility for saving resources during cleaning and disinfection processes is provided by shock waves. These are successfully used in medicine for treating kidney stones and gallstones. The dirty textiles are treated with shock waves in cold, still water – without the use of detergents. Preliminary investigations by the wfk – Cleaning Technology Institute have shown that the shock wave method can clean textiles reliably and gently while also reducing bacteria.