



MIXING GROUP



Sustainability report of Harburg-Freudenberger Maschinenbau GmbH Site: Freudenberg, Germany

Reporting period: 2015



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Statement from the Board of Management

This is the second sustainability report of Harburg-Freudenberger Maschinenbau GmbH [HF]. This report is valid for the site in Freudenberg, Germany and covers the 2015 fiscal year (01.01.2015-31.12.2015). The report is aimed at our customers, employees and suppliers, as well as all additional partners affiliated with our company.

We aim to use this report to ensure transparent and comprehensible documentation of our commitment to sustainability. The report highlights the ongoing development of the company, inter alia, with the comparison of current numbers against values for previous period(s). This also includes an analysis of potential for improvement which will be addressed in the future.

This sustainability report contains standard information from the GRI guidelines on sustainability reporting. It was drafted on a voluntary basis.

If you have any queries regarding our sustainability report or its contents, please consult Mrs Nadine Massuard (nadine.massuard@hf-group.com).

A handwritten signature in black ink, appearing to read 'Limper'.

Prof. Dr. Ing. Andreas Limper
Board of Management

A handwritten signature in blue ink, appearing to read 'M. Meulbroek'.

Mark Meulbroek
Board of Management



MIXING GROUP

Organisation profile of Harburg-Freudenberger Maschinenbau GmbH

Harburg-Freudenberger Maschinenbau GmbH (Freudenberg plant)

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Board of Management:

Jens Beutelspacher, Prof. Dr.-Ing. Andreas Limper, Mark Meulbroek, Günter Simon

Chairman of the Supervisory Board: Dr. Joachim Brenk

Commercial Registry: Hamburg District Court, Dept. B No. 64651

Registered office: Hamburg

VAT ID No. DE811151610, Tax No. 21 22 290 0900 3



Locations

The reporting site is located in Freudenberg, Germany; however, HF MIXING GROUP has locations all over the world. The main commercial and production sites include the following:

- Harburg-Freudenberger Maschinenbau GmbH, Germany
- Farrel Corporation, USA
- Farrel Ltd., UK
- POMINI Rubber & Plastics srl, Italy
- HF Rubber Machinery, Inc., USA
- HF NaJUS, a.s., Slovakia

Our locations worldwide:

- Harburg-Freudenberger Machinery (China) Co., Ltd. • China
- HF France S.a.r.l. • France
- Farrel Sales Office Líbeznice • Czech Republic
- HF MIXING GROUP Sales Office Barcelona • Spain
- HF MIXING GROUP Services S.E.A. Sdn Bhd • Malaysia
- INDUS UTH HF MIXING SYSTEMS PVT LTD • India
- Farrel Asia Ltd. • Singapore

Our sales partners, along with details of our country / product responsibilities, can be found on the website <http://www.hf-mixinggroup.com/contact>

Products

HF MIXING GROUP develops and produces machines and accessories for the rubber and plastics processing industry, with a high level of technical expertise. In particular, this includes mixers for manufacturers of technical rubber products and the tyre industry. HF also builds discharge units and special machines for these industrial sectors, as well as equipment for mixing rooms – right up to complete automation systems. All over the world, these future-proof products are used in the manufacture of tyre applications, sealing profiles, cables and friction linings, as well as for thermoplastic elastomers and special plastic mixtures.

Information on the products can be found on the webpage:

<http://www.hf-mixinggroup.com/products/>



Corporate Social Responsibility – silver status

The independent service provider for CSR assessments, commissioned by an HF customer – EcoVadis – conducted an audit of HF in 2015 in the following areas: environmental issues, work practices and human rights, fair business practices and sustainable procurement.

In the overall evaluation, HF attained silver status, with 58 points out of 100 (point of reference: on average, all companies assessed by EcoVadis attained a score of 42 points); this is clear proof of how deeply the topic of sustainability is already ingrained in the culture of the company and lived by its members every day.

The image shows a certificate from EcoVadis, a Sustainable Supply Management company, awarded to Harburg Freudenberger Maschinenbau GmbH (Freudenberg Site). The certificate states that the company has been granted a Silver Recognition Level based on their EcoVadis CSR rating for October 2015. A circular graphic shows the 2015 CSR Rating as Silver. The certificate includes the EcoVadis logo, the company name, the award level, and the date. A signature and stamp of EcoVadis SAS are visible in the bottom right corner. The text 'Valid until: October 2016' is printed at the bottom of the certificate.

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MIXING GROUP

Labour practices and human rights

A clear commitment to sustainable and responsible corporate governance

HF distinguishes itself for its high level of overall technical and procedural competence developed over 150 years, its corporate philosophy which focuses on long-term sustainability and its conscious close cooperation with clients and business partners. The result: common and lasting success. The central component of the company's value system is sustainability; an expression of the forward-thinking actions of the group. One logical addition to and continuation of the company's sustainability activities is the signing of the letter of commitment of the Global Compact initiative of the United Nations (UN) in early May 2015.





The ten principles of the UN Global Compact initiative:

- Principle 1: Businesses should support and respect the protection of internationally proclaimed human rights; and
- Principle 2: make sure that they are not complicit in human rights abuses.
- Principle 3: Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining;
- Principle 4: the elimination of all forms of forced and compulsory labour;
- Principle 5: the effective abolition of child labour; and
- Principle 6: the elimination of discrimination in respect of employment and occupation.
- Principle 7: Businesses should support a precautionary approach to environmental challenges;
- Principle 8: undertake initiatives to promote greater environmental responsibility; and
- Principle 9: encourage the development and diffusion of environmentally friendly technologies.
- Principle 10: Businesses should work against corruption in all its forms, including extortion and bribery.

www.unglobalcompact.org | www.globalcompact.de

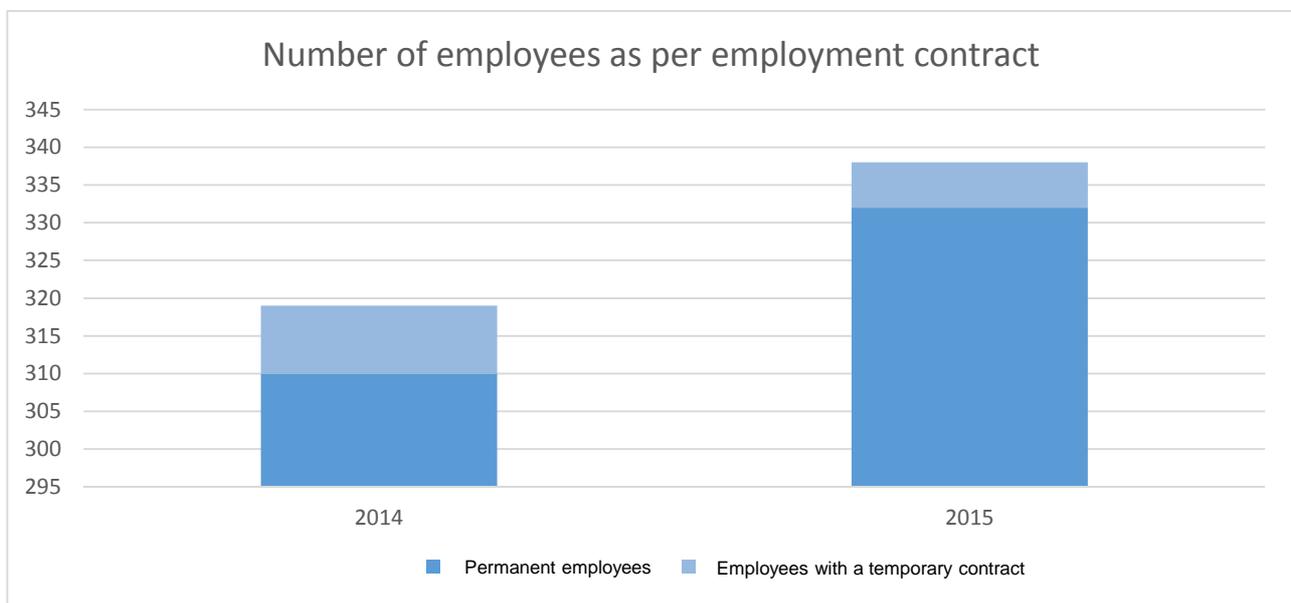


HF integrates the ten principles of the UN Global Compact initiative in its daily activities. At the same time, the company commits to ensuring that its business partners also conduct their business activities in a manner consistent with the ten universally recognised principles in the areas of human rights, labour standards, protection of the environment and fight against corruption. You can read details on how HF achieves all this on the following pages.



Labour practices and remuneration of employees

HF is tariff-bound, and offers its employees flexible working hours, tariff special payments (such as Christmas and holiday pay) and non-tariff payments in the form of e.g. private laptops, fuel vouchers or e-Bike leasing. HF upholds the right to collective bargaining in that employees are allowed to participate in strikes. This procedure is consistent with the principles of the UN Global Compact initiative.



Anti-discrimination / social security

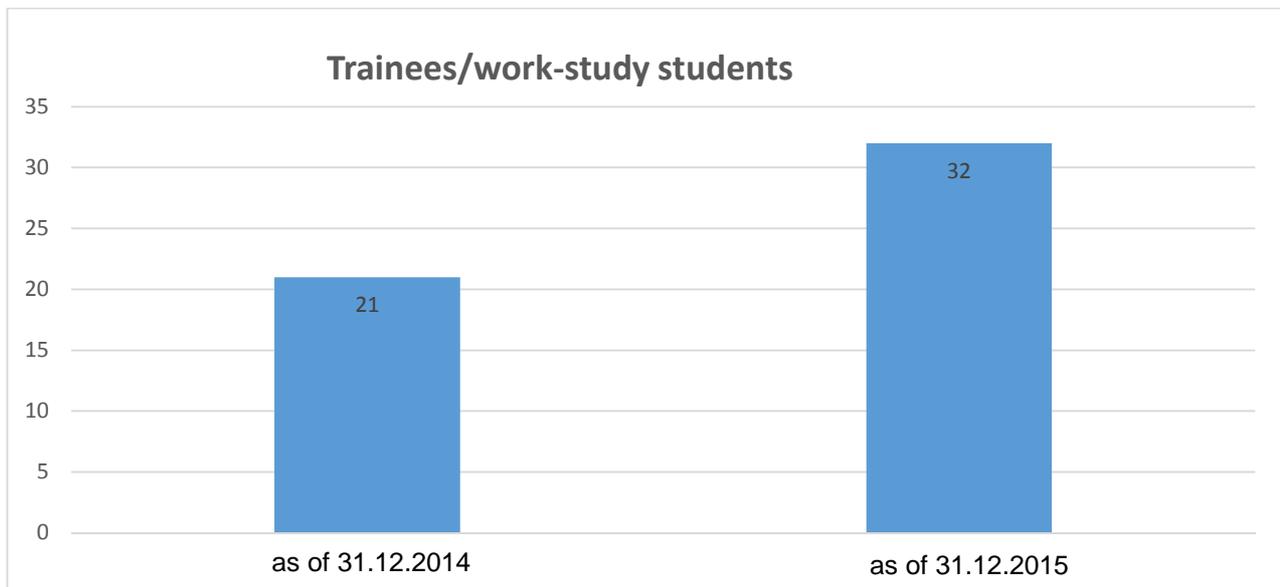
HF ensures fair pay through the collective pay agreement. As part of the collective pay agreement, the work placements (not employees) are grouped in appropriate pay groups. When hiring or transferring employees, the previously created job description is applied, regardless of age, gender or existing qualifications. So that employees may be offered a reasonable living wage, the hourly wage is noticeably above the minimum wage; this is applied to all employees. In this respect, too, HF is duly acting in accordance with the principles of the UN Global Compact initiative.



Training

For the purpose of remaining true to its corporate value of sustainability, in the area of Human Resources, HF pays special attention to training. In 2015, nearly 10% of the workforce were apprentices or dual students. HF would like to offer all apprentices a long-term perspective wherever possible; in this regard, they only provide training as needed.

In the industrial / technical sector, HF offers training courses for the following professions: mechatronics engineer, industrial mechanic, construction mechanic, machining mechanic and technical product designer. The commercial sector includes training courses in these professions: industrial clerk, warehouse logistics specialist and IT specialist.



In 2014, HF began restructuring the mechatronics engineer training programme; this was completed in 2015. Together with the training sponsorships, this training programme was customised in accordance with the requirements of the training framework plan. Due to the growing demands of customers and technological progress, the main focus here was in the areas of automation and hydraulics knowledge. There was also a decision made to acquire a training machine for internal training of trainees and employees. This allows HF to keep employees up to date with the company's own technology. By expanding training programmes after the first year of training as a skilled worker, HF is able to offer the client personnel who are even better qualified. A revision of the other training occupations began in 2015.



In addition to conventional vocational training, HF offers dual study programmes in cooperation with the dual university of Baden-Württemberg (DHBW). In addition to the Industrial Engineering and Business Administration study courses, in 2015 the course of Process Engineering was included in the offer of the Mechanical Engineering studies programme.

The battle for the best young talents has also come about at HF. In recent years applicant numbers have been continuously declining. For this reason, in addition to visits to training fairs, two HF training days were organised in June 2015. The eight professions that HF provides training in, as well as the additional services offered by the company, were presented at various stands. By the motto "It's all about the mixture", during the first event day 40 students and teachers of the surrounding schools had the opportunity of being guided (in groups) through the production steps and up to the individual stations. On the second day, the company gates were open from 10:00 to 14:00. A total of 250 visitors were able to move freely around the company premises and between the various stations.

The training days fully satisfied their purpose. Seven of the nine new trainees for 2016 attended the training day where they were informed in detail about HF as an employer.

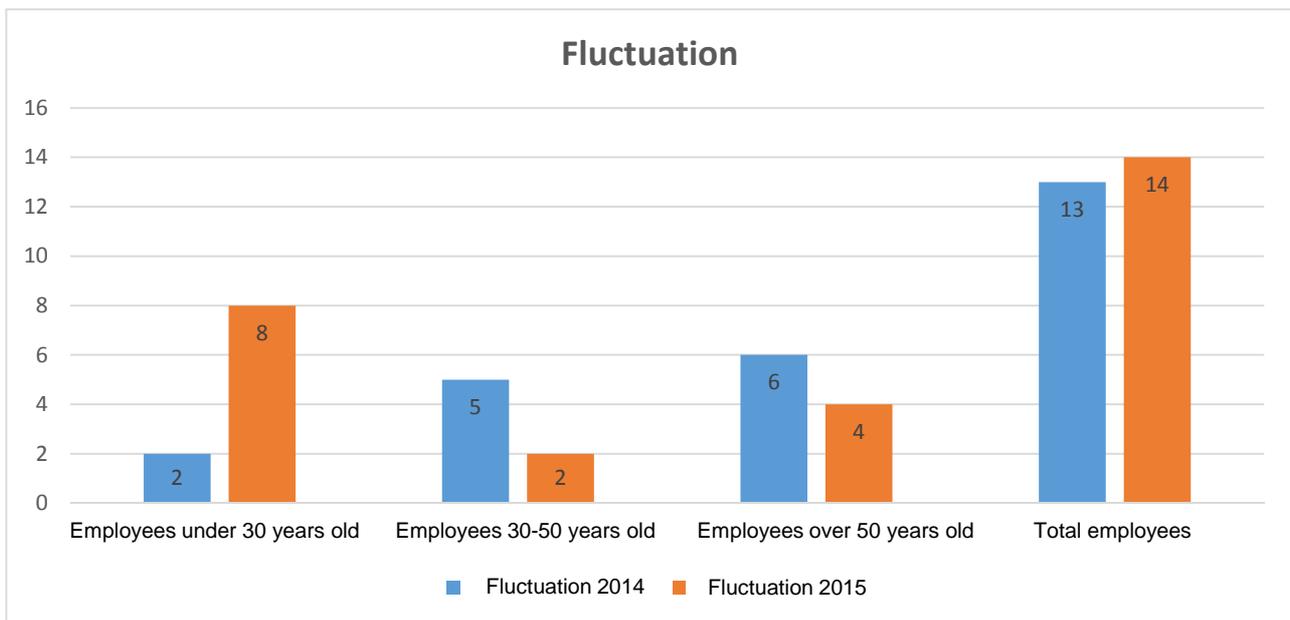




Employee retention

After training, HF aims to retain the employees within the company long-term. HF aims to secure knowledge acquired during training in a sustainable manner, in and for the company.

During 2014, the fluctuation rate was 4.21%; in 2015 it increased slightly to 4.26%. The fluctuation rate of male employees was 4.91% in 2014. In 2015 it was 3.53%. No female employee has left HF in 2014. In 2015, the rate was 4.40%.



HF offers a variety of development opportunities and social benefits aimed at increasing employees' commitment to the company. In addition to the company's own fitness studio, the opportunity to benefit from physiotherapeutic services and the leasing of e-Bikes, HF is also active sports-wise, in an annual summer festival. This takes place at the various European company locations in rotation; the individual locations compete against each other in a football tournament.

As part of a job rotation arrangement, in 2015, some employees were able to expand their skills on an international level.

Moreover, employees are able to reconcile private obligations without stress thanks to flexible working hours in the company; and, in addition to the collective special payments, HF factors all employees in the company's profits.



Personnel development

HF is ISO 9001 certified.

To ensure further improvement of the qualifications of employees, a training management system was installed in 2015. HF is currently in the data collection phase. With the help of registration forms, all the skills that a team requires are listed before they are assigned to employees.

The system is then used to compare the actual analysis with the target analysis at the level of the team. This allows for identification of both individual and group training requirements. It is also possible to conduct assessments like age structure for the sake of knowledge management. It allows supervisors to analyse (in cooperation with HR management) at an early stage which skills the company will lose as soon as an employee goes into retirement.

Supervisors also have access to details of the qualifications and evaluations of their employees, allowing for discussion of qualification requirements with employees during annual interviews.



MIXING GROUP
Technical Center

The company provides its own staff as well as its customers with training on technical innovations and consolidation of knowledge at its own Technical Center. This allows HF to offer customers added value in the long run, as employees remain on the

cutting edge of technology. There is also a plan to purchase a training machine on which to train employees and customers in the area of mechanics, hydraulics, automation, maintenance and technological innovations.





Health management

Healthy employees make a healthy organisation. For this reason, the offer of the company's own fitness center STARK (English: "STRONG") has been expanded. With this, since July 2015 it has been possible for employees to bring a grown-up family member to STARK. The company aims to further increase the already considerable motivation to train by doing this.



STARK was opened in 2013. In cooperation with an outpatient therapy centre, the courses that it offers, along with the care and the physiotherapy, are constantly adapted to the needs of employees.

The response to the possibility of physiotherapeutic care in the company's own treatment room has also been consistently positive. In order to meet increasing demand, the physio times have been extended in the course plan.

In addition, HF continues to uphold the "Luxembourg Declaration on Workplace Health in the European Union" (signed in 2014), which is designed to promote and maintain employees' health.

Luxemburger Deklaration

zur betrieblichen Gesundheitsförderung in der Europäischen Union





HF employees can, in regular sessions, decide whether they would like to receive a part of their profit share in the form of an e-Bike leasing. The first action took place in 2013, where 129 employees decided to accept the e-Bike leasing offer. In 2015, another 21 bikes were provided in addition to the 129 e-Bikes.

There is a full smoking ban in the entire building area / on the premises and in all leased / used buildings, spaces and outdoor areas. The only excepted areas are the six designated smoking zones, which are covered, weather-protected and equipped with an ashtray.

Efforts should be made to guard against employees developing addictions, and those affected should be afforded help to overcome existing illnesses. For this reason, HF has trained an employee as an addiction counsellor. In addition to action strategies for operational practice, he has gained knowledge in the field of prevention strategies and completed an internship in an addiction clinic.

HF does not just support its employees with cures for addictions through mediation to addiction clinics; the company also offers them a company-related business perspective afterwards.

Diakonie in Südwestfalen

Employees' mental health also plays a major role as far as HF health management is concerned. For this reason, HF has, in cooperation with the South Westphalia deaconry, offered the health and social hotline since December 2015. Employees can call it anonymously via a number specially created for HF. They will then receive help from trained employees in the deaconry straight away.

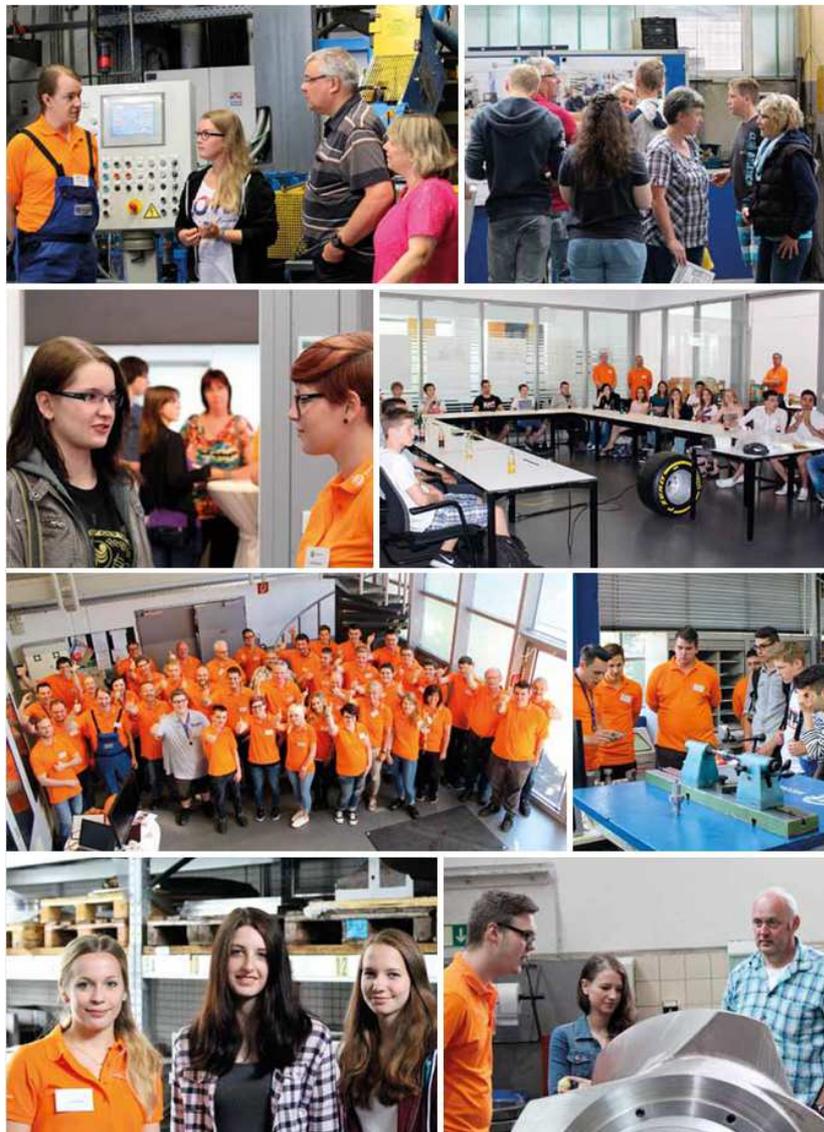
The programme of services offered by the deaconry ranges from nursing care to counselling for mental illness right up to agreement for dates for improved diagnosis (e.g. MRT, CT). All hotline costs are borne by HF.



Employer branding

In the context of strengthening the HF employer brand and consolidating its reputation both regionally and nationally, the project “Employer Branding” was initiated in 2015. Following some workshops with the management and the business unit directors, the slogan “It’s all about the mixture – Create the future with HF” was developed.

The Corporate Design was also customised with the employer brand. Two photoshoots, held with our own employees, provided authentic graphical material for job advertisements and the HF career website (<http://www.hf-mixinggroup.com/career/>), for example.





The core topic “More community” shows that HF values and accepts the opinions of its employees. A culture of face-to-face discussion is upheld with meetings.

In recent years, the demand for well-trained skilled workers has continually increased. A proper order situation and restructuring work in various areas have meant a demand for new staff, including in key positions which are hard to fill.





Fair business practices

Human rights, ethics and integrity

HF works in accordance with the principles of the UN Global Compact initiative. The company upholds and observes international human rights and is committed to ensuring that employees are not complicit in human rights abuses. HF opposes child labour and forced labour and supports fair pay. The company is committed to protecting the privacy of each individual and acts by the principle of integration rather than discrimination.

The Code of Conduct reflects the company's social responsibility as part of its activities and shows which principles have been applied in this regard for years.

With its Code of Conduct, HF also aims – more than anything else – to have new employees observe the principles of honesty and integrity when they join the company. This guarantees that, both now and in the future, the name of HF, the reputation of the company and its most important asset – the people that it employs – are supported and protected. In the future, new employees will receive the Code of Conduct when they are handed the “Welcome Package” by the HR department; they will also be instructed in this area and referred to the concept of adherence to the principles of the Code of Conduct. In addition, in the coming year, the first new employees will be informed and trained about the Code and its content after its final publication.

Anti-corruption prevention

The topic of anti-corruption and compliance has already been covered in the Code of Conduct. However, since this topic is of fundamental importance and incorporates one of the principles of the UN Global Compact initiative, a directive on the topic of anti-corruption has also been developed in order to provide employees with the best possible support in this area. HF rejects all forms of corruption, bribery, theft or extortion and expects the same from its employees. The company is confident that its employees will also act in accordance with these principles and not do anything for the sake of personal gain.

The directive includes many examples aimed at showing employees the differences between doing business and corruption or taking advantage. One thing that is particularly important here is the close exchange between employees and their respective superiors, who are always on hand to provide help and advice on anti-corruption. In the coming year, this will be achieved through uniform training of technicians and department heads. The department heads shall then provide further information in direct exchanges with their employees.

In order to ensure this internationally (through worldwide HF representations), the representation contracts have been supplemented to include anti-corruption guidelines.



Environment and climate

HF environmental management

With the successful introduction of an environmental management system as per DIN EN ISO 14001 in August 2015, HF has intensified its already active commitment to protection of the environment; it is now contributing even more to the preservation of natural resources (soil, water, air). This is achieved through a holistic view of the effects of the products / their manufacture on the natural foundations of life. The company's environmental performance is continually improved in this way.





Water

Water from the local supply network is used as service water in sanitary facilities, for cooling of heated components in production and for cooling of test facilities in the Technical Center. Water consumption in the Technical Center alone accounts for 70% of the total water consumption in the company, making it a focal point under the topic of renovated environmental management. More aware employee behaviour and some smaller scale savings projects have led to a significant reduction in water consumption. Thus water consumption has dropped by more than 30% in the past 3 years (Fig. 1). The lower level of water consumption in 2012 resulted from a construction project of expansion of the Technical Center. This year, the systems installed there were not operational or only operational to a limited extent.

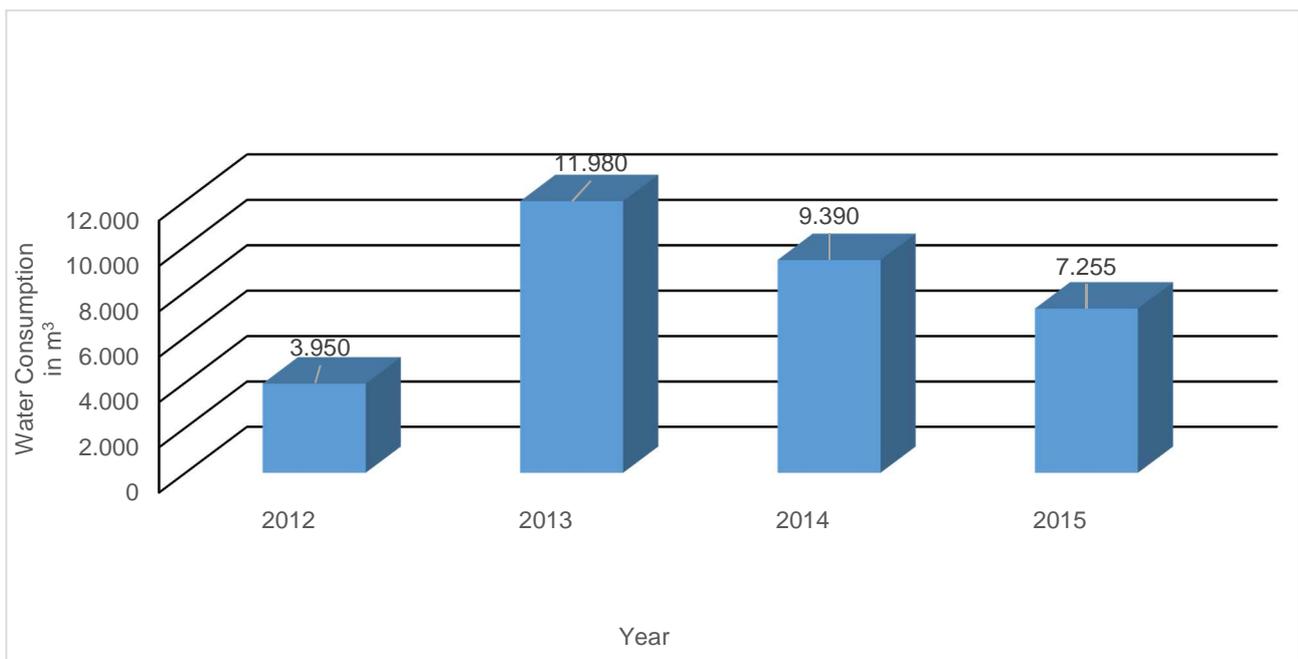


Fig. 1: Water consumption 2012-2015



Waste

As part of the environmental management system, HF places a special focus on waste management. This involves detailed recording of all waste, regular checking for alternatives and utilisation of all opportunities for reducing waste and substitution of hazardous waste with the use of safer alternatives.

As part of our waste management improvement efforts, in 2015, our waste disposal partner issued a waste sustainability certificate, with which waste streams (excluding metals) were recorded and taken into account. The calculation model for balancing of primary raw materials, energy and greenhouse gas emissions saved through the disposal and recycling of waste materials is methodologically based on the life cycle assessment (DIN EN ISO 14040). The model considers the following process steps:

- Recording
- Transportation
- Pre-treatment
- Recycling

87 tonnes of primary raw materials have been saved. For the recycled waste streams, the volume of primary raw materials saved through recycling was considered.

A total 310 MWh were saved through energy generation / saving. With energy-recycled waste streams, the amount of energy generated through combustion or fermentation was considered.

The CO₂ emissions savings amounted to the equivalent of 55 tonnes of CO₂. For the saved greenhouse gas emissions, all charges and discharges in all process steps were considered.

The total amounts of generated waste are listed in Fig. 2 (separated by hazardous and non-hazardous waste). 80-90% of the dangerous waste products consist of drilling emulsion for the lubrication of tools used in mechanical production.

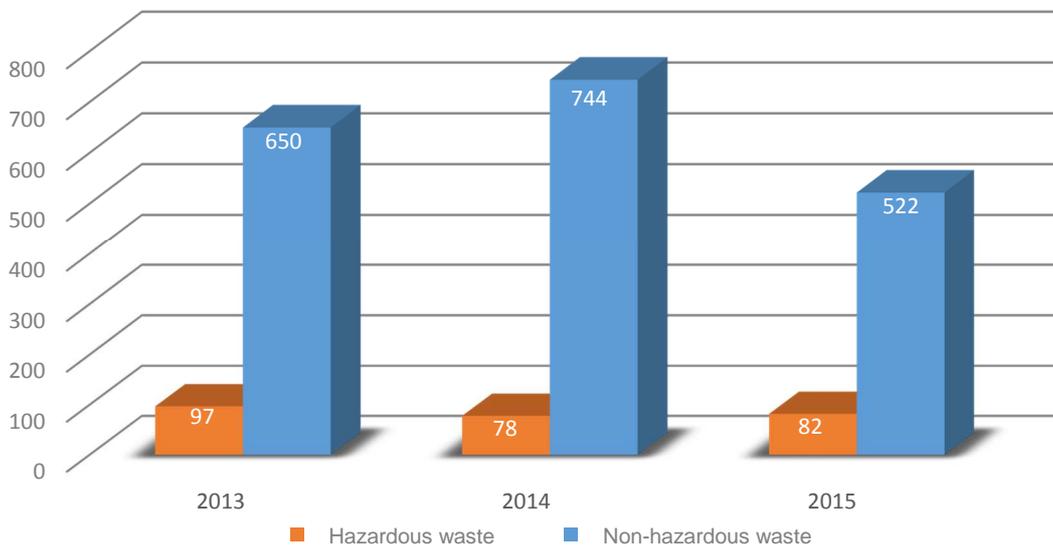


Fig. 2: Waste in years 2013-2015

2014 was marked by considerable conversion measures, which led to large amounts of construction and demolition waste. As a result, the volume of non-hazardous waste reached an all-time high this year.

Concrete options aimed at reducing waste volumes were considered only prior to this (e.g.: cleaning cloths, spray cans etc.), but they should be addressed in the coming year.



Waste Balance Sheet 2015

Waste code	Waste designation	Container type	Quantity	Unit
08 01 11	Paint and varnish waste containing organic solvents or other hazardous substances	800 l ASP	1,28	TO
12 01 09	Halogen-free machining emulsions and solutions	Vacuum vehicle	76,00	CBM
15 01 01	Packaging made of paper and cardboard	10.0 cbm press container	12,34	TO
15 01 02	Packaging made of plastic	2.5 cbm large waste container	2,00	PC
15 01 02	Packaging made of plastic	5.0 cbm large waste container	4,00	PC
15 01 03	Packaging made of wood	10.0 cbm waste skip	39,88	TO
15 01 06	Mixed packaging	20.0 cbm rolling press container	44,10	TO
15 01 06	Mixed packaging	2.5 cbm large waste container	4,00	PC
15 01 06	Mixed packaging	5.0 cbm large waste container	7,00	PC
15 01 10	Packaging containing residues of hazardous substances	120 l lidded drum with clamping ring	187,00	KG
15 01 10	Packaging containing residues of hazardous substances	200 l lidded drum with clamping ring	175,00	KG
15 01 10	Packaging containing residues of hazardous substances	200 l lidded drum with clamping ring	161,00	KG
15 02 02	Absorbent and filter materials	1.1 cbm, galvanised	1,00	PC
15 02 02	Absorbent and filter materials	800 l ASP	3,26	TO
16 05 04	Hazardous substances containing gases in pressure vessels	120 l lidded drum with clamping ring	57,00	KG
16 05 04	Hazardous substances containing gases in pressure vessels	200 l lidded drum with clamping ring	33,00	KG



MIXING GROUP

REMONDIS[®]

IM AUFTRAG DER ZUKUNFT

Nachhaltigkeitszertifikat

Harburg Freudenberger Maschinenbau GmbH, Freudenberg

hat über die Zusammenarbeit mit der REMONDIS-Gruppe im Jahr 2015 wertvolle Beiträge für die Umwelt geleistet.*

- Primärrohstoffeinsparung in Höhe von 87 Tonnen
- Energiegewinnung und -einsparung in Höhe von 310 MWh
- CO₂-Einsparung in Höhe von 55 Tonnen CO₂-Äquivalent

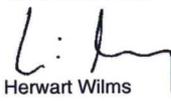
Gemäß Abfallbilanz 2015 wurden die nachfolgenden Abfallströme separat erfasst und berücksichtigt:
Gemischte Abfälle zur Verwertung // Papier, Pappe, Kartonagen // Folien, Kunststoffe // Holz // Gemischte Bau- und Abbruchabfälle // Ölverunreinigte Betriebsmittel // Farb- und Lackabfälle.

Die Umwelt dankt. Wir danken für die Zusammenarbeit.

REMONDIS SE & Co. KG


Thomas Conzendorf
Vorstand

REMONDIS Assets & Services
GmbH & Co. KG


Herwart Wilms
Geschäftsführer

* Die Daten wurden von der REMONDIS-Gruppe unter Anwendung eines Berechnungsmodells ermittelt, das vom Fraunhofer-Institut für Umwelt-, Sicherheits- und Energietechnik UMSICHT, Institutsteil Sulzbach-Rosenberg erstellt wurde.



HF energy management

In the face of rising prices and dwindling resources all over the world, responsible use of energy has become increasingly important. The growing demand for energy with limited natural resources presents everyone with the challenge of using energy as efficiently and economically as possible with the least possible damage to the environment. To fulfil this responsibility, in 2015, HF established a company energy management system in line with the globally valid norm DIN EN ISO 50001.





As part of the energy management system introduced here, the energy-demanding processes in the company were looked at more closely. Energy flows were recorded and evaluated. This was the basis for the recognition of savings potential and the derivation of energy-saving measures. In addition, company employee awareness on the economical use of energy was honed.

By maintaining and developing its energy management system, HF documents its energy awareness and supports the positive image of the company. This can also strengthen its competitive position in the global market.

The fuels used in the company are electricity, natural gas and diesel. Electricity is needed for the operation of our machines and systems, natural gas is the almost exclusive requirement for heating of the buildings and the supply of hot water and diesel is used for operation of vehicles (internal and external). More detailed observations on these energy sources, together with introduced and implemented energy reduction measures can be found below.

Electricity

Total energy consumption continually increased in the 2009-2013 period due to strong growth in sales and the resulting higher number of machines manufactured on the Freudenberg premises (Fig. 3). In 2013, the zenith in energy consumption was exceeded – since then it has declined slightly despite numerous orders coming in.

A power consumption distribution to individual consumers was initially not possible, owing to lack of measuring technology. For this reason, a mobile energy measuring device was procured and used with the existing power distributors, and also used sporadically with individual systems. With the furnaces used for the preheating of components, a stationary energy measurement device was upgraded.

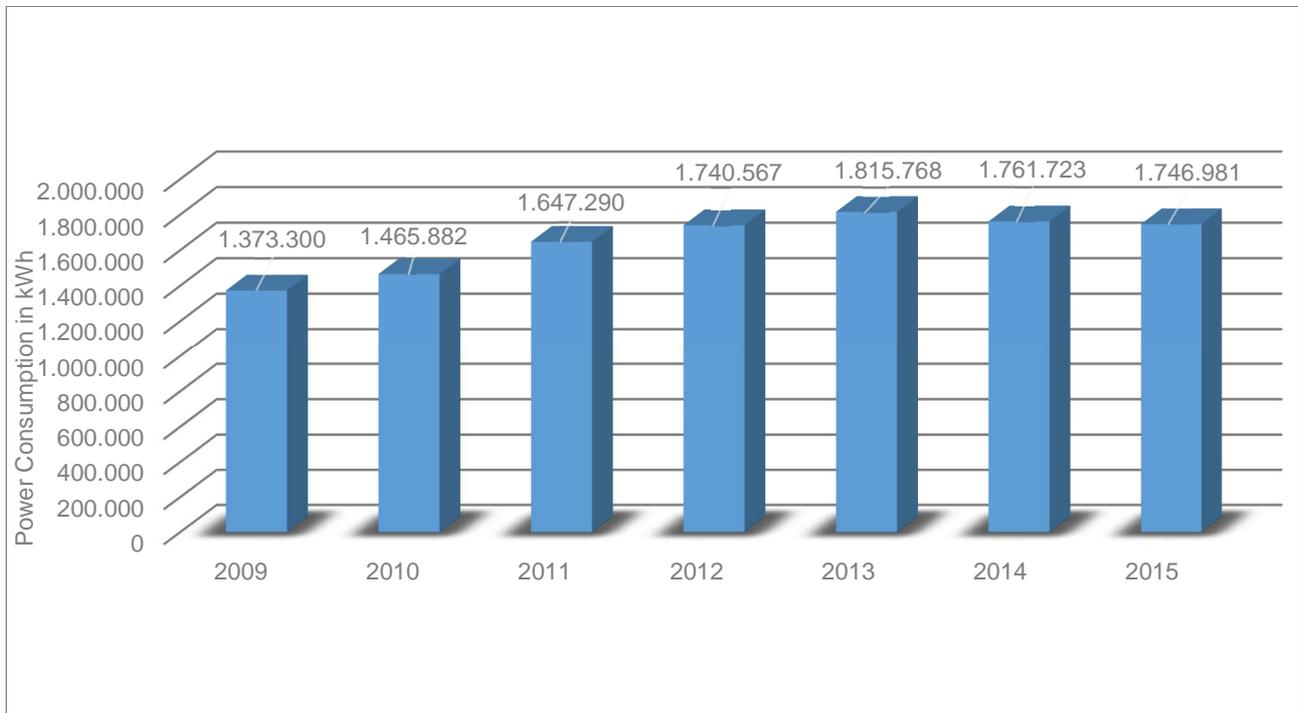


Fig. 3: Power consumption between 2009 and 2015

With the help of existing measuring technology, the project of determining energy consumption in individual areas and/or with individual systems over a given constant period of 14 days was initiated, followed by extrapolation on annual consumption. This was the only way to provide a more accurate assessment of annual consumption at individual plants or for combined consumption ranges.

In the coming year, a concept for continuous assessment of energy consumption throughout the company, with intensification of consumption measures, is to be developed.

As part of a bachelor's thesis, energy consumption in the company was inspected, individual consumption ratings of certain departments and/or existing facilities were estimated, possible energy saving measures were highlighted and the energy reductions achievable with the same were calculated. Compressed air – the area with the highest savings potential – was assessed. According to this bachelor's thesis, considerable electrical energy savings are possible with both the generation and the distribution and use of compressed air. For this reason, the decision was made to look at this topic more closely in the coming year with a subsequent bachelor's thesis and derive appropriate improvement measures.

Two electrically operated chamber furnaces are used in the preheating of components in the company. In order to record the power consumption of the two furnaces, the respective controls were modified. This made it possible to determine energy consumption at these two



facilities. As part of the analysis in the aforementioned bachelor's thesis, it turned out that much more power was consumed than what was theoretically required. This was as a result of an excessively long operating time of the systems. A reduction of the operating time to one third ultimately led to a reduction in the power consumption of these furnaces of up to 50%. The annual operating times of the two furnaces allowed for an annual energy consumption saving of approx. 2.4%. Thus, small changes in the company processes are enough to generate considerable contributions when it comes to energy consumption reduction.

Modern lighting technology does not only represent considerable energy saving potential, it also helps to increase lighting quality. With it, needs-based lighting can reduce CO₂ emissions while, at the same time, employees' visual comfort and well-being are increased. An estimate has shown that approx. 20% of all the consumed energy in the company is owed to lighting. With this, HF also sees here a starting point for reduction of power consumption, through the use of more efficient lighting technology. In 2015 HF began exchanging old mercury vapour lamps for modern energy-saving LED lighting in one of the large production halls. In the coming years, this measure shall be gradually implemented in the other halls too.



Natural gas

Natural gas is 95% used for heating the buildings and the supply of hot water. Natural gas is used in the production of components, up to their pre-heating, in only a few areas. With this, the natural gas consumption depends heavily on the weather during the respective years and on the occupancy rate in the company (Fig. 4).

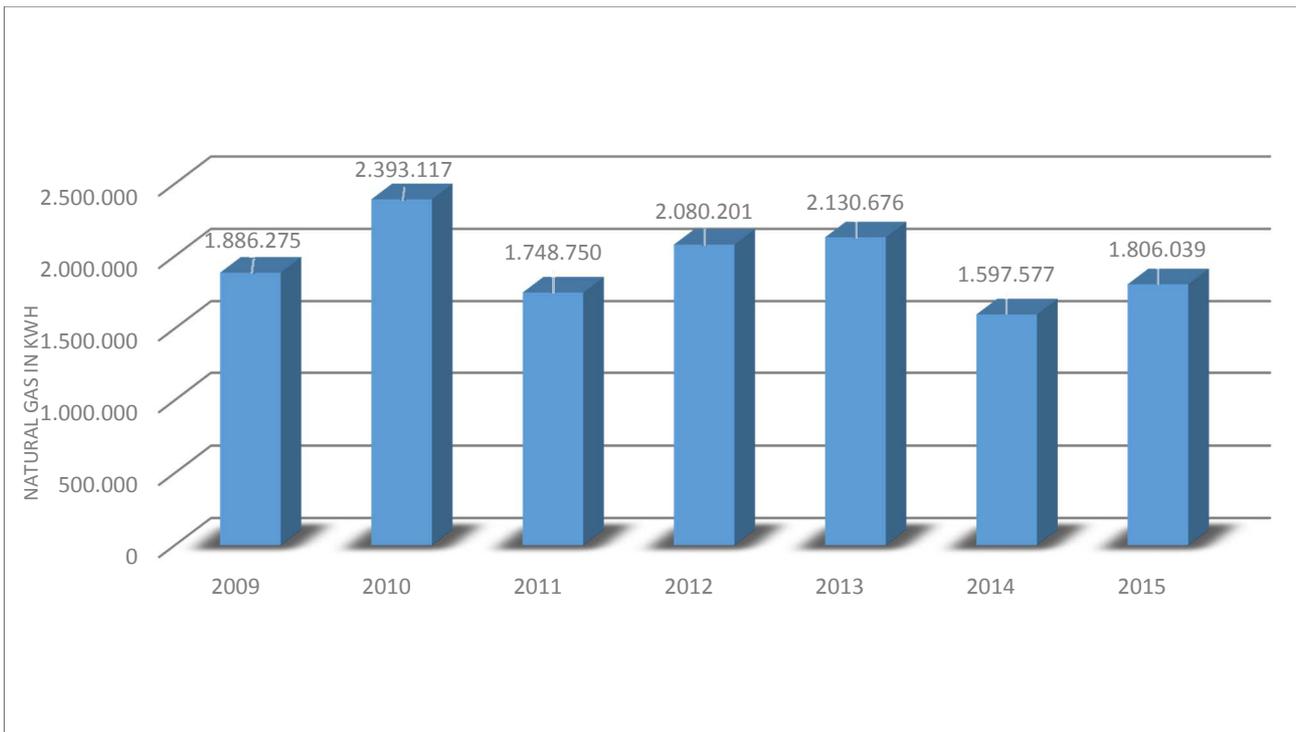


Fig. 4: Natural gas consumption between 2009 and 2015

Consumption of natural gas in the company is measured with a single main counter. With this, while the overall gas consumption rating is known, there is no information on the consumption ratings of individual facilities available. Until recently, it was possible to split consumed natural gas among individual consumers only with the application of estimates. For the years to come, the aim is one of obtaining detailed information about the distribution of natural gas to individual consumers in the company.



Regarding the consumption structure in the company, the newly introduced energy management system included the development of a gas consumption measurement concept at the individual facilities. This included the selection of appropriate measuring devices and as the end of the year approached the first two devices were installed and commissioned on the heating facilities with the highest performance ratings. Other consumers will also be installing measuring devices in the coming years.

Knowledge of actual consumption ratings at individual facilities allows first of all for transparency in the consumption structure. In addition, this will mean that it will also be possible to conduct an analysis of the consumption ratings to identify potentials for gas consumption reduction. Measures aimed at reducing gas consumption should be initiated and implemented wherever this is economically viable.

As part of the aforementioned bachelor's thesis, possible measures for the reduction of natural gas consumption (buildings, gates, heating technology, power / heating combining etc.) were mentioned. Further considerations are required here, e.g. for the use of new heating technologies (e.g. condensing technology) and/or possible measures for reducing waste heat through the building shell. At the same time, such measures must undergo an economic assessment. This is planned for the following years.

Energy-efficient technologies for customers

HF does not only think of ways to reduce energy consumption on its own premises it also offers clients advanced technologies which allow them to save energy whenever they use HF systems. One example is the energy-efficient temperature control systems, which HF offers clients both with new systems and in connection with the renewal of existing systems. These systems automatically adjust to the respective cooling requirements of the mixing systems and they fulfil their task with the lowest energy consumption rating. Tests on a production system in the tyres industry have shown that energy savings of more than 50% are possible when these intelligent temperature control systems are used.

Find out more on the following pages.



MIXING GROUP

The energetically ideal mixer line



In order to cut the processing costs of its customers, HF MIXING GROUP is working on a high-efficiency mixer line. And that means every aggregate is on the test stand. Increasing energy efficiency is a major topic, and not only for customers. HF MIXING GROUP is continuously putting its production operations and its processes on the energy-efficiency test stand. Since early 2015, HF has been operating an energy and environmental management system according to DIN 50001 and DIN 14001. As a machinery constructor in whose brand DNA the principle of sustainability is securely anchored, HF naturally supports the Blue Competence Initiative of VDMA, the Plastics and Rubber Machinery Association. HF will also apply for the RAL “Efficient use of energy in manufacturing industries” quality mark as soon as it has been established. Unlike existing certifications, the RAL quality mark assesses not only the energy efficiency of the processes, but also that of the individual products.

BLUECOMPETENCE

Alliance Member

Partner of the Engineering Industry
Sustainability Initiative



But what HF does above all else is that what HF has always done: provide the best possible support to the customers for their projects. Specifically with regard to energy efficiency, this means that HF is working in high gear to optimise all aggregates of a mixer line relative to their energy efficiency. The company is working to build mixers that combine low energy consumption with high efficiency. And HF didn't just start yesterday.

Efficiency factor: drive system

Take the drive system, for example, where already a great deal was accomplished. The drive of the mixer very strongly dominates the overall energy requirements of the mixing process, so its efficiency largely determines the energy savings potential of a mixing line. Not so long ago the direct current (DC) drive was the standard for mixer lines, but over the past decade HF has equipped its mixers with modern alternating current (AC) drives. In combination with frequency converters, they deliver considerably more favourable efficiency curves for the specific requirements in the mixing room. This is because mixing demands very high outputs for only a short period of time, while requiring only low output from the motor during long phases of the process. In partial load operation, the AC motor works much more efficiently than its older brother. On average, it is reasonable to expect a 20% increase in efficiency when replacing direct current by alternating current. The effect of this on energy consumption is by no means negligible.

In the tyre industry, a 320-litre DC-motor-driven internal mixer with a throughput of 3 t/h consumes 2.6 million kWh per year (assuming 6,000 h/yr operation), while the energy consumption of an internal mixer equipped with an AC motor can, due its greater efficiency, be reduced by 650,000 kWh per year. Expressed in euros, the operating costs for the drive are reduced - at an electricity price of 14 cents/kWh and an average power input of 900 kW - by 90,000 euros!

In order to achieve further efficiency increases, HF has studied modular drive systems. These work - depending on the size of the internal mixer - with four to six motors, which drive the mixer rotors via a special gearbox. Since the drives of internal mixers operate under partial load conditions during many mixing phases, they often work very far from their optimum rated power and therefore inefficiently. The additional motors counteract this problem: by switching them off and on as necessary, it can be ensured that the motors are operated in the optimal efficiency range. This serves to optimise the efficiency of the drive by another 5%. For the 320-litre mixer from the example previously mentioned, this improvement in efficiency would mean additional savings of about 16,000 euros per year.



Savings potential: ram

Savings can also be achieved on elements other than the main drive, however. There is latent energy optimization potential hidden in all other aggregates as well. Take the ram, for example. For about 15 years now, hydraulic ram pressure systems have been increasingly displacing the pneumatic systems widely used in the past. Not only are they quieter, but they also enable significantly faster ram motion while providing more precise and more reliable position control at the same time. In this way, they ensure constant process conditions - unlike the pneumatically driven ram, which can cause inconsistent mix quality due to pressure level variations.

When we compare the energy expenditures - and therefore the operating cost - of the two systems, the hydraulic ram is clearly superior. Operating an IM 320E mixer with a hydraulic ram results in up to 70% lower operating costs for the same number of hours - a considerable savings potential. A 320-litre internal mixer with a hydraulic ram requires half a million kWh per year less than an internal mixer equipped with a pneumatic ram. Expressed in euros, the operating costs for the ram are reduced - at an electricity price of 14 cents/kWh - by 70,000 euros.

The use of hydraulic feed systems offers many further advantages, however. With iRAM, the intelligent ram control system, process technicians and engineers have a powerful new process optimisation tool in their hands. Where the ram was once driven up and down pneumatically, iRAM permits displacement by predetermined distances. This function and many other interesting ones can be used to exploit an extremely wide range of process engineering potentials. A broad range of practical experience shows that ram displacement control can be used to save cleaning steps and reduce ventilation steps. The result: mixing times reduced by up to 25%. Here, too, it is possible to save significant amounts of energy. Hydraulic feed systems and iRAM offer, beside the energy savings potentials described here, a large range of additional options. Not all rams are created equal.

Influence of the temperature control units

When we turn our attention to the periphery of the internal mixer, we see that temperature control units can also be designed for greater energy efficiency. Under the normal operating conditions of the mixing process, which is characterised by continuously changing requirements, the pumps of the temperature control units run only very rarely at their optimal operating point. This means that whenever the temperature control system is operating, the pump is always running at full volumetric capacity without speed regulation and accordingly at full power, although only part of that volumetric flow is needed. Without a need-dependent power adjustment, this results in unnecessarily high consumption of drive energy and therefore also higher operating costs.



Through the use of frequency-controlled pumps, the cooling can be adjusted to the process, thereby achieving additional energy savings. Tests on the system in the HF Technical Center have shown that by controlling the speed control of the temperature control units, the pump input power of the three TCU units - rotor / mixing chamber / ram - can be reduced by 50 to 75%. Expressed in energy costs, that amounts to about 8,000 euros per year.

Moreover, there is considerable savings potential in designing temperature control units with their specific purpose in mind. In order to do so, engineers must know not only the characteristic curve of the mixer component to be temperature controlled (i.e. pressure loss as a function of flow rate) but also that of the temperature control unit (flow rate as a function of the back pressure to be overcome). The proper selection of pumps for each temperature control circuit first requires a holistic analysis of those two relationships. Through individual examination of the mixer circuits, the size of a pump in a circuit can be reduced by up to 30% from the outset.

Thanks to intensive studies of temperature control units with conventional temperature control systems, HF Automation has developed its own control hardware and software, which demonstrates significantly better energy consumption. Knowledge of the interaction of mixer components and the temperature control unit also played a decisive role here. Once the overall system response had been analysed, it was possible to develop stable control algorithms, unlike those of conventional temperature control unit which often oscillate around the operating point. The new HF TCU controllers also enable the direct control of the temperature of the mixing chambers and not just the water flow temperature. They are already being used in the latest generation of temperature control units.

Twin-screw extruder

In the downstream aggregates underneath the internal mixer, the installed drives are also scrutinised. These machines are also installed with substantial drive power ratings - up to 300 kW for a Convex™ 12, for example. Outdated drive concepts such as direct current or hydraulic drives are often still in use here - the efficiency of which usually still offers considerable optimization potential.

Extensive comparison testing in the field has shown that the screw geometry of the twin-screw extruders has a significant impact on the operating characteristics. In general, the conicity of the screw diameter results in a substantially higher capacity in the inlet area versus the discharge area of the screw. For this reason, a large proportion of the mixture is transferred “in the loop” (or backflow) from the front to the back of the extruder area. With a favourable screw arrangement, that amount of backflow (which is unnecessary for the





functioning of the machine) can be diminished considerably and the energy consumption of the screw drive can be reduced by up to 33%.

Saving potential: dust seal

The area of the dust seals of an internal mixer offers attractive savings potentials, and not only with regard to energy efficiency. The load-dependent control of the compression forces of dust seals provides many additional benefits as well. With the recently developed “iXseal”, the HF MIXING GROUP offers an advanced concept aimed at achieving the following optimisation potentials:

Reduction of lube oil consumption

Minimisation of recycling costs

Extension of dust seal service life

Reduction of the load on the main drive

But how are these improvements achieved in the dust seal area? Extensive analyses at HF have shown that the rings of the dust seal need not be compressed against one another with full pressure in all process phases - as is the case today. Moreover, this intelligent reduction of the hydraulic compression forces automatically enables a reduction of the lube oil supply between the seal rings. Shutting off the lube oil supply temporarily in this way can save significant quantities of oil.

A portion of the lube oil required for operation is not fed into the mixing chamber. The discharged oils must be collected and recycled. The associated costs often exceed the purchase price of the relevant oils several times over. So the reduction of the oils described here also minimises recycling expenses and makes the operation of mixers more environmentally sound.

“iXseal” reduces - as described above - the mean contact pressure between the rotating and fixed ring. This has a positive impact on the service life of the seal. Downtimes and maintenance frequency are reduced to a minimum. In simplified form, the seals of an internal mixer are comparable to four disc brakes. If they are continuously subjected to high compression forces, that condition has an effect on the power consumption of the main drive. The intelligent reduction reduces the load on the seals, thereby also reducing the load on the drive of the rotors.



MIXING GROUP

Conclusion: a holistic view of the mixing process opens up opportunities for high savings potentials. Moreover, comprehensive automation of the complete mixer line system can eliminate further inefficiencies. Load spikes that occur when multiple lines are running load-intensive mixtures at the same time can be avoided in advance with an intelligent planning algorithm. Further potentials for energy savings become available to mixing room operators when the central automation system records and fully documents the energy consumed by each of the aggregates in the mixing room. This path will continue to be systematically followed by HF MIXING GROUP.



Sustainable procurement

In line with the motto “Downtime is regression”, in 2015 HF redesigned a few things in the area of procurement and continuously improved and further developed them in terms of sustainability. This has allowed the company to consolidate its economic and above-all forward-thinking direction in the market, where the growing demands of customers across the entire value chain (right up to the procurement markets) are becoming ever more demanding.

Based on the supplier self-assessment on the topic “Corporate Social Responsibility (CSR)” conducted last year with the 50 highest selling suppliers, all suppliers assessed based on the usual annual supplier evaluation were questioned for the year 2015 (wherever there was no information already available). The pre-requisites were an annual turnover of > EUR 20,000 and a company size greater than >20 employees. As a result, 157 companies were contacted.

Out of a total of 157 questionnaires, 123 were answered and could be assessed.

The following point scores were noted:

- Part I: Environment 90 points
- Part II: Workplace and health protection 70 points
- Part III: Energy management 30 points
- Part IV: Operation and business practices 50 points

On average, the following summarised results were noted from the evaluated questionnaires:

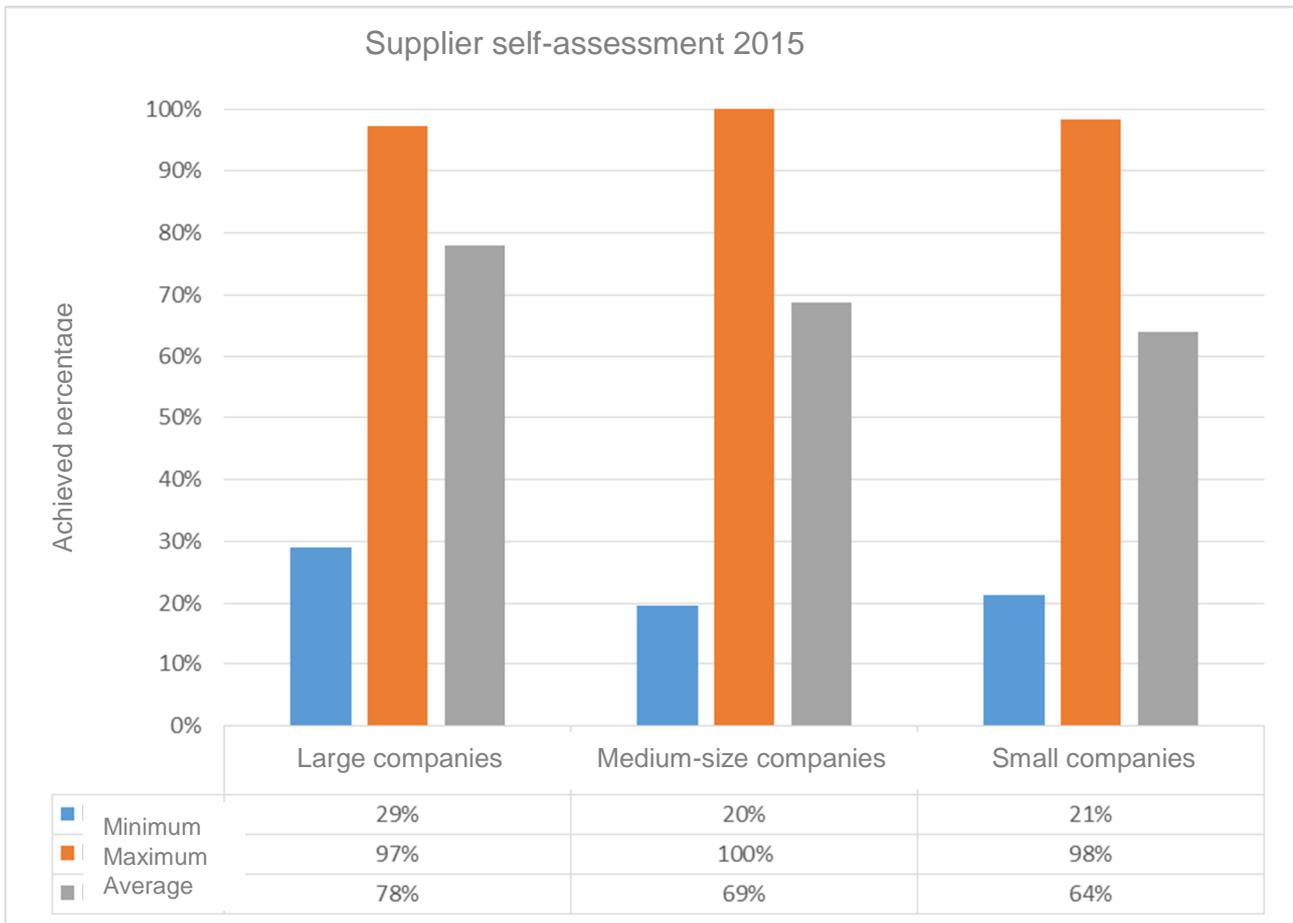
	Part I:	Part II:	Part III:	Part IV:
Ø No. of points:	49.5	49.0	15.9	37.7
Ø Percentage:	55%	70%	53%	75%

So size differences between our suppliers could be considered, the following factor, which evaluates the overall result of the individual suppliers more fairly, was applied.



<u>Large companies</u>	<u>Medium-size companies</u>	<u>Small companies</u>
Employees >= 250	Employees 50-249	Employees <= 49
Factor x 1	Factor x 1.1	Factor x 1.2

This has yielded the following results:



The company sizes were broken down as follows:

Large companies: 43
 Medium-size companies: 47
 Small companies: 33



The average result has hardly changed compared to the previous year. This shows that almost all relevant suppliers are already active in terms of corporate social responsibility. Based on existing evaluations and findings, CSR will in future factor into supplier management, playing a firm role in the development of suppliers.

In this context, the supplier assessment (addressed in advance) was also completely redeveloped. In addition to the criteria of quality, price, on-time delivery and order processing: for the first time, the CSR criterion (based on the supplier self-assessment) was included in the evaluation. Since 2015, sustainable procurement has thus been an integral part of supplier evaluation.

In August 2015, there was also a letter sent to all relevant HF suppliers, which notified a successful introduction of the energy and environmental management systems (DIN EN ISO 50001 and DIN EN ISO 14001) on the company premises. In addition to the letter, there was also a request made of the suppliers that they provide long-term support to HF in the new and challenging task areas of process optimisation in the field of energy saving and better environmental awareness, along with continuous self-improvement.

Further optimisation in the area of the order and enquiry process was successfully implemented at the beginning of the year. This allowed for paper consumption to be reduced by 1/3; even by half, according to the enquiries! Another aspect here is that mail delivery of orders was discontinued, allowing for both the elimination of additional postage costs and saved transportation distance. Deliveries to business partners are now done via email or fax.

In order to ensure the continued safety of colleagues, employees and external workers on the HF premises (including preventive optimisation), new house rules were drafted for contractors and issued to all relevant suppliers and partners in the service sector. The instructions in this paper outline how external persons should behave on the company premises and what measures should be taken in an emergency. The house rules must be signed by all relevant companies. e