The Pipe Is Right

Dr David Smoker* looks at the environmental advantages of ductile iron water and sewer pipesSpecifiers of water and sewer pressure pipes face three main choices in terms of materials – plastic, steel or ductile iron.

While performance and financial cost remain key considerations in specification, an increasingly important factor is the environmental impact of the sourcing, manufacture, transport, installation, maintenance and disposal, as well as the recyclability (or otherwise) of pipes of each of these material types.

Environmental impact has over the years been measured in several ways, based on carbon emissions, acidification or depletion of natural resources. There are a variety of schemes that cover the environmental impact of manufactured products, meaning different products may appear 'greener' depending on which set of criteria is used. For example, the Climate Change Agreement (CCA) relates solely to the manufacturing process itself, while the Carbon Reduction Commitment extends beyond manufacturing to areas such as stocking and day-to-day office functions. Meanwhile, the overall carbon footprint goes even further to include all real or assumed business mileage in the transportation of both raw materials and finished products.

Another method is to calculate the total CO2 impact and then divide by the product's complete life, to acquire an 'annual' emissions figure. Meanwhile, PAS 2050, sponsored by Defra and the Carbon Trust and developed in response to broad community and industry desire for a consistent method for assessing the life cycle GHG emissions of goods and services, provides a specification for the assessment of the life cycle greenhouse gas emissions of goods and services, reflecting the impact of processes, materials and decisions occurring throughout the life cycle of goods and services.

The Carbon Trust Standard scheme and CEMARS, the Environment Agency approved Certified Emissions Measurement and Reduction Scheme, aim to provide a proper assessment of the levels of embodied carbon in a product, all the way from raw materials used, such as iron ore, carbon and coke, through to the final journey to the customer. This means that any manufacturing process using recycled materials automatically gains a huge advantage, as any carbon usage will have been covered by the life cycle of the previous product.

It is generally agreed that a true 'cradle to grave' analysis – from raw material extraction through manufacture, delivery and maintenance to disposal, gives the truest picture of overall impact. For products, which can be recycled into the same products, such as ductile iron, this, can be taken one step further to provide a 'cradle to cradle' analysis.

It is this lack of clarity in how environmental impact is defined which allows manufacturers of different materials to set their own boundaries and so claim their product is the 'greenest' based on their own preferred criteria, meaning specifiers must do their own research to obtain a 'like for like' comparison.

For example, the final manufacturing process of plastic pipes – the forming of the pipes from resin – has a relatively low environmental cost. However, this ignores the creation of the resin, which will have been undertaken by another manufacturer, the cracking of the crude oil or natural gas undertaken at a refinery, and the pumping of oil or gas from underground. But of course even this is far from being the most important environmental issue in plastic pipe manufacture. All plastics used in pipes are made from crude oil or natural gas, depleting an increasingly scarce and highly valuable resource. When one considers the remaining supply of crude oil – around 50 years' worth – against that of iron ore, which is some 20 times longer, the arguments begin to stack up in favour of metal-based products.

Ductile iron is made from 97 per cent recycled material and is 100 per cent recyclable with a residual value at the end of its life. This provides the necessary incentive to ensure it is recycled, rather than used for landfill. While plastic products claim a level of recyclability, this is frequently more costly to achieve than the value of the product, while the degradation created by the recycling process means the 'new' plastic created is lower grade and cannot be used for pipe manufacture as it may harbour chemicals which had previously been absorbed into the walls of the previous pipe. Furthermore, plastics cannot be recycled indefinitely. For these two reasons, water industry standards only permit a limited quantity of primary waste to be incorporated into PE pipe extrusion and no 'second hand' polymer is allowed. It is, therefore, widely accepted that old plastic pipes will end up in landfill.

It is true, of course, that plastic is lighter than most metals and that transport costs for both raw materials and finished products may therefore be lower than those for metal pipes.

However, this is a relatively small consideration when compared with overall environmental impact.

It is not just the impact of the pipes themselves that must be considered, but of the required ancillary products needed to ensure their effective operation. Proponents of plastic pipe systems often claim that if properly welded, these systems do not require thrust blocks, but this is not borne out by the laws of physics.

A plastic pipe laid in the ground, fixed at two points and then put under working pressure, will expand depending on how well the soil is compacted around it. (Virgin aggregate can be added to achieve the desired compaction level, but this entails a further environmental cost and means creating a wider trench than a metal pipe would require).

The expansion is due to creeping, with the plastic 'relaxing' to reduce the stress on it. However, Poisson's ratio means that the radial expansion results in a contraction in the longitudinal direction. By 'fixing' the end points in a pipeline (for example between valves), the resultant stresses generated in the pipe wall and at flanges can be in the order of tens of tonnes.

The problem can, to a point, be address, by welding flanges onto the pipe or using additional bolts, or even concrete thrust blocks – but all of these add both financial and environmental costs to the job, significantly so in the case of thrust blocks which are rarely if ever needed with metal pipes.

With ductile iron, since its diameter does not expand significantly under pressure (and with a much lower Poisson's ratio) the resultant longitudinal stresses are easily accommodated by the variety of restrained joint systems developed by the major ductile iron manufacturers.

Meanwhile, from European studies and the more recent UKWIR report (09/WM/08/39 Large Diameter Trunk Mains Failures) we can infer that plastic pipes only typically last half as long as metal alternatives, meaning they must be dug up and replaced twice during the life of the metal product, adding further to overall sourcing, manufacturing and transport costs, as well as the environmental costs of the replacement work.

Given its greater longevity as well as the lower environmental costs involved across the whole product life, it is no surprise that metal-base pipe systems, and ductile iron pipe solutions in particular, are being more and more widely selected by specifiers with a brief to meet environmental as well as quality and performance credentials.

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