Energy saving actions at Michelin, Dundee.

With the help of the Carbon Trust, Michelin has achieved significant energy and carbon savings by investing in energy efficiency improvements across a range of technologies at its Dundee site. Projects included recovering flash steam to reduce gas consumption by the site's main boilers, reducing losses in the compressed air system and introducing variable speed drives on a number of key motors. These measures, together with other initiatives implemented on site have contributed to energy use reductions of 8.0% in electricity and 3.8% in natural gas[1].

[1] Reductions in production related energy consumption between 2010 and 2011.

CO_2 emissions reduced by 860 tonnes per annum.

Energy cost savings of £83,000 per annum.

Payback period on overall investment of less than 2 years.

Introduction

Michelin has been making tyres at its manufacturing site in Dundee since 1971. Approximately 900 people are currently employed at the site which produces 7 million tyres per year for the lightweight car market.

Michelin's corporate environmental commitments require a 20% reduction in production related energy use between 2008 and 2016. Following the installation of two large wind turbines at the site, managers and engineers at Michelin in Dundee called on the Carbon Trust to provide specialist support in identifying and implementing actions that would improve the site's energy efficiency.

In 2010 the Carbon Trust concluded a detailed assessment of energy use in a number of key areas at Michelin in Dundee, providing the company with recommendations for actions that would make considerable savings in energy use and operating costs - as well as reducing emissions of carbon dioxide. Reducing energy consumption helps to maintain the site's competitiveness and lowers its sensitivity to future increases in energy prices.

The savings have been achieved through improvements in several areas including the steam and compressed air systems as well as to the large water pumping systems. Whilst the level of investment was considerable, the payback period offered by the improvements was attractive.

Technical case

Flash steam recovery

Gas consumption for the generation of steam accounts for the majority of energy use at Michelin Dundee. The steam is mainly used to provide heating for several tyre manufacturing processes. Condensate is produced from process steam as it gives up energy inside the production machinery and condenses into water. The condensate is very hot and remains at high pressure until it enters the lower pressure condensate recovery system[2]. Here, as the hot condensate reduces in pressure, the water boils and flash steam is generated[3]. This flash steam, however, contains valuable energy and there were a number of locations at Dundee where it was simply vented to the atmosphere and so the energy that it contained was lost.

The Carbon Trust quantified the amount and cost of energy wasted at each of these locations and was able to prioritise where further flash steam recovery should take place.

> As a rule of thumb, vented steam with a plume of 2.5 meters in length would produce 265 kg of steam each hour, which equates to 2,000 tonnes of CO_2 emitted by the boiler annually.

[2] A system of pipes that is used to recycle condensate back to the boiler-house, where it fed back into the boilers.

[3] The boiling point of water reduces with pressure, so when high pressure hot water suddenly decreases in pressure it boils and releases (flashes) steam.

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The Carbon Trust then identified specialised equipment which recovers the heat in the flash steam and uses it to pre-heat boiler feed water. In addition, by re-condensing the flash steam and recycling it back to the boiler-house, the new equipment reduces the amount of fresh make-up water required by the boilers and so reduces water costs.

As a rule of thumb, vented steam with a plume of 2.5 meters in length would produce 265 kg of steam each hour, which equates to 2,000 tonnes of CO_2 emitted by the boiler annually.

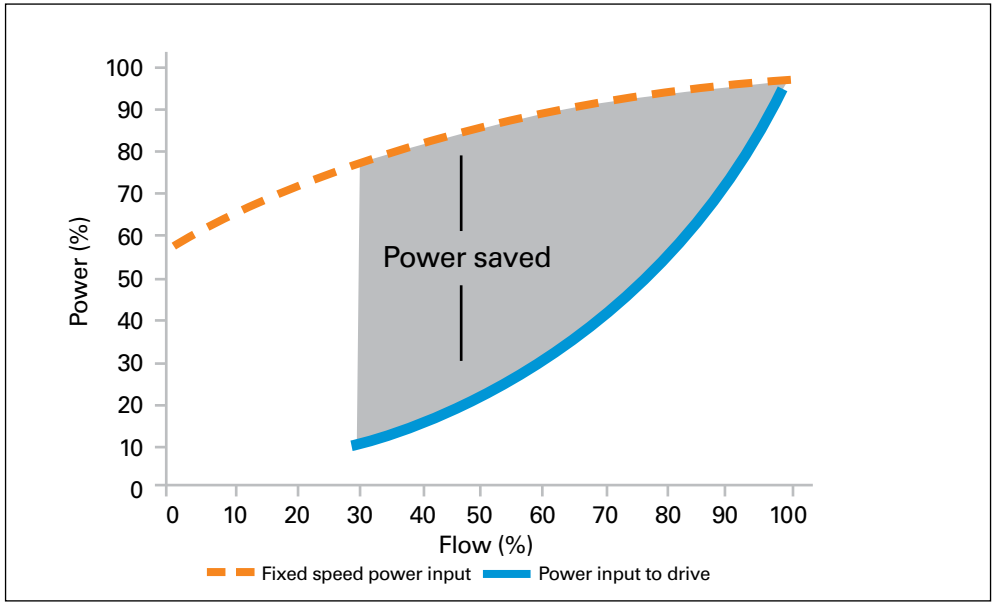
By installing a system to recover heat from the flash steam that would otherwise have been vented to atmosphere, Michelin has reduced gas consumption by 3million kWh and reduced CO_2 emissions by 562 tonnes per annum.

Variable speed drives

Michelin Dundee has a number of systems that employ large power-hungry centrifugal water pumps. These include systems for supplying feed water to the site's boilers, distributing hot process water to the manufacturing areas as well as for circulating cooling water.

Each of these systems used control valves to regulate the flow of water in relation to the site's requirements at any time – the valves open to allow a high flow rate when large volumes of water are needed and partially close to restrict the flow from the pumps when less water is required.

Comparison of pump power use for fixed speed and variable speed systems.



From CTG070 - Variable Speed Drive (Note: When operating at near full speed there is a crossover point where VSD control can use more energy than fixed speed control with a throttle. This is due to the losses in the VSD exceeding the savings from the speed reduction.

This is a very common approach to varying the output of pumps, however by throttling the flow in this way, control valves place additional load on the pumps and so waste energy.

Aware of this issue, managers and engineers at Michelin asked the Carbon Trust to investigate the potential for energy savings by the installation of Variable Speed Drives (VSDs) within the site's large water pumping systems.

VSDs are motor control devices that can be used to control the flow-rate by varying the speed of the electric motor driving the pump. VSDs therefore remove the need for control valves in the pipe.

For centrifugal pumps, like those used in Dundee, the power use reduces with the cube of the pump's speed.

Therefore a small reduction in the pump's speed results in a significantly greater reduction in the power used by the pump's motor; **for instance reducing the pump speed by 20% reduces energy consumption by almost 50%.**

The Carbon Trust determined the operating modes and power consumption for each of the large water pumps at the site and liaised with Michelin's preferred supplier to develop a proposal for the installation of VSDs.

Installation of VSDs to control the flow-rates on the three large water pumping systems in Dundee generated electricity savings of 436,000 kWh p.a. over the use of control valves. The associated reduction in CO_2 emissions was 228 per annum.

Compressed air

Production equipment at Michelin in Dundee consumes significant volumes of compressed air, which is supplied from a number of very large compressors located in the site's energy centre.

On discharge from the compressor, compressed air contains very high levels of moisture and in order to protect the production machinery it is necessary to remove this moisture before the air is distributed around the rest of the site.

At Michelin in Dundee, refrigerated driers are used to condense and remove the moisture entrained in the compressed air. However, upstream of the dryers the high moisture levels in the mild steel compressed air pipe can cause scale and debris to build up which may cause damage to the internal components of the driers.

Frequently, filters are installed before the drier to protect it by intercepting such scale and debris. However, in order to overcome the pressure drop created by these filters, the air compressors consume additional energy.

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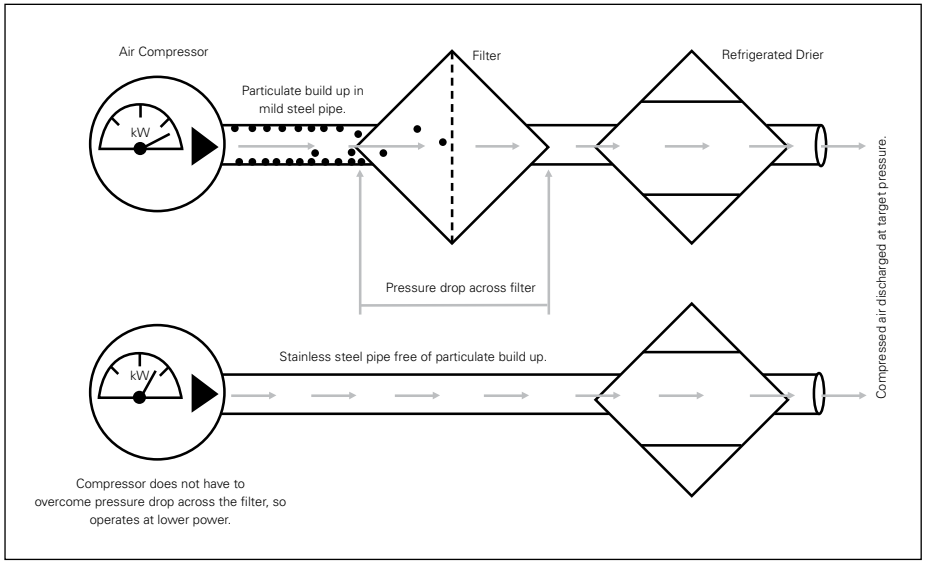
Due the very large size of the compressed air installation at Dundee, the total energy use required to overcome the pressure drop across the filters was large and resulted in significant additional costs. In order to eliminate these losses the Carbon Trust suggested installing stainless steel pipe between the compressors and the driers. Stainless steel is not corroded by moisture and so there is no build-up of scale in the pipe and hence no requirement for filters to be installed before the drier.

By installing stainless steel pipework between the air compressors and the refrigerated driers at their site in Dundee, Michelin was able to remove the air filters which were placing additional load on the compressors.

This action has reduced compressor energy consumption by 130,000kWh per annum and the reduction in carbon dioxide emissions was 70 tonnes per annum.

Michelin has also invested in VSD controlled air compressors which save electricity by varying the compressor's motor speed in relation to the rate of air consumption across the site.

The VSD compressors are able to maximise the savings offered by a programme of compressed air leak detection and maintenance throughout the site. In addition, compressed air meters have been installed in the manufacturing departments which allow engineers on site to track air consumption rates and quickly identify increases as a result of wastage or leaks.



Financial case

The Carbon Trust has helped Michelin in Dundee to put in place a number of measures which have realised significant savings in energy costs.

These measures include:

- Recovering heat from flash steam in the condensate recovery system (that previously was vented to the atmosphere) reduces natural gas consumption by the boilers and provides energy cost savings of almost £46,000 per annum. In addition, the savings in fresh water achieved by recycling the re-condensed flash steam reduces running costs by a further £2,000 per annum. The overall cost for the project was £100,000 and so the payback period was slightly over 2 years.
- Using VSDs instead of control valves to regulate water flow-rates in several key systems has reduced electricity costs by £27,000 per annum. The project costs were £20,000 and so a payback period of only 9 months.
- Installing stainless steel pipework between the air compressors and driers to eliminate the pressure losses caused by a set of air filters. This project cost approximately £16,000 to implement but has generated cost savings of £8,000 per annum, resulting in a payback period of 2 years.

Michelin at Dundee continues to engage in energy efficiency projects in pursuit of the group's corporate commitments and is currently investing in a programme to upgrade thermal insulation on pipework components around the site.

Carbon Trust publications

Steam & high temperature hot water boilers overview (CTV052)

Heat recovery - A guide to key systems and applications (CTG057)

Motors and drives technology overview (CTV048)

Variable speed drives technology guide (CTG070)

Compressed air overview (CTV050)

For more information on energy and cost savings go to: www.carbontrust.com/scotland or phone 0800 085 2005.