Tire Rubber Chemicals Market 2018

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Sample Report

Full Report: 170 Pages, 72 Figures, 159 Tables
+ Excel Workbook

Please refer to report contents in separate document for full details on sections, tables and figures

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2 EXECUTIVE SUMMARY

This summary details tire rubber chemical volumes in kMT (thousands of metric tonnes) and values in MM$ (millions of United States Dollars, USD).

2.1 SCOPE

Tire Rubber Chemicals: The following rubber chemical groups are analysed: Plasticisers, antidegradants, curatives, process aids, coupling agents, bonding agents and reinforcing resins used in tire rubber compound preparation. Each rubber chemical group is segmented into appropriate subgroups.

Excluded: Elastomers, fillers and specialist additives.

Markets: The tire market for rubber compounds including main tire types and subtypes.

Geographies: Global split by RCCL defined regions: Africa, China, CIS, Europe, India, Middle East, North America, North Asia, South America and South Asia.

Time Frame: Years 2011 to 2030.

Market Volumes: Volumes for 2011 to 2017 are determined and validated against historic usage patterns. Volumes for 2018 to 2030 are projected using stated modelling techniques. Market volumes are provided globally and regionally by rubber chemical group and subgroup.

Market Prices: Average weighted 2017 regional market prices are provided for each rubber chemical group and subgroup. Average weighted pricing is provided for APAC, EMEA, NAFTA and S. America.

Market Values: Market values for 2017 are estimated from weighted average pricing by rubber chemical subgroup. Market values for 2023 and 2029 are estimated using 2017 prices projected by yearly volume.

2.2 OBJECTIVES

The key report objectives are as follows:

- Provide an overview of tire rubber chemicals and their use.
- Provide an overview of the tire rubber chemical industry.
- Analyse past, present and future market drivers for tire rubber chemicals.
- Analyse and contrast 2017 tire rubber chemical market prices by region.
- Analyse tire rubber chemical volumes for 2011 to 2030
  - By region, chemical group, chemical subgroup.
- Analyse tire rubber chemical market values for 2017, 2023 and 2029.
  - By region and chemical group, chemical subgroup.
2.3 Market Drivers

A summary of key market drivers is presented in Figure 2.1. Each of these is addressed below.

Figure 2.1 - Tire Rubber Chemical Market Drivers

2.3.1 Mobility Megatrend

Tire ********* and ***** demand ** clearly ***** directly ** tire ***** chemical *****. Current *** future ******** megatrends ******** a **** rise ** tire ***** in ************ regions. This ** coupled **** associated ******** in ***** mix *see *** below* which ** regionally **********.

2.3.2 High Value Added (HVA) Products

The ********* for *** products ********* depending **** the **** manufacturer. One ***** thread ** the ***** towards ***** diameter* lower ***** ratio ***** for ** and *** vehicles. This ** also ******** influenced ** the *********** market ******** for *** tires **** PC *****. These *** trends ***** increased ******** usage *** to *** increase ** tire *****. HVA ******** differentiate *********** via *********** characteristics ***** can ** strongly ********** by ***** chemical **********. Other **** value ***** types ***** aero* motorcycle *radial* and ***-the*road ****, these *** expected ** have ***** growth ***** as **** as ***** significant *** chemical ***** interest.

2.3.3 Sustainability

Leading **** companies **** individual ************ policies ******** on **** business ********* and ** fit **** UN ********** goals. Sustainability ********* are *********** broader **** simple ******** sourcing ***** such ** renewable ***********. Current **** is ** natural ********, however* leading **** companies **** stated ***** intent * increase *********** and ********** content ** their ****. Individual **** company ******** are ***** to ***** in *** with *********** developments ** ensure ********** supply. Higher ***** rubber ********** will ***** certainly ** the *****, therefore ******** are ***** to ***** in *** plasticiser **********.

2.3.4 Safety, Health & Environment

Rubber ********* appearing ** regional *substances ** concern’ ***** are ** focus ** efforts **** a ***** and ***** prospective. This ******** bonding ******, antidegradants *** curatives. From ** environmental ***** tire ********* are ***** much ******** on ** use ***** of * tire ***** is ********** for **** **% ** energy **********. This *** complicates ** whole *********** issue ***** there *** be ********** between ** material ********** and ********** in **.

2.3.5 Market Evolution

Vehicle ********** will ** a ********* driver *** tire ********** and ********** rubber ******** use. Technologies **** do **** with **** material **** become **** important. Intelligent ******** which *** with *solutions ********** will ***** more ********** in ** future.
2.4 MARKET VOLUMES

A global overview of market volumes by rubber chemical group and type is presented in Figure 2.2. The groups presented descending volumes. Plasticisers substantially market compared curatives. These groups substantially volumes to other.

The combined 2017 market volume for all chemical groups was kMT.

Figure 2.2 - Summary Market Volumes by Rubber Chemical Group & Type 2011 to 2029

The following sections look at each individual group:
2.4.1 Plasticisers
The 2017 market volume for plasticisers was estimated at **** kMT.

- Short Term (2017/23) Prospects
  - % CAGR******kMT
- Long Term (2023/29) Prospects
  - % CAGR, *** kMT growth

Highest short term (2017/23) growth plasticisers (kMT)

******* ****) > **** ***** = ***** ****) > *********** ***)

Highest short term 2017/23 growth by CAGRs (%):

**** **.6* * ********* **.6* * ***.5* * *** **.9*

*Figure 2.3 - Plasticiser Market Volumes by Type 2011 to 2029*

Note: true RAE volumes may be higher, the volumes reside in the DAE entries.

2.4.2 Curatives
The 2017 market volume for curatives was estimated at 1935 kMT.

- Short Term (2017/23) Prospects
  - % CAGR* *** *** ********
- Long Term (2023/29) Prospects
  - % CAGR, *** kMT growth

Highest short term 2017/23 growth by absolute volume (kMT):

*** ****) >> ******** ***** ****) > ***. ***** ***) > ************* ***)

Highest short term 2017/23 growth by CAGRs (%):

***** ***.8%* ***. ********* **.9%* *** * *.*. ********* * ********** **.6%

*Figure 2.4 - Curative Market Volumes by Type 2011 to 2039*
2.4.3 Antidegradants
The 2017 market volume for antidegradants was estimated at 582 kMT.

- Short Term (2017/23) Prospects
  - %.*** CAGR *** *** ******

- Long Term (2023/29) Prospects
  - %.** CAGR, *** kMT growth

Highest short term 2017/23 growth by absolute volume (kMT):

```
***** **** >> *** *** >> *.*** (***) >> *.*** (***) >> ***** *** ***
```

Highest short term 2017/23 growth by CAGRs (%):

```
*.*** (*.5* **** **.6* **.3* **.5* ****** **.4* *.*** (*.2*
```

*Figure 2.5 - Antidegradant Market Volumes by Type 2011 to 2029*

2.4.4 Process Aids
The 2017 market volume for process aids was estimated at 306 kMT.

- Short Term (2017/23) Prospects
  - *.** CAGR ** *** ******

- Long Term (2023/29) Prospects
  - *.** CAGR, ** kMT growth

Highest short term 2017/23 growth by absolute volume (kMT):

```
*********** *** >> ***** **
```

Highest short term 2017/23 growth by CAGRs (%):

```
*********** **.5* **** **.3*
```

*Figure 2.6 - Process Aid Market Volumes by Type 2011 to 2029*
2.4.5 Bonding Agents
The 2017 market volume for bonding agents was estimated at 168 kMT.

- Short Term (2017/23) Prospects
  - *.% CAGR* *** ***
- Long Term (2023/29) Prospects
  - *.% CAGR, ** kMT growth

Highest short term 2017/23 growth by absolute volume (kMT):

- ** ***** ***) > ******** **) > ***** **)

Highest short term 2017/23 growth by CAGRs (%):

- ** ***** * ******** **.7% * ******** **.8*

*Figure 2.7 - Bonding Agent Market Volumes by Type 2011 to 2029*

2.4.6 Reinforcing Resins
The 2017 market volume for reinforcing resins was estimated at 80 kMT.

- Short Term (2017/23) Prospects
  - *.% CAGR* *** ***
- Long Term (2023/29) Prospects
  - *.% CAGR, ** kMT growth

Highest short term 2017/23 growth by absolute volume (kMT):

- ******** **) >> ******** **) > ***** **.5*

Highest short term 2017/23 growth by CAGRs (%):

- ******** **.4* * ******** **.1* * ******** **.8*

*Figure 2.8 - Reinforcing Resin Market Volumes by Type 2011 to 2029*
2.4.7 Coupling Agents
The 2017 market volume for coupling agents was estimated at 90 kMT.

➢ Short Term (2017/23) Prospects
  o **.3% CAGR**

➢ Long Term (2023/29) Prospects
  o **.1% CAGR, 2 kMT growth**

Highest short term 2017/23 growth by absolute volume (kMT):

******** ******* ******* ******* ******* ******* ******* ******* ******* ******* ******* *******

Highest short term 2017/23 growth by CAGRs (%):

******* **.3* ****** ****** ****** ******

* Figure 2.9 - Coupling Agent Market Volumes by Type 2011 to 2029
2.5 Market Values

A global overview of market values by rubber chemical group and type is presented in Figure 2.10. The groups presented descending values. Ranking different groups to market (2.4) due to changes in prices. The group the value followed plasticisers antidegradants.

The combined 2017 market value for all rubber chemical groups was MM$.

Figure 2.10 - Summary Market Values by Rubber Chemical Group & Type 2017, 2023, 2029
2.5.1 Plasticisers
The 2017 market value for plasticisers was estimated at **** MM$. The highest short term (2017/23) value growth was:

Naphthenic ****) > **** (*** > DAE ****) > *** (**)

Figure 2.11 - Plasticiser Market Values by Type 2017, 2023, 2029

2.5.2 Curatives
The 2017 market value for curatives was estimated at **** MM$. The highest short term (2017/23) value growth was:

Zinc ***** (***) > Sulphenamides ****) > ***. Sulphur ****) > ******** Acid ***

Figure 2.12 - Curative Market Values by Type 2017, 2023, 2029

2.5.3 Antidegradants
The 2017 market value for antidegradants was estimated at **** MM$. The highest short term (2017/23) value growth was:

**** (*** > ***** PPD ***) > *** (** > M. Wax ***)

Figure 2.13 - Antidegradant Market Values by Type 2017, 2023, 2029
2.5.4 Process Aids
The 2017 market value for process aids was estimated at *** MM$.

Figure 2.14 - Process Aid Market Values by Type 2017, 2023, 2029

2.5.5 Bonding Agents
The 2017 market value for bonding agents was estimated at *** MM$. The highest short term (2017/23) value growth was:

RF ***** (**) > Cobalt ***** (**) > Melamine ***** (**)  

Figure 2.15 - Bonding Agent Market Values by Type 2017, 2023, 2029

2.5.6 Reinforcing Resins
The 2017 market value for reinforcing resins was estimated at *** MM$. The highest short term (2017/23) value growth was:

Novolak **) > ******** (*.4) * Resole **.4*  

Figure 2.16 - Reinforcing Resin Market Value by Type 2017, 2023, 2029
2.5.7 Coupling Agents
The 2017 market value for coupling agents was estimated at *** MM$.

Figure 2.17 - Coupling Agent Market Values by Type 2017, 2023, 2029

2.6 INDUSTRY OUTLOOK
The **** production ******** has ********** significant ***** in *** past *** decades* with ********* of ********** volumes ** APAC *China ** particular*. These ******** were ********* focused ** commodity *********. This ******** has ******** significantly ** recent *****, the **** of ***** towards **** value ***** (*** products in **** region ** accelerating. In *****, additional ***** by *** government ** enforce ******** environmental *********, along **** forthcoming *********** for **** labelling* will ***** changes ** the ***** chemical ***** chain *** rubber ******** product **.

From *** tire ************* perspective* future ************* for ***** mobility *** raising ********* regarding *** material ***** security. This ***** with ********* public ************* awareness ** leading ** development ** sustainability ******** with **** spans ** some ********* out ** ****. Tire ********* have ********* in *** first ********* on ******** rubber ***********, however* focus ** likely ** shift ** other ********* as **** progresses. From * rubber ******** perspective**** company’s ************* focus ** most ********* to **** on **** volume *********, such ** plasticisers* as **** provides ** biggest ************* change ** helps **** towards ***** sustainability *********.

Sustainability ** be ******** and ********* in **** ways. A ***** driver *** tire ************* is *** recognition **** most ** the ********** impact ** a **** occurs ** use* therefore * significant ***** is ** rolling ******** reduction *** elimination ** materials ***** may ***** the ************. It ** clear *** the ************* of * sustainable ******** can ** somewhat **********.

Examples *********: a ******** derived ******** which ** manufactured ********* could ** some **** be ********** sustainable* a ***-renewable ******** which *********** to **** energy **** in **** use **** also ** considered ***********. Current ********** purchasing ********* from **** companies ********* the ******** of ******** technologies* however* it ***** be ********* that ***** policies **** evolve ** newer ******** technologies *****.

Environmental ***********, in ********** to **************, included ********** and*or *********** of *********** which *** on ********** of ******** lists. The **** industry ** slow ** adjust ** these ******** due ** the *********** of ******** offerings *** inherent ******** safety
************. Additional ************ also **** different ************ frameworks ************ upon *** region*country ** manufacture. The **** of ***** is ******** fastest ** Europe* followed ** other ***** markets *** slowest ** the ************ nations. The **** recent ************ in **** area *** the *** tire **** adhesives ***** have **** developed ** several ******** tire ********, this **** accelerate ******** in *** dry ******** chemical *****.

Tire ************ remains *** strongest ***** for **** design *** material *****. This ** particularly **** for *** more ************* advanced **** manufacturers ***/or *** HVA ******** segments. This ** an **** which *** seen ***** in ***** chemical ******** offerings ********* at ************* specific **** performance **********. A **** example ** this ** the ******** replacement ** standard ************ with ************ performance**********. Targets ** this *** tread *** apex **********, especially ** selected ** and *** tire **********.

Potential ************ come **** market ************ which *** many ************ routes *** outcomes. Vehicle ************ is ********* a ***** consideration **** the ************ to *** a ************ influence ** tire ******** choice ** design ** the ***** decades. Car *** and ************ may **** radically *****, especially ** view ** the ***** tendency *** populations ** concentrate ** urban *****. This *** impact ***** term **** growth *** influence ***** megatrends ** the ***** term.

Given *** above ************, it ** likely the **** of *****, in * historically ************** industry* will ***** pace ** the ***** decades.
3 INTRODUCTION

This section provides the framework for this market research report. Definitions and scope provide critical components necessary for a clear understanding of the report and conclusions. The objectives provide the building blocks for the market report. Information sources allow the user to understand the level of detail and reliability of the data.

3.1 DEFINITIONS, ABBREVIATIONS AND NOMENCLATURE

Definitions, abbreviations and nomenclature are provided in Table 3.1.

<table>
<thead>
<tr>
<th>Item</th>
<th>Definition/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3PMSF</td>
<td>The Three Peak Mountain Snowflake label found on winter tires and all weather tires.</td>
</tr>
<tr>
<td>6PPD</td>
<td>(N-(1,3\text{-dimethylbutyl})-N'\text{-phenyl-p-phenylenediamine.}</td>
</tr>
<tr>
<td>AMS</td>
<td>Alpha methyl styrene type tread performance resin.</td>
</tr>
<tr>
<td>API</td>
<td>American Petroleum Institute.</td>
</tr>
<tr>
<td>AS</td>
<td>All Season tire type. This covers tires with M+S tire labelling.</td>
</tr>
<tr>
<td>AW</td>
<td>All Weather tire type. This covers tires designed for all weathers which includes snow performance. These tires have the 3PMSF label indicating measurable and standardised snow and low temperature performance.</td>
</tr>
<tr>
<td>CARB</td>
<td>California Air Resource Board Regulation.</td>
</tr>
<tr>
<td>CoRAP</td>
<td>European Union community rolling action plan list. This is part of the process for evaluating substances of concern in the European Union.</td>
</tr>
<tr>
<td>CIS</td>
<td>CIS Countries plus countries outside of the Europe and EFTA. (Albania, Armenia, Azerbaijan, Belarus, Bosnia, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Montenegro, Russia, Serbia, Tajikistan, Ukraine, Uzbekistan)</td>
</tr>
<tr>
<td>DAE</td>
<td>Distillate aromatic extract oil.</td>
</tr>
<tr>
<td>Eco</td>
<td>Eco tires represent tires manufactured in energy and resource efficient factories. These tires typically incorporate a proportion of sustainable materials and also provide environmental credentials through low rolling resistance. In the case of truck tires there is also significant importance placed on retreading and case life.</td>
</tr>
<tr>
<td>EFTA</td>
<td>European Free Trade Association.</td>
</tr>
<tr>
<td>ELT</td>
<td>End of life tires.</td>
</tr>
<tr>
<td>EPA</td>
<td>USA Environmental Protection Agency.</td>
</tr>
<tr>
<td>Europe</td>
<td>Countries of the European union plus EFTA.</td>
</tr>
<tr>
<td>GADSL</td>
<td>Global automotive declarable substance list.</td>
</tr>
<tr>
<td>GTRCDDB</td>
<td>RCCL’s Global Tire &amp; Rubber Chemicals Database.</td>
</tr>
<tr>
<td>HBU</td>
<td>Heat build-up.</td>
</tr>
<tr>
<td>HC</td>
<td>Hydrocarbon type tread performance resin.</td>
</tr>
<tr>
<td>HMIII</td>
<td>Hexamethoxymethylmelamine bonding agent for use with Novolak phenolic resins.</td>
</tr>
<tr>
<td>HMT</td>
<td>Hexamethyleneetetramine bonding agent for use with Novolak phenolic resins.</td>
</tr>
<tr>
<td>HP</td>
<td>High Performance tire. These are tires with speed ratings of H and V.</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------</td>
<td>------------</td>
</tr>
<tr>
<td>HVA</td>
<td>High Value Goods.</td>
</tr>
<tr>
<td>IPPD</td>
<td>N-isopropyl-N'-phenyl-p-phenylenediamine.</td>
</tr>
<tr>
<td>India</td>
<td>Mainland India.</td>
</tr>
<tr>
<td>kMT</td>
<td>Thousands of metric tonnes.</td>
</tr>
<tr>
<td>LATAM</td>
<td>Latin America (South America, Central America) Excluding Mexico.</td>
</tr>
<tr>
<td>LFY</td>
<td>Last full completed year. For market reports this is the last full year which can be benchmarked against RCCL’s range of confidential market volume information.</td>
</tr>
<tr>
<td>LRR</td>
<td>Low rolling resistance.</td>
</tr>
<tr>
<td>LT</td>
<td>Light Truck tire. Tires for commercial vehicles &lt;3.5MT.</td>
</tr>
<tr>
<td>M-PPD</td>
<td>Mixed para-phenylenediamine. (e.g. Wingstay types)</td>
</tr>
<tr>
<td>M-Wax</td>
<td>Microcrystalline wax.</td>
</tr>
<tr>
<td>MES</td>
<td>Mild extracted solvate oil.</td>
</tr>
<tr>
<td>Middle East</td>
<td>Countries around the Persian Gulf. (Afghanistan, Bahrain, Iran, Iraq, Israel, Jordon, Kuwait, Lebanon, Oman, Pakistan, Palestine, Qatar, Saudi Arabia, Sudan, Syria, Turkey, Turkmenistan, United Arab Emirates, Yemen).</td>
</tr>
<tr>
<td>MMS</td>
<td>Millions of US dollars.</td>
</tr>
<tr>
<td>MT</td>
<td>Metric Tonne.</td>
</tr>
<tr>
<td>M + S</td>
<td>Mud and snow label. This label is not a rigorous performance standard and only applies within a manufacturer and range of tires. It is typically indicative of a tread design allowing for better handling in adverse conditions, it does not necessarily indicate low temperature performance.</td>
</tr>
<tr>
<td>MW</td>
<td>Molecular Weight.</td>
</tr>
<tr>
<td>N. America</td>
<td>NAFTA countries (Canada, Mexico and United States).</td>
</tr>
<tr>
<td>N. Asia</td>
<td>Countries around mainland Asia. (Bangladesh, Bhutan, Cambodia, Japan, Laos, Mongolia, Myanmar, Nepal, North Korea, South Korea, Taiwan, Thailand, Vietnam).</td>
</tr>
<tr>
<td>NAPHT</td>
<td>Naphthenic process oil.</td>
</tr>
<tr>
<td>NR</td>
<td>Natural Rubber.</td>
</tr>
<tr>
<td>OE</td>
<td>Original equipment (new vehicle production).</td>
</tr>
<tr>
<td>P-Wax</td>
<td>Paraffin wax.</td>
</tr>
<tr>
<td>pa</td>
<td>Per annum.</td>
</tr>
<tr>
<td>PAH</td>
<td>Polycyclic aromatic hydrocarbon.</td>
</tr>
<tr>
<td>PARAF</td>
<td>Paraffinic process oil.</td>
</tr>
<tr>
<td>PC</td>
<td>Passenger car.</td>
</tr>
<tr>
<td>PPDs</td>
<td>Generic para-phenylenediamine of unknown type.</td>
</tr>
<tr>
<td>Precedence</td>
<td>RCCL’s tire allocation method. AW &gt; WT &gt; UHP &gt; HP &gt; ECO &gt; Others.</td>
</tr>
<tr>
<td>RCCL</td>
<td>Rubber Chemical Consultants Ltd.</td>
</tr>
<tr>
<td>PHR</td>
<td>Parts per hundred rubber.</td>
</tr>
<tr>
<td>PPD</td>
<td>Para-phenylenediamine type of antidegradant.</td>
</tr>
<tr>
<td>RAE</td>
<td>Residual aromatic extract oil.</td>
</tr>
<tr>
<td>RP</td>
<td>Replacement market (components serving the used car market).</td>
</tr>
<tr>
<td>RPO</td>
<td>Rubber process oil.</td>
</tr>
<tr>
<td>RR</td>
<td>Rolling resistance.</td>
</tr>
<tr>
<td>S. America</td>
<td>Countries of central and South America.</td>
</tr>
<tr>
<td>S. Asia</td>
<td>Countries separate from mainland Asia. (Australia, Brunei, East Timor, Fiji Islands, Indonesia, Malaysia, New Zealand, Philippines, Samoa Islands, Singapore, Solomon Islands, Sri Lanka, Tonga, Vanuatu).</td>
</tr>
<tr>
<td>S. America</td>
<td>Countries of central and South America.</td>
</tr>
<tr>
<td>SHE</td>
<td>Safety, health and environment.</td>
</tr>
<tr>
<td>SBR</td>
<td>Styrene butadiene rubber.</td>
</tr>
<tr>
<td>SDG</td>
<td>United Nations sustainable development goal.</td>
</tr>
<tr>
<td>SM</td>
<td>Summer Tire. For the purposes of this report summer tires are budget tires with S &amp; T speed ratings. Other summer performance tires are accounted for in the HP and UHP types.</td>
</tr>
<tr>
<td>SM – LRR</td>
<td>Summer Low Rolling Resistance tire. These tires are early generation low rolling resistance tires, or budget low rolling resistance tires.</td>
</tr>
<tr>
<td>SUV</td>
<td>Sports utility vehicle or similar type.</td>
</tr>
<tr>
<td>TD</td>
<td>Tangent delta. The ratio of dynamic loss modulus to dynamic elastic modulus.</td>
</tr>
<tr>
<td>TDAE</td>
<td>Treated distillate aromatic extract (process oil).</td>
</tr>
<tr>
<td>TMQ</td>
<td>2,2,4-trimethyl-1,2-dihydroquinoline and derivatives.</td>
</tr>
<tr>
<td>TPE</td>
<td>Thermoplastic elastomer.</td>
</tr>
<tr>
<td>TPR</td>
<td>Tread performance resin.</td>
</tr>
<tr>
<td>TRAE</td>
<td>Treated residual extract oil.</td>
</tr>
<tr>
<td>Touring</td>
<td>Touring tires are typically designed with comfort in mind. These tires cross a range of performances from budget (typically AS) through to UHP.</td>
</tr>
<tr>
<td>TR</td>
<td>Truck Radial. Tires for vehicles &gt;3.5MT.</td>
</tr>
<tr>
<td>UHP</td>
<td>Ultra-High Performance tire. These are tires with speed ratings &gt; V.</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile organic compounds.</td>
</tr>
<tr>
<td>WG</td>
<td>Wet grip.</td>
</tr>
<tr>
<td>WT</td>
<td>Winter tires. Winter tires are tires with the 3PMSF designation (Europe and North America) and also designated winter tires in North Asia (Japan and South Korea).</td>
</tr>
<tr>
<td>YoY</td>
<td>Year-on-year.</td>
</tr>
</tbody>
</table>
3.2 **SCOPE**

The following items are included in the scope:

**Tire Rubber Chemicals**: The following rubber chemical groups are analysed: Plasticisers, antidegradants, curatives, process aids, coupling agents, bonding agents and reinforcing resins used in tire rubber compound preparation. Each rubber chemical group is segmented into appropriate subgroups.

**Excluded**: Elastomers, fillers and specialist additives.

**Markets**: The tire market for rubber compounds including main tire types and subtypes.

**Geographies**: Global split by RCCL defined regions: Africa, China, CIS, Europe, India, Middle East, North America, North Asia, South America and South Asia.

**Time Frame**: Years 2011 to 2030.

**Market Volumes**: Volumes for 2011 to 2017 are determined and validated against historic usage patterns. Volumes for 2018 to 2030 are projected using stated modelling techniques. Market volumes are provided globally and regionally by rubber chemical group and subgroup.

**Market Prices**: Average weighted 2017 regional market prices are provided for each rubber chemical group and subgroup. Average weighted pricing is provided for APAC, EMEA, NAFTA and S. America.

**Market Values**: Market values for 2017 are estimated from weighted average pricing by rubber chemical subgroup. Market values for 2023 and 2029 are estimated using 2017 prices projected by yearly volume.

3.3 **OBJECTIVES**

The key report objectives are as follows:

- Provide an overview of tire rubber chemicals and their use.
- Provide an overview of the tire rubber chemical industry.
- Analyse past, present and future market drivers for tire rubber chemicals.
- Analyse and contrast 2017 tire rubber chemical market prices by region.
- Analyse tire rubber chemical volumes for 2011 to 2030
  - By region, chemical group, chemical subgroup.
- Analyse tire rubber chemical market values for 2017, 2023 and 2029.
  - By region and chemical group, chemical subgroup.
3.4 INFORMATION SOURCES

Primary Sources

Tire & rubber chemical company confidential contacts covering a broad range of disciplines (e.g. technical, commercial, marketing, production).

Knowledge gained via industry participation – no confidential information is presented.

Consultation for a range of clients on market and technical issues, enables extensive industry interaction and ensures up to date knowledge. Active consultations include carbon black companies, tire companies, rubber chemical companies, petrochemical companies, investment institutions and technology start-ups. While confidential information is not used directly in reports, information is used to benchmark and fine tune the reporting system providing realistic volume estimates via real life volume and technology benchmarking.

Secondary Sources

Company annual reports & news feeds.

Industry journals.

Industry association journals and websites.

Industry conferences and papers.

Company web sites.

Government websites.

Patent reviews.

Global Tire & Rubber Chemicals Database (GTRCDB©)

The GTRCDB© is a proprietary database and reporting system designed specifically to gather and process market information relating to companies active in material compounding. This database is constantly fed information relating to tire, rubber and plastics compounding activities. Bespoke reporting tools allow flexible reporting of past, present and future market requirements for individual compounding ingredients. This is complimented by an extensive repository of chemical manufacturer information.

3.5 ASSUMPTIONS

RCCL tries wherever possible to rely on fact based analysis. Much of the underlying analysis via the GTRCDB© uses factual information gathered over many years from reliable sources. In order to provide a full market picture of a complex segment it is always necessary to make assumptions. Wherever possible, RCCL will make these clear by making a comment in bold red. This type of annotation will be present in the methodology section (Section 4) as well as within the market volume and values sections.

RCCL’s centrally controlled market analysis system allows alternative scenarios to be run. Clients wishing to adjust any of the stated assumptions can arrange for further analysis at an additional agreed fee.
4 METHODOLOGY

This section explains the principles behind the generation of rubber chemical market volumes. Section 4.1 introduces a high level view of the ‘consumer-up’ approach. Section 4.2 discusses the framework for the ‘consumer-up’ approach with Sections 4.3 detailing segment specifics for Tires.

4.1 GENERAL REPORTING PRINCIPLES

A key concept of the methodology used is that of consumer driven demand using ‘Consumer Up’ analysis. A high level view of the approach is presented in Figure 4.1. This shows that in order to evaluate the market an understanding of product mix, product technology and production capacity is required. Further to this, it is also necessary to adjust production capacity for market demand. All of these aforementioned factors are bound by time and geography. Time in this case represents shifting product mixes, market demands and associated production capacities, whereas geography represents additional regional constraints/opportunities related to legislation and megatrends.

Figure 4.1- 'Consumer-Up' Market Analysis

4.2 CONSUMER-UP ANALYSIS

RCCL’s ‘Consumer up’ methodology is based upon analysis of individual rubber chemical consumers at the plant level. Each plant is allocated to a region, country and, as appropriate, state. Analysis is then done by iterating through all plants for each of the required years. This plant level analysis is coupled with market driven product and technology changes which allows a significantly more granular reporting approach versus other market volume assessment methods.

This is explained in more detail in the following sections.
4.2.1 Key Parameters
RCCL has determined all the key parameters (these parameters can also be considered as variables) associated with a robust and meaningful analysis of the rubber chemical market. The reporting system is built to reflect ‘real-life’ usage based upon individual production plant output. This output can be broken down into product constructions with associated components and compound formulations.

4.2.2 Consumer Plant Parameters
Parameters related to consumer plants are highlighted in Figure 4.2.

*Figure 4.2- Consumer Plant Parameters*

The following information is regularly updated for each consumer plant from a range of different industry sources:

- Yearly production capacity at the plant level.
- Yearly product splits at the plant level.
- Intelligence information relating to future production and product developments.
- Changes in ownership or transfer of assets.

4.2.3 Product Technology Parameters
Parameters related to products are highlighted in Figure 4.3. Product technology parameters are dependent upon time as well as region. Time dependency is evident especially in shifting sizes and underlying compound formulations (chemicals). Regional dependency is evident in both shifting sizes as well as compositions, with increased sensitivity to chemical composition on a regional basis due to a number of differing drivers.

The following product information is regularly updated and applied to the appropriate consumers based on a range of industry sources:

- Yearly product technology changes (construction based).
Yearly product compound changes (material based).

Introduction of differentiated product sub categories.

Regional product shifts (e.g. tire sizes in each sub category).

Figure 4.3 - Product Technology Parameters

4.2.4 Market Parameters
Top level parameters relating to market demands are presented in Figure 4.4. These market parameters are used to create a range of possibilities for future market volume outlooks via the use of incremental changes to product split and technologies. When potentially disruptive drivers are considered (e.g. potential legislation changes) the analysis can vary demands based on predicted splits versus publically stated developments.

The following market information is regularly updated and applied to generate the appropriate utilisation rates based on maximum production capacities:

- Past, present and future product unit production.
- Economic indicators & drivers, industry specific and IMF based regional and country forecasts.
- Tire company market assessments.
- Industry market assessments from a range of different sources.
- Upcoming regional legislative drivers.
Regional influences on specific sub segments.
Individual consumer responses to market changes and requirements.

**Figure 4.4 - Market Utilisation Parameters**

4.2.4.1 **Historic Values**
The RCCL reporting system uses market models to adjust the manufacturing capacities to actual market volumes. These are explained in Section 4.3. Historic values include values from the start year (2011) to the last completed full year (LFY). These values utilise the market model plus a manual adjustment to bring regional figures in line with those found from research.

Specific tire sub-segment markets are better defined than others. For tire industry data, historic figures are adjusted to give overall regional balances for truck, light truck, SUV and PC tires. This is done by adjusting regions with well-defined tire production and/or market data first and then applying necessary adjustments to the remaining regions. Currently this means that North America, Europe, North Asia and India are adjusted first and the remaining regions are adjusted to give a global figure in agreement with research.

Market demand for rubber goods is not well documented, this means that the market model is applied from the start year (2011) with manual adjustments being made for specific sub-segment changes. Examples of specific changes relate to the mining and energy industries where performance may not track GDP values.

4.2.4.2 **Future Projections**
Reporting years after the LFY can be projected in various ways, as shown in Table 4.1. The two most common projections (PI and PIII) are highlighted in bold.
Projection I gives an upper bound to market volumes based on the theoretical maximum production capacities.

Projection III gives the most probable market volume based on the LFY capacity adjusted by forward market models as well as changing actual product splits. Actual splits are either reported plant product splits or those estimated by RCCL.

**Table 4.1- Future Year Projections**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Demand based on total production capacity and actual splits for all years.</td>
</tr>
<tr>
<td>II</td>
<td>Actual demand to LFY. LFY projected by market model utilisation.</td>
</tr>
<tr>
<td>III</td>
<td>Actual demand to LFY. LFY projected by market model utilisation and YoY actual product splits.</td>
</tr>
<tr>
<td>IV</td>
<td>Actual demand to LFY. LFY projected by market model utilisation and YoY predicted product splits.</td>
</tr>
<tr>
<td>V</td>
<td>Actual demand to LFY. LFY capacity and utilisation fixed using actual product splits.</td>
</tr>
<tr>
<td>VI</td>
<td>Actual demand to LFY. LFY capacity and utilisation fixed using predicted product splits.</td>
</tr>
</tbody>
</table>

**4.3 Market Volumes for Tire Chemicals**

Section 4.2 discussed the general principles for ‘Consumer-Up’ analysis. This section discusses Tire Segment specific details which build upon the general principles adding additional levels of discrimination in order to achieve accurate and precise results tailored to the Tire Segment.

**4.3.1 Consumer-Up Analysis**

Cumulative experience gained from numerous global tire chemical research projects has led to the tire subtype splits which can be viewed in the Appendices – Section 13.1. These tire subtypes are allocated year-on-year to the individual tire manufacturing plants. An additional level of product discrimination required is the differentiation between OE tires and Replacement tires. This differentiation is required because OE tires are the technology drivers in the market place, with newer technologies evolving from OE tires and then cascading down into the RP market.

In view of the above considerations the GTRCDB model for Tires is extended from the general model according to the scheme outlined in Figure 4.5. This shows separation of product types by tire company tier level as well as product end use. The primary function of this scheme is to enable different component formulations for the different end uses e.g. OE versus RP and tire company tier levels.

The extended scheme works by allocating tire subtypes to each manufacturer plant YoY as detailed, these are the tire subtype splits by year (S<sub>yr</sub>). These subtypes utilise the Tier II/III constructions and formulations. If the manufacturing plant produces OE tires then the appropriate allocation is split out from S<sub>yr</sub> with the residual allocated to RP, both allocations using Tier I/II constructions and formulations designated as application types (A<sub>yr</sub>).

1 **NOTE:** the above scheme is currently used for PC, SUV, LT & TR tires only.
4.3.2 Tire Parameters

Tire parameters are derived from individual tire subtypes and application types. These are calculated year-on-year by combining tire sizes, constructions, components and formulations in order to derive appropriate parameters used in the plant level calculations.
The following parameters \( (P_r) \) can be derived for tires:

**Table 4.2 - Tire Parameters**

<table>
<thead>
<tr>
<th>Rubber Chemical or Chemical Group</th>
<th>Material Type</th>
<th>Component Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass/unit production</td>
<td>Compound</td>
<td>Tread</td>
</tr>
<tr>
<td>Mass/MT product</td>
<td>Textile</td>
<td>Sidewall</td>
</tr>
<tr>
<td>Mass/MT compound</td>
<td>Steel</td>
<td>...</td>
</tr>
<tr>
<td>Mass/MM$ sales revenue</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**High Level Example** - Determining a specific rubber chemical mass by tire unit production for a given tire sub type:

The tire sub type is programmatically constructed using a defined construction which consists of individual components, each of which has an underlying formulation. Regional sizes and formulations ensure appropriate dimensions and technologies which are varied YoY. The final result is the unit mass (MT) of rubber chemical per unit tire production for each year and region for the designated tire sub type.

4.3.3 Tire Utilisations

The GTRCDB\(^\circ\) uses market utilisations to adjust tire plant manufacturing capacity to match market demand. The adjustments are made either as forward projected utilisations as described in Section 4.3.3.1 or as historic utilisations as described in Section 4.3.3.2. Utilisations are calculated for each tire sub type in a tire market group. A tire market group is made up of one or more tire sub types which are grouped together based upon market drivers and the need to differentiate market performance. Utilisation figures are derived for each of the 10 different regions in the GTRCDB\(^\circ\).

4.3.3.1 Projected Utilisations

Projected utilisations for years after the LFY use an appropriate market model which is set up according to the tire type (e.g. PC, SUV, LT, TR etc.). An example covering PC, SUV and LT tires is presented below:

The model utilises regional car automotive production figures and estimated regional car parcs, these are derived from a number of different sources and crosschecked.

The OE contribution for the year in question is determined by assuming \( K = 4.5 \) tires per new vehicle and calculating the weighted contribution as per Equation 1. The final OE contribution (Equation 3) is determined by relative change in OE from the previous to current year multiplied by the OE weighting.

The RP weighted contribution for the year in question is determined according to Equation 5. The final RP contribution is determined by the relative change in RP from the previous to the current year (Equation 5), this figure is adjusted (Equation 4) according to changes in GDP which reflect differing market conditions which affect the replacement market.

Final utilisation for the year in question is determined by averaging the OE and RP contributions and adding this to the previous years’ utilisation as per Equation 6.
Equation 1 - Original Equipment Market Weighting

\[ O_w = \frac{K O_c}{(K O_c + R_c)} \]

Equation 2 - Replacement Market Weighting

\[ R_w = \frac{R_c}{(K O_c + R_c)} \]

Equation 3 - Original Equipment Contribution

\[ O_{cnt} = \left( \frac{O_c}{O_p} - 1 \right) O_w \]

Equation 4 - GDP Adjuster

\[
\text{If } G_c < G_p \text{ Then } G_{adj} = -\frac{(G_p - G_c)}{100} \text{ Else } G_{adj} = 0
\]

Equation 5 - Replacement Contribution

\[ R_{cnt} = \left( \frac{R_c}{R_p} - 1 \right) + G_{adj}R_w \]

Equation 6 - Utilisation for Current Year

\[ U_c = U_p + \frac{O_{cnt} + R_{cnt}}{2} \]

Definition of terms:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O_w</td>
<td>Original equipment market weighting</td>
</tr>
<tr>
<td>K</td>
<td>Constant (number of tires per OE vehicle)</td>
</tr>
<tr>
<td>O_c</td>
<td>Current year’s regional automotive production</td>
</tr>
<tr>
<td>O_p</td>
<td>Previous year’s region automotive production</td>
</tr>
<tr>
<td>R_c</td>
<td>Current year’s regional auto parc</td>
</tr>
<tr>
<td>R_w</td>
<td>Replacement market weighting</td>
</tr>
<tr>
<td>O_{cnt}</td>
<td>Original equipment contribution</td>
</tr>
<tr>
<td>G_c</td>
<td>Regional GDP for current year</td>
</tr>
<tr>
<td>G_p</td>
<td>Regional GDP for previous year</td>
</tr>
<tr>
<td>G_{adj}</td>
<td>GDP adjuster</td>
</tr>
<tr>
<td>R_{cnt}</td>
<td>Replacement contribution</td>
</tr>
<tr>
<td>U_c</td>
<td>Utilisation rate for the current year</td>
</tr>
<tr>
<td>U_p</td>
<td>Utilisation rate for the previous year</td>
</tr>
</tbody>
</table>

NOTE: The GTRCDB© uses additional proprietary calculations to adjust utilisation rates in order to remove organic manufacturing growth (which is not market growth). This is not detailed here, however it is an important step in the process of obtaining realistic market growth volumes.
4.3.3.2 Historic Utilisations

Historic utilisations are those covering the years 2011 to the LFY. Utilisations are calculated as per Section 4.3.3.1 with the addition of a manual adjustment (Equation 7) which is used to bring results in line with actual regional and global totals. When years are completed, regional and global figures are compared to manufacturing information to ensure sensible regional figures and an overall global balance for production. This is currently done for TR, PC, SUV and LT.

*Equation 7 - Historic Utilisation*

\[ U_{hst} = U_c + M \]

4.3.4 Reported Values

Reported market values are derived according to the stated projections (definitions in Section 4.2.2). The two most frequently used projections are provided by Equations 8 & 9.

*Equation 8 - Projection I Total Available Volumes*

\[ PI = \sum_{y_s,p=1}^{y_f,p=n} CSAP \]

*Equation 9 - Projection III Best Estimate Actual Market Volumes*

\[ PIII = \sum_{y_s,p=1}^{y_f,p=n} CSAPU \]

Definition of terms:

<table>
<thead>
<tr>
<th>ys</th>
<th>Start year</th>
</tr>
</thead>
<tbody>
<tr>
<td>yf</td>
<td>Finish year</td>
</tr>
<tr>
<td>p</td>
<td>Production plant</td>
</tr>
<tr>
<td>C</td>
<td>Plant production capacity</td>
</tr>
<tr>
<td>S</td>
<td>Plant percentage tire subtype split</td>
</tr>
<tr>
<td>A</td>
<td>Plant percentage application type split</td>
</tr>
<tr>
<td>P</td>
<td>Parameter value</td>
</tr>
<tr>
<td>U</td>
<td>Utilisation rate</td>
</tr>
</tbody>
</table>

4.4 Market Values for the Tire Segment

The global market value is obtained from the regional values. The determination of regional values is explained in the following section.

4.4.1 Regional Valuations

Regional market value is determined from weighted average delivered prices. The global value is determined from the weighted regional market values.
Weighted delivered prices are determined for APAC, EMEA, NAFTA and SAM. This is done by generating an average weighted price based on regional material usage from underlying grade types. RCCL’s regions are then assigned based on the four top level regions. For examples EMEA weighted prices are used for Africa, Europe and Middle East.

The weighted average delivered rubber chemical price \( C_{wt} \) is determined according to Equation 10.

\begin{equation}
C_{wt} = \frac{\sum_{n=1}^{N} G_n W_n}{\sum_{n=1}^{N} W_n}
\end{equation}

Where: \( G = \) Individual grade delivered price, \( W = \) grade weighting, \( n = \) number of grade types

4.5 DATA VALIDATION

This section addresses the issue of data validation.

4.5.1.1 Market Volumes

Market volume data is determined following the principles set out earlier in this section. Underlying compound formulations are adjusted by region, manufacturer tier, tire type, sub type and component (e.g. Europe – OE – PC – All Season – Tread). Formulations have been developed from 2009 onwards from a wide range of sources and have been validated for different groups of rubber chemicals (e.g. carbon black, precipitated silica, process oils etc.). Rubber chemicals were incorporated into formulations starting with OE and then moving to tier I/II RP and finally RP tier III. This process was iterative with reports being run after each modification with cross checks versus real life usage data from confidential sources (by tire manufacturing company).

Validation of market volumes for many different rubber chemical groups and subgroups have been made versus rubber chemical manufacturer information. Real life validation has also been made for specific rubber chemical groups versus actual tire manufacturer utilisation (from confidential sources).

4.5.1.2 Market Values

Delivered prices were obtained from reliable confidential sources.

It should be noted that regional prices may vary due to material availability, contract volumes and the range of individual products within a product group. All prices were determined in US dollars.
5  TIRE RUBBER CHEMICALS OVERVIEW

This section provides the necessary background relating to tire compound formulations and rubber chemical use. Section 5.1 provides the typical structure of a tire compound along with application specific requirements. Section 5.2 provides details of the individual chemical groups covered by this report. Each of these chemical groups is broken down into constituent chemical subtypes with examples of product types and tire use.

5.1  ANATOMY OF TIRE FORMULATIONS

This section provides an overview of tire formulations looking at common ingredients and those which are included for application specific purposes. This provides the background necessary prior to looking at individual ingredient groups.

5.1.1  Typical Compound Structure

The typical structure of a tire compound is presented in Figure 5.1. This shows the basic composition which typically applies to all tire compounds. Chemical groups in scope for this report are shown in green with reference to the relevant report section. Chemical groups not in scope are shown in red.

Table 5.1 provides an example formulation which follows the typical structure. This is provided as an example and should not be considered representative for reasons explained below.

![Figure 5.1 - Typical Compound Structure](image-url)

Table 5.1 - Example PC Sidewall Compound

<table>
<thead>
<tr>
<th>Chemical Group</th>
<th>Ingredient</th>
<th>PHR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastomer</td>
<td>Natural Rubber</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Butadiene Rubber</td>
<td>45</td>
</tr>
<tr>
<td>Filler</td>
<td>Carbon Black</td>
<td>50</td>
</tr>
<tr>
<td>Plasticiser</td>
<td>Process Oil</td>
<td>3</td>
</tr>
<tr>
<td>Antidegradant</td>
<td>Antidegradant</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Wax</td>
<td>1.5</td>
</tr>
<tr>
<td>Curative</td>
<td>Zinc Oxide</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Stearic Acid</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sulphur</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Accelerator</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td><strong>158.9</strong></td>
</tr>
</tbody>
</table>

The elastomers form the backbone of the formulation with other ingredients specified on a parts per hundred rubber (PHR) basis. It can be seen that this formulation uses a blend of elastomers (natural rubber and butadiene rubber) with the sum adding to 100 PHR. The formulation also includes a filler, a process oil, antidegradants and curatives. The actual composition of a sidewall compound depends upon a large number of factors including but not limited to: tire manufacturer, tire type and subtype, region of manufacture and region of use.
The chemical types which are in scope are discussed in more detail in Section 5.2 and in the relevant chemical group section of this report.

### 5.1.2 Application Specific Requirements

The typical compound structure discussed in Section 5.1.2 is varied according to specific application requirements. This requires variations in the following:

- Elastomer types and blend ratios
- Filler type/s and loadings
- Plasticiser type/s and loadings
- Antidegradant types and loadings
- Curative types and loadings

Other chemical groups are required for application specific purposes. The additional groups have been added to the typical tire compound structure and are shown in Figure 5.2.

---

**Figure 5.2 - Typical Tire Compound Ingredient Types**

![Typical Tire Compound Ingredient Types](image)

**Table 5.2 - Example PC Tread Compound**

<table>
<thead>
<tr>
<th>Chemical Group</th>
<th>Ingredient</th>
<th>PHR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastomer</td>
<td>Butadiene Rubber</td>
<td>25</td>
</tr>
<tr>
<td>Elastomer/Process</td>
<td>SBR Rubber + Oil</td>
<td>103</td>
</tr>
<tr>
<td>Oil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filler</td>
<td>Carbon Black</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Precipitated Silica</td>
<td>20</td>
</tr>
<tr>
<td>Plasticiser</td>
<td>Process Oil</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Performance Resin</td>
<td>[?]</td>
</tr>
<tr>
<td>Coupling Agent</td>
<td>Silane</td>
<td>1.6</td>
</tr>
<tr>
<td>Antidegradant</td>
<td>Antidegradant</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Wax</td>
<td>1.5</td>
</tr>
<tr>
<td>Curative</td>
<td>Zinc Oxide</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Stearic Acid</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sulphur</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Accelerator</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Accelerator</td>
<td>1.7</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td>221.8</td>
</tr>
</tbody>
</table>

One or more of these additional rubber chemical groups may be required depending upon the application.

An example PC tread formulation is provided in Table 5.2. As with the example PC sidewall compound in the previous section, it must be recognised that a PC tread formulation varies substantially depending upon a number of factors. These factors include: tire type and subtype as well as the manufacturer, region of manufacture and region of use.

The example shows the use of oil extended styrene butadiene rubber (SBR) which is common for tread applications where high molecular weight polymer is required. The elastomer content is based on 100
PHR with provision for the oil content of the oil extended SBR (typically 37.5 PHR oil which gives a polymer content of 72.7%, so 103 PHR oil extended SBR = 75 PHR elastomer). The use of oil extended elastomers is important for the consideration of total plasticiser use, this will be discussed in Section 5.2.1 and 7.

The tread formulation is clearly more complex versus the basic sidewall formulation. There is a blend of fillers, a requirement for a coupling agent, a more complex cure system plus the potential use for performance resins and in some cases other specialist additives. The coupling agent (silane) is required to maximize the performance of the precipitated silica (especially wear resistance), this is discussed in Sections 5.2.5 and 11. The plasticiser is required to allow high filler loadings for grip performance, and there is also the potential of traditional plasticiser replacement with specialist resins or additives depending upon the tire subtype.

Other application specific chemical groups and applications include the following:

- **Process Aids**
  - These are required for a wide range of processing requirements. They are most typically used in ‘dry compounds’ with high filler loadings and/or low plasticiser loadings. They function as tackifiers, dispersion aids, homogenisers and viscosity reducers. Typical applications include PC/SUV tread compounds with high silica content, components requiring high tire building tack (bead apex, sub-tread, carcass ply). Other types of process aid include homogenisers which are used to help blend polymers and compounds which are difficult to mix, such as butyl liner compounds.

- **Bonding Agents**
  - Cobalt salts are required for bonding to brass coated wires (belt or bead), this is sometimes augmented with dry bonding ingredients such as resorcinol/phenolic based resins in conjunction with methylene donors.
  - Dry bonding ingredients are required for bonding to treated textile cords.

- **Reinforcing Resins**
  - Reinforcing resins are used in compounds requiring very high stiffness such as the bead apex compound.
  - Secondary networks created via reinforcing resins also benefit certain tread applications (truck, industrial and OTR) for damage resistance and reduced heat build-up.

- **Specialist Additives**
  - Specialist additives vary widely and include materials for heat stability, reversion resistance, ice grip and other tire specific performances.
5.2 **Rubber Chemical Types and Groupings**

This section defines the individual rubber chemical groups covered in this report. Each of these chemical groups is expanded to include relevant chemical subtypes which are also defined with examples.

5.2.1 **Plasticisers**

The plasticiser chemical group and subgroups are summarised in Figure 5.3 with examples for each subgroup provided in Table 5.3.

**Figure 5.3 - Plasticiser Chemical Group and Subgroups**

**Table 5.3 - Plasticiser Subgroup Examples: Type, Manufacturer & Trade Name**

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Type</th>
<th>Manufacturer</th>
<th>Trade Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubber Process Oil</td>
<td>DAE</td>
<td>Petrobras</td>
<td>Mobilsol</td>
</tr>
<tr>
<td></td>
<td>TDAE</td>
<td>H&amp;R Group</td>
<td>Vivatec</td>
</tr>
<tr>
<td></td>
<td>RAE</td>
<td>Shell</td>
<td>Flavex</td>
</tr>
<tr>
<td></td>
<td>MES</td>
<td>H&amp;R Group</td>
<td>Tudalen</td>
</tr>
<tr>
<td>Performance Enhancer</td>
<td>AMS Resin</td>
<td>Arizona Chemical (Kraton)</td>
<td>Sylvatraxx</td>
</tr>
</tbody>
</table>

Plasticisers include traditional rubber process oils including aromatic, naphthenic and paraffinic types. These oils are used to improve compound processing, lower viscosity and cured stiffness and to allow adjustments in filler loadings to achieve the desired compound property balance. The use level (PHR) and oil type is determined by the elastomer type/s and the desired effect. This means that oil loadings may vary from a few PHR up to 50+PHR (loose oil + extender oil).

The type of process oil and application varies by region, for example Europe uses large quantities of aromatic oils whereas NAFTA uses mainly naphthenic oils. The range of aromatic oil types has been extended significantly in the last decade due to European legislation for PAH content in tire oils. This gave rise to various treated versions of DAE (TDAE, RAE, MES). The driving force for this was the need to
maintain safety critical performance aspects of a tire (wet grip) while meeting the new PAH legislation, this could not be achieved by swapping to a different oil type such as naphthenic oil.

Performance enhancers have been included in the plasticiser grouping as they influence the final level of plasticiser (e.g. there is typically a substitution of process oil with the performance enhancer). AMS resin types are the most predominant type, with use targeted at tread performance enhancement.

Other specialist additives also fall in this grouping (but outside the scope of this report), these include performance additives which have been developed to address sustainability as well as tire performance. These additives are generally used at low loadings in specific tire subtypes, for example ‘Eco’ labelled tires.

Another group of specialist materials which compete with plasticisers are reactive plasticisers. These materials cross the boundary between polymer and plasticiser. They are typically low MW polymers, sometimes with additional functionality (e.g. silane termination). These materials are liquid phase for mixing and forming, but then form an integral part of the polymer matrix in the final component. This offers additional opportunities for compound property optimisation. (These materials are outside the scope of this report).

5.2.2 Antidegradants
The antidegradant chemical group and subgroups are summarised in Figure 5.4 with subgroup examples provided in Table 5.4.

Figure 5.4 - Antidegradant Chemical Group and Subgroups

Table 5.4 - Antidegradant Subgroup Examples: Type, Manufacturer & Trade Name

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Type</th>
<th>Manufacturer</th>
<th>Trade Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antioxidants / Antiozonants</td>
<td>PPD: 6PPD</td>
<td>Eastman</td>
<td>Santoflex</td>
</tr>
<tr>
<td></td>
<td>PPD: Mixed PPD</td>
<td>Goodyear</td>
<td>Wingstay</td>
</tr>
<tr>
<td></td>
<td>PPD: IPPD</td>
<td>Sinorgchem</td>
<td>Sirantox</td>
</tr>
<tr>
<td></td>
<td>Phenolic: TMQ</td>
<td>Lanxess</td>
<td>Vulkanox</td>
</tr>
<tr>
<td></td>
<td>Phenolic: S-TMQ</td>
<td>Eastman</td>
<td>Flectol</td>
</tr>
<tr>
<td>Waxes</td>
<td>Paraffinic</td>
<td>International Group</td>
<td>Nochek</td>
</tr>
<tr>
<td></td>
<td>Micro Crystalline</td>
<td>Paramelt</td>
<td>Okerin</td>
</tr>
</tbody>
</table>
Antidegradants are split into two subgroups. Antioxidants and antiozonants include two main chemical groupings, para-phenylenediamine (PPD) and phenolic types. These two types can be considered active ingredients in contrast to waxes which are passive barrier technologies.

The most common active antidegradant is 6PPD which is used extensively in all regions and in most tire applications as it provides a balanced level of protection. The most common phenolic type is TMQ (and higher purity derivatives) which provides cost effective oxidation and heat resistance but is more limited with respect to ozone and flex fatigue resistance (versus 6PPD). These ingredients are used at different loadings in most tire components, one reason for this is prevention of migration from one compound to another due to concentration differences.

Waxes are used to form a protective barrier under static conditions. This relies on migration of the wax to the surface of the tire. This is achieved by blending of aromatic and aliphatic components with different polymer solubility which function according to the underlying compound composition.

5.2.3 Curatives
The curative chemical group and associated subgroups are summarised in Figure 5.5 with subgroup examples presented in Table 5.5.

*Figure 5.5 - Curative Chemical Group and Subgroups*

Curatives are split into three subgroups:

- **Accelerators**
  - This subgroup is used to increase the rate of cure during vulcanisation. Accelerator types may be used individually or in combinations. The type/s and loadings are determined based on the process, curing and final compound property requirements. Sulphenamide types are the most common, however there is also extensive use of guanidine and thiazole types for specific compounds. Other specialist accelerators are used for specific
applications, these are included in the ‘Others’ category along with sulphur donors (see cross linkers below).

➢ Cross Linkers
  o This subgroup consists of materials which form the chemical bond between elastomer chains.
  o Sulphur is the most common being used in either soluble or insoluble form. Soluble sulphur is cheaper and is used in components which do not require high tack levels for tire building. Insoluble sulphur is used for components which require high building tack, due to the insoluble nature the sulphur does not migrate on storage.
  o Sulphur donors can be considered specialist accelerators. These materials have sulphur content which is used to form the sulphur cross links during vulcanisation. The donors create short, heat stable, cross links which are beneficial in some application environments – these are included in the ‘Others’ category along with
  o Specialist materials (outside the scope of this report) include ingredients designed to restrict compound reversion on over cure. This is a common problem with thick natural rubber components in large tires (e.g. treads for truck and OTR applications).

➢ Activators
  o This subgroup consists of materials which assist in the vulcanisation process.
  o Zinc oxide is used extensively for cure activation in most tire compounds. The type and loading is determined by the individual application requirements. The amount of zinc oxide (or zinc stearate) also influences the aging resistance of the compound. Zinc is the subject of environmental concern, however due to its central role in curing and final product performance changes in use are seen as long term.
  o Stearic acid is also used in most tire compounds, this assists in the vulcanisation process and is also a process aid for some compounds (for example milling performance for butyl liner compound).

Table 5.5 - Curative Subgroup Examples: Type, Manufacturer and Trade Name

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Type</th>
<th>Manufacturer</th>
<th>Trade Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerators</td>
<td>Sulphenamide: CBS</td>
<td>Nocil</td>
<td>CBS</td>
</tr>
<tr>
<td></td>
<td>Sulphenamide: DCBS</td>
<td>Tianjin Organic</td>
<td>DCBS</td>
</tr>
<tr>
<td></td>
<td>Sulphenamide: MBS</td>
<td>Merchem</td>
<td>Mercure</td>
</tr>
<tr>
<td></td>
<td>Sulphenamide: TBBS</td>
<td>Duslo</td>
<td>Duslin</td>
</tr>
<tr>
<td></td>
<td>Sulphenamide: TBSI</td>
<td>Eastman</td>
<td>Santocure</td>
</tr>
<tr>
<td></td>
<td>Guanidine: DPG</td>
<td>Shandong Sunsine</td>
<td>SXChem</td>
</tr>
<tr>
<td></td>
<td>Thiazole: MBTS</td>
<td>Merchem</td>
<td>Mercure</td>
</tr>
<tr>
<td>Cross Linkers</td>
<td>Sulphur: Insoluble</td>
<td>Eastman</td>
<td>Crystex</td>
</tr>
<tr>
<td></td>
<td>Sulphur: Soluble</td>
<td>Miwon Chemicals</td>
<td>Midas</td>
</tr>
<tr>
<td>Others</td>
<td>DTDM</td>
<td>Nocil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thiurams</td>
<td>Lanxess</td>
<td></td>
</tr>
<tr>
<td>Activators</td>
<td>Stearic Acid</td>
<td>Acidchem</td>
<td>Palmac</td>
</tr>
<tr>
<td></td>
<td>Oleic Acid</td>
<td>Emery Oleochemicals</td>
<td>Emersol</td>
</tr>
<tr>
<td></td>
<td>Zinc Oxide</td>
<td>US Zinc</td>
<td>Zinc Oxide</td>
</tr>
</tbody>
</table>
5.2.4 Process Aids

The process aid chemical group and associated subgroups are summarised in Figure 5.6 with subgroup examples presented in Table 5.6.

The process aid chemical group is complex with product overlaps by type and function. For example many resins are sold as dispersion aids and viscosity reducers. Generally, improvements in dispersion of ingredients (typically fillers) leads to a wide range of other property improvements which is why it is sometimes difficult to categorise these materials.

RCCL has chosen to subgroup these materials according to primary function. Tackifiers are typically considered the lowest technology products used primarily to aid in the tire building process. Other groups such as viscosity reducers and dispersants typically provide a range of benefits for processing and in the final cured compound.

- **Tackifiers**
  - This subgroup consists of materials designed to promote adhesion between tire compounds during the tire building process. The choice of tackifier depends upon the application, region and cost.

- **Others**
  - This subgroup consists primarily of fatty acid derivatives (FAD) as well as homogenizing resins which are typically a blend of aromatic and aliphatic feedstocks. Advanced compounding (especially silica compounds) has seen several proprietary and specialist materials developed in this area (outside report scope).

*Figure 5.6 - Process Aid Group and Subgroups*

*Table 5.6 - Process Aid Subgroup Examples: Type, Manufacturer & Trade Name*

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Type</th>
<th>Manufacturer</th>
<th>Trade Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tackifiers</td>
<td>Aliphatic:</td>
<td>Exxonmobil</td>
<td>Escorez</td>
</tr>
<tr>
<td></td>
<td>Phenolic:</td>
<td>SI Group</td>
<td>SP1068</td>
</tr>
<tr>
<td></td>
<td>Rosin:</td>
<td>Resinall</td>
<td>Resinall</td>
</tr>
<tr>
<td></td>
<td>Aromatic:</td>
<td>Rutgers</td>
<td>Novares</td>
</tr>
<tr>
<td>Others</td>
<td>FAD:</td>
<td>Struktol</td>
<td>Struktol</td>
</tr>
<tr>
<td></td>
<td>Aliphatic / Aromatic</td>
<td>Performance Additives</td>
<td>Ultradblend</td>
</tr>
</tbody>
</table>
5.2.5 Coupling Agents

The coupling agent chemical group and associated subgroups are summarised in Figure 5.7 with subgroup examples presented in Table 5.7.

Figure 5.7 Coupling Agent Chemical Group and Subgroups

Table 5.7 - Coupling Agent Subgroup Examples: Type, Manufacturer & Trade Name

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Type</th>
<th>Manufacturer</th>
<th>Trade Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>Si69</td>
<td>Evonik</td>
<td>Si69</td>
</tr>
<tr>
<td></td>
<td>Si266</td>
<td>Hungpai</td>
<td>Si266</td>
</tr>
<tr>
<td>Proprietary</td>
<td>NXT</td>
<td>Momentive</td>
<td>NXT</td>
</tr>
<tr>
<td></td>
<td>Si363</td>
<td>Evonik</td>
<td>Si363</td>
</tr>
</tbody>
</table>

The coupling agent group is primarily silanes. Silanes are used to bond inorganic materials to organic materials and are therefore useful for coupling silica to hydrocarbon elastomers. Standard silanes include Si69 and Si266, the former being the most common and oldest rubber silane, the latter replacing Si69 due to processing and performance benefits. The two standard silanes have deficiencies with respect to processing performance and environmental emissions, proprietary silanes have been developed to overcome these deficiencies.

Other specialist proprietary coupling agents are used for specific silica and carbon black applications in tires (outside report scope).
5.2.6 Bonding Agents

The bonding agent chemical group and associated subgroups are summarised in Figure 5.8 with subgroup examples presented in Table 5.8.

**Figure 5.8 - Bonding Agent Chemical Group and Subgroups**

![Diagram showing the bonding agent chemical group and subgroups]

**Table 5.8 - Bonding Agent Subgroup Examples: Type, Manufacturer & Trade Name**

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Type</th>
<th>Manufacturer</th>
<th>Trade Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal Bonding</td>
<td>Cobalt Salt</td>
<td>Dalian Advance</td>
<td>Texistab</td>
</tr>
<tr>
<td>Dry Bonding</td>
<td>Resorcinol</td>
<td>Atul</td>
<td>Resorcinol</td>
</tr>
<tr>
<td></td>
<td>Phenolic</td>
<td>Lerg</td>
<td>Novolak</td>
</tr>
<tr>
<td></td>
<td>HMT</td>
<td>Chemipol</td>
<td>HMT</td>
</tr>
<tr>
<td></td>
<td>HMMM</td>
<td>Allnex</td>
<td>Cyrez</td>
</tr>
</tbody>
</table>

Bonding agents are split into two chemical subgroups: metal bonding and textile/dry bonding. There is some overlap between these groups with the use of dry bonding chemicals in some metal bonding applications (steel breaker skim coat, especially in truck applications).

Metal bonding typically utilises a cobalt salt as part of the bonding system with the brass coated wire. In some circumstances this is also enhanced with a dry bonding system with the addition of silica. Cobalt is the subject of environmental concern and there is ongoing work looking at alternative systems, or systems reducing cobalt’s environmental availability.

Dry bonding utilises resorcinol or phenolic based resins in combination with methylene donors to form a bond with treated tire cord. Free resorcinol is considered harmful, therefore the tire industry is moving towards types with low free resorcinol content. Several major tire makers have recently developed alternative dry bonding systems (Michelin, Continental).
5.2.7 Reinforcing Resins

The reinforcing resins chemical group and associated subgroups are summarised in Figure 5.9 with subgroup examples presented in Table 5.9.

Figure 5.9 - Reinforcing Resin Chemical Group and Subgroups

![Diagram of reinforcing resins]

Table 5.9 - Reinforcing Resin Subgroup Examples: Type, Manufacturer & Trade Name

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Type</th>
<th>Manufacturer</th>
<th>Trade Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenolic</td>
<td>Resole:</td>
<td>SI Group</td>
<td>SP</td>
</tr>
<tr>
<td></td>
<td>Novolak:</td>
<td>SI Group</td>
<td>Multiple (SMD, HRJ)</td>
</tr>
<tr>
<td>Methylene Donors</td>
<td>HMMM</td>
<td>Allnex</td>
<td>Cyrez</td>
</tr>
</tbody>
</table>

Reinforcing resins, while similar in composition to dry bonding ingredients, have different performance drivers. These resins are used to increase stiffness and/or improve durability (tear and damage resistance in particular). The subgroups are phenolic resins which include self-curing resole types or Novolak two part systems which require a methylene donor. Issues with free phenol have increased development work on higher purity resins and the old methylene donor (HMT) is now replaced with HMMM resins driven by health and safety requirements (which differ by region).
6 MARKET DRIVERS COMMON TO ALL CHEMICAL TYPES

This section focuses on market drivers common to all chemical types. Section 6.1 analyses the tire manufacturing and market landscape looking at global and regional trends. Section 6.2 looks at sustainability and Section 6.3 covers environmental issues. Market drivers specific to a chemical group or subgroup are discussed in detail in the relevant chemical group section (Sections 7 to 13).

6.1 GLOBAL MEGATRENDS AND TIRE INDUSTRY GROWTH

The tire industry is driven by changing regional requirements relating to mobility. For regions undergoing fast paced development, such as APAC, there is a strong organic growth in demand based on increasing population affluence. This demand translates initially into increased tire product requirements across a broad spectrum of brands, tire types and subtypes. As a natural follow-on to this, the rise in the middle income population incrementally increases demand for higher value tires. For developed regions the organic market growth is more constrained, however, the increasing move to high value products (larger diameter tires and higher speed ratings) has an influence on product mix and material requirements.

RCCL tracks historic tire production trends and also projects this into the future by accounting for changing production capacities and product mixes (see Section 4.3). Section 6.1.1 illustrates this with historic and projected tire unit production by tire type and tire subtype. This is followed by additional examples in Section 6.1.2 based on tire compound demand used to fulfil these changing tire productions.

6.1.1 Historic and Projected Tire Unit Production by Main Tire Type

This section provides examples of tire production trends which are important for quantifying tire rubber chemical usage. RCCL’s GTRCD® holds extensive information on all tire types and subtypes. The information presented is not exhaustive, but is designed to emphasize the important aspects of tire rubber chemical market analysis.

Table 6.1 presents total global PC + SUV tire production. This ***** a ***/** CAGR ***.*% which drops ******** to *.%. for ***/** and ***** again **.*% for ***/**. While ***** are ***** growth ***** they ** correspond ** significant **** production ********.

Table 6.1 - PC + SUV Tires Global Production 2011 to 2030

<table>
<thead>
<tr>
<th>Units, MM</th>
<th>Growth</th>
<th>CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tire Type</td>
<td>Year</td>
<td></td>
</tr>
<tr>
<td>PC+SUV</td>
<td>****</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>****</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>****</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>****</td>
<td>****</td>
</tr>
</tbody>
</table>

Table 6.2 presents PC global tire unit production. PC ******** is **** to **** the ******** share ** the ** + *** total* with **.*% in ****. This ***** to **.*% by ****. This ** reflected ** the ***** CAGR’s **** the ***** analysed.
Table 6.2 - PC Tires Global Production 2011 to 2030

<table>
<thead>
<tr>
<th>Year</th>
<th>Production (Million Tires)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>100</td>
</tr>
<tr>
<td>2020</td>
<td>150</td>
</tr>
<tr>
<td>2030</td>
<td>200</td>
</tr>
</tbody>
</table>

End of Sample Report

Full Report: 170 Pages, 72 Figures, 159 Tables

+ Excel Workbook

Please refer to report contents in separate document for full details on sections, tables and figures

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