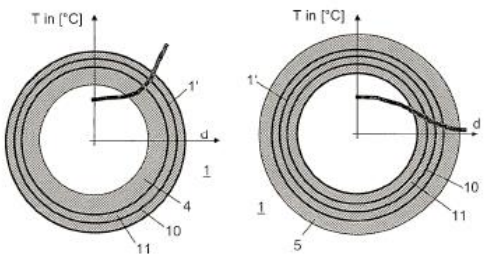
Metal Pipe as a Structural Component

The technology is related to the use of metal pipes constructed from several layers of metal foil as structural components, and the process for their manufacture. The original use of these is in nuclear fusion reactors, for which they have been successfully tested and where such pipes would be exposed to extremely high temperature and pressure regimes, far exceeding the allowable regime of application of conventional (steel) pipes. The technology is ready for use in the non--fusion domain and was patented by the inventors Jens Reiser, Bermhard Daffemer, Anfreas Hoffmann, Michael Rieth, Werner Schulmeyer and Anton Möslang.

Description of the technology

The metal pipes are composed of layers of refractory metal. Such metals, for example Tungsten and Molybdenum, are extraordinarily resistant to heat and wear and have a melting point well above 1772 °C. They are elastic enough to be wrapped in tube form.



Metal pipe with layers of foil made of refractory metals outside (left) and inside (right) with the corresponding cross temperature distribution (Source: WO 2013/053500 A1)

Tungsten laminate pipe, with steel plugs on both ends (Source: J. Reiser, M. Rieth, B. Dafferner, J. Hoffmann, A. Hoffmann, D.E.J. Armstrong "W laminate pipes for structural divertor applications", Presentation at KIT, 30.10.2014)

Tungsten laminate pipes, HHF testing at the Max Planck Institute of Plasma Physics, Garching (Source: H. Greuner, IPP, Garching)

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Innovation and advantages of the offer

Metal pipes are commonly used in many facilities. They transport fluids such as water, oil, liquid metal or gas. Conventional pipes made out of steel are not however suitable for operation in a high temperature and/or pressure regime as they suffer from structural deficits and aging. A further disadvantage of steel is the low heat conductivity. Refractory metals show a substantially improved performance. However producing pipes made e.g. of Tungsten is not cost efficient as they cannot be extruded and do not provide the required mechanical properties. Up to now this has also prohibited the manufacturing of pipes with a small wall thickness of order 1 mm. In addition, Tungsten is brittle, which prohibits its use as a structural component. The technology innovation described here resolves these problems by constructing the tube out of several layers of refractory metal, which may be combined with layers of other material. The layers are joined by gluing, soldering or welding, but only in areas where this is necessary. Tests have shown that such tubes also show a high ductility; thus they are deformed under high load rather than breaking.

Non-fusion Applications

The technology has been tested successfully for application in the Nuclear Fusion domain. Diverters currently use copper tubes that need to be replaced by the new technology, in particular in view of future requirements for fusion power plants. Further application areas are space, such as for electric propulsion components made of tungsten, as well as (test) facilities outside the fusion domain but subject to high temperature and/or pressure regimes. The technology is also applicable to liquid metal transport e.g. use in new solar farms.

Fusion Heritage

The innovative application and production of pipes made of refractory metal foils was developed at the Karlsruhe Institute of Technology (KIT). It was successfully tested and patented. It shows superior performance, i.e. a substantially increased ductility and resistance, when exposed to high temperature and/or pressure compared to conventional metal pipes.

This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 and 2019-2020 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission