Keeping a grip on the road ahead....
…exploring the valuable role of phenolic resins in the tyre & rubber industry

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In rubber we trust….

Although society in general may not be aware of it, the daily trip to school with the children or the longer journey to a holiday location critically depend on the reliability of the means of contact with the road. The importance of the few square centimetres of tyre rubber cannot be over-estimated. Nevertheless, we take this all for granted. Indeed, in the past 30 years, we have seen the reliability of tyres increase, with far less likelihood of blow-outs and better wear rates. This is all the more important as average speeds have increased.

The 'greening' of the tyre…

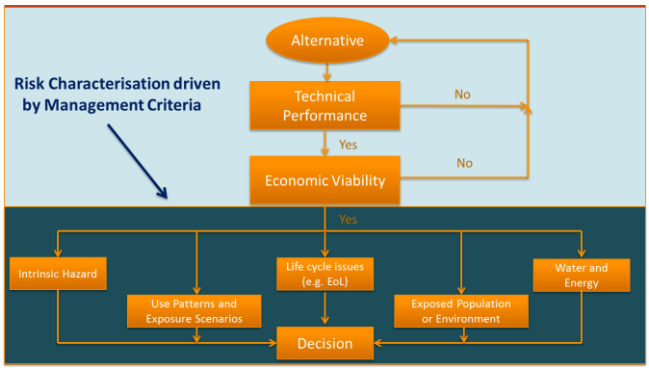
We have also seen the increased recognition of the role of the tyre in achieving better fuel economy and the emergence of the 'green tyre'. However, contrary to the desires of some, this has not extended as far as the chemicals used to manufacture the tyre itself. The focus now being made on chemical selection through initiatives such as the green chemistry movement, would imply that the chemicals of manufacture are more important than the product performance itself. However, these are the same people who would be deeply concerned if formulation changes led to increased incidences of tyre failures and resulting increases in deaths on the road. In the end, we have to live with the paradox that we want to have chemicals that are persistent in our tyres, but not persistent in the environment. The challenge to the tyre industry is three-fold:

- To maintain sufficient versatility in the options for tyre formulation to ensure continuing progress in tyre performance
- To ensure that it understands the human health and environmental hazards that are posed by the chemicals it chooses
- To ensure that those chemicals do not pose any risks to human health and the environment during their entire life cycle, from tyre manufacturing to end-of-life tyre management

It is clear that, in a product with such widespread and dispersive use, manufacturers must take great care not to be providing technological solutions that can cause risk to human health or be in danger of polluting the environment. However, if that requires the avoidance of all hazardous chemicals, the consequences in tyre performance would be severe. The tyre industry is therefore tasked with assessing the available alternatives to make its selections based on performance, cost and societal impacts. As pressures to justify chemical selections grows, this is becoming an increasingly important aspect of the tyre industry's life.

Alternative Assessment in context…

There are those who would advocate that a hazardous chemical needs to be ruled out 'at source'. However, all reactive chemicals are intrinsically hazardous and become a risk when placed in the wrong situation. It is a truly clever chemist who can ensure that a molecule reacts only with the intended co-reactant and avoids all else. Hence, the management of a hazardous chemical is all about controlling its sphere of influence (i.e. our exposure to it). This is tackled in a holistic risk characterisation as shown in the following diagram:



The diagram clearly illustrates the pre-eminence of product performance and economic viability. In this context, the tyre industry can, and should, be permitted access to hazardous chemicals provided that the industry can demonstrate safe use – not only during the manufacturing process but throughout the lifecycle.

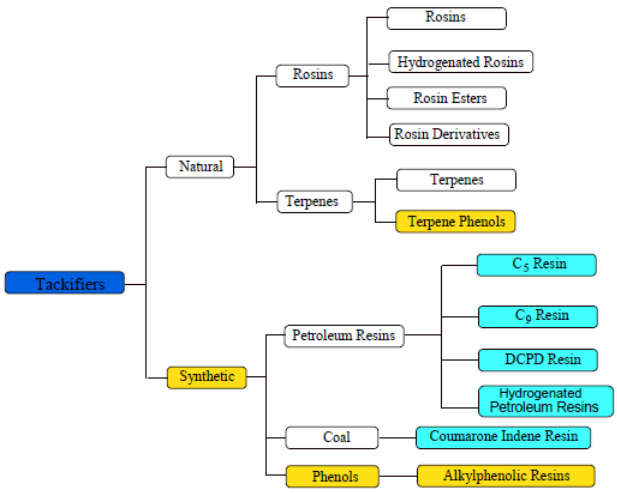
Versatility is a key asset in tyre chemistry…

The challenge for all tyre-makers is to find ways of binding heterogeneous components: rubbers, metals, fibres and fillers into a homogeneous 'whole' that will withstand the temperatures and pressures of normal tyre use. A

number of roles for chemicals therefore appears. These include:

- Plasticisers
- Tackifiers
- Reinforcing Agents
- Adhesion Promoters
- Curing/vulcanizing Agents

Within each application, there can be a multitude of chemical solutions, as indicated in the diagram below for tackifiers:



While there can be a multitude of chemical solutions for any specific role, it is also important to note that individual chemical classes can fulfil a number of roles. With the exception of the plasticiser role, phenolic resins can meet the whole range of applications shown in the list above from tackifier to curing agent. This is a testament to the versatility of the chemical forms that phenolic chemistry offers. From self-curing resoles on the tackifier side to novolacs with focused cross-linking roles.

One chemistry – but targeted performance

The really interesting aspect of this analysis is that phenolic chemistry is able to lay claim to "best-in-class" in virtually all applications.

In the area of tackifiers, the 'super-tackifier' class are made up of patented technologies based on p-tert butyl phenol and vinyl modified novolacs. Whereas, in the area of adhesion promotion, resorcinol-based chemistries are still seen as leaders in the field. In that case, even the competitive materials have their own regulatory concerns, with cobalt salts being targeted under REACH over concerns about their potential as carcinogens.

It is important to note, that phenolic chemistry is not without its own health, environmental and regulatory challenges, with concern over octyl and butyl phenols in the persistent, bio-accumulative and toxic (PBT) category, formaldehyde having some disputed links to nasal cancer and resorcinol as a thyroid active substance. Nevertheless, exposures to all three of these chemicals is limited in processing and non-existent in the final articles produced from them.

Drawing some conclusions

The challenge for society is to recognize that life cannot be lived without inherent hazard. We accept this each time we go to fill our vehicles with fuel. In that case, we are comfortable with the risks we undertake because we know that the operation of filling a car with fuel has been very well engineered, such that the number of accidents is low.

For the manufacturing industry in general, and the tyre industry in particular, it is important to recognize that the burden of proof relating to safe use has passed squarely to the supply-chain making the products available. Citizens now have rights to ask about the content of their products and are perfectly justified in exercising those rights.

The providers of technological solutions to the tyre industry need to be responsive to the importance of this new transparency, but must equally be clear that the change in scrutiny does not imply a need to compromise on product performance where no real risk is posed to wider society. Risk characterization therefore remains the key.