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ALTERNATIVE METHODOLOGIES SPECIAL WORKING GROUP

Case Study: Roadstone TQM

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Roadstone TQM Case Study

Roadstone, Bunratty, Co. Clare

Roadstone builds a case for alternative tools

ROADSTONE is the leading manufacturer and supplier of building materials in Ireland. It is strongly committed to energy efficiency and environmental sustainability. Roadstone's strategy involves developing IS393 certified energy-management systems to drive energy efficiency. It is currently certified to the standard in nine quarries, with an additional ten planned for 2009.

The Bunratty, Co Clare quarry was certified in 2008. As a result of Roadstone's membership of SEI's Energy Agreements Programme and participation in the Alternative Methodologies Special Working Group, a project was undertaken to improve energy performance at Bunratty using alternative methods.

The initial intent was for SEI to work with Roadstone to investigate an opportunity to perform a Six Sigma project on the Blacktop process, diagnosing the variability in input process and material variables which link to energy usage, and controlling the quality of the end product. Preliminary data analysis suggested a variability in the amount of energy required to process batches and this could vary by up to +/-15%. This indicated that the process was not in 'statistical control'.

Historically, there has been an acknowledged high reject rate of aggregate produced for tar processing at Bunratty's Blacktop plant. This rejected aggregate is segregated into a reject hopper, located close to the hot bins. To reach this stage, the aggregate has been transformed and subsequently dried and heated using considerable amounts of energy. A reduction in the amount of rejected product will have immediate quantifiable energy savings.

The use of alternative methodologies requires understanding of data-collection techniques and the application of the most appropriate improvement tools in a chosen focussed area or process. A problem-solving technique was required to reduce the rejection rate of aggregate materials, as this was the most evident issue in the process and it had a direct influence on energy usage.

The timeframe for this project did not allow Six Sigma to be used, but it remains valid for the Blacktop process.

All objectives met

The objectives of this project were to demonstrate that alternative methodologies such as Total Quality Management (TQM) and Statistical Process Control (SPC) could be used to considerably reduce the reject rate, improve the energy performance and, ultimately, save money in the Titan tar plant.

All objectives were met. The reject rate at the hot bins was reduced by 76% between November 2008 and February 2009. The management team has continued to scrutinise the defect rate and is using root-cause analysis to bring about further reductions. The energy, CO_2 and energy-related cost savings associated with the 76% reduction in reject rate are considerable.

	THREE-MONTH PERIOD	ANNUALISED
ENERGY (KWH)	164,970 kWh	659,881 kWh
CO_2 (TONNES)	55.2 T	220.8 T

Table 01. Energy, CO_2 and energy-related cost savings resulting from a 9.5% decrease in defects

Energy performance indicators (EPIs) are used by Roadstone to demonstrate continuous improvement of the energy performance of the Tar plant. The improvement trend is plotted in Figure 1. This reduction in energy requirement per tonne of product is considerable and include all energy reduction initiatives at the site in addition to this project.

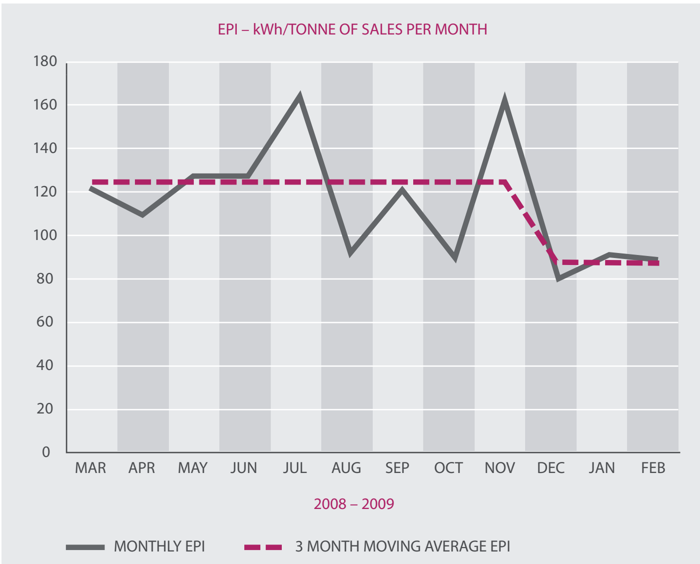


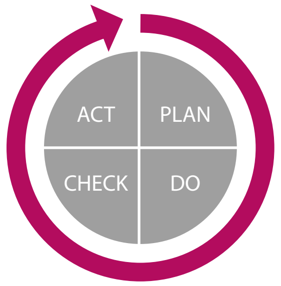
Figure 01. EPI showing energy consumed per tonne for the preceding 12 months and indicating a process shift between December and February. This reflects the savings derived from the reduction in rejected material.

The tar plant process

In the Titan tar plant, a batch process blends the aggregate, binder and any additives at an elevated temperature to produce a homogenous mix. The major components are the cold-feed system, bitumen supply system, dryer, mixing tower and emission-control system.

The mixing tower consists of the hot-bin elevator, screen deck, hot bins, weight conveyor, bitumen weighter and mixer. The dryer operates on a counterflow system and is on an incline. The hot, dry aggregate is discharged from the dryer at the lower end and transported by the hot-bin elevator to the hot-bin screening deck.

Aggregate is then separated into one of six hot bins by size. The aggregate in the hot bins is discharged from a gate at the bottom of each bin into the weight conveyor, according to the blend. Similarly, the bitumen is pumped from the tanks into a weight bucket and held ready for discharge into the mixer. The aggregate from the hot bins is mixed with the bitumen until the aggregate surface is uniformly coated with bitumen. The mix is then discharged to the skip, which transfers the mix into one of four holding silos. Trucks drive under the silos and are gravity-fed.



The approach: plan, do, check, act

The approach to solving/reducing the excessive reject rates problem was based on Deming's plan, do, check, act (PDCA) methodology. This continuous-improvement methodology fosters an approach whereby measurement and analysis are used to determine the main contributor(s) to a problem and its root cause. An action plan is implemented to correct the problem, while verification and standardisation steps ensure that the new method becomes the standard.

Data-analysis tools helped to highlight the energy invested in each of the aggregate ending up in the reject bin, after the dry-and-heat process.

The combined energy service was split into four processes: dry and heat, bitumen storage, mix, and fill. It was graphed using a stacked bar chart (Figure 02).

ENERGY SERVICE TO THE TITAN PLANT

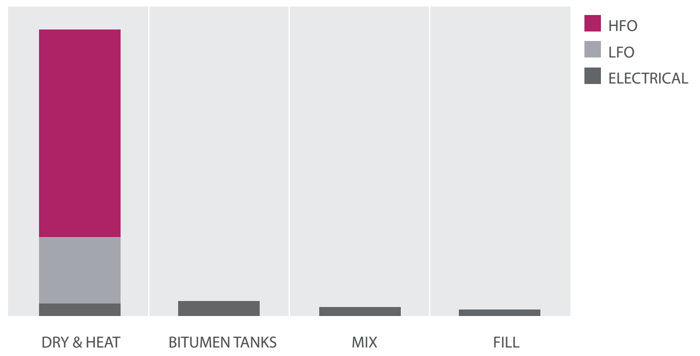


Figure 02. Stacked bar chart demonstrates the significant overall energy services to the four Tar plant processes

Checks lead to corrective actions

Sampling of aggregate from the hot, cold and reject bins began in November 2008. For quality-control purposes, aggregate is a 3D shape, with a length, breadth and depth measurement. The breadth of the aggregate is an important measurement as the screen meshes are square-shaped; if this mid-point measurement is larger than the mesh size, the aggregate will not pass.

CONTAMINATION FIXED

There was inconsistency found in samples of aggregate measured from the hot bins. Samples for the 14mm bin had a mean of 13.16mm and standard deviation of 2.4σ. Similarly, samples of aggregate from the 10mm bin had a mean of 10.9mm and standard deviation of 1.91σ.

Results of the sampling inspection and analysis were discussed with the plant manager and quality technician. A number of possible causes for the excessive defect rate were sought from operators, the plant manager and quality technicians. Their opinions were entered in a fishbone or Ishikawa diagram. The Ishikawa diagram helps identify the root cause of a problem by using a structured approach to continually question why the result happened.

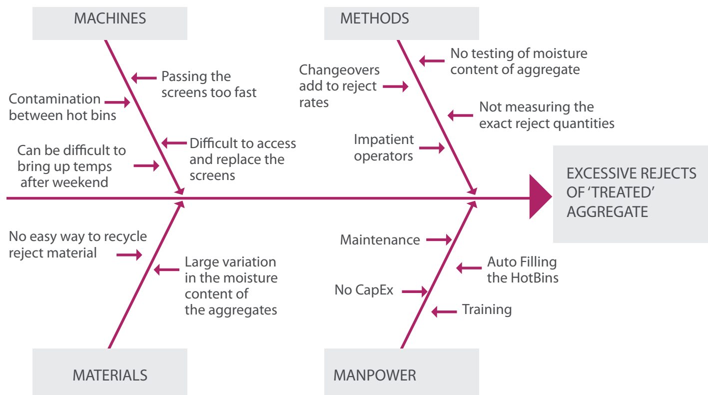


Figure 03. Fishbone (or Ishikawa) diagram used to identify possible causes of reject material at the hot bins.

When the team examined machine-related causes in the screens and hot bins, the examination revealed that common walls between the bins were corroded, causing contamination across the bins. It was determined that the corrosion had recently deteriorated and the defect was detected by this sampling process. Remedial action was taken immediately. The fishbone diagram was modified to include this contamination issue.

Sampling of aggregate from the hot, cold and reject bins continued. By implementing a corrective action to address the hot-bin contamination, the average reject rate fell by 60%.

FAULTY SENSOR REPLACED

Actions to reduce the defect rate and improve energy performance using the plan-do-check-act methodology have continued. For example, during routine sampling of the breadth measurement of the 10mm hot bin and the reject bins, in March 2009, it was revealed that the aggregate in each of these bins was statistically identical. This information was shared with the quality technician and the plant manager, who took corrective action.

They discovered that the high-level sensor on the 10mm hot bin was faulty, causing the operators to continue filling the 10mm bin, even though the bin was at its maximum capacity. This caused the 10mm aggregate to overflow into the reject hopper. The faulty sensor was replaced immediately and the rejects rates monitored. Since the corrective action was carried out, the reject rate has fallen by a further 16%.

The measures of success

Measurement is the key ingredient for continued-improvement programmes. The adage, 'If we cannot measure, we cannot improve', is apt. Collecting and analysing breadth measurement data helped understanding of the size, shape and spread of aggregate in the hot bins and made this easily communicable.

Process improvement

More detailed process capability studies were carried out during this project. Process capability can be quantified using two calculated measures: Cp and Cpk. The Cp compares the size of the process variation with the size of the tolerance. Cpk measures capability in a similar way and also takes account of the position of the sample mean in relation to the specified limits. That is, it measures how well the process is centred within the specification.

The mean, standard deviation, Cp and Cpk results for 6mm, 10mm and 14mm hot-bin samples, taken in November 2008, January 2009 and March 2009 are shown in the following table. It shows that the process, in general, gradually improved over the three months.

There is one exception: the 10mm hot-bin samples taken in March 2009. Results indicate that the distribution is deviating from the tolerance. This will be investigated further and will become the next corrective action in the continuous-improvement programme.

MONTH	HOT BIN	MEAN	STD DEV	CP	CPK
Nov 08	6mm	6.23	2.59	0.41	0.27
Jan 09	6mm	5.43	1.38	0.76	0.69
Mar 09	6mm	4.47	1.24	0.85	1.03
Nov 08	10mm	10.93	1.91	0.58	0.19
Jan 09	10mm	8.45	1.20	0.93	0.99
Mar 09	10mm	8.46	1.45	0.77	0.82
Nov 08	14mm	13.16	2.41	0.48	0.39
Jan 09	14mm	12.74	1.97	0.59	0.55
Mar 09	14mm	12.57	1.25	0.94	0.92

Figure 02. Stacked bar chart demonstrates the significant overall energy services to the four Titan plant processes

Quality techniques boost performance

This improvement project was initiated as a result of collaboration between Roadstone and SEI's Alternative Methodologies Special Working Group. It was on the basis of an energy initiative that it investigated a quality issue, which in turn yielded significant energy improvements. In all such projects, cost, quality, productivity and energy are found to be inter-dependent. An initiative on one issue invariably leads to improvements in others.

The alternative methodologies bring with them a discipline of measurement and continuous improvement, with an emphasis on standardisation, through procedures, instructions, training, etc… to ensure that the improved system becomes the norm and is not allowed to 'slip back to the old ways'.

In the case described above, it is evident that quality has a direct bearing on Roadstone Bunratty's energy usage per tonne of production. Quality techniques such as TQM and SPC can be used with great effect in improvement projects. The plant manager and his quality and operations team are actively seeking the next improvement opportunity. They will continue to measure and monitor rejected aggregate rates and apply Six Sigma, PDCA or other such improvement methodologies to continuously improve both quality and energy performance.

An energy-performance-indicator league table may be used to compare how other Tar plants in the Roadstone group are performing. Plants with less favourable ratings should monitor and measure their percentage rejects and apply TQM and SPC tools, such as those detailed in this report, to make energy-performance improvements.

The company's IS393 certification should play a vital role in ensuring that the improved energy performance of the Titan tar plant is maintained into the future.

[1] Standard deviation, symbolised by the Greek letter sigma, σ, is a simple measure of the variability of a set of data. A low standard deviation indicates that the data points tend to be very close to the mean; a high standard deviation indicates that the data is 'spread out' over a large range of values.

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