Tyres final report

Using waste tyre rubber in retreads at high inclusion rates

A new surface polymerisation technique now enables crumb rubber from waste tyres to be incorporated into retread compounds at much higher inclusion rates than before.

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Front cover photograph: An earthmover tyre retread built with 50% recycled compound.

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Executive summary

WRAP (Waste & Resources Action Programme) commissioned and funded a project to investigate the recycling of rubber from used tyres, and it's incorporation into a new compound for use in retreading large commercial and industrial tyres. The raw product used to manufacture tyres and rubber products is a mixture of virgin rubber and synthetic additives and is described as a compound. To date, technologies used in the manufacture of rubber compound have only achieved small percentages of inclusion of recycled rubber. Rubber Recovery (RR), a Barnsley-based recycling business, and Envirogen Technologies Ltd, the global development partner for Rubber Research Elastomerics Inc., owners of the proposed technology, suggested the use of a novel process that recycles rubber from waste tyres to produce a compound mixture of recycled rubber and virgin materials for use in retreading truck and earthmover tyres.

This project used the technology to provide a compound with an element of recycled rubber and manufactured retreaded tyres for laboratory and road-going wear trials on truck and large earthmover tyres. The trials were carried out by two organisations. Tun Abdul Razak Research Centre (TARRC), www.tarrc.co.uk manufactured the truck tyres and carried out laboratory and road-going tests. The earthmover tyres were retreaded by OTR Tyres Ltd of Alfreton (OTR), www.otr-tyres.co.uk, and fitted to dump trucks for trials on working construction sites and quarries.

The technology, whilst proven and in use in the USA and Australia, has not been used commercially in the UK. It is referred to as surface polymerisation. A specially formulated polymer system is deposited onto rubber particles to create a new compound. It allows previously vulcanized rubber to become reactivated into a new blend of part-uncured virgin rubber and part-vulcanized material. The surface polymerisation is easily integrated into the rubber process and uses standard industry equipment.

Laboratory and road trials

The TARRC method for use of the new compound was to manufacture the retreaded tyres at 40% and 50% content of recycled compound respectively and trial them against control retread tyres using industry-standard compounds and tread patterns. Controlled tests in laboratory and road trials provided a direct comparison between the new compound and commercially available tyres.

The OTR method similarly used the recycled compound to retread large earthmover tyres fitted to dump trucks to conduct wear tests in operational construction and quarry environments.

The trials commenced in January 2006 and were completed in June 2007.

The OTR project, whilst similar to that of TARRC, had different manufacturing parameters. OTR needed to retread large earthmover tyres requiring the compound to be extruded with sufficient adhesion or 'tack' to allow each layer to bond with subsequent layers. The first compound for testing did not have sufficient tack and further test samples were produced in an attempt to improve the tack. Various additives and combinations were trialled and with each amended sample the adhesive capacity improved. Once the correct level of tack had been achieved, the tyres were built and the operational trials commenced.

Until now, the inclusion of recycled rubber crumb in tyres has been limited to very small amounts – no greater than 15%. It has not been technically possible to increase this level without detrimentally affecting the tyres' operational characteristics. Surface re-polymerisation now offers a new option for re-using waste tyres in new and retread manufacture. Interest in this project and the products is growing and the results will help to persuade others of the use and capacity of recycled rubber.

Contents

1.0 Background

WRAP (Waste & Resources Action Programme) has commissioned a range of R&D, operational trials and demonstration projects to investigate specific issues relating to the recycling of rubber from used tyres and the development of alternative end uses for the material.

Unlike plastics, rubber cannot be re-formed and re-used through standard heat processes. Cured rubber molecules are linked together in long chains that cannot be easily broken and re-linked. Technologies to break the links and enable the cured rubber to be re-used have been tried in the past, with limited success rates or practical applications.

Barnsley-based company Rubber Recovery Ltd, part of Renew Holdings plc, and Envirogen Technologies Ltd proposed the use of an advanced process, originally developed in the USA, to treat vulcanized crumb rubber from waste tyres in order to make it chemically reactive with virgin compound, producing a technically competent compound with a significantly high recycled content.

To put the technology to the test, both road and off-road tyres were retreaded with the new compound and their performance compared to that of control tyres constructed with industry-standard compound.

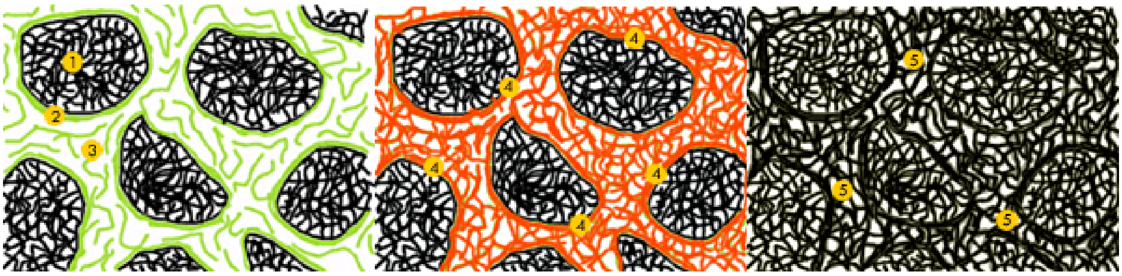
2.0 The surface polymerisation technology

This surface polymerisation technology is an innovative and specially formulated polymer system that can be surface-deposited onto a rubber particle to create a new compound. This new compounding tool offers many technical and physical advantages that are not currently available to the rubber compound manufacturer and the tyre manufacturing process.

The polymerisation system is a unique method that now allows previously vulcanized materials to be re-activated into a new master batch blend. A new composite and alternative feedstock material – part uncured virgin rubber and part vulcanized – is now possible by using these specially formulated low molecular polymers.

This surface coating technology not only enables previously vulcanized materials to be re-vulcanized, but also gives the rubber compound significant and unique physical properties. These improved physical properties are not currently attainable in the conventional manufacturing and rubber compounding process. The surface polymerisation process is easily integrated into the rubber compounding process and uses industry-standard equipment.

Figure 1 The surface polymerisation system results in a fully cured and cross-linked polymer



1 Base crumb particle
2 Reactive surface treatment
3 Virgin uncured compound

4 During cure, the surface treatment reacts, integrating particles into polymer matrix

5 End result: a fully cured and cross-linked polymer material.

The crumb used for the process is a high-grade 30 mesh produced from truck tyres specifically for this purpose. The procedure for liberating the crumb is ambient and involves effective removal of the steel and fibre elements of the tyre.

Once the crumb has been liberated it is introduced into the polymer coating process. The polymer is specially formulated with the required properties of the end product in mind and is capable of being tailored accordingly. The final result is a re-polymerised compound that can be provided in strip form or in flakes for compounding with virgin material at the required level suitable for the end use.

Whilst this study focuses on the use of re-polymerised crumb at 40% and 50% inclusion levels and specifically for use in retread compound, the technology is capable of producing compounds with up to 85% recycled crumb content whilst maintaining product integrity.

3.0 Methodology

The purpose of this trial was to establish the following:

- Can re-polymerised cured rubber be introduced into retread compound at high content levels and produce a workable product?
- Can the finished retread tyres compete with industry-standard tyres in real operational conditions?
- What are the benefits and detractors of the process and materials?

The trial was split into two distinct sections:

- road truck tyres
- earthmover tyres.

3.1 Road truck tyres

Though truck tyres were selected for the production of the re-polymerised rubber compounds in this case, passenger tyres can also be used to produce new hybrid compounds.

The re-polymerised compound for this trial was produced overseas using 30 mesh clean truck tyre crumb as a feedstock with the addition of specially formulated surface coating polymers.

The new compound was imported and delivered directly to the Tun Abdul Razak Research Centre (TARRC), who manufactured and the tyres and carried out laboratory and road-going tests. TARRC also mixed the control compound to the manufacturer's specification. This compound was then used to build control tyres to test against the recycled compound. TARRC have a small but replicated process that matches that of large commercial-scale tyre retreading companies.

TARRC also mixed the control compound with the recycled compound. This was used to retread equal numbers of truck tyres with batches of compound with 40% and 50% re-polymerised compound inclusion respectively.

Figure 2 The tyre buffing machine

Figure 3 A buffed tyre ready to be retreaded

The casings were buffed prior to retreading and then applied with either 50% recycled compound, 40% recycled compound or standard compound.

The tyres were then subjected to laboratory tests at TARRC, and fitted to dual axle tipper trucks belonging to a local transport firm for road trials. The recycled tyres were fitted to the two rear drive axles with control tyres fitted on opposite sides to the trial tyres to give similar wear conditions for comparison. TARCC engineers conducted monthly site visits to take wear measurements on the operational truck tyres. Their report is featured in Appendix 1.

3.2 Earthmover tyres

For this section of the trials, Rubber Recovery Ltd asked OTR Tyres in Derbyshire – Europe's leading earthmover tyre specialists – to produce a set of remoulds using compounds with a high recycled content.

The availability of tyre casings and the quantities of compound required suggested that the trials be carried out using 23.5 size earthmover tyres. These have an overall diameter in excess of 1.6m and OTR's specialist retreading equipment and expertise is required.

The OTR retread process employs a similar strip-winding method to that used for truck tyres. However, because of the larger section, there is a need to build a thicker layer of rubber onto the tyre carcass. This requires the extruded strip to have sufficient adhesion to allow a greater number of layers to stick to one another. The layers of strip compound also need to maintain their adhesion to the carcass whilst moving to and loading into the tyre mould.

The extruder needed some experimentation to assess the optimum compound strip properties. Therefore it was decided initially to import a small amount of the new compound to trial to ensure the build could be practically carried out.

25kg of the recycled compound was imported and extruded. This first pass lacked the tack required for OTR's unique process. TARRC offered its services to experiment with remixing and methods to improve tack. TARRC's research facility has small-scale tyre manufacturing capability but can closely monitor and analyse all aspects of the tyre manufacturing process. They re-milled the compound and added a resin in the amount of 3% by weight. This seemed to improve tack and mix. However, TARRC did not have the capacity to mill the larger amount of new compound.

Avon Rubber was approached for use of a larger mixing plant to re-mill and add resin on a larger scale. The re-milled compound with the addition of 3% tackifier was given to OTR for extrusion to assess tack levels. The test showed a tack improvement of 50% compared to the previous sample, although there was still insufficient tack to justify building the tyres at this stage. Further trials were required, and on receipt of more compound from overseas, testing resumed. The compound which was successfully tested at OTR included 6% resin and 2.5% natural rubber additives. This achieved sufficient tack to give OTR confidence that the tyres could be built. This prompted import of the remaining material for mixing at Avon Rubber.

Figure 4 Checking the trial compound for tack

OTR prepared the casings by peeling and buffing off the old tread and repairing minor damage to the steel cage before applying a thin layer of base compound to the tyre. This gives a tacky layer for the retread compound to adhere to. The retread compound is then extruded and pressed onto the rotating casing via a head roller. The tyre is then trimmed to remove excess compound and a 3mm sidewall veneer of ozone-protective rubber applied to provide an extra protective layer and improve the aesthetics of the tyre. The tyre is then transferred to the mould where it is inflated to 14 bar with nitrogen and steam-heated to between 140 and 150 °C for 4 hours to cure.

The completed tyres were fitted to Moxy articulated dump trucks. As in the road tyre tests, retread control tyres were fitted on opposite sides of the axles to the test tyres to give fair comparisons of wear. In addition, wear data was recorded from new non-remould tyres to compare to the retreads. The dump trucks were operated on a brownfield remediation contract in a harsh operating environment, to best show the capabilities and limitations of the recycled compound.

4.0 Findings

4.1 Truck tyres

TARRC was tasked with using the new compound to re-retread truck tyres and conduct both laboratory and service trials, including fitting them to tipper trucks in order to carry out road-going wear tests over a period of time.

Initial comments from the TARRC tyre builders were that the new compound seemed to have a grainier surface texture than in the case of virgin compounds. However, under extrusion and strip building the new compound performed well. The tyres, when moulded under the specified temperatures, cured well to produce a finished tyre. The manufacture and laboratory tests were carried out successfully. Tests showed that the new compound cured in 8 minutes as opposed to the control compound, which cured in 10 minutes; i.e. there was a reduction in cure time and energy usage of 20%. This reduction in cure and energy offers future significant savings in the tyre process using re-polymerised rubber.

TARRC then fitted tyres to the tipper trucks and took measurements of tyre wear throughout the summer, issuing their final Service Wear Trials Report in November 2006 (see Appendix 1).

The results indicate that on the low to medium severity applications, i.e. third axle of the tipper wagons in this study, the inclusion of 40% re-polymerised crumb into virgin tyre tread compound has the effect of reducing rolling resistance by almost 20%, giving an expected fuel saving of 3–5%, whilst in addition exceeding the predicted service life of the tyre by up to 20%.

Results from the high severity applications, i.e. the fourth axle of the tipper wagons in this study, indicated that the inclusion of re-polymerised crumb at 40%, whilst achieving the lower rolling resistance and associated fuel saving benefits, also resulted in a reduction in the predicted service life of the tyre of 25% compared to the control tyres.

The increase to 50% inclusion of re-polymerised crumb within the tread compound further reduced rolling resistance by a marginal amount; however the predicted tyre service life dropped to between 50% (high severity applications) and 66% (low to medium severity applications) of that of the control tyres.

Though the findings here have indicated a tyre with 50% inclusion of re-polymerised crumb wears faster than the control, both the 40% findings and also extensive testing overseas show the opposite is true, with 50% re-polymerised tyres outperforming the control tyres. Further evaluation is needed with the 50% level of re-polymerised crumb to assess if this test tyre had a slightly softer compound because of the faster curing of the re-polymerised compound. Generally, other data indicate that 50% re-polymerised tyres have worn at a slower rate than virgin control tyres.

For the full results please see Appendix 1.

4.2 Earthmover tyres

In this trial, OTR was tasked with building earthmover tyres with 40% and 50% recycled compound respectively, as well as a number of control tyres for comparison purposes.

In order to build an earthmover tyre there needed to be sufficient tack from the re-polymerised crumb compound. The layers of extruded compound need to be able to adhere to the buffed tyre casing and to each other prior to loading the tyre into the mould.

Achieving the correct level of tack proved to be the biggest delay to the project. It was important to ensure not only that the extrusion had sufficient tack to enable the tyre build, but also that the additives used to achieve the tack were not likely to compromise the effectiveness of the re-polymerised crumb compound.

A trial mixing of the compound was conducted at the end of November 2006 and the first earthmover casing successfully retreaded with the compound at the beginning of December.

The final mixing of the compound was carried out in early January 2007 and the tyre build at OTR commenced immediately afterwards. Although the build was problem-free, the retread operatives noted that the compound was still not as tacky as virgin compound and had a grainier appearance.

The operators are familiar with the way their standard compound performs and have pre-set ideas, and so were very cautious to embrace the concept of the new compound. However, the compound retained sufficient tack to build the retread and once the casing had been removed from the mould, the completed tyre was virtually indistinguishable from the control tyres. Aesthetically, there is a slight dullness to the finish of the recycled tyre compared to new, but this would become irrelevant after first use.

The cure times were maintained the same as for OTR's premium compound for all the tyres, even though the re-polymerised crumb can offer up to 20% shorter cure times, as recorded during the truck tyre build. Future trials could include the use of thermocouples within the tyre during the moulding process to record the optimum cure time. A 20% reduction in cure time in OTR's environment would save 50 minutes per tyre and allow another 2 tyres to be moulded during a typical 8-hour shift.

Darren Flint, OTR's Production Manager, confirmed that the compound had performed well, with flow characteristics the same as the company's premium compound and giving a smooth finish to the cured tyre.

Figure 5 The tyres retreaded with recycled content performed well in tough conditions

The tyres were fitted to Moxy 3-axle dump trucks operating on a remediation contract in South Yorkshire. Although the site is relatively small, conditions were demanding with abrasive surfaces such as crushed concrete, as well as mud and slurry

The initial results from March 2007 showed the recycled tyres suffering no significant lack of performance against OTR's premium compound, and in fact showed an improvement in most cases over new tyres. OTR's compound performed best on the front axles, the 40% recycled compound performed best on the middle axles and the 50% compound best on the rear axles. Overall, the OTR compound gave the most hours of use per mm of wear (89.41). The 50% recycled compound achieved 84.44hrs/mm; brand-named new tyres 68.4hrs/mm and the 40% compound 63.33hrs/mm.

The final measurements were taken at the end of June 2007 and only the tyres fitted to the rear axles had suffered any significant wear. The lack of wear can be attributed to the site conditions throughout most of the trial period, where heavy rain created soft, heavy ground and slurry that had the effect of reducing abrasion to the tyres.

Despite the site conditions, overall the tyres that had been retreaded with 50% recycled re-polymerised crumb and those with OTR's premium compound suffered the least wear (147.48hrs/mm). The 40% recycled compound tyres achieved 135.68hrs/mm and the new tyres 122.55hrs/mm.

Performance on individual axles varied from the overall results in that the OTR compound tyres performed best on the front axles and the 40% recycled compound on the middle & rear axles. The poorer performance of the 40% compound on the front axles increased the overall wear result, whilst the 50% compound resisted wear well in all tyre positions.

These results (shown in Appendix 2) prove that re-polymerised crumb can be successfully used to manufacture quality earthmover tyres with performance levels that can compete with new tyres and those using premium retread compounds.

5.0 Summary

Waste recycling is emerging as one of the fastest-growing sectors in industry today, and at approaching 500,000tpa, tyres are a significant potential resource. However, unlike recycled plastics, markets for recycled crumb rubber are limited primarily due to the non-thermoplastic nature of rubber.

This project has shown the potential for recycled crumb rubber to be treated with a polymer process enabling the incorporation of significant proportions back into virgin compound with limited, if any, negative effects to compound performance. In fact, positive benefits that are not available with the original compound have been identified with the use of the re-polymerised crumb. The re-polymerisation process offers promising potential for addressing the waste tyre problem by converting waste tyres into renewable materials for tyre manufacture.

The TARRC testing showed impressive results for tyres with 40% recycled content on low and medium severity applications. However the testing also showed that truck tyre life using the new compound did reduce at 50% inclusion. Lower inclusions of 30%, for instance, may well prove more resilient whilst still incorporating significant percentages of recycled crumb. A retest of the 50% inclusion should be considered with the 50% tyre cured at the same time and temperature as the virgin control tyre.

The OTR trial proves competitively low wear rates on the tyres with a recycled content. In this case, the 50% inclusion of re-polymerised crumb provides a better overall performance in comparison to the 40% inclusion and achieved a performance equal to OTR's premium compound and outperformed a new tyre.

The disparity between the truck and earthmover trial results may be as a result of differences in the application severity and further trials are likely to be conducted to confirm performance under a variety of conditions. However, this study has demonstrated that high percentages of rubber crumb can be re-polymerised and incorporated back into virgin compound with a resulting specification that competes with the current market-standard compounds.

Thanks must go to Rubber Research Elastomerics Inc. for making their technology available for these trials and to Envirogen Technologies Ltd for their role in the project inception and development.

OTR, TARRC, Avon Rubber are also to be thanked for their enthusiasm and support throughout the project, the results of which will hopefully dispel some of the scepticism within the rubber manufacturing industry over the use of compound with a high recycled content.

Appendix 1 TARRC Report

Summary of work conducted by TARRC March–November 2006: Tyre Service trials

Introduction

This WRAP project is to study the effect of replacing a portion of the material in a commercial vehicle tread compound with treated crumb rubber derived from waste tyres (re-polymerised crumb). The re-polymerised crumb was added as a direct replacement for masterbatch rubber in the finalising stage of compound mixing. Re-polymerised crumb was added at 40% and 50% of the compound, and the virgin compound was used to build the control tyres.

Tyres

The tyres built in the first quarter of 2006 were fitted to dual drive axle tipper lorries that experienced mixed road conditions (mainly highway), transporting road chippings. These vehicles have 4 axles, 2 steer axles with 2 tyres/axle and 2 drive axles with 4 tyres/axle. The test tyres were fitted to both drive axles, axles 3 and 4. The two drive axles offer two different severities of service, the 4th axle being generally described as high severity wear and the 3rd axle as medium severity wear. The difference in severity arises from the amount of scrubbing experienced by the tyre in manoeuvres; tyres on the third axle tend to roll more whilst those on the fourth suffer a lot more sideways scrubbing.

Rolling Resistance

The tyres were tested to the ISO method: tyres run at a constant speed and load for a 90-minute warm-up period, then drive torque is measured under the prescribed load and in a skim mode (<20kg load). The difference between these two values is the rolling resistance. Four separate readings, separated by sufficient time for the tyre to return to equilibrium running conditions, were taken and the average of the last 3 is reported below.

The ISO standard reports the rolling resistance in terms of the kgf at the rim.

	Control	40%	50%
Value, kgf	26.25	21.39	20.82
Rating vs control	100	81.5	79.3

The observed 20% reduction in rolling resistance would be expected to give a 3–5% reduction in fuel use, depending on the service conditions; mainly urban or mainly highway.

Service Trial Results

The tyres were measured 2 months after fitting and then monthly. Unfortunately, one of the controls suffered a casing failure in the 40% re-polymerised crumb trial.

The predicted mileages in the tables below are determined from the average wear rate to the time when the tyres were removed, using 14mm of tread available for wear (2mm tread left).

Plots of the service trial data are included below.

40% Re-polymerised crumb

Table 1: Predicted tyre service life 40% re-polymerised crumb: 3rd axle

3rd Axle	Control Inner	Control Outer	40% inner	40% outer
Service life, km	39,400*	45,700	51,200	54,400
Rating			108%*	120%

*This figure is based upon the first 4mm of wear of the control tyre. Over the service life of a tyre the wear rate usually reduces, so that over the life of the tyre its predicted service increases. For the 40% inner tyre the increase was 25%, thus it is fair to estimate a service life of 47–49,000 km for the control, hence a rating of 108%.

Table 2: Predicted tyre service life 40% re-polymerised crumb: 4th axle

4th Axle	Control Inner	Control Outer	40% inner	40% outer
Service life, km	36,900	41,800	27,800	31,800
Rating			75%	76%

The compound with 40% re-polymerised crumb exceeds the performance of the control compound (which makes up the other 60% of the material in the test tyres) on the lower severity 3rd axle, but not on the high severity 4th axle, where the results are almost the opposite.

50% Re-polymerised crumb

Table 3: Predicted tyre service life 50% re-polymerised crumb: 3rd axle

3rd Axle	Control Inner	Control Outer	50% inner	50% outer
Service life, km	93,500	76,000	51,900	49,800
Rating			56%	66%

Table 4: Predicted tyre service life 50% Re-polymerised crumb: 4th axle

4th Axle	Control Inner	Control Outer	50% inner	50% outer
Service life, km	49,800	55,400	22,900	27,300
Rating			46%	49%

50% replacement of the control material with re-polymerised crumb is not successful; the wear rates are much higher than those of the control compound.

Conclusion

Re-polymerised crumb material can be used to replace a significant proportion of a truck tyre tread compound to give a material that can match or even exceed the performance of the parent compound in certain applications. At 40% replacement the tyres perform well on the 3rd, less severe, axle of the tipper trucks, predicted tyre life being 10–20% better. However, on the 4th axle the tyres with 40% replacement wore 25% faster, giving only 75% of the service life of the parent.

For these applications, 50% replacement of parent compound with re-polymerised crumb is not successful; service lives are one-half to two-thirds of the control.

It appears that increased re-polymerised crumb content or severity of service conditions both reduce the relative performance. There is a crossover point where the tyre tread with re-polymerised crumb in the formulation outperforms the tyre tread containing the virgin compound alone.

The rolling resistance of the tyres with re-polymerised crumb is some 20% lower than in the control tyre, there being little difference between the two loadings studied.

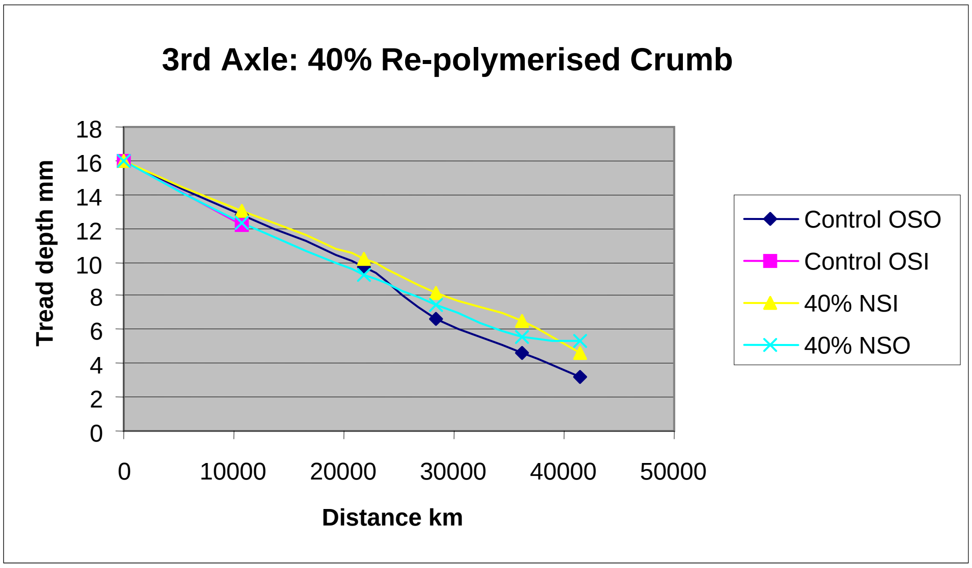
Comments and Recommendations

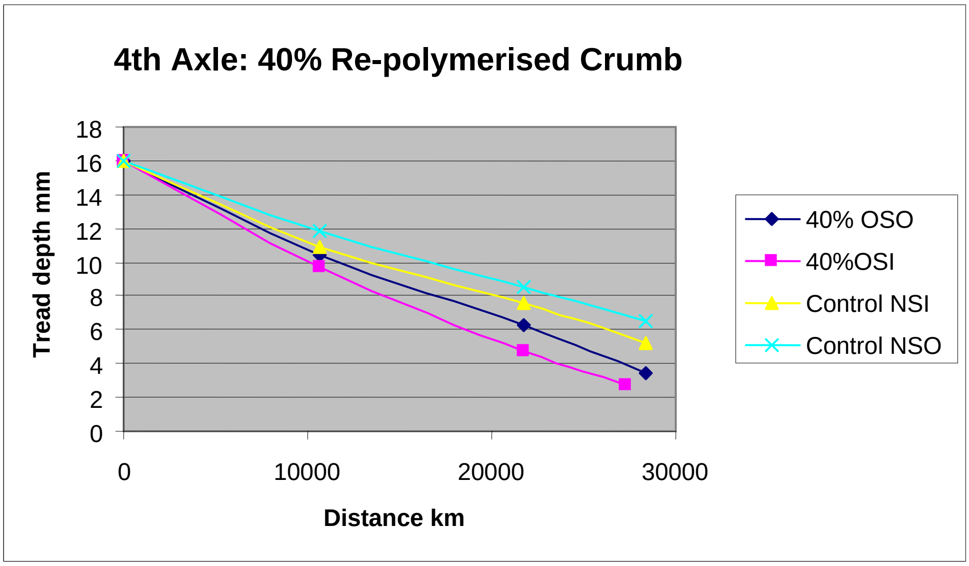
Replacing 40% of the virgin material with re-polymerised crumb in the final stage of mixing gives a tread compound that offers 20% reduction in tyre rolling resistance (3–5% fuel saving) without compromising wear performance in low to medium severity applications. In addition to the saving in raw materials, use of re-polymerised crumb thus offers a significant reduction in the energy used by the vehicle during the life of the tyre and might also offer a higher service mileage.

For high severity applications, where wear is worse, the fuel savings offered by the tyre with re-polymerised crumb might not offset the reduced service life. It is, however, reasonable to assume that a compound with 30% re-polymerised crumb would still offer significant fuel savings but might also improve the wear performance relative to the virgin compound. Road service trials would be needed to confirm this.

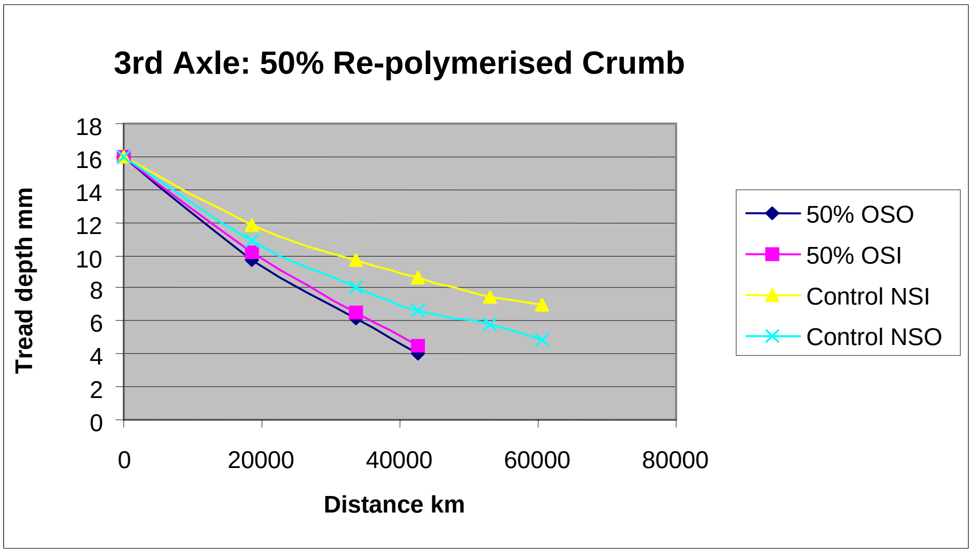
For low severity applications, such as those experienced by trailer tyres, it is possible that a tread compound containing 50% re-polymerised crumb might match the wear of the virgin compound, but this would need to be checked. It would certainly give fuel consumption benefits.

Wear data: 40% Re-polymerised crumb





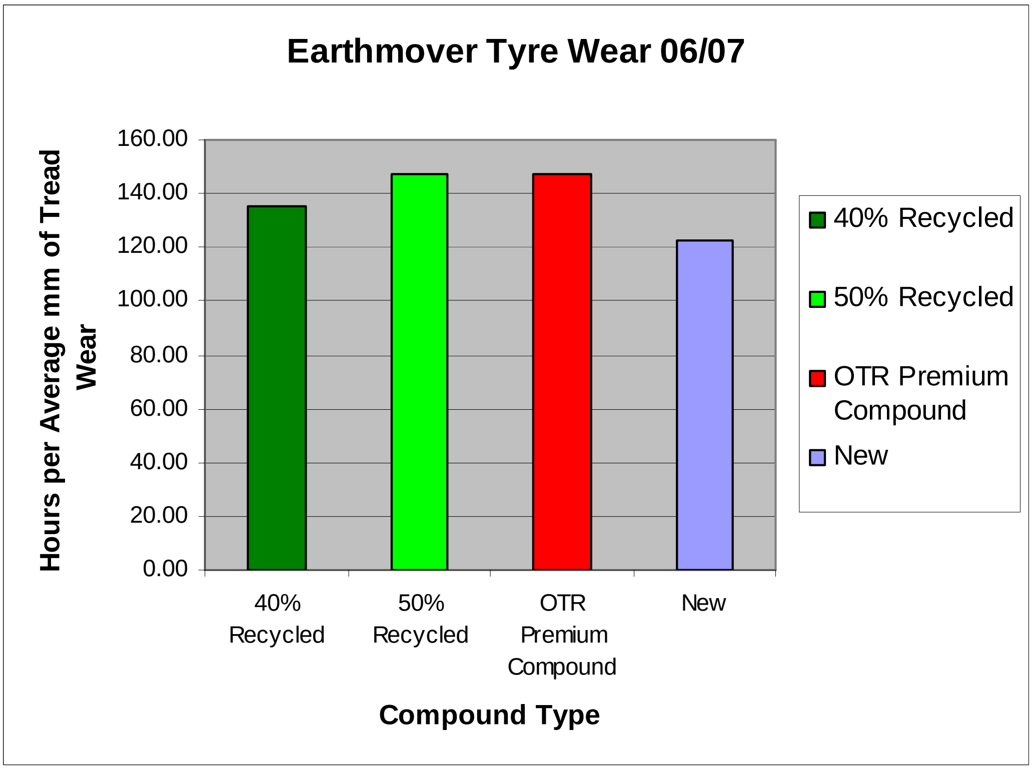
Wear Data: 50 % Re-polymerised crumb



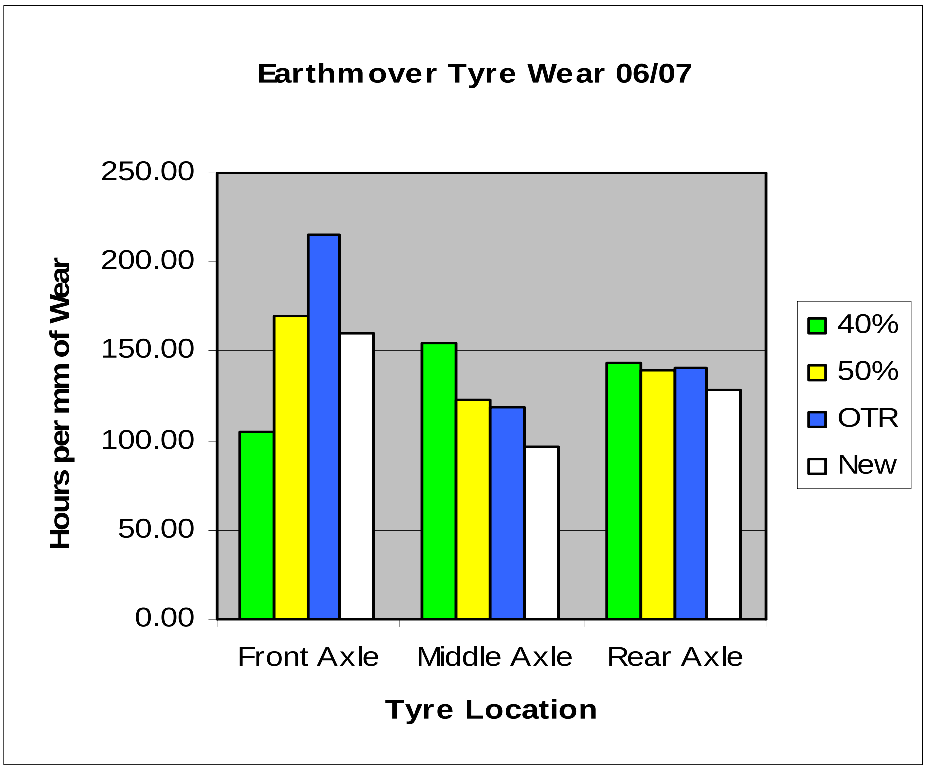
Appendix 2 Earthmover tyre service trial results

Final Results – June 2006

WRAP/Rubber Recovery Ltd								
Earthmover Service Trials - Final Results								
Fleet No	Size	Position	Compound	T/D Start	T/D Remaining June	Diff	Hrs Used	Average Hrs Per MM
946	23.5R25	Front left	40% Recycled	40	32	8	835	104.38
946	23.5R25	Front right	50% Recycled	40	35	5	835	167.00
946	23.5R25	Middle left	40% Recycled	40	35	5	835	167.00
946	23.5R25	Middle right	OTR RTDN	40	33	7	835	119.29
946	23.5R25	Rear left	50% Recycled	40	34	6	835	139.17
946	23.5R25	Rear right	OTR RTDN	40	34	6	835	139.17
947	23.5R25	Front left	New tyres	44	38	6	960	160.00
947	23.5R25	Front right	New tyres	44	38	6	960	160.00
947	23.5R25	Middle left	New tyres	44	34	10	960	96.00
947	23.5R25	Middle right	New tyres	44	34	10	960	96.00
947	23.5R25	Rear left	New tyres	44	36	8	960	120.00
947	23.5R25	Rear right	New tyres	44	37	7	960	137.14
948	23.5R25	Front left	50% Recycled	40	35	5	861	172.20
948	23.5R25	Front right	OTR RTDN	40	36	4	861	215.25
948	23.5R25	Middle left	40% Recycled	40	34	6	861	143.50
948	23.5R25	Middle right	50% Recycled	40	33	7	861	123.00
948	23.5R25	Rear left	40% Recycled	40	34	6	861	143.50
48	23.5R25	Rear right	OTR RTDN	40	34	6	861	143.50



Earthmover Tyre Wear 06/07
Hours per Average mm of Tread Wear
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
40% Recycled
50% Recycled
OTR Premium Compound
New
Compound Type
40% Recycled
50% Recycled
OTR Premium Compound
New



Earthmover Tyre Wear 06/07
Hours per mm of Wear
250.00
200.00
150.00
100.00
50.00
0.00
Front Axle
Middle Axle
Rear Axle
Tyre Location
40%
50%
OTR
New

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