THIN WALL CABLE:

The Untapped Opportunity To Reduce Rolling Stock Weight

Switching to thin wall cable can deliver operational and environmental savings

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AS A TECHNOLOGY LEADER, TE CONNECTIVITY DESIGNS AND MANUFACTURES THE ELECTRONIC CONNECTORS, COMPONENTS AND SYSTEMS INSIDE PRODUCTS THAT ARE CHANGING THE WORLD, MAKING THEM SMARTER, SAFER, GREENER AND BETTER CONNECTED.

In the world of rail, TE Connectivity delivers the broadest portfolio and systems expertise required to connect power and data safely and reliably, from the high-voltage supply and on throughout the entire train.

This white paper examines the case for high performance thin wall wire and cable products and explains their benefits, including their capability to outperform conventional thick wall cabling in performance and whole-life cost.

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NEW CHALLENGES IN THE RAIL WORLD

Manufacturers of rolling stock have been making huge strides in recent years to hone their designs in order to reduce operating costs for end-customers – the train operators. Tactics that reduce weight of rolling stock, lower energy consumption and reduce the impact on the tracks all combine to deliver an optimised Total Cost of Ownership (TCO) as well as improved environmental performance.
Weight of rolling stock is particularly important because of its major influence on operating expenditure (OPEX). Every extra tonne of mass means additional cost in terms of acceleration and traction energy, braking energy, maintenance of components like motors, brakes and the tracks themselves.
An estimated 70 – 80% of energy consumption comes from repeated acceleration on commuter and short distance railways. The design decisions made by rolling stock designers have an impact over their 30+ year operational life.

To save weight, manufacturers have introduced lightweight and high value materials such as high tensile steel and regenerative braking to gain a competitive edge. There is also a significant trend for rail operators to specify systems based on their whole lifetime cost – rather than initial purchase price.
With more than 35 years of supplying cables for rail applications, TE Connectivity believes that high performance thin walled cable is the next great untapped opportunity for reducing the weight of rolling stock.

Conventional rail cables are insulated by material that is based on a tried and tested formulation and meets safety regulations. But they are also heavy and bulky, with a thick wall of insulation around the copper conductor at the cable's core. Through its programme of research and development, TE Connectivity (TE) has developed an innovative thin wall product that delivers the same performance in a compact and lightweight form.

THE VALUE OF SAVING WEIGHT

The average commuter train has eight cars, each of which can carry around 30 km of cable with a weight of 500 kg or more for signals, power and instrumentation. A significant proportion of the weight of these cables is their protective insulation. There is huge potential to reduce the weight of rolling stock by using an alternative insulating material while maintaining the same level of electrical performance.

TE Connectivity's thin wall cable is between 30-50% lighter and 50-100% less bulky than its conventional thick wall counterpart. By making the switch to thin wall cable, there is potential to save several hundred kilograms per car. This delivers real financial, environmental and operational benefits for rail operators and rolling stock manufacturers.

This weight saving represents a corresponding saving in energy over every kilometre that the train runs, year after year. A typical commuter or underground train with frequent stops will save 36 MWh energy and 5 tons of CO_2 per 100 kg saved.

By switching to thin wall cable an eight-car train could save more than $60,000 in energy costs and 60 tons of CO_2 during its lifetime (assuming an energy price of 10 cents per kWh).

But savings are not limited to energy costs. Less wear and tear on the tracks themselves and rolling stock components like axles, wheels and brakes will reduce planned and unplanned maintenance costs.

RAIL WIRE AND CABLE

Wire and cable products for the rail industry need to meet stringent safety standards. Low Fire Hazard products have been in place since the 1970s but developments led by TE Connectivity have come a long way since then.

Today, there are two types of rail wire and cable product on the market, defined by the thickness of their protective insulation.

Thick wall cable has a low unit cost and is manufactured using freely available polyethylene resins mixed with mineral fillers. These fillers generate the products' Low Fire Hazard (LFH) properties of low flammability, low smoke and low toxicity.

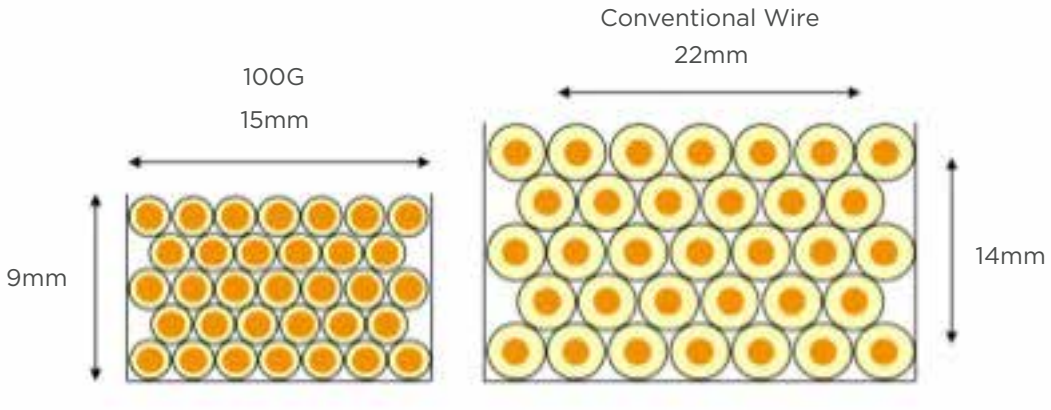
Thin wall cable uses naturally flame retardant polymers instead. These deliver the same LFH properties in a much more compact cross-section that has the added benefit of low weight, low bulk and superior mechanical properties.

While manufacturers of rolling stock have traditionally selected thick wall cable based on its unit price, they are increasingly turning to thin wall products. This is becoming increasingly common as innovation becomes a higher priority in rail design and manufacture.

SAVING WEIGHT AND BULK

TE Connectivity's wire and cable business grew out of the materials science of radiation chemistry when the first filled cross-linked polyethylenes found applications as an insulating material. TE Connectivity's team of polymer scientists and engineers were developing TE Connectivity's own polymer materials that delivers LFH properties as well as excellent mechanical and chemical properties.

These unique proprietary insulation materials, which are not available to other manufacturers, delivers high performance protection of the cable's copper conductor in a thickness as low as 0.2 mm. This compares with wall thicknesses from 0.7mm to more than 1.0mm on small copper sections for traditional thick walled insulation, representing both reduced mass and bulk

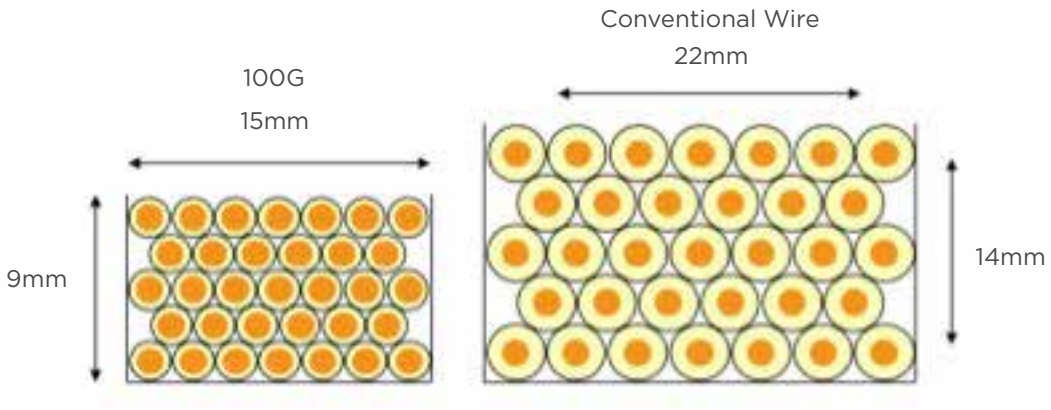


35x1mm^2 wires > 50% reduction bulk of wiring

But while the thickness and weight advantages for a single cable is clear, the real savings are established when cabling is used in bundles.

Looking at the example of a standard size 1.0mm2 wire bundle - a bundle of 33 conventional wires would require an installation footprint of 22 mm by 14 mm. Switch to thin wall technology, and the same number of cables will fit into an area of just 15 mm by 9 mm.

Seen another way, twice as many thin wall wires fit into the same space.



35x1mm^2 wires > 50% reduction in weight of wiring

Eliminating the weight and bulk of thick wall insulation means a reduction of 30% in the weight of wiring and 50% in its volume.

OPENING UP DESIGN POTENTIAL

Because thin wall cable is so much more compact and lightweight, it opens up the potential for rolling stock designers to route cabling through tighter spaces or fit more cable services on board than previously possible.

This can mean freeing up space for fare-paying passengers and their luggage, which makes for a more comfortable ride. Alternatively, operators can use the additional space and weight to install more sophisticated systems, which could become a key consideration as the trend continues towards more automation, including driverless cabs and greater adoption of passenger infotainment systems.

MECHANICAL AND CHEMICAL PROTECTION

While the primary purpose of insulation is to prevent short circuits, it also has to protect conductors from damage during operation and installation. TE Connectivity's thin wall wire and cable is proven to outperform thick wall alternatives in terms of both mechanical and chemical resistance, meaning less maintenance is required over a longer life.

To understand why, it's helpful to appreciate how each type of product is made. Thin wall insulation is a naturally LFH product but thick wall insulation uses mineral additives to lend LFH properties to standard polyethylene.

Put simply, the act of adding minerals lends the final insulation product not only fire retardancy but also brings with it the minerals' mechanical properties. This means that thick wall insulation tends to start acting as a mineral (or rock) product in some conditions. This will lead to poor bending properties at low temperatures and a tendency to crack at hot temperatures. Both of these have major implications for operations and maintenance.

Because thin wall insulation is a polymer without mineral additives, it behaves like a polymer, maintaining its mechanical properties throughout its operating temperature range of -40˚C to 120˚C. This means that it delivers reliable mechanical protection from cutting and abrasion.
In essence, the simplicity of its material structure means that it offers better mechanical protection than thick wall products.

Another important consideration is that cable insulation needs to protect against the fluids found in the rail industry such as diesel, oil and other chemicals. Thin wall insulation delivers outstanding chemical resistance compared to thick wall insulation.

These mechanical and chemical performance advantages add to the already significant operational benefits of thin wall wire and cable. The cables' superior properties mean that they are less prone to damage, reducing the need for inspection and maintenance and delivering value over a longer life.

EASIER HANDLING AND INSTALLATION

The benefits of thin wall cable extend to the installation phase. While the primary reason to select a thin wall product is likely to be its light weight, compact form and low maintenance performance, there are aspects of thin wall wire and cable that mean easier handling for those with the task of installing and making cable connections.

First, as a lightweight and compact product, thin wall cable is more amenable to handling, meaning it's easier and faster to install.

Also, the polymer does not wrinkle on bending and has a low surface friction. This can have a big impact on the factory floor. Conventional insulators have a relatively high surface friction and can block together in bundles, but thin wall cable's low surface friction means that they slide past each other. This makes it easier to bend bundles to fit them into ducts and in confined spaces.

Another aspect that improves the ease of fitting is related to the low thickness of the insulation. Because there is less margin for error in the manufacture of thin wall cable, the copper strands must be perfectly circular and compact, a practice that ensures a standard insulation thickness. The end result is a conductor that is much rounder in shape, which makes it an easier to strip and crimp.

This simplicity of connection, combines with being lighter and easier to handle and bend in bundles provides faster and simpler installation for thin wall cables, helping to reduce manufacturing costs.

While easier to hand, care must be taken to avoid damage during installation, particularly to avoid crushing. This is because thin wall insulation cable does not withstand the type of loads that might be experienced if the cable were to be abused mechanically, such as by crushing or rolling loads which are not typical of operational applications.

PRACTICAL APPLICATIONS

TE Connectivity already supplies thin wall cable to major rolling stock manufacturers worldwide. It is particularly popular for rolling stock that is bound for metro systems, where frequent stops for passengers mean that any reduction in weight will pay dividends in energy savings over the years, as well as helping to improve rail design and passenger experience.

Since the 1960s, the quantity of cables needed on trainsets has doubled, even by a conservative estimate. The demands of some markets will see the volume of cabling required grow even further as air conditioning, safety controls, automation, lighting, sensors, internet and entertainment systems increase in popularity.

As rail operators worldwide increasingly look for innovative ways to reduce TCO, those who don't consider the savings they could make by using thin wall cables are missing a trick.
Selecting thin wall cable can deliver operational and energy savings that outstrip the entire purchase price of the cable itself within a few years, not just the price differential between the two cable types.

HOW TO SPECIFY THIN WALL CABLE FOR RAIL

Traditionally, cable has been selected late in the design process by the manufacturer's engineering team. However, it is increasingly important to recognise the benefits of tHhin wall cable as a significant engineering component that adds value, rather than a commodity to be bought at the lowest unit cost. Thin wall cable is covered by the EN50306 standard, while the standards EN45545 or DIN 5510 cover low fire hazard (LFH) cable, which could be thick or thin walled.

Specifying engineers should take particular care to specify the EN50306 standard if they want to realise the benefits of genuine thin wall cable.

TE Connectivity can deliver 100G rail cable to meet specific customer requirements for size and colour and can even package up multiple power, signal and control cables in a custom designed multi-core cable protected by a single jacket.

TE CONNECTIVITY'S OFFER

Rapid expansion in metropolitan rail networks across the globe means that rolling stock manufacturers are now innovating fast to differentiate themselves. All the leading rail manufacturers have introduced products that have weight and energy saving potential.

TE Connectivity is committed to providing operators and manufacturers of rolling stock 100G thin wall cables can deliver real operational and environmental savings over the long term.

In support of this, TE Connectivity is happy to work with rail operators and manufacturers to demonstrate the space and weight saving potential of its thin wall cable, as well as to demonstrate that it meets the EN50306 standard with no compromise in mechanical and chemical performance.

As automation and connectivity grow in importance in the railway business, TE Connectivity believes that thin wall wire and cable represents a great untapped opportunity.

ABOUT THE AUTHORS

John Wadeley has more than 30 years experience in wire and cable across all market segments served by TE Connectivity and has served as the firm's Global Senior Product Manager with responsibility for leading the development, production and marketing of wire and cable products across TE's portfolio. He has a degree in Electrical Communications Engineering and is now serving as a specialist consultant to TE Connectivity.

Paul Croft is TE Connectivity's Global Product Manager for the rail sector. He is responsible for leading and delivering the rail wire and cable product strategies, a task that makes use of his expert knowledge of the rail sector as well as wire and cable production and marketing.

HISTORY OF TE CONNECTIVITY

TE Connectivity is a technology leader that designs and manufactures the electronic connectors, components and systems inside the products that are changing the world – making them smarter, safer, greener and more connected.

In the world of wire and cable, TE Connectivity's legacy dates back to the 1950s when Raychem, which has since joined the TE Connectivity group, first used the technique of radiation chemistry to develop products. Since then, the firm has undergone a number of changes of name and structure. These include the name of Tyco Electronics, which the firm bore until March 2011 when it took the name TE Connectivity to reflect its role as a component and communications manufacturer.

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