TECHNICAL BULLETIN

BUSBAR TRUNKING SYSTEMS – A MATERIAL CHOICE ALUMINIUM OR COPPER?

NOVEMBER 2011

Aluminium or Copper?

These two materials are both physically and economically viable for use as conductors in power busbar trunking systems (BTS). Some manufacturers of BTS offer a product with copper busbars and others offer a product with aluminium conductors. Increasingly major UK manufacturers are offering both products, leaving the choice to the customer.

Historically the choice of busbar material by the manufacturer has been based on the expectations of the local market. Traditionally, in the UK copper conductors have predominated both for BTS and cable. In other markets, the USA and mainland Europe for example, aluminium has had the greater role. The decisions leading to the choice of material would have been influenced by the availability of the raw material and its cost, rather by the physical properties of the respective materials.

Another factor would have been the ratio between the use of cable and the use of BTS in the market. In the UK, it can be shown that BTS has increased its share of the market relative to cable, to some extent due the increasing amounts of power required in buildings and the in particular for automated industrial units and high-rise commercial centres.

Some of the factors affecting the choice of busbar material are subject to change, in particular the cost of raw material, and the facts needed to allow an informed choice are summarised below.

Performance

The performance of a busbar trunking system (BTS[1]) using either aluminium or copper busbars will be the same for any given specification. Performance is dictated by compliance with the current national standard BS EN 60439-2[2] which is identical with international standards EN 60439-2 and IEC 60439-2. The performance requirements consist of:

- Dielectric properties (power frequency and impulse voltage withstand)
- Fire resistance (where applicable)
- Impedance characteristics (R, X, Z)
- Ingress protection (IP rating)
- Mechanical strength, crush resistance
- Short-circuit withstand
- Temperature rise
- Thermal cycling (tap-off units)
- Voltage drop characteristics

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Physical Properties

Aluminium has a lower density than copper and copper has a higher conductivity. The effect of these differences on busbar trunking unit (BTU[3]) design is explained, taking high-power, low-impedance BTS (also known as 'compact' or 'sandwich-type') as the basis:-

Weight

The lower density of the material means aluminium busbar BTS will be lighter for a given current rating. The lower density is offset to some extent since the lower conductivity of aluminium means that the size of the busbars will be greater than copper for a given current rating. The busbar weight is only a proportion of the total weight of a BTU which includes the case, which may be of aluminium or steel, plus the insulation and jointing means. However it can be shown that, on average, a BTU with aluminium busbars will be 30% lighter than a BTU of the same current rating with copper busbars.

Dimensions

Size does matter sometimes! To accommodate the larger busbar sizes needed with aluminium, the overall dimensions of the BTS are generally greater than for copper busbar BTS. Typically the overall cross-sectional area (c.s.a) of a straight-length BTU with aluminium busbars will be 10 – 20% greater than a length of the same current rated BTU with copper busbars. *The exception to this is when a step-change occurs between a single-bar construction and a double-bar construction, usually at around 2500A. In this case the difference in size will be in the order of 70%.*

Note that the size of the conductors in the busbar trunking is designed to meet the performance characteristics of the standard. It is not necessary or helpful for conductor sizes to appear in the user specification.

Voltage-drop

The voltage-drop along a BTS run is dependent on the current flowing and the impedance (resistance and reactance) of the busbars. The data published by the manufacturer for voltage drop is based on worst-case conditions i.e. with the BTS at a temperature resulting from full-load current and an ambient temperature of 35^{o}C.

Due to the higher conductivity of copper, offset to some extent by the larger busbar c.s.a in aluminium, the voltage-drop per unit length with copper busbars will be on average some 25% lower than with aluminium of the same current rating.

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Power-loss

A few years ago this might not even have been a consideration but now it may enter the equation since it will be a factor, however small, in the overall operating efficiency of an installation. Power-loss figures can be made available from the data taken during BTS performance testing. Since power-loss is largely proportional to the electrical resistance of the busbars it will be typically 25% lower with copper busbar BTS than with aluminium busbar BTS of the same current rating. This however needs to be put in perspective; for example, an 800A 3-phase trunking run can transmit up to 500kW of load power, the power loss in 50m of the trunking is in the order of 8kW!

Cost/Price

The cost of any commodity can only be considered at a point in time due to fluctuations in the market price of raw materials. The price of the raw material is only part of the equation; the process costs to produce the finished components are also significant. In the case of a BTU additional costs include the casing, insulation, terminations, tap-off outlets, where applicable, and the assembly cost. At the present time (late 2011) on a simple basis of same current rating, for a straight length BTU, aluminium busbar units are typically 20% – 30% lower than the price of copper busbar units. When considering other factors, such as like-for-like voltage-drop or power loss, the price difference reduces.

[1] A BTS is defined as an enclosed assembly used to distribute and control electrical energy for all types of loads, intended for industrial, commercial and similar applications, in the form of a conductor system comprising busbars which are spaced and supported by insulating material in a duct, trough or similar enclosure

[2] BS EN 60439-2 is due to be replaced by BS EN 61439-6. There will be no technical changes that will affect the information given in this article.

[3] A BTU is defined as a unit of a BTS complete with busbars, their supports and insulation, external enclosure and any fixing and connecting means to other units, with or without tap-off facilities