Aggregate Portal Asphalt Plant Case Study

Introduction

The production of surface coated materials – Asphalt – is the most energy intensive process in the Aggregates sector. A large amount of heat is required to remove moisture from the crushed material and elevate it to a temperature where it can be mixed with the bitumen binder.

Although the methods of production in Asphalt do differ slightly, the basic operations are relatively similar with common areas for energy saving opportunities that would be applicable across most sites.

This case study is an introduction to the energy saving measures that are possible at Asphalt Plants. All the ideas and suggestions have been implemented as the result of surveys undertaken by the Carbon Trust.

Consider a typical Asphalt plant that spends around £450,000 a year on fuel and electricity. It is looking to reduce energy costs and carbon emissions across its business.

The Site Manager and staff are working together to identify new technologies, processes and behaviours that can be introduced at the site. Unsurprisingly, they are particularly interested in low cost options.

They have grouped their energy saving measures, where possible, to follow the process at its site. Some measures/activities can be applied across a number or all of the activities on a site.

1. Energy Management

The energy team is uncertain exactly how much energy the site uses and how this changes over time. The team has decided to undertake monitoring of fuel and electricity consumption to identify trends, distinguish potential areas of energy reduction, to benchmark themselves against other sites and companies and to demonstrate success over time.

The team has decided to install a number of sub meters across the site to provide a more detailed view of the site activities and energy saving opportunities.

The team has started raising awareness, training and motivating staff in good energy management - such as through switch-off regimes, efficiency loading of conveyors, and efficient driving practices - as they have been shown on other sites to be the most important and cost-effective way to save energy.

Some of their favourite awareness ideas are poster campaigns, energy champions for each team, weekly progress reports and motivational speakers at events.

2. Material Storage

The crushed stone, sand and recycled asphalt planings (RAP) is currently held in open storage on the stockyard with only small quantities of dust held undercover. The team has begun a programme of monitoring the moisture content of the sand. They recognised that wet sand can have a significant impact on the fuel usage of plant (over 25 % of the total site's fuel is needed to drive off the moisture). They have targeted to reduce moisture content from 6% to 4% by requesting drier sand from their supplier along with improving the drainage of the stockpiles.

In the medium term the team is looking into covering the material and in the long term using dedicated covered storage bins.

3. Bitumen Tank storage

The Asphalt plant has three storage tanks that hold the various grades of bitumen at an elevated temperature in preparation for mixing. The temperature of the bitumen is controlled by insertion thermocouples that control banks of electrical element heaters to maintain the set temperature. From a walk-around survey the energy team noticed the bitumen tank heaters being left on continuously. The team used temporary data loggers to identify the performance of each individual tank and found that all the tank heater controls were left on permanently and that the oldest of the three tanks was using the most electricity. An infrared thermographic survey revealed that the tank insulation was inadequate leading to uncontrolled losses of heat. The site team implemented a plan to:

- fit timers to the switch on Tank heaters overnight (midnight to 5am)
- check Tank thermostat settings – reduce set point
- replace Tank insulation.

4. Rotary Drier

The majority of fuel use in an Asphalt plant is used in the Rotary drier. The site team decided to focus their attention on the drier system to deliver the maximum savings for their efforts. This involved installing a fuel meter on the burner supply along with an electricity meter on the dust bag house extraction fan. Looking at other asphalt plants, the site team identified that the fuel per tonne performance of the drier was too high for this type of operation and drew up a priority plan to implement the following improvements:

- Repair the insulation on the drier to significantly reduce heat lost through radiation.
- Remove damper control on the dust extraction fan and replace with a variable speed drive (VSD) to regulate the flow.
- Inspect condition of internal drum lifters to improve drier efficiency.

- Carry out a combustion efficiency test on the drier burner and ensure the burner is maintained correctly thereafter.
- Recover the heat to pre-heat combustion air.
- Enclose the drier in a shelter to provide additional protection from the weather and extend the life of the insulation.

5. Hot Stone bins

Hot bins are used to store the Asphalt before mixing. The mix operators often find that these bins had been overfilled and dried product had to be returned to the stockpile and ultimately re-heated. They suggested that the bin level indicators were upgraded to provide an accurate level reading, eliminating overfilling and the associated wastage.

6. Mixer

The plant mixer is driven by a large single motor driving through a train of fluid couplings, gear boxes and chain drives through to the two mixer shafts. By monitoring the mixer motor running current the site team established that the motor would draw approximately 50% of its normal load when running idle. The team invited an electrical drives supplier to review the mixer drive train and to recommend improvements with a view to future capital investment. The results of the survey were to:

- replace the large single motor with two smaller direct coupled motor drives
- use VSDs to enable the mixer motors to be slowed down during idle periods.

7. Hot Storage Bins

The site has three hot storage bins where the mixed asphalt is stored. Using half-hourly electricity data for the site, the energy team noticed that consumption did not drop as expected during evenings and weekends. During a site walk-around survey they realised that lack of timers and controls meant the storage bin door heaters were left on permanently.

They decided to add better controls for the door heaters, whilst at the same time improving insulation of the charging doors to increase heat retention.

8. Mobile Plant

Material is currently carried by the mobile plant to the cold feed bins on the site. Energy data assessment showed that diesel used in the mobile plant is not a significant proportion of total site energy consumption but is still an area for consideration. The team stressed that a joined-up approach to all operations across the site could lead to energy and carbon savings.

They found that driver training led to reduced vehicle idling and fuel savings, they improved the maintenance regimes (such as tyre pressures) and improved haulage routes for more efficient driving.

The team also found that where feasible savings could be realised by locating the most popular crushed material closer to the cold feed bins and reducing mobile plant distances.

9. Conveyors

There are only a small number of conveyors on the Asphalt Plant delivering material from the cold conveyor to the rotary drier. Actions identified by staff running the conveyors included:

- Improve conveyor operation control with programmable start up and presence sensors.
- Improve motor controls such as variable speed drives (see below).
- Reducing energy losses through torque adjustment or conversion, or where possible, through the removal of V belts and gearboxes and replacing with internal drum motors.
- Improved maintenance of the belts and drive system.

10. Motors

Motors are used on the site for a variety of applications such as crushing, pumps, conveyors and fans. From energy monitoring it has been shown that motors are one of the largest consumers of energy on the site. In some cases the annual cost of energy to run a motor can be up to ten times its purchase cost.

Currently there is no inventory of the size, number and application of the use of motors on the site. As a first step site engineers decided to put together a motor management policy to determine management decisions. As motors are most efficient at high loads, monitoring consumption and installing new motors can reduce costs. New motors are also classified by efficiency, with higher efficiency motors (HEMs) able to be purchased at similar costs.

Running the correct motor and controls (also known as drives) can lead to significant energy savings. Motors and improvements to their controls need to be understood within the context of the application and load served, and the operation pattern.

Variable speed drives are suited to applications with load conditions at continuously variable demand. VSDs can also be useful for constant conveyors and grinders, with a fixed output that varies from job to job. The team found from monitoring that installing a VSD to a 30 kW pump could save around £2,000 a year in energy costs.

Other controls include a soft starter that reduces the large energy spike when a motor is switched on – but these do not control motor speed in normal operation. Smart motors can reduce energy consumption as they analyse load conditions for themselves, without needing to feed back information to a central control system.

11. Compressors

Compressed air is used for power and control for a number of applications within processing on a site.

Monitoring has shown that compressed air is the most expensive utility and around 90% of the energy input is wasted as heat. They have implemented a number of measures to reduce the use and improve the efficiency of compressed air at the site:

- They have replaced compressed air in the process where feasible - for example by using suitable electrical actuators or low energy fans.
- Reduced the pressure where high pressure was not required.
- They reduced idling of compressors, which consume 20–70% of their full load power.
- Carried out ultrasonic leak detection surveys and repairs. They found that one small leak costs over £500 a year.
- Where possible reduced air intake temperatures, monitoring found that 10% reduction in air inlet temperature improves efficiency by about 3% .
- Installation of Variable Speed Drives on generators with variable loads and fixed duty motors.
- Where feasible, the installation of Variable Speed Drives on idling compressors saved between 20% and 70% of their full load power.
- Recovering and using waste heat was used to compliment to heating the office buildings on site.
- The team is currently considering integrating small distribution networks into a more efficient joined up systems approach.

12. Buildings and Lighting

Energy saving measures for on-site buildings and structures can be overlooked as not directly related to the quarrying process. A range of cost effect opportunities are likely to exist to improve heating and cooling systems, fabric, controls, lighting and ventilation within a building.

Lighting around the site is up to 10 years old with limited control and it is noticed that lighting is on for most of the time. Timers and occupancy controls would reduce this lighting load and have a small impact on the site's energy consumption.

13. Electricity supply

The electrical engineers are keen to implement savings to lower overall electrical demand. They are aware that many of the newer drives and motors can operate satisfactorily at the European voltage of 380 Volts although the current site voltage is 415v. Using voltage optimisation equipment they can alter the Site Transformer tap settings to reduce the site voltage from 415v to 380v – saving 1-3% of the site electricity demand.

14. Low carbon technologies

The energy team is also looking at low carbon and renewable technologies such as wind turbines, and biodiesel fuels to reduce overall energy consumption.

They are also following the development of warm and cold mix asphalt trails being carried out by other sites.

15. Opportunities in the Case Study

Opportunity	Capital Cost	Carbon reduction	Payback
Energy Management and training	£8,000	2-10% Overall consumption	Immediate to 4 yrs
Covered Storage	£50,000	8% Fuel saving	3 – 5 years
Relocate high use storage bays	£1,000	5 % of vehicle fuel	Quick win
Bitumen Tank Heater Timers	<£1,000	1-2%	Quick win
Bitumen Tank Heater set point reduction	Nil	<1%	Quick win
Bitumen Tank Insulation	Low capital cost		1-4 yrs
Insulate Rotary Drier	£5,000	10 % Fuel Saving	1 year
Additional shelter for Rotary Drier	£15,000	2 -5 % Fuel Saving	1 year
Heat recovery	£50- 150,000	5%	1-4 yrs
Burner Combustion efficiency check	<£1,000	2% Fuel Saving	Quick win
VSD for dust extraction fan	£5,000	5%	1-4 yrs
Mixer drive replacement	Low capital cost	2%	3 years
Driver training	£12,000	10% of vehicle fuel emissions	Quick win
Vehicle maintenance	£10,000	<1% of site emissions	1-4 yrs
Conveyor improvements – belt and torque adjustment	Low capital cost (<£20k)	0.5%	1-4yrs

Conveyor controls	£1,000	0.5%	Quick win
Motor Management Policy	£6,000	2%	1-4 yrs
Motor controls	£15,000	Up to 10% of site electricity	1-4 yrs
Reduced use and losses from compressed air	£2,500	1-2% of site energy	Quick win
Buildings and lighting	£5,000	<1%	1-4 yrs
Voltage optimisation	£1,000	1-3% of electricity consumption	Quick win

16. Quick Wins

- Dry Storage of Sand, Dust and RAP.
- Good Insulation of Rotary drier and protect from the elements.
- Improved Burner Maintenance.
- Improve Rotary Drier lifters.
- Energy management and training.
- Driver training and monitoring.
- Improve vehicle maintenance.
- Motor Control - Survey and install variable speed drives on largest suitable motors (Extraction Fans, Mixers).
- Compressed air - reduce use losses, identify and fix leaks and install variable speed drives.
- Buildings and lighting around site – ensure sufficient controls.
- Electricity control – Reduce site voltage.